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METEOROLOGICAL OFFICE

Climatological Services(Met.O.3.)

CLIMATOLOGICAL MEMORANDUM N°54A

THE CLIMATE OF EDINBURGH

(2ND EDITION)

by J.A. Plant

FOREWORD

The Meteorological Office at 26, Palmerston Place, Edinburgh, and the Glasgow Weather Centre at 118, Waterloo Street, Glasgow, C2 receive an ever increasing number of requests from all sections of the community, especially from members of the building and construction industries, for information about the past weather at places in Scotland.

It is not yet possible to issue precise long range weather forecasts and one can only plan or design well ahead on the basis of past experience i.e. by consulting recorded facts and statistics of past weather of the type contained in this Report, but from these, one can at least set limits and assess the probabilities.

The first Edition of "The Climate of Edinburgh" was compiled in 1965 at the request of the Planning Department of Edinburgh Corporation. This first Report on Edinburgh's climate was followed in late 1967 by a similar but much more detailed Report on "The Climate of Glasgow". Since the publication of the more comprehensive Report on Glasgow's climate, the Meteorological Office has received numerous requests for a 2nd Edition of "The Climate of Edinburgh" similar in general content to "The Climate of Glasgow". Thus, this 2nd Edition of "The Climate of Edinburgh" is an enlarged and more detailed version of the 1st Edition.

There are several innovations in the 2nd Edition including certain data which will be of interest at the tendering or design stages of a building contract in Edinburgh. For example, building contractors will be interested in the figures showing the probable amount of working time during which outdoor work may be hampered or have to cease because of rainfall, low temperatures and high winds. Similarly, engineers concerned with the design and efficiency of heating and air conditioning installations will wish to consult the detailed statistics of temperature and relative humidity. Also published in the Report are expectations of extreme wind speeds for the calculations of wind loadings on buildings, glass specifications etc. Statistics of rainfall amounts and intensities have been included for the guidance of drainage engineers concerned with the design of sewers and culverts etc. and there are many other facts and figures in the 2nd Edition which will be of interest to architects and engineers.

It is hoped that the information contained in this Report will also be of interest to students and the general reader and will meet the needs of members of the building profession who have work to do in or near the capital city.

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EDINBURGH

November 1968

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C O N T E N T S

THE CLIMATE OF EDINBURGH

by J. A. PLANT

In broad terms the climate of Edinburgh is typical of that of the east coast of Scotland. The hours of sunshine are high in relation to the latitude, and the average rainfall is well below the average for the United Kingdom as a whole. The sea breezes which penetrate as far as the city temper the summer maximum temperatures, and the proximity of the North Sea prevents the temperatures from being unduly low in winter when compared with, say, Kent, where very severe spells can result from winds from Central or Northern Europe crossing the Channel without appreciable warming. Perhaps the most unpleasant aspect of the climate is the liability to spells of easterly winds in the spring and early summer. At best, these easterly winds are "raw", and they frequently bring with them the sea fog or very low cloud known as "haar". Most of the city lies open to the winds from south-west through north to south-east, and it might be euphemistically described as well-ventilated.

Within this general framework, however, Edinburgh must be almost unique in the range of local climates within its boundaries. There can be very few cities in which the built-up area rises from sea level to 600 ft. A study of the vegetation in the Royal Botanic Garden and on the foothills of the Pentlands, or a journey from Fairmilehead to Granton on a wintry day will illustrate the effects of this. Some parts of the city which lie in local hollows, or in the shelter of ridges, enjoy relative immunity from the wind, but these same areas tend to be "frost hollows" and they are liable to much lower temperatures in still frosty conditions than are the more exposed parts. For example, the lowest air temperatures ever recorded at Blackford Hill and Turnhouse Airport are 14°F and 1°F respectively. There is a decrease of about 1°F in the mean monthly temperature for every 300 ft increase in altitude, but this figure in itself may appear insignificant. It is the consequent decrease in the number of hours with temperatures above a given value, combined with the increased exposure to the wind, that is important for horticulture, the heating of buildings etc.

The separate aspects of the climate of Edinburgh are discussed in more detail in the following paragraphs under the headings of Rainfall, Temperature, Relative Humidity, Sunshine, Winds, Fog, Snow, Thunderstorms, and Barometric Pressure.

1. RAINFALL

The annual average rainfall over the Edinburgh area (see annual average rainfall map at Figure 1) gradually increases with altitude from the flat coastal stretch along the Forth southwards to the high ground of the Pentland Hills. The average annual rainfall ranges from a value of less than 25 inches per year along the stretch of coast near Musselburgh to over 40 inches in the highest parts of the Pentlands southwest of Glencorse Reservoir. The more densely populated parts of the City have less than $27\frac{1}{2}$ inches per year but some of the suburbs in the higher southern outskirts of the City nearer the Pentlands e.g. Fairmilehead, Colinton and Juniper Green have about 31 inches per year.

Broadly speaking, the average rainfall over most of the drier parts of the City is very similar to that in the London area but considerably less than say Glasgow which has about 40 inches per year.

Rain falls quite frequently in Edinburgh when winds are blowing from the quadrant between south and west but the most prolonged and heaviest downpours usually occur when winds are blowing from an easterly point, particularly from the sector between east-north-east and north-east. These rain bearing easterly winds are associated with depressions, the centres of which have moved eastwards from the Atlantic across the country to the south of Edinburgh and then have become stationary or slow-moving in the North Sea. It is interesting to note that these prolonged heavy rainfalls tend to occur more often in the late summer and early autumn than at any other time of the year, and August, which on average is the wettest month of the year in Edinburgh, usually has the highest frequency of prolonged heavy rainfalls associated with easterly winds.

Monthly and Annual Rainfall Averages for a number of rainfall measuring stations in Edinburgh and the Lothians are given in Tables 1 and 1A.

Cumulative Averages of Daily Rainfall for the Royal Observatory at Blackford

Hill, from which the average rainfall over any particular period of the year can be calculated, are given in Table 1B.

Statistics of Monthly and Annual Rainfalls for Blackford Hill are given in Table 1C.

Cumulative Frequencies of Daily Rainfall for Blackford Hill which show the total number of days in 35 years with specified amounts of rain (i.e. the number of days with 0.5 inches or more, 1 inch or more, 2 inches or more etc.) are given in Table 1D.

Maximum Daily Rainfalls recorded at Blackford Hill are given in Table 1E

The Frequency of Dry Days in Edinburgh

Table 1F gives, for each calendar date, the total number of "dry" days in Edinburgh during the 50 years from 1915 to 1964. These data have been extracted from the daily rainfall records of the Royal Observatory at Blackford Hill and the occasions counted as "dry days" were the dates on which the 24 hour amounts of rainfall (including melted snow), from 0900 hours GMT on one day to 0900 hours GMT on the next day were either 'Nil' or 'less than .005 inches'. It can be seen from Table 1F that over the 50 years considered, the months of May and June had the highest frequencies of dry days and that November, December, January and February had the lowest frequencies.

If running 7-day totals of the figures in Table 1F are prepared, it will be noticed that over the 50 years considered, the 7-day period commencing 28th May had the highest frequency of dry days, viz. 196 dry days out of a maximum possible of 7 days x 50 years = 350 days. The 7-day periods in each month with the highest frequency of dry days over the 50 years were:

7-day period commencing	Total number of Dry Days out of a Possible Total of 350
19th January	160
15th February	175
11th March	187
14th April	178
28th May	196
13th June	185
29th July	179
1st August	165
27th September	174
8th October	157
21st November	164
1st December	146

While the 7-day values quoted above and the daily values in Table 1F do serve to highlight the periods of the year which usually have the highest frequencies of dry days, the generally moderate to low frequencies and the large day to day variations in the number of occasions emphasise the uncertainty and shortcomings of this type of statistic as a guide to the probability of occurrence of a dry day or a dry 7-day period in any particular year in the future. For example, it can be seen from Table 1F that 21st January was dry on 20 occasions in the 50 years while 22nd January was dry on 27 occasions. However, the day to day incidence of dry days and days with rainfall is such that during a future period of 50 years, the position could be reversed with 21st January being drier more often than 22nd January.

Intense Falls of Rain in Short Periods of Time

In general, the more intense the rainfall, the less likely it is to last for a given period of minutes or hours. The probability that rainfall of a certain intensity will last for a certain time is less in Edinburgh than in the upland parts of Scotland and the more thundery areas in central and southwest Scotland. It is appreciably less for the shorter durations than in the south of England and

the Midlands which have a much higher incidence of thunderstorms and thundery downpours than Edinburgh.

Table 1G gives the number of days in each year from 1949 to 1967 with specified amounts of rain falling in specified times at the Meteorological Office at Turnhouse (Edinburgh) Airport. The total numbers of days over the whole period of 19 years are shown at the foot of the Table. Turnhouse Airport is the only location in Edinburgh for which statistics of this type are available but unfortunately, a period of 19 years of recorded rainfall intensities is too short a term from which to obtain a reliable assessment of the long term relationship between intensity and frequency at any individual recording station.

There are very few long period records of rainfall intensities for places in Scotland and therefore drainage engineers make fairly wide use of the Bilham formula (1) for obtaining probabilities of intense falls of rain in short periods of time. Following a recent investigation by D. J. Holland (2) it has become necessary to modify the frequencies obtained from Bilham's formula in respect of intensities greater than 1.25 inches per hour and the figures given in the upper table of Table 1H, which refer to falls with durations of 2 hours or less, are based on Bilham's formula modified where necessary by Holland. However, it can be seen from Table 1I which compares the estimated frequencies obtained from the Bilham formula with observed frequencies obtained from the Turnhouse Airport records that for durations up to about 2 hours, the frequencies obtained from the Bilham formula appear to be too high when related to Edinburgh. Experience suggests that for durations up to about 2 hours, the frequencies obtained from the Bilham formula could be halved when applied to Edinburgh i.e. a return period of "1 day per 5 years" obtained from the upper table of Table 1H would become "1 day per 10 years". Alternatively, for durations up to 2 hours, a 20 per cent reduction could be made to the amounts quoted in the upper table of Table 1H to relate the Bilham intensities to the Edinburgh area.

When studying the comparison of the observed and estimated frequencies given in Table 1I, it should also be noted that for durations of about 4 to 8 hours or

more, the estimated frequencies obtained from the Bilham formula are lower in most cases than the actual frequencies observed at Turnhouse Airport.

So far, the data discussed refer to rainfall at a point, but areal rainfall is required for most design purposes. Because of the variability of intense rain in space and time, the areal rainfall for a given duration and return period is always smaller than the corresponding point rainfall. To obtain areal rainfall, the point rainfall should be multiplied by the appropriate factor in the lower table of Table 1H. These factors were derived from a formula by D. J. Holland, assuming a roughly circular area and a roughly equal contribution to the drainage system from all parts of the area. Advice on how to apply these factors to the more difficult cases can usually be given by the Meteorological Office or the Road Research Laboratory of the Ministry of Transport. The formula is based on results from an experimental raingauge network at Cardington near Bedford (3). A similar experiment in rather more hilly country near Winchcombe in the Cotswolds is still being analysed.

Floods

It has already been stated that Edinburgh has a relatively low frequency of intense rainfalls of short duration and therefore it is hardly surprising that flooding caused by thundery downpours or "cloudbursts" is extremely rare in the city. Indeed, serious flooding from any cause is a rare event in the city especially when Edinburgh is compared with other cities and towns in the valleys of major rivers or cities and towns in the more thundery areas in England where the flooding of low lying stretches of roads, under bridges and viaducts for example, is by no means uncommon.

For most of its length, Edinburgh's river "The Water of Leith" is remarkably well-contained in a steep sided defile and the volume of water in the river is largely governed by the reservoir at the river's source at Harperrig which lies about 13 miles to the west of the city. In a few places where the river is not naturally well-contained e.g. in the Warriston, Canonmills and Murrayfield areas, flooding has occurred on a few occasions in the past. However, certain engineering works at the danger spots along the river appear to have greatly reduced the risk

of flooding and while the level of the water in the river sometimes does give cause for concern, it is perhaps significant that the last case of serious flooding by The Water of Leith occurred in August 1948.

On the few occasions when flooding does occur in the Edinburgh district, the cause is due more often than not, to prolonged rainfall, over many hours, a day, or even a number of days, rather than to intense thundery falls of short duration. For example, the prolonged heavy rainfalls of late summer and autumn sometimes cause widespread flooding of fields and agricultural land in Edinburgh and the Lothians, particularly flat land near the many streams or places near the foot of the numerous slopes.

The flooding which occurred in August 1966 is a case in point. August 1966 was an extremely wet month with a 24 hour rainfall of about 2 inches on 3rd August 1966 and further falls on some of the following days. Only ten days after 3rd August 1966, i.e. on 13th August, a further 24 hour fall of 2 inches could not be absorbed by the already saturated ground and consequently, numerous fields and golf courses in Edinburgh and the surrounding districts were inundated.

Similar flooding occurred as a result of the prolonged rainfall during the first half of May 1968 when a total of 5.33 inches fell at the Royal Observatory at Blackford Hill in the first fourteen days of the month. However, flooding in Edinburgh during May, one of the normally dry spring months, is almost unprecedented and it is worthy of note that May 1968 was the wettest May in Edinburgh for at least 200 years.

The prolonged rainfall during August 1948 caused the most serious floods in living memory in Edinburgh and southeast Scotland but the worst effects of the August 1948 floods were experienced in the Border Counties particularly at places in the valleys of the Tweed and its tributaries.

The daily falls recorded at Blackford Hill during August 1966, August 1948, July 1940, September 1927 and October 1907 are given in Table 1J. These months which all had more than 7 inches of rain, were the five wettest months at Blackford Hill during the 72 years from 1896 to 1967.

Driving Rain

When rain is carried along at an angle to the vertical by the wind, so that it impinges on vertical surfaces, some of it will be absorbed if the surface is porous or driven into cracks between units which are impervious. Damage to buildings, to their decorations and even to their contents from rainwater which is driven on to a wall in this manner is of common occurrence. Not only does the rainwater absorbed by the structure cause direct damage, but also by increasing the thermal conductivity of the materials it tends to lower the temperature at the inner face and so increase the risk of condensation there. Greater heat-losses because of the higher thermal conductivity either reduce the comfort of the occupants or increase costs because the losses must be made good by burning more fuel. Such wind-driven rain is called "driving rain" and it is useful to have some measure of its severity (5).

Driving rain can be represented by an index which is proportional to the product of the wind speed and rainfall amount but there is a marked absence of suitable wind and rainfall data from the districts of Edinburgh which are most prone to driving rain viz. the districts sited on or near the crests of the high ridges which traverse the city, particularly the ridges to the south and west of the city. Owing to the complex topography, the worst winds will vary in direction from place to place depending on the siting of individual buildings and houses and the amount of local shelter.

The Meteorological Office at Turnhouse Airport is the only location in the Edinburgh area for which suitable records of wind speeds and rainfall amounts exist but unfortunately the period of records available from Turnhouse Airport is not yet long enough to permit a detailed analysis. However, an examination of the Turnhouse Airport records shows that the most severe hour of driving rain during the years from 1962 to 1967 was one in which 8.3 millimetres of rain fell in association with an hourly mean wind speed of 23 mph from direction 240 degrees (southwest) between 1300 and 1400 hours Greenwich Mean Time on 21st October 1963. Hourly amounts of from 2 to 2.5 millimetres of rain falling in association with

hourly mean wind speeds of from 25 to 30 mph are fairly common at Turnhouse Airport particularly with winds blowing from the sector between southwest and west. Thus, it would seem desirable to pay special attention to making west-facing walls weather tight, particularly west-facing walls of multi-storey buildings which are more exposed to the wind than their general surroundings. Owing to the shortage of building land in the city, a greal deal of building development is either being carried out or is planned for the high southern and western outskirts of the city and it should be borne very much in mind that many locations to the south and west of Edinburgh are exposed to the full effect of winds from a westerly point.

As mentioned earlier in this Report, the most prolonged and heaviest downpours of rain in Edinburgh are usually associated with easterly winds. Fortunately, easterly winds in Edinburgh are normally much less strong than westerly winds particularly during prolonged and heavy rainfall. Nevertheless, there are occasions when considerable amounts of rain, of the order of 2.5 to 3.0 millimetres in an hour, associated with hourly mean speeds of about 25 mph bring a risk of driving rain from the east, particularly from the sector between northeast and east. The most severe hour of driving rain from an easterly point at Turnhouse Airport during the years from 1962 to 1967 occurred between 1800 and 1900 hours Greenwich Mean Time on 1st September 1963 when an hourly amount of 7.6 millimetres fell in association with an hourly mean speed of 23 mph from direction northeast. Although the frequency of driving rain from an easterly point does not appear to be as high as the frequency of driving rain with westerly winds, the occasions with driving rain from the east tend to be more prolonged. The best example of this in recent years occurred during the period between about 1000 and 2100 hours GMT on 10th November 1963 and the hourly durations and amounts of rainfall together with the associated hourly mean wind directions and speeds recorded at Turnhouse Airport during this period are given below.

Date: 10th November 1963

Hour (G.M.T.)	Hourly Duration of Rainfall (minutes)	Hourly Amount of Rainfall (millimetres)	Hourly Mean Wind Direction	Hourly Mean Wind Speed (m.p.h.
Between 1000 and 1100 hours	60	1.7	East-North-East	25
Between 1100 and 1200 hours	60	3.1	East-North-East	28
Between 1200 and 1300 hours	60	3.1	East-North-East	27
Between 1300 and 1400 hours	60	1.6	East	25
Between 1400 and 1500 hours	60	2.8	East	25
Between 1500 and 1600 hours	60	3.3	East-North-East	24
Between 1600 and 1700 hours	60	2.9	East-North-East	27
Between 1700 and 1800 hours	60	1.8	East-North-East	28
Between 1800 and 1900 hours	60	1.7	East-North-East	25
Between 1900 and 2000 hours	60	3.9	East-North-East	27
Between 2000 and 2100 hours	60	1.8	East-North-East	22
Between 2100 and 2200 hours	60	2.9	East-North-East	13

Many districts of Edinburgh are sheltered by high ground, trees or buildings to strong winds from the sector between northeast and east but this is not generally true of multi-storey buildings, places on east-facing ridges or locations on the eastern fringe of the built-up area. Thus, the greatest threat of driving rain to buildings well exposed to the east but relatively sheltered to the west could be to their east-facing walls.

Rain as a Factor interrupting Outdoor Building Work in Edinburgh

Tables 1K to 1M give frequencies of rain falling in the working part of the day which may be helpful in assessing the probable amount of time during which rainfall may hamper or interrupt outdoor building work in the Edinburgh area. These Tables have been prepared from hourly measurements of rainfall recorded at Turnhouse Airport during the 10 years from 1958 to 1967.

Builders will need no reminding of the many complex factors which need to be taken into account in trying to assess the probable amount of working time which might be lost because of inclement weather, particularly the time lost because of rainfall. Many of the factors involved are not entirely "meteorological", e.g. a heavy downpour of rain at the excavation stage could have very serious consequences

and similarly, a fall of rain wetting the ground of a building site could preclude the use of heavy vehicles and earth-moving operations. Then there are the questions whether protective clothing is to be issued, whether the men can be transferred to work at another site, whether the men are to be paid a bonus or not, the tenancity of the foreman etc.

The meteorological factors involved are probably equally complex but experience suggests that as far as rainfall is concerned, building contractors' main interest lies in the number of working days and working hours with (a) rainfall equal to or exceeding 0.1 millimetres per hour and (b) rainfall equal to or exceeding 0.5 millimetres per hour.

As intensities of rainfall are critical to the problem, this would seem to be an appropriate point at which to quote the Meteorological Office classifications of "slight", "moderate" and "heavy" rainfall. The following classifications have been taken from the Meteorological Office Observer's Handbook (H.M.S.O.):

(a) Slight Rain is rain of low intensity, that is to say the rate of accumulation on the ground or in a raingauge is slow, not more than about 0.5 millimetres (0.02 inches) per hour. Such rain may consist of scattered large drops or more numerous small drops.

(b) Moderate Rain is rain falling fast enough to form puddles rapidly and to accumulate in a raingauge at a rate between about 0.5 and 4.0 millimetres (0.02 to 0.16 inches) per hour.

(c) Heavy Rain is a downpour which makes a roaring noise on roofs, forms a misty spray of fine droplets by splashing on road surfaces etc. and accumulates in a raingauge at a rate of more than about 4 millimetres (0.16 inches) per hour. The term includes not only the torrential rain of thunderstorms but also the heavier falls occurring without thunder.

Table 1K gives the total number of days per month during the 10 years from 1958 to 1967 on which 0.1 millimetres or more of rain fell during the working part of the day i.e. between 0700 and 1700 hours Greenwich Mean Time (0800 and 1800 hours British Standard Time). Similarly, Table 1K also gives for the same ten

year period, the total number of hours per month between 0700 and 1700 hours GMT with a total of 0.1 millimetres or more of rain falling within the hour. Days and hours with only a few spots of rain amounting to less than .05 millimetres have not been included in Table 1K but otherwise the reader will realise from what has already been said that days and hours with rain of 0.1 millimetres or more include all occasions of "slight", "moderate" and "heavy" rain. However, it should be borne in mind that amounts of the order of 0.1 millimetres are very small amounts of rain and that the totals in Table 1K therefore include many working days and many working hours with very slight rain i.e. rain so slight that most types of outdoor work would not be affected.

It is, of course, extremely difficult to decide on a critical rate of rainfall above which outdoor work would be seriously hampered or have to cease, because, as stated previously, this will depend to a great extent on the type of work, whether the building site is an exposed place and other factors. There is practically no experimental evidence on this subject but in consultation with the Building Research Station, Ministry of Public Building and Works, it has been decided that the lower limit of precipitation (rain, drizzle, snow etc.) contributing to time lost in the building industry should be set at a rate of 0.5 millimetres or more per hour. The reader will notice that this critical rate of 0.5 millimetres or more per hour corresponds to the lower limit of the Meteorological Office classification of 'moderate' rainfall i.e. rain falling fast enough to form puddles rapidly. Thus, occasions with rain falling at a rate of 0.5 millimetres or more per hour can be thought of more simply as occasions with 'moderate' or 'heavy' rain.

Table 1L gives the total <u>duration</u> in hours and tenths of rain falling at a rate of 0.5 mm/hr or more (i.e. the total duration of 'moderate' or 'heavy' rain) between the hours of 0700 and 1700 GMT during the 10 years from 1958 to 1967. The monthly totals quoted in Table 1L have been obtained by adding up the duration of rain falling at a rate of 0.5 mm/hr or more in each hour between 0700 and 1700 hours on each day of the month. For example, rain falling at a rate of 0.5 mm/hr or more

for 18 minutes during one hour would contribute a value of 0.3 hours to the total duration. Perhaps it should be emphasised at this point that the actual amount of working time lost on a day with rain will seldom keep in step with the duration of moderate or heavy rain on that day. For example, if moderate or heavy rain fell continuously for a period of say 30 minutes during part of the working day, the working time lost from the cessation to the resumption of work would almost certainly be considerably more than 30 minutes. It should also be borne in mind that, more often than not, a period of 'moderate' or 'heavy' rain is also preceded or followed by a period of 'slight' rain. Consider, for instance, a single working day of ten hours between 0700 and 1700 GMT with intermittent rain, most of it quite slight but increasing to the critical rate of 0.5 mm/hr (i.e. becoming moderate or heavy) for say a period of 12 minutes in each of the ten hours. The total duration of rain falling at a rate of 0.5 mm/hr throughout the whole ten hour period would be 10 times 12 minutes (or 10 times 0.2 hours) = 2 hours, whereas the actual amount of working time lost on this particular day might well be the whole period of ten hours.

Thus, it should be realised, that in the majority of cases, the duration figures quoted in Table 1L underestimate, perhaps grossly underestimate, the probable amount of time which would be lost on outdoor work in Edinburgh. However, the duration figures in Table 1L are useful in that they serve as an indication of the extreme lower limit of the working time likely to be lost because of rain.

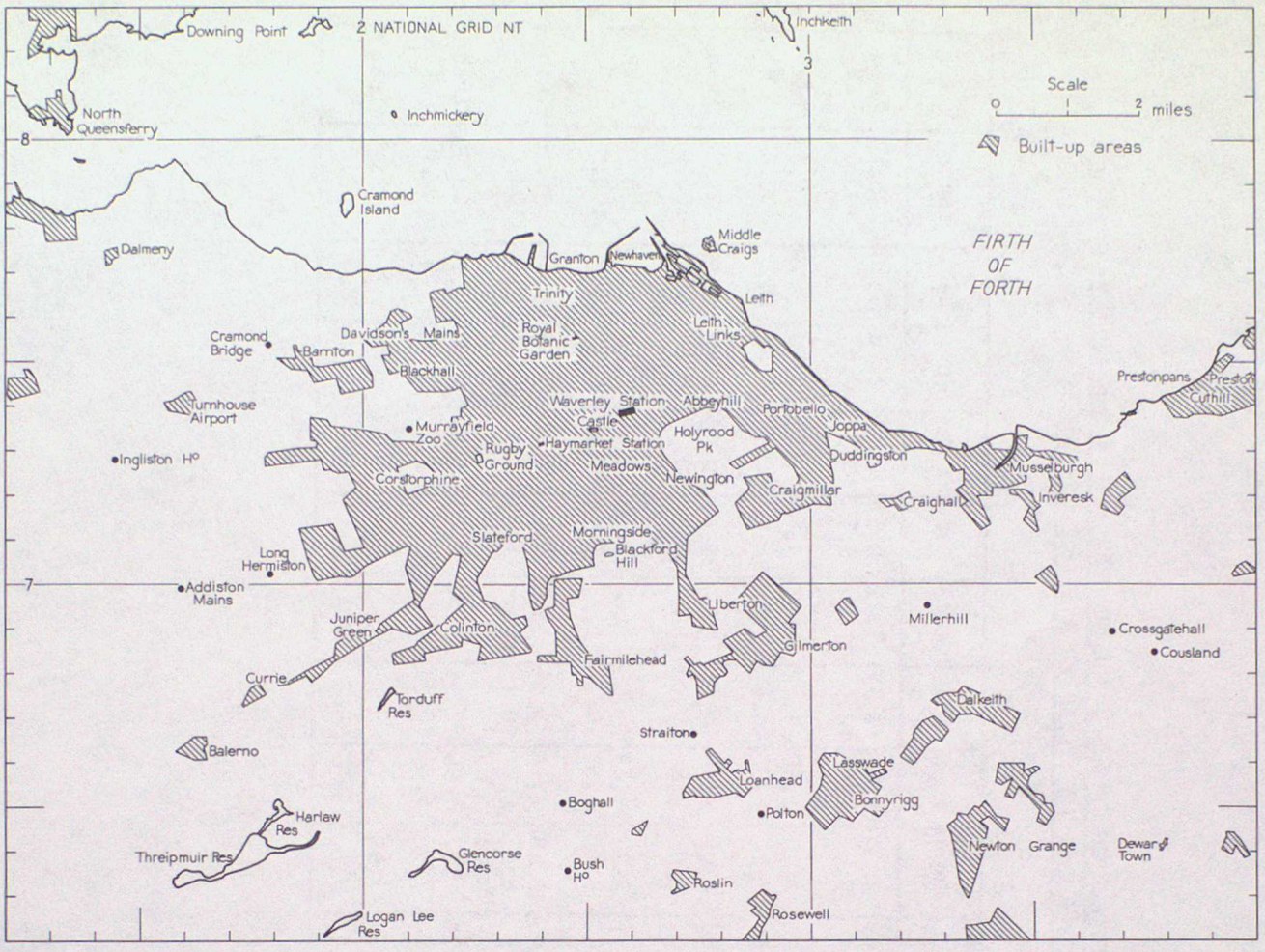
A more satisfactory alternative to the figures in Table 1L showing the durations of moderate or heavy rain are figures showing the number of hours during which moderate or heavy rain fell for some time during the hour. Table 1M provides this type of information and comprises the total number of days per month over the 10 years from 1958 to 1967 on which moderate or heavy rain fell at some time during the working day from 0700 to 1700 hours Greenwich Mean Time. Similarly, this Table also gives the total number of "hours" per month between 0700 and 1700 hours GMT in which moderate or heavy rain fell at some time during the hour. The figures in Table 1M will tend to overestimate the actual time lost on outdoor work because of rain, although the reader will appreciate from what has been said earlier that these

figures will undoubtedly provide a safer and perhaps more realistic guide for planning purposes than the figures giving the actual durations of moderate or heavy rain.

Polythene shelters to cover the building site, or part of the site, obviate loss of working time due to inclement weather, and a study of the data in Tables 1K to 1M with a possible interpolation between the three sets of figures, may help building contractors to decide for particular jobs whether it is an economic proposition to use these shelters. On the other hand, perhaps it should be stressed that while the figures in Tables 1K to 1M provide a guide to the duration of rainfall falling during the working part of the day, the figures do not provide a guide to the duration of the effects of the rain. For example, a localised heavy downpour of rain of short duration in Edinburgh could flood a building site (especially at the excavation stage) bringing work to a standstill for several days, but such a downpour might only contribute a value of say one or two extra hours with moderate or heavy rain. Clearly, a heavy downpour of rain falling outside the ten hour period from 0700 to 1700 hours could bring about a similar stoppage.

When consulting Tables 1K to 1M it should be borne in mind that the figures relate to a 7-day working week and not to a 5-day working week.

A table for converting amounts of rainfall in millimetres into amounts in inches is given at Table 1N.



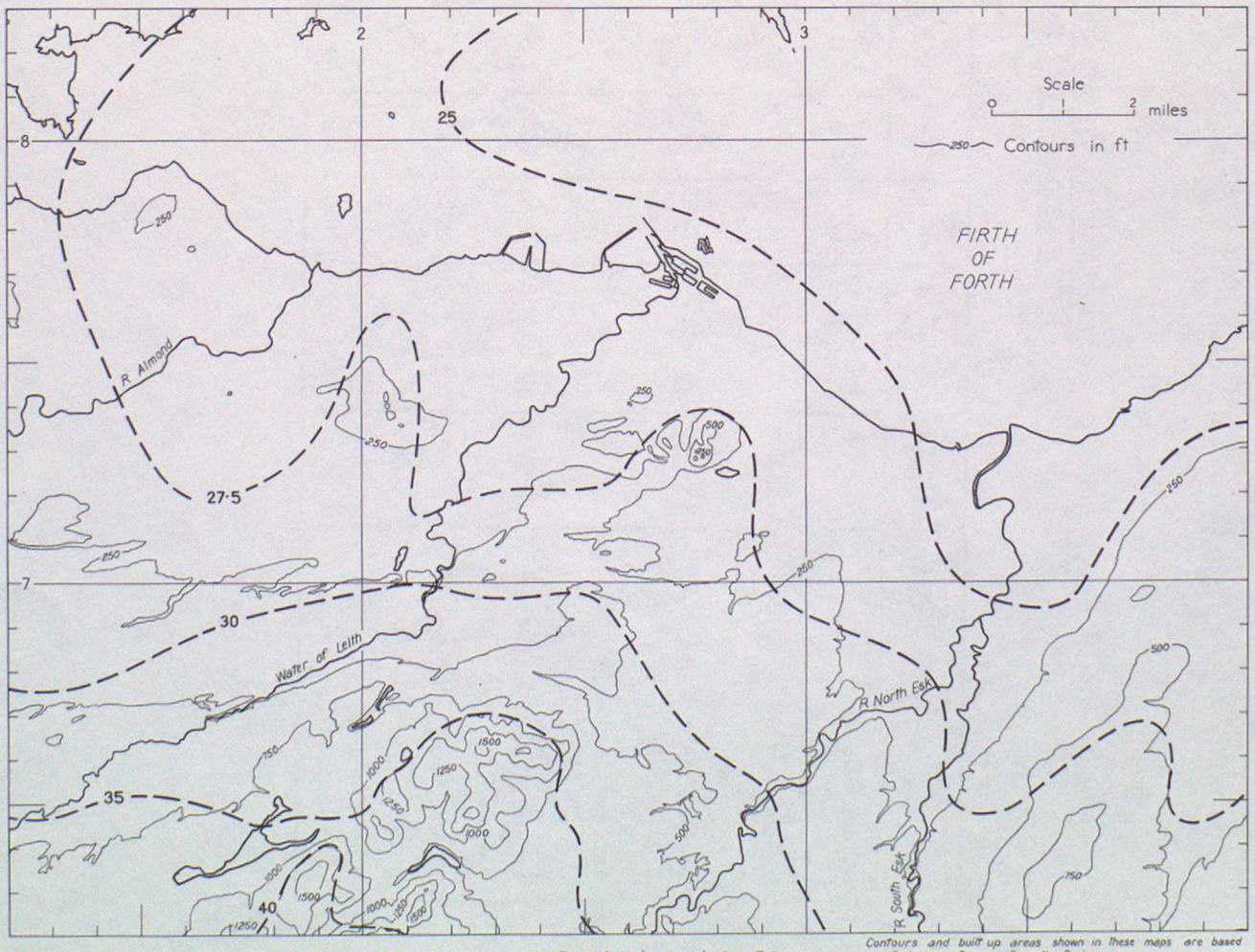


Fig 1. Average Annual Rainfall (inches) 1916-50

Contours and built up areas shown in these maps are based on Ordnance Survey Seventh Series.

Table 1 MONTHLY AND ANNUAL AVERAGES OF RAINFALL IN INCHES FOR LONG TERM RAINFALL MEASURING STATIONS IN THE EDINBURGH AREA (35 YEARS FROM 1916 TO 1950)

Station	Height (feet)	N.G.R.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
Dalmeny House	20	NT 163779	2.55 9.0	1.74 6.2	1.70 6.0	1.66 5.9	2.20 7.8	1.99 7.1	2.97 10.5	3.24 11.5	2.67 9.5	2.89 10.3	2.48 8.8	2.10 7.4	28.19 100.0	Inch %
Harperrig	900	NT 102613	4.17 10.3	2.90 7.1	2.70 6.6	2.63 6.5	2.90 7.1	2.58 6.3	3.42 8.4	4.03 9.9	3.60 8.9	4.18 10.3	3.80 9.4	3.72 9.2	40.63 100.0	Inch %
Royal Observatory, Blackford Hill	441	NT 259706	2.45 8.9	1.68 6.1	1.60 5.8	1.62 5.9	2.21 8.0	1.88 6.8	3.03 11.0	3.15 11.4	2.55 9.3	2.83 10.3	2.42 8.8	2.11 7.7	27.53 100.0	Inch %
Astley Ainslie Hospital, Morningside	270	NT 251713	2.56 9.0	1.76 6.2	1.75 6.1	1.71 6.0	2.27 8.0	1.87 6.5	3.05 10.7	3.24 11.3	2.60 9.1	2.98 10.4	2.47 8.7	2.27 8.0	28.53 100.0	Inch %
Fairmilehead Waterworks	590	NT 249683	2.84 9.1	2.01 6.5	1.91 6.1	1.96 6.3	2.48 8.0	2.15 6.9	3.15 10.1	3.40 10.9	2.91 9.3	3.16 10.1	2.78 8.9	2.43 7.8	31.18 100.0	Inch %
Alnwick Hill, Liberton	407	NT 273690	2.77 9.6	1.83 6.4	1.78 6.2	1.73 6.0	2.27 7.9	1.94 6.8	2.96 10.3	3.06 10.6	2.65 9.2	2.94 10.2	2.58 9.0	2.24 7.8	28.75 100.0	Inch %
Glen Cottage, Glencorse Reservoir	739	NT 223635	3.73 9.8	2.63 6.9	2.44 6.4	2.54 6.7	2.77 7.3	2.42 6.3	3.62 9.5	3.92 10.3	3.46 9.1	3.83 10.0	3.57 9.4	3.19 8.3	38.12 100.0	Inch %

Table 1A MONTHLY AND ANNUAL AVERAGES OF RAINFALL IN INCHES ESTIMATED FOR SHORT TERM RAINFALL MEASURING STATIONS IN THE EDINBURGH AREA (35 YEARS FROM 1916 TO 1950)

Station	Height (feet)	N.G.R.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year (inches)
Davidson's Mains	200	NT 199757	2.53	1.83	1.63	1.66	2.25	2.00	2.93	3.14	2.62	2.90	2.45	2.19	28.13
Turnhouse Airport	114	NT 159739	2.43	1.65	1.56	1.59	2.16	1.86	2.91	3.10	2.54	2.78	2.37	2.02	26.97
East Craigs, Corstorphine	200	NT 183735	2.50	1.68	1.60	1.62	2.17	1.92	2.95	3.17	2.59	2.83	2.42	2.06	27.51
Clubbiedean Reservoir, Torphin	773	NT 203670	3.06	2.16	1.96	1.96	2.45	2.16	3.28	3.38	2.99	3.31	2.86	2.61	32.18
Firrhill	412	NT 226699	2.70	1.97	1.76	1.79	2.29	2.03	2.97	3.21	2.76	3.00	2.59	2.32	29.39
Craiglockhart Avenue, Craiglockhart	295	NT 224705	2.81	2.05	1.83	1.86	2.38	2.11	3.09	3.34	2.86	3.11	2.70	2.41	30.59
The Inch, Liberton	150	NT 277708	2.72	1.89	1.77	1.77	2.36	2.04	3.04	3.26	2.75	3.04	2.60	2.30	29.54
Liberton	190	NT 273705	2.62	1.82	1.71	1.71	2.28	1.97	2.94	3.14	2.65	2.94	2.51	2.22	28.51
Fountainhall Road, Grange	225	NT 262715	2.59	1.79	1.68	1.71	2.28	1.96	2.93	3.11	2.67	2.90	2.50	2.33	28.45
Royal Botanic Garden, Inverleith	74	NT 247756	2.38	1.71	1.55	1.57	2.19	1.90	2.75	2.96	2.52	2.75	2.35	2.08	26.71
Milton Road West, Portobello	100	NT 302728	2.40	1.68	1.57	1.57	2.16	1.90	2.78	3.04	2.48	2.75	2.32	2.06	26.71
Midcalder	400	NT 053676	3.37	2.25	2.09	2.02	2.42	2.12	3.15	3.21	3.08	3.40	3.05	2.95	33.11
Balerno	700	NT 147651	3.67	2.49	2.30	2.30	2.74	2.37	3.63	3.71	3.45	3.83	3.37	3.23	37.09
Bush House, Milton Bridge	605	NT 244636	3.35	2.35	2.28	2.25	2.71	2.39	3.57	3.78	3.28	3.67	3.17	2.85	35.65
Penicuik	620	NT 233599	3.66	2.57	2.35	2.20	2.76	2.46	3.62	3.78	3.40	3.84	3.40	3.28	37.32
Gorebridge	560	NT 344618	2.86	2.05	1.90	1.93	2.32	1.93	2.98	3.12	2.71	3.07	2.77	2.47	30.11
Newbattle	300	NT 337649	2.56	1.81	1.71	1.71	2.15	1.84	2.81	2.96	2.47	2.83	2.45	2.20	27.50

TABLE 1B

CUMULATIVE MEAN DAILY RAINFALL, IN INCHES, 35 YEARS FROM 1916 TO 1950
ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	.14	2.52	4.18	5.78	7.38	9.65	11.51	14.55	17.73	20.28	23.07	25.49
2	.23	2.59	4.21	5.83	7.41	9.73	11.60	14.61	17.81	20.37	23.19	25.58
3	.31	2.66	4.26	5.88	7.45	9.81	11.67	14.64	17.89	20.46	23.29	25.64
4	.42	2.73	4.31	5.92	7.59	9.88	11.85	14.69	17.97	20.54	23.39	25.69
5	.46	2.79	4.40	5.96	7.70	9.95	11.93	14.73	18.01	20.67	23.49	25.76
6	.54	2.85	4.43	5.99	7.78	10.03	12.05	14.87	18.09	20.76	23.59	25.82
7	.64	2.91	4.46	6.06	7.85	10.08	12.23	15.03	18.18	20.86	23.70	25.87
8	.70	2.99	4.50	6.10	7.92	10.14	12.31	15.19	18.22	20.98	23.77	25.93
9	.79	3.05	4.55	6.15	7.96	10.21	12.44	15.26	18.34	21.10	23.85	26.01
10	.87	3.11	4.58	6.20	8.00	10.28	12.55	15.32	18.39	21.21	23.90	26.06
11	.94	3.16	4.64	6.27	8.07	10.33	12.65	15.38	18.47	21.26	23.98	26.14
12	.99	3.19	4.69	6.32	8.13	10.39	12.69	15.57	18.53	21.33	24.06	26.19
13	1.07	3.22	4.74	6.36	8.21	10.45	12.88	15.64	18.63	21.40	24.13	26.26
14	1.16	3.29	4.77	6.43	8.26	10.54	12.95	15.81	18.71	21.43	24.22	26.31
15	1.22	3.37	4.81	6.48	8.37	10.59	13.03	15.92	18.79	21.47	24.30	26.36
16	1.30	3.40	4.91	6.54	8.40	10.63	13.15	16.02	18.91	21.53	24.37	26.43
17	1.38	3.43	4.96	6.62	8.50	10.68	13.32	16.23	19.04	21.64	24.49	26.48
18	1.46	3.51	5.02	6.66	8.56	10.74	13.44	16.33	19.13	21.72	24.60	26.50
19	1.53	3.57	5.07	6.72	8.59	10.78	13.53	16.43	19.28	21.76	24.66	26.59
20	1.61	3.63	5.12	6.77	8.68	10.84	13.60	16.59	19.39	21.84	24.71	26.68
21	1.70	3.68	5.17	6.83	8.76	10.93	13.68	16.68	19.49	21.97	24.78	26.76
22	1.76	3.74	5.21	6.91	8.87	11.02	13.72	16.74	19.62	22.08	24.83	26.83
23	1.85	3.78	5.26	6.98	8.94	11.06	13.76	16.80	19.66	22.25	24.92	26.87
24	1.93	3.81	5.28	7.04	9.02	11.12	13.81	16.90	19.75	22.35	24.97	26.93
25	2.01	3.85	5.34	7.09	9.08	11.17	13.86	17.00	19.81	22.50	25.06	27.04
26	2.07	3.93	5.39	7.14	9.15	11.21	13.95	17.10	19.89	22.58	25.13	27.11
27	2.12	4.00	5.45	7.20	9.23	11.29	14.12	17.21	19.97	22.64	25.16	27.16
28	2.21	4.05	5.52	7.26	9.34	11.35	14.24	17.35	20.07	22.72	25.28	27.25
29	2.30	4.13	5.59	7.31	9.38	11.41	14.33	17.48	20.10	22.83	25.34	27.38
30	2.34		5.66	7.35	9.48	11.44	14.40	17.56	20.17	22.92	25.42	27.47
31	2.45		5.73		9.56		14.47	17.62		23.00		27.53

Note: The entry opposite any particular date is the mean rainfall from January 1st to that date. The mean rainfall for any period of the year can be obtained from the table by subtracting the cumulative total at the beginning of the required period from the corresponding total at the end of the required period.

TABLE 1C

STATISTICS OF MONTHLY AND ANNUAL RAINFALLS FOR THE ROYAL OBSERVATORY BLACKFORD HILL, EDINBURGH
(PERIOD OF RECORD - 72 YEARS FROM 1896 TO 1967)

Statistics of Monthly Rainfalls

Month	Highest Rainfall	Rainfall Seldom* Above	Median†	Rainfall Seldom* Below	Lowest Rainfall
January	5.27 inches in January 1948	2.91 inches	2.11 inches	1.26 inches	0.32 inches in January 1953
February	3.99 inches in February 1903	2.42 inches	1.50 inches	0.73 inches	0.09 inches in February 1934
March	4.20 inches in March 1909	2.41 inches	1.52 inches	0.87 inches	0.20 inches in March 1929
April	4.07 inches in April 1934	2.10 inches	1.49 inches	0.96 inches	0.15 inches in April 1938
May	4.53 inches in May 1906	2.93 inches	1.71 inches	1.20 inches	0.14 inches in May 1959
June	5.18 inches in June 1928	2.65 inches	1.70 inches	1.00 inches	0.34 inches in June 1962
July	8.26 inches in July 1940	3.88 inches	2.55 inches	1.64 inches	0.46 inches in July 1913
August	9.40 inches in August 1948	4.81 inches	3.15 inches	1.47 inches	0.19 inches in August 1947
September	7.91 inches in September 1927	3.09 inches	1.97 inches	1.26 inches	0.35 inches in September 1929
October	7.90 inches in October 1907	3.76 inches	2.36 inches	1.39 inches	0.52 inches in October 1951
November	6.96 inches in November 1963	3.60 inches	2.10 inches	1.04 inches	0.24 inches in November 1937
December	4.80 inches in December 1932	3.09 inches	2.19 inches	1.19 inches	0.23 inches in December 1908

Statistics of Annual Rainfalls

Period of record	Highest Annual Rainfall	Annual Rainfall Seldom* Above	Median†	Annual Rainfall Seldom* Below	Lowest Annual Rainfall
72 years	39.00 inches in 1916	30.52 inches	25.88 inches	22.54 inches	16.44 inches in 1902

*Seldom = 20 per cent of occasions or one year in 5; the figures given are the upper and lower quintiles.

†Median = the "middle" value i.e. half the rainfalls exceed it and half fall below it.

N.B. The highest May rainfall during the years from 1896 to 1967 of 4.53 inches in May 1906 was exceeded in May 1968 when a monthly total of 5.77 inches was recorded at the Royal Observatory, Blackford Hill. Even more noteworthy is the fact that 5.33 inches fell at the Royal Observatory during the first fourteen days of May 1968.

TABLE 1D

CUMULATIVE FREQUENCIES OF DAILY RAINFALLS IN INCHES WITH EQUIVALENTS IN MILLIMETRES AT THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH (35 YEARS FROM 1933 TO 1967)

Daily Totals (inches)	(mm)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	All Months
2.80	71.1								1					1
2.70	68.5								1					1
2.60	66.0								1					1
2.50	63.4								1					1
2.40	60.9								1					1
2.30	58.4								2					2
2.20	55.8								2					2
2.10	53.3								4					4
2.00	50.7								4					4
1.90	48.2								5	1				6
1.80	45.7							1	5	1				7
1.70	43.1							2	5	1				8
1.60	40.6	1						5	6	2		1	1	16
1.50	38.0	1				1		6	9	2	2	2	1	24
1.40	35.5	1				1		8	11	2	2	2	1	28
1.30	33.0	1				2		10	12	2	2	3	1	33
1.20	30.4	1			2	3		13	15	6	3	3	1	47
1.10	27.9	1	1	1	2	4	1	16	15	7	4	3	1	56
1.00	25.4	1	1	1	3	5	1	21	18	8	4	4	1	68
0.90	22.8	3	1	1	4	8	2	26	21	10	6	6	2	90
0.80	20.3	3	1	1	5	12	4	29	26	13	10	14	5	123
0.70	17.7	8	4	3	9	18	6	33	30	15	14	18	9	167
0.60	15.2	16	6	9	11	22	13	42	40	18	28	22	12	239
0.50	12.6	29	8	17	17	28	18	62	55	27	37	33	16	347
0.40	10.1	42	19	27	20	43	37	78	73	46	63	53	29	530
0.30	7.6	63	37	44	40	66	65	108	103	78	84	84	57	829
0.20	5.0	127	72	89	83	107	113	166	159	130	134	135	115	1430
0.10	2.5	235	179	149	170	203	191	263	268	238	245	254	241	2636
.04	1.0	385	323	289	304	333	319	384	396	375	391	399	391	4289
.005	0.16	581	523	504	503	507	516	550	575	562	578	595	604	6598
* ≤.004	* ≤0.15	504	465	581	547	578	534	535	510	488	507	455	481	6185
Total Number of Days in 35 years		1085	988	1085	1050	1085	1050	1085	1085	1050	1085	1050	1085	12783

*Including days with no rain.

Example: In the 35 Januarys during the years from 1933 to 1967, there was a total of 63 days with 24 hour rainfall amounts of 0.30 inches or more (7.6 millimetres or more).

Note: The contents of the raingauge at the Royal Observatory, Blackford Hill, Edinburgh, are emptied and measured once-daily at 09h. Greenwich Mean Time (10 am British Standard Time) to obtain the 24 hour amount of precipitation collected in the gauge since the measurement made at 09h on the previous day. When the gauge contains solid precipitation in the form of hail or snow, the contents are melted by warming to give the equivalent amount of rain water. The above table has been calculated from records of the 24 hour (09h on one day to 09h on the next day) measurements made during the 35 year period from 1933 to 1967.

TABLE 1E

MAXIMUM DAILY RAINFALLS IN INCHES AT THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH DURING THE 72 YEARS FROM 1896 to 1967

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Maximum Daily* Fall	1.65	1.43	1.24	1.29	1.54	1.32	2.68	3.00	2.08	3.13	1.63	1.67
Year of Occurrence	1942	1903	1925	1934	1938	1931	1916	1920	1927	1907	1962	1953

*24 hours from 09h GMT on one day to 09h GMT on the next day.

Example:

The maximum daily fall of 1.65 inches which occurred in January 1942 is the highest daily fall recorded at Blackford Hill in any January during the years from 1896 to 1967.

TABLE 1F

TOTAL NUMBER OF "DRY" DAYS DURING THE PERIOD OF 50 YEARS FROM 1915 TO 1964 AT THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH

("Dry" = 24 hour rainfall amount of 'Nil' or less than .005 inches)

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1st	21	13	24	27	27	25	26	23	19	25	14	23	
2nd	18	18	25	21	29	27	27	21	23	21	10	21	
3rd	16	15	24	25	27	29	21	31	17	24	16	26	
4th	21	21	19	20	24	26	18	27	23	21	19	22	
5th	23	19	20	23	21	26	26	21	24	21	16	20	
6th	17	17	24	23	18	23	20	19	23	20	19	19	
7th	21	15	27	27	21	21	21	23	23	22	21	15	
8th	16	18	20	26	24	25	29	15	20	25	15	17	
9th	19	17	19	25	27	24	24	16	25	18	17	19	
10th	19	24	21	26	28	25	19	21	23	21	16	21	
11th	21	18	27	19	19	27	24	21	20	26	16	21	
12th	21	25	30	25	22	22	20	18	21	24	18	16	
13th	22	25	26	22	19	29	16	19	16	15	22	16	
14th	18	22	29	30	23	27	24	23	23	28	22	16	
15th	22	25	29	25	25	22	20	17	25	21	19	21	
16th	22	25	21	21	24	27	24	19	22	19	24	20	
17th	19	26	25	26	26	28	23	15	21	20	24	23	
18th	21	26	23	28	24	26	14	21	23	22	20	20	
19th	20	25	20	25	25	26	22	17	16	23	20	13	
20th	21	24	17	23	23	26	23	20	23	21	18	20	
21st	20	24	17	19	24	21	25	19	22	20	26	19	
22nd	27	23	25	23	26	24	19	23	27	18	24	21	
23rd	25	22	25	20	23	31	23	23	18	19	22	24	
24th	25	19	30	25	24	27	29	22	19	20	22	23	
25th	22	21	26	18	25	26	25	25	22	22	23	21	
26th	19	22	24	17	22	23	25	21	19	26	23	16	
27th	18	18	26	22	27	20	20	25	29	16	24	21	
28th	18	24	24	24	30	29	21	19	28	19	20	15	
29th	18	7*	17	25	30	28	22	22	24	16	18	14	
30th	13		17	19	29	25	25	27	23	19	15	19	
31st	19		23		26		30	24		16		24	
Totals	622	598	724	699	762	765	705	657	661	648	583	606	8030
Total ÷ 50	12.4	12.0	14.5	14.0	15.2	15.3	14.1	13.1	13.2	13.0	11.7	12.1	
Date in each month which was dry on most occasions	22nd	17th) 18th)	12th) 24th)	14th	28th) 29th)	23rd	31st	3rd	27th	14th	21st	3rd	

*7 occasions on 29th February in 13 leap years.

Example: 1st January was dry on 21 occasions in the 50 years from 1915 to 1964.

TABLE 1G

INTENSITIES OF RAINFALL RECORDED AT TURNHOUSE (EDINBURGH) AIRPORT

Number of Days with Specified Amounts of Rain falling in specified times (19 years from 1949 to 1967)

Year	Amount of 5 mm (0.2 inch) falling within			Amount of 10 mm (0.4 inch) falling within				Amount of 15 mm (0.6 inch) falling within					Amount of 20 mm (0.8 inch) falling within					Amount of 25 mm (1.0 inch) falling within				
	5 mins	10 mins	15 mins	5 mins	15 mins	30 mins	1 hr.	15 mins	30 mins	1 hr.	2 hrs.	4 hrs.	30 mins	1 hr.	2 hrs.	4 hrs.	8 hrs.	1 hr.	2 hrs.	4 hrs.	8 hrs.	16 hrs.
1949	-	-	-	0	0	0	2	0	0	0	1	3	0	0	1	2	4	0	0	2	3	5
1950	-	-	-	0	0	0	1	0	0	0	1	3	0	0	0	0	1	0	0	0	1	3
1951	-	-	-	0	0	0	1	0	0	0	2	5	0	0	1	2	4	0	0	1	3	3
1952	-	-	-	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1
1953	-	-	-	0	1	1	1	0	0	0	1	2	0	0	0	0	1	0	0	0	1	1
1954	-	-	-	0	0	0	1	0	0	0	1	2	0	0	0	1	3	0	0	0	2	2
1955	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1956	0	2	2	0	0	0	1	0	0	0	0	4	0	0	0	0	3	0	0	0	0	3
1957	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0	0	1	3
1958	2	3	5	0	0	1	1	0	0	1	1	2	0	0	1	1	2	0	0	1	2	2
1959	0	1	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1
1961	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0	0	0	2	2
1962	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	4	0	0	0	2	2
1963	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	1	0	0	1	1	0	0	1	1	3	0	0	0	0	1	0	0	0	0	0
1966	2	3	4	0	1	2	3	0	1	1	1	3	0	0	0	0	3	0	0	0	2	2
1967	0	0	1	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Total	4	9	15	0	2	7	14	0	1	3	10	37	0	0	3	11	35	0	0	4	20	33
Number of Years of record	12	12	12	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19

Note: Records of amounts of 5 millimetres (0.2 inch) falling within 5 minutes, 10 minutes and 15 minutes are not available from Turnhouse Airport for the years before 1956.

TABLE 1H

MAXIMUM RAINFALL IN INCHES FROM MODIFIED BILHAM FORMULA

Duration (minutes)	Return Period (years)						
	1 day per Annum	1 day per 2 years	1 day per 5 years	1 day per 10 years	1 day per 20 years	1 day per 50 years	1 day per 100 years
2 minutes or less	0.09	0.11	0.14	0.16	0.19	0.22	0.24
4 minutes or less	0.15	0.18	0.23	0.27	0.31	0.36	0.40
6 minutes or less	0.18	0.23	0.30	0.35	0.40	0.48	0.54
8 minutes or less	0.21	0.27	0.35	0.41	0.48	0.58	0.65
10 minutes or less	0.24	0.30	0.39	0.47	0.55	0.66	0.75
15 minutes or less	0.28	0.36	0.48	0.58	0.68	0.83	0.96
20 minutes or less	0.31	0.40	0.54	0.66	0.79	0.97	1.12
25 minutes or less	0.34	0.43	0.58	0.72	0.87	1.09	1.27
30 minutes or less	0.36	0.46	0.62	0.77	0.94	1.18	1.39
40 minutes or less	0.40	0.50	0.68	0.85	1.05	1.34	1.59
50 minutes or less	0.43	0.54	0.73	0.91	1.13	1.46	1.75
60 minutes or less	0.46	0.58	0.78	0.96	1.19	1.56	1.88
90 minutes or less	0.52	0.66	0.88	1.09	1.35	1.78	2.18
120 minutes or less	0.58	0.72	0.96	1.19	1.47	1.94	2.38

Example: The maximum rainfall in 60 minutes or less on one day in 50 years = 1.56 inches

FACTORS FOR CONVERTING POINT RAINFALLS INTO AREAL RAINFALLS

Area (acres)	Duration (minutes)						
	2	6	10	15	30	60	120
100	0.94	0.95	0.96	-	-	-	-
150	0.92	0.94	0.95	0.95	0.96	-	-
200	0.91	0.93	0.94	0.94	0.95	0.95	0.96
300	0.89	0.91	0.92	0.93	0.94	0.94	0.95
500	0.86	0.89	0.90	0.91	0.92	0.92	0.93
700	0.83	0.87	0.88	0.89	0.90	0.91	0.92
1000	0.80	0.85	0.86	0.87	0.88	0.89	0.90
1500	0.75	0.81	0.83	0.84	0.86	0.87	0.88
2000	-	-	0.80	0.82	0.83	0.85	0.86
3000	-	-	-	0.78	0.80	0.82	0.83
5000	-	-	-	-	0.74	0.76	0.77
7000	-	-	-	-	-	0.72	0.73

TABLE 1I

COMPARISON OF OBSERVED AND ESTIMATED INTENSITIES OF RAINFALL FOR THE EDINBURGH AREA

Number of Days in 10 years with specified amounts of rain falling in specified times

	A. Observed Frequency (number of days in 10 years)	B. Estimated Frequency (number of days in 10 years)	C. Observed Frequency as Percentage of Estimated Frequency	D. Period of Record used for Calculation of A. (years)
Amount of 0.2 inches falling within:				
5 minutes or less	3.3	5.5*	60%	12
10 minutes or less	7.5	14.9	50%	12
15 minutes or less	12.5	22.3	56%	12
Amount of 0.4 inches falling within:				
15 minutes or less	1.1	3.5*	31%	19
30 minutes or less	3.7	7.3	51%	19
60 minutes or less	7.4	14.6	51%	19
Amount of 0.6 inches falling within:				
30 minutes or less	0.5	2.2	23%	19
1 hour or less	1.6	4.4	36%	19
2 hours or less	5.3	8.8	60%	19
4 hours or less	19.5	17.6	111%	19
Amount of 0.8 inches falling within:				
2 hours or less	1.6	3.6	44%	19
4 hours or less	5.8	7.2	81%	19
8 hours or less	18.4	14.4	128%	19
Amount of 1.0 inches falling within:				
4 hours or less	2.1	3.6	58%	19
8 hours or less	10.5	7.2	146%	19
16 hours or less	17.4	14.4	121%	19

Notes

1. The observed frequencies in column 'A' above have been calculated from intensities of rainfall recorded at Turnhouse (Edinburgh) Airport during the 19 years from 1949 to 1967 - see column 'D' and Table 1G.

2. The estimated frequencies in column 'B' above were mainly obtained from Bilham's formula:-

$$n = \frac{1.25t}{(r + 0.1)^{3.55}}$$

where:

n = frequency (number of days in 10 years)
t = duration in hours
r = rainfall in inches

But the following modification due to D. J. Holland for intensities greater than 1.25 inches per hour was used to estimate the frequencies marked with an asterisk:-

$$n = \frac{r \exp. \left(1 - \frac{0.8r}{t}\right)}{(r + 0.1)^{3.55}}$$

TABLE 1J

DAILY RAINFALLS AT THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH, DURING THE FIVE WETTEST MONTHS IN THE 72 YEARS FROM 1896 TO 1967

(Wettest Month = Month with total of more than 178 millimetres (7 inches) of rain)

(Daily rainfalls in millimetres with equivalents in inches from 09h GMT on one day to 09h GMT on the next day)

Date	OCTOBER 1907		SEPTEMBER 1927		JULY 1940		AUGUST 1948		AUGUST 1966	
	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
1st	Trace	.001	1.3	.051	Nil	Nil	Nil	Nil	0.1	.004
2nd	Nil	Nil	Nil	Nil	9.4	.370	0.8	.031	Nil	Nil
3rd	Nil	Nil	Nil	Nil	0.4	.016	Nil	Nil	49.0	1.929
4th	0.4	.017	Nil	Nil	3.4	.134	Nil	Nil	16.9	.665
5th	0.4	.015	8.5	.335	Nil	Nil	2.1	.083	Nil	Nil
6th	26.5	1.042	25.2	.992	16.7	.657	14.1	.555	Nil	Nil
7th	0.2	.007	Nil	Nil	6.9	.272	71.2	2.803	Nil	Nil
8th	19.5	.768	3.4	.134	0.4	.016	16.9	.665	7.0	.276
9th	18.3	.720	Nil	Nil	4.5	.177	0.7	.028	8.3	.327
10th	0.5	.021	1.5	.059	40.2	1.583	Nil	Nil	0.7	.028
11th	0.1	.006	Nil	Nil	35.9	1.413	0.8	.031	7.2	.283
12th	0.9	.036	Nil	Nil	0.1	.004	58.5	2.303	2.6	.102
13th	7.8	.305	4.3	.169	11.0	.433	Nil	Nil	55.3	2.177
14th	0.2	.007	1.3	.051	5.5	.217	7.3	.287	0.1	.004
15th	79.4	3.125	Nil	Nil	0.1	.004	1.8	.071	Nil	Nil
16th	0.8	.032	1.6	.063	3.1	.122	14.9	.587	Nil	Nil
17th	18.5	.727	2.4	.094	43.1	1.697	4.3	.169	0.2	.008
18th	0.6	.025	2.3	.091	8.6	.339	Nil	Nil	Nil	Nil
19th	1.3	.050	5.8	.228	11.2	.441	Nil	Nil	0.2	.008
20th	0.8	.032	12.7	.500	0.2	.008	Nil	Nil	31.8	1.252
21st	2.5	.099	52.8	2.079	Nil	Nil	7.9	.311	4.6	.181
22nd	0.3	.010	39.6	1.559	0.9	.035	0.6	.024	0.5	.020
23rd	6.3	.250	Nil	Nil	0.9	.035	2.2	.087	Trace	Trace
24th	0.1	.004	3.1	.122	Nil	Nil	16.1	.634	Nil	Nil
25th	3.9	.155	3.3	.130	0.6	.024	1.6	.063	Nil	Nil
26th	0.3	.010	4.4	.173	3.7	.146	3.9	.154	Nil	Nil
27th	Trace	.001	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
28th	2.6	.102	18.6	.732	0.8	.031	0.6	.024	0.8	.031
29th	5.2	.204	0.2	.008	1.6	.063	Nil	Nil	1.3	.051
30th	3.2	.125	8.6	.339	0.6	.024	2.7	.106	1.2	.047
31st	Trace	.001			Nil	Nil	9.7	.382	Trace	Trace
Total	200.6	7.897	200.9	7.909	209.8	8.261	238.7	9.398	187.8	7.393

Note: A 'Trace' of rainfall is a very small amount less than .05 millimetres (or .005 inches).

TABLE 1K

NUMBER OF DAYS WITH 0.1 MILLIMETRES OR MORE OF RAIN FALLING AT SOME TIME DURING THE 10 HOUR PERIOD BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME (0800 AND 1800 HOURS BRITISH STANDARD TIME) IN EACH MONTH AND YEAR DURING THE 10 YEARS FROM 1958 TO 1967 AT TURNHOUSE (EDINBURGH) AIRPORT

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Number of Days												
1958	11	12	11	11	13	12	9	16	13	10	8	18	144
1959	6	7	11	11	9	11	8	3	2	9	15	17	109
1960	14	11	7	10	5	8	21	16	9	18	12	13	144
1961	10	15	9	10	8	9	7	14	12	16	11	13	134
1962	17	8	9	14	8	6	8	15	11	6	13	12	127
1963	12	8	14	15	13	13	9	16	10	11	17	4	142
1964	6	6	11	12	12	8	6	15	15	9	9	13	122
1965	14	5	11	15	14	12	15	9	17	11	14	17	154
1966	14	20	6	12	12	15	8	15	7	13	9	14	145
1967	13	13	15	9	24	6	9	11	12	16	10	7	145
10 year mean	11.7	10.5	10.4	11.9	11.8	10.0	10.0	13.0	10.8	11.9	11.8	12.8	136.6

NUMBER OF HOURS DURING THE 10 HOUR PERIOD BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME WITH 0.1 MILLIMETRES OR MORE OF RAIN FALLING AT SOME TIME DURING THE HOUR IN EACH MONTH AND YEAR DURING THE 10 YEARS FROM 1958 TO 1967 AT TURNHOUSE (EDINBURGH) AIRPORT

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Number of Hours												
1958	25	41	35	32	38	39	58	51	31	21	22	77	470
1959	16	24	20	37	16	25	26	3	9	22	75	48	321
1960	51	39	25	19	15	18	63	39	31	70	30	37	437
1961	36	46	15	47	18	18	19	42	41	46	43	50	421
1962	52	23	18	45	34	12	20	58	33	23	54	38	410
1963	30	31	44	50	39	41	36	63	29	29	87	18	497
1964	16	8	35	38	29	15	14	57	41	29	27	41	350
1965	45	10	40	45	45	25	57	30	48	35	62	61	503
1966	44	68	14	47	48	41	24	55	22	39	32	53	487
1967	40	42	38	29	85	16	27	37	41	53	18	18	444
10 year mean	35.5	33.2	28.4	38.9	36.7	25.0	34.4	43.5	32.6	36.7	45.0	44.1	434.0
10 year mean expressed as percentage of total working time	11%	12%	9%	13%	12%	8%	11%	14%	11%	12%	15%	14%	12%

TABLE 1L

TOTAL DURATION IN HOURS AND TENTHS OF RAIN FALLING AT A RATE OF 0.5 MILLIMETRES OR MORE PER HOUR BETWEEN THE HOURS OF 0700 AND 1700 HOURS GREENWICH MEAN TIME (0800 AND 1800 HOURS BRITISH STANDARD TIME) IN EACH MONTH AND YEAR DURING THE 10 YEARS FROM 1958 TO 1967 AT TURNHOUSE (EDINBURGH) AIRPORT

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Total Duration in Hours and Tenths												
1958	8.0	20.7	17.2	14.2	16.4	21.1	31.2	20.5	13.1	6.0	10.0	31.3	209.7
1959	2.1	6.6	6.5	11.9	4.7	9.9	11.8	0.8	4.0	5.8	31.9	22.9	118.9
1960	20.1	16.5	10.4	4.3	10.7	5.3	24.4	15.3	14.1	26.8	12.5	12.1	172.5
1961	19.1	14.8	5.4	21.0	5.6	5.3	10.0	22.7	15.4	14.1	13.7	17.2	164.3
1962	16.5	6.7	4.0	23.5	8.6	4.7	8.8	32.3	18.9	4.5	17.2	11.0	156.7
1963	6.8	10.8	19.9	13.8	12.5	19.1	16.5	24.4	11.2	14.6	46.5	4.9	201.0
1964	8.0	1.7	15.8	17.6	9.7	7.8	6.2	25.1	20.6	11.8	8.2	20.9	153.4
1965	20.0	2.3	17.6	14.0	16.7	6.1	26.9	17.0	20.6	16.3	26.4	18.0	201.9
1966	14.3	35.3	4.8	18.5	19.8	21.1	10.0	30.8	10.7	19.2	12.8	25.0	222.3
1967	14.7	15.7	17.2	5.8	35.3	5.6	9.7	19.2	19.6	22.6	4.0	6.5	175.9
10 year mean	13.0	13.1	11.9	14.5	14.0	10.6	15.5	20.8	14.8	14.2	18.3	17.0	177.7
10 year mean expressed as percentage of total working time	4%	5%	4%	5%	5%	4%	5%	7%	5%	5%	6%	6%	5%

TABLE 1M

NUMBER OF DAYS WITH RAIN FALLING AT A RATE OF 0.5 MILLIMETRES OR MORE PER HOUR BETWEEN THE HOURS OF 0700 AND 1700 HOURS GREENWICH MEAN TIME (0800 AND 1800 HOURS BRITISH STANDARD TIME) IN EACH MONTH AND YEAR DURING THE 10 YEARS PERIOD FROM 1958 TO 1967 AT TURNHOUSE (EDINBURGH) AIRPORT

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Number of Days												
1958	6	9	9	9	12	11	9	12	10	10	6	17	120
1959	3	3	7	10	7	8	8	2	2	7	14	14	85
1960	12	10	5	7	3	8	21	15	9	17	8	12	127
1961	9	14	8	10	8	8	7	12	12	15	9	13	125
1962	16	8	7	13	6	6	7	14	11	4	12	11	115
1963	10	6	10	14	11	11	9	16	9	10	15	4	125
1964	3	4	8	9	11	8	6	15	13	9	8	11	105
1965	14	5	10	15	13	11	14	9	16	9	13	16	145
1966	11	13	4	11	12	13	8	14	7	12	9	13	127
1967	10	13	13	9	23	6	8	10	11	16	10	4	133
10 year mean	9.4	8.5	8.1	10.7	10.6	9.0	9.7	11.9	10.0	10.9	10.4	11.5	120.7

NUMBER OF HOURS WITH RAIN FALLING AT A RATE OF 0.5 MILLIMETRES OR MORE PER HOUR BETWEEN THE HOURS OF 0700 AND 1700 HOURS GREENWICH MEAN TIME (0800 AND 1800 HOURS BRITISH STANDARD TIME) IN EACH MONTH AND YEAR DURING THE 10 YEARS PERIOD FROM 1958 TO 1967 AT TURNHOUSE (EDINBURGH) AIRPORT

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Number of Hours												
1958	13	26	23	24	29	29	49	33	25	18	13	53	335
1959	11	10	14	25	12	19	20	2	4	15	59	38	229
1960	34	32	15	15	12	17	56	32	25	59	23	33	353
1961	34	31	12	36	14	14	18	36	37	38	33	37	340
1962	49	20	11	37	22	11	17	51	29	17	29	28	321
1963	20	22	28	37	31	35	26	41	26	27	63	14	370
1964	11	5	25	29	25	14	14	44	38	26	19	34	284
1965	40	5	21	42	34	21	45	29	40	28	44	46	395
1966	28	53	12	29	38	34	21	45	17	29	26	42	374
1967	27	39	35	19	64	13	20	30	34	53	17	11	362
10 year mean	26.7	24.3	19.6	29.3	28.1	20.7	28.6	34.3	27.5	31.0	32.6	33.6	336.3
10 year mean expressed as percentage of total working time	9%	9%	6%	10%	9%	7%	9%	11%	9%	10%	11%	11%	9%

NOTE: The number of days and numbers of hours quoted in the above tables should not be taken to mean that rain has fallen continuously at a rate of 0.5 millimetres or more per hour throughout the day between 0700 and 1700 hours or continuously at the same rate throughout an hour during this period. For example, the above tables include days and hours when rain fell at a rate of 0.5 millimetres or more per hour for only a few minutes.

TABLE 1N

TABLE FOR CONVERTING AMOUNTS OF RAINFALL IN MILLIMETRES TO INCHES

mm.	inch	mm.	inch	mm.	inch
.1	.004	10	.394	100	3.937
.2	.008	15	.591	200	7.874
.3	.012	20	.787	300	11.811
.4	.016	25	.984	400	15.748
.5	.020	30	1.181	500	19.685
.6	.024	35	1.378	600	23.622
.7	.028	40	1.575	700	27.559
.8	.031	45	1.772	800	31.496
.9	.035	50	1.969	900	35.433
				1000	39.370
1	.039	55	2.165		
2	.079	60	2.362		
3	.118	65	2.559		
4	.157	70	2.756		
5	.197	75	2.953		
6	.236	80	3.150		
7	.276	85	3.346		
8	.315	90	3.543		
9	.354	95	3.740		
10	.394	100	3.937		

2. TEMPERATURE

In winter, the surface temperature of the North Sea remains relatively high when compared with the ground surface temperatures over the adjacent coastal areas of Northern Europe and because of the moderating influence of the North Sea, winter temperatures in Edinburgh are comparable with those of London or other places on or near the east coast of England. Moreover, the city tends to escape the very low temperatures of severe winters which are characterized by bitterly cold easterly winds from the Continent affecting east and south-east England much more than the Edinburgh area. The reason for this is that these cold blasts from the Continent have a much longer track over the North Sea and thus have a better opportunity of taking up the sea surface temperature before reaching Edinburgh. A glance at the map will show that, in contrast, easterly winds from the Continent have a much shorter track over the sea before reaching Kent or East Anglia. However, because of the high latitude of Edinburgh, the very slow rise in sea temperature and the onset of cold easterly winds in the spring, the rise of temperature at the end of winter is much more of an uphill struggle, and spring is later and cooler than in the south. In summer and early autumn, the effect of latitude on the heat received from the sun is the dominant factor, and temperatures are several degrees lower than they are in the south of England.

The temperature regime within Edinburgh is rather complex. Generally speaking, day-time temperatures are higher for a longer period of time on the lower ground, particularly in the more sheltered parts of the city but this is offset to some extent by a tendency to lower night temperatures in these same areas, except in the immediate vicinity of the Forth. This effect is most marked on clear, calm nights. It is the result of air which has been cooled by contact with the ground and which has become relatively dense (i.e. heavier) draining downhill and stagnating in the valleys and hollows. The cold air is replaced at higher levels by rather warmer air which has not been in contact with the ground. As an illustration of the effect, the lowest air temperature recorded at the

/Royal

Royal Observatory at Blackford Hill (altitude 450 feet) over the last 70 years or so is 14°F., while at Turnhouse Airport (altitude 110 feet), where records began as recently as 1948, the air temperature has fallen to below 7°F. on several occasions, the lowest recorded to date (i.e. up to the end of 1967) being 1°F. The absolute lowest air temperature of 1°F. was recorded at Turnhouse Airport on the night of 14th/15th February 1966 and it is interesting to note that during the same night the minimum air temperature recorded at Blackford Hill was 21°F. There are numerous places subject to the "frost hollow" effect in Edinburgh; parts of the Meggetland area and Slateford village being particularly good examples. In some parts of the city, the downhill flow of cold air is dammed by trees or buildings giving rise to some rather curious examples of this kind of effect. For example, the surface of the road and footpaths of Viewforth Terrace which is a short stretch of road close to Boroughmuir Secondary School near, but lying across, the foot of a fairly steep slope, down from the Meadows, is often covered with hoar frost when the adjoining roads nearby and lower down the same slope are completely frost-free. Snow and ice also tend to lie for much longer in Viewforth Terrace than on the adjoining roads.

The available evidence suggests that the areas most likely to suffer from the "frost hollow" effect are the more sheltered and flatter parts of the basins of the various streams which flow through the city. In windy cloudy weather the surface of the ground cools less rapidly at night and the air near the surface is too disturbed for the effect to develop.

It should perhaps be explained at this point that air ("shade") temperatures are read from thermometers exposed at a height of four feet above ground level and an "air frost" occurs when the temperature at four feet falls to below 32°F. However, at night-time and particularly on clear, calm nights, the air in close contact with the ground is nearly always cooled to below the temperature at four feet. Consequently, the incidence of frost at the surface of the ground is much higher than the incidence of "air frost". It is difficult to provide representative statistics of frost at the surface of the ground as conditions will vary

/considerably

considerably over quite short distances from place to place depending on the composition of the surface (e.g. grass, bare soil, tarmacadam or concrete) and whether a particular site lies in a sheltered place or is exposed to the wind. Owing to its excellent insulating characteristics, a grass covered surface will normally have a higher frequency of frost than the other surfaces mentioned because the grass seals off the only source of heat during the night, i.e. the soil. At a sheltered grass covered site in Edinburgh away from the vicinity of the Forth, grass minimum temperatures could fall to below freezing point in any month of the year and the average number of days per year with grass minimum temperatures below freezing point could be as high as twice the average number of days with air frosts.

It has already been shown that in Edinburgh night minimum temperatures can vary considerably from place to place often over quite short distances. In contrast, maximum temperature even at different altitudes within the city are remarkably uniform on warm days during the summer being governed to a very large extent by sea breezes which penetrate to all parts of the city. However, a maximum temperature on a warm summer's day seldom persists for more than an hour or two and, as stated previously, day temperatures are higher for a longer period of time in the lower lying parts of the city. On average, one would expect something like a 2 degree Fahrenheit difference in mean temperature from a place at sea level near the Forth and a suburb like Fairmilehead most of which lies near the 600 feet contour.

The temperature regime is further complicated by the "heat island" effect which large built-up areas create particularly at night. This effect is the product of a number of factors including the heat released in artificially heating the buildings, the high thermal capacity of the buildings, the effect of pollution haze and tall buildings in cutting down the loss of heat by outward radiation at night, the general reduction in wind speed etc. Unfortunately, little is known about the effect in Edinburgh. Some of the most densely built-up areas are in hollows and the "frost hollow" and "heat island" effects will tend to counteract

/each

each other. This combined with the open, well ventilated nature of the city makes it probable that the total effect on temperature in Edinburgh is considerably less than in London.

In dealing with problems involving heat loss, whether it is related to human comfort, heating of buildings or frost penetration, it is necessary to consider the combined effect of temperature and wind. For example, the wind cooling effect is roughly proportional to the square root of the wind speed and in cold air with a wind of 12 m.p.h. the loss of heat from a dry surface is about three times the loss at the same temperature in calm air. As a general rule, the heat loss will be greatest in the higher windier suburbs, and in the upper storeys of high blocks of flats which are more exposed to the wind than their surroundings. The effect of wind on frost severity is illustrated by the following table which is used by the Meteorological Office to define their descriptions of frost.

Terms used to indicate severity of frost

Term	Corresponding to Air Temperature - Degrees Centigrade with Equivalents in °F.	
	Wind speed less than 11 m.p.h.	Wind speed more than 11 m.p.h.
Slight Frost	below 0.0 to minus 3.5°C. (below 32 to 25.6°F.)	below 0.0 to minus 0.4°C. (below 32 to 31.3°F.)
Moderate Frost	minus 3.6 to minus 6.4°C. (25.5 to 20.5°F.)	minus 0.5 to minus 2.4°C. (31.2°F. to 27.6°F.)
Severe Frost	minus 6.5 to minus 11.5°C. (20.4 to 11.3°F.)	minus 2.5 to minus 5.5°C. (27.5°F. to 22.1°F.)
Very Severe Frost	minus 11.6°C. or below (11.2°F. or below)	minus 5.6°C. or below (22°F. or below)

Averages and Extremes of Air Temperature for several locations in the Edinburgh area are given in Tables 2, 2A and 2B. The standard period for temperature averages in current use in the Meteorological Office is the 30 years period from

/1931

1931 to 1960. The averages quoted for Blackford Hill in Table 2 are actual averages over this period of 30 years but the averages quoted for the other locations have been estimated from shorter periods or broken periods of records.

Statistics of Monthly and Annual Mean Temperatures for Blackford Hill are given in Table 2C.

Statistics of Annual Maximum and Minimum Temperatures for locations in the Edinburgh area are given in Table 2D.

The Percentage Amount of Time with Air Temperatures below Certain Limits at Turnhouse Airport are given in Table 2E.

The Number of Days with Maximum Air Temperatures exceeding 60°F., 65°F., 70°F., 75°F. and 80°F. at Turnhouse Airport are given in Table 2F.

The Actual and Average Numbers of Days with Air Frost are given for certain locations in Edinburgh in Tables 2G and 2H together with the average and extreme dates of occurrence of the first and last air frosts in Table 2I. A note is also included in Table 2H of the longest period to date with air temperatures continuously below freezing point at Turnhouse Airport.

Hourly Temperature Readings during a Very Warm Day and During a Very Cold Night at Turnhouse Airport are given in Tables 2J and 2K together with associated values of wet bulb temperature, vapour pressure and relative humidity.

Hourly Averages and Extremes of Air Temperature at Turnhouse Airport are included in the Tables of Relative Humidity given in the following section (Section 3) of this Report.

Temperature Statistics of Periods of Cold Weather in Edinburgh (and other cities) during the heating seasons from 1925/1926 to 1949/1950 are quoted in Appendix 'C' to the H.M.S.O. publication "Post War Building Studies No. 33".

Averages and Extremes of Soil and Earth Temperatures at depths of 4 inches, 8 inches, 1 foot and 4 feet are given in Tables 2L and 2M for certain locations in the Edinburgh area.

East Craigs, which lies on the western outskirts of Edinburgh, is the only location from which records of soil temperature at depths of 4 inches and 8 inches

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are available for a reasonably long period of years. At these depths under bare soil, there is a well marked diurnal variation on fine sunny days especially when the soil is dry in contrast to the practically constant temperature prevailing on dull days with a wet soil. From some recent continuous recordings at East Craigs during a very mediocre summer (maximum air temperature 64°F.), daily ranges of 12°F. to 15°F. have been registered at the 4 inch depth and up to 9°F. at 8 inches. At the other extreme, the soil was frozen at the 4 inch depth for 54 days continuously (12th January to 6th March) and at the 8 inch depth for 15 days (17th to 31st January) during the severe winter of 1962/63. Broadly speaking, the 0900 G.M.T. reading of soil temperature at depths of 4 inches and 8 inches is near to the daily minimum. In the middle of the year at the latitude of Edinburgh, the minimum of the daily cycle normally occurs two to three hours before the time of the daily reading at 0900 hours, and at the turn of the year about one to two hours later than the routine observation time. (8)

At the 1 foot depth, the range of the diurnal variation of temperature could amount to 5 degrees in summer but is quite small at the 4 feet depth. The minimum temperature at a depth of 1 foot usually occurs around 0900 hours and the maximum about 2000 hours. It can be seen from Table 1M that the annual variation is quite large at both the 1 foot and 4 feet depths. At 1 foot, the highest and lowest air temperatures in a year usually occur in the months with the highest and lowest air temperatures but at 4 feet, the extremes usually lag about one month behind.

Temperature as a Factor Interrupting Outdoor Building Work

Outdoor building work will be seriously hampered or have to cease when temperatures are somewherenear or below freezing point but it is difficult to decide a precise threshold temperature because this will obviously depend on the type of work, the materials being used and other factors. However, experience suggests that the temperature thresholds "below 32°F.", "below 34°F." and "below 36°F." are the thresholds of most interest to builders and thus the number of working days and working hours below these three limits should provide a good

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guide for estimating the time likely to be lost because of low temperatures on different kinds of outdoor work.

Tables 2N to 2P have been prepared from records of hourly readings of air temperature made at Turnhouse Airport between 0700 and 1700 hours Greenwich Mean Time (0800 and 1800 hours British Standard Time) on each day during the 10 years from 1958 to 1967. Owing to the convention formerly in use in the Meteorological Office whereby tenths of a degree Fahrenheit were rounded off and recorded in the records to the nearest whole degree, "below 31.6°F.", "below 33.6°F." and "below 35.6°F." are the nearest precise values of temperature available from the records to the suggested thresholds of "below 32°F.", "below 34°F." and "below 36°F." respectively.

The Tables giving the total numbers of <u>days</u> in each month with hourly readings of air temperature less than 31.6°F., 33.6°F. and 35.6°F. include days on which only one hourly reading of air temperature was below these levels and therefore the figures in these Tables should not necessarily be taken to mean that these are days on which the air temperature was continuously below 31.6°F., 33.6°F. or 35.6°F. throughout the whole period of ten hours between 0700 and 1700 hours. On the contrary, during the 10 years considered, there were many more days with two or three hourly readings of air temperature below 31.6°F., 33.6°F. or 35.6°F. than there were with ten hourly readings below these levels. The numbers of days quoted in these Tables slightly underestimate the true number of days on which the air temperature fell to below the stated levels because on several days the air temperature would have fallen to below these levels for a short time during the 60 minutes <u>between</u> the routine hourly readings, although the hourly readings themselves might have been above 31.6°F., 33.6°F. or 35.6°F.

The Tables showing the total number of <u>hours</u> during the ten hour period between 0700 and 1700 hours G.M.T. with air temperatures below 31.6°F., 33.6°F. and 35.6°F. at Turnhouse Airport have been determined by counting up the number

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of hourly readings below these limits between 0700 and 1700 hours on each day during the 10 years from 1958 to 1967.

It should be borne in mind when consulting Tables 2N to 2P that there will be occasions when the ground is frozen for several hours with an air temperature higher than 33.6°F. or 35.6°F.; perhaps the number of these occasions will be approximately counter-balanced by the number of occasions when outdoor building work is able to proceed even though the air temperature is below 33.6°F. or 35.6°F.

The reader should note that the figures in Tables 2N to 2P relate to a 7-day working week and not to a 5-day working week.

A table for converting degrees Fahrenheit to degrees Centigrade is at Table 2Q.

TABLE 2

AVERAGES OF DAILY MAXIMUM, MINIMUM AND MEAN [½(MAX. + MIN.)] TEMPERATURE IN DEGREES FAHRENHEIT FOR TEMPERATURE RECORDING STATIONS IN THE EDINBURGH AREA
30 YEARS PERIOD FROM 1931 TO 1960

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
BLACKFORD HILL (altitude 441 feet)													
Maximum	41.8	42.7	46.4	51.5	56.4	62.1	65.2	64.0	60.2	53.7	47.7	44.3	53.0
Minimum	33.7	33.9	36.3	39.4	43.5	48.6	52.4	52.2	49.2	44.5	39.1	36.3	42.4
Mean	37.7	38.3	41.3	45.5	49.9	55.3	58.8	58.1	54.7	49.1	43.4	40.3	47.7
ROYAL BOTANIC GARDEN (altitude 74 feet)													
Maximum	42.9	44.6	48.2	53.2	58.1	63.7	66.6	65.6	62.1	55.4	48.9	45.0	54.5
Minimum	31.9	33.1	35.3	38.6	43.0	48.4	52.0	51.4	48.1	43.0	37.1	34.7	41.4
Mean	37.4	38.9	41.7	45.9	50.5	56.1	59.3	58.5	55.1	49.2	43.0	39.9	47.9
DAVIDSON'S MAINS (altitude 200 feet)													
Maximum	41.9	43.4	47.4	52.7	57.7	63.1	66.2	65.2	61.3	54.4	47.9	44.1	53.8
Minimum	32.4	32.9	35.6	38.4	43.0	48.5	51.7	51.1	48.0	43.1	37.5	35.3	41.5
Mean	37.1	38.1	41.5	45.6	50.4	55.8	58.9	58.1	54.7	48.7	42.7	39.7	47.7
TURNHOUSE AIRPORT (altitude 114 feet)													
Maximum	41.8	43.7	47.7	52.8	57.7	63.0	66.1	65.2	61.3	54.7	48.4	43.9	53.9
Minimum	32.1	32.6	35.0	37.5	42.2	47.5	51.2	50.3	47.2	42.6	37.3	35.1	40.9
Mean	36.9	38.1	41.3	45.1	49.9	55.3	58.7	57.7	54.3	48.7	42.9	39.5	47.4
LIBERTON (altitude 200 feet)													
Maximum	42.6	43.9	47.9	53.0	58.1	63.9	66.8	65.6	61.9	55.2	48.6	44.8	54.4
Minimum	32.7	33.4	35.4	38.5	42.4	47.8	51.5	50.7	47.7	42.5	37.8	35.2	41.3
Mean	37.7	38.6	41.6	45.7	50.3	55.9	59.2	58.2	54.8	48.8	43.2	40.0	47.8
BUSH HOUSE (altitude 605 feet)													
Maximum	41.2	42.2	45.7	50.4	55.5	60.9	64.3	63.0	59.2	53.1	46.1	43.2	52.1
Minimum	31.1	31.3	33.9	36.3	40.5	46.1	49.8	49.5	46.0	41.5	36.0	33.3	39.6
Mean	36.1	36.7	39.8	43.3	48.0	53.5	57.1	56.3	52.6	47.3	41.1	38.3	45.9
BOGHALL near Hillend (altitude 639 feet)													
Maximum	41.0	41.7	45.7	50.9	56.7	62.2	64.4	63.7	59.7	53.1	46.8	43.2	52.3
Minimum	31.8	32.5	34.7	37.6	41.7	46.8	50.5	50.0	46.9	42.3	37.4	34.5	40.6
Mean	36.4	37.1	40.2	44.3	49.2	54.5	57.5	56.9	53.3	47.7	42.1	38.9	46.5

TABLE 2 (continued)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
PENICUIK (altitude 620 feet)													
Maximum	40.7	42.0	46.5	51.8	57.5	63.0	65.9	64.7	60.6	53.7	46.9	43.3	53.0
Minimum	30.5	31.1	33.4	36.5	40.9	46.3	50.1	49.5	46.3	41.3	35.9	33.1	39.6
Mean	35.6	36.5	39.9	44.1	49.2	54.7	58.0	57.1	53.5	47.5	41.4	38.1	46.3
HADDINGTON (altitude 162 feet)													
Maximum	41.7	43.4	47.3	53.1	57.6	63.7	66.6	65.3	62.0	54.8	48.0	43.8	53.9
Minimum	30.4	31.6	34.4	37.7	41.5	46.8	50.5	50.1	46.6	41.8	36.0	33.7	40.1
Mean	36.1	37.5	40.9	45.4	49.5	55.3	58.5	57.7	54.3	48.3	42.0	38.7	47.0
BALERNO (altitude 700 feet)													
Maximum	41.1	40.9	46.1	51.6	57.8	63.0	65.4	65.1	60.7	54.9	47.3	43.9	53.1
Minimum	30.1	30.0	33.1	36.0	40.3	45.6	48.6	48.9	47.5	43.0	37.1	34.0	39.5
Mean	35.6	35.5	39.6	43.8	49.1	54.3	57.0	57.0	54.1	48.9	42.2	38.9	46.3

TABLE 2A

AVERAGES OF THE HIGHEST AND LOWEST TEMPERATURES IN EACH MONTH IN DEGREES FAHRENHEIT FOR TEMPERATURE RECORDING STATIONS IN EDINBURGH

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
BLACKFORD HILL (altitude 441 feet) 30 years from 1938-1967													
Average of the Highest each Month	51	52	57	63	69	74	74	73	69	63	56	53	77*
Average of the Lowest each Month	24	25	27	31	35	42	46	45	41	35	30	26	21**
ROYAL BOTANIC GARDEN (altitude 74 feet) 29 years from 1939-1967													
Average of the Highest each Month	53	53	58	64	70	75	74	74	71	65	58	54	78*
Average of the Lowest each Month	19	21	24	28	33	40	43	43	36	30	25	21	16**
DAVIDSON'S MAINS (altitude 200 feet) 30 years from 1938-1967													
Average of the Highest each Month	51	53	57	64	70	75	75	73	70	64	56	54	79*
Average of the Lowest each Month	21	22	25	29	34	40	44	43	38	32	27	23	18**
TURNHOUSE AIRPORT (altitude 114 feet) 19 years from 1949-1967													
Average of the Highest each Month	53	53	57	64	69	75	74	73	70	65	56	54	78*
Average of the Lowest each Month	17	16	22	26	32	37	40	39	36	29	24	18	12**

* = Average of the Highest each Year

** = Average of the Lowest each Year

TABLE 2B

ABSOLUTE HIGHEST AND LOWEST TEMPERATURES IN DEGREES FAHRENHEIT RECORDED IN EACH MONTH AT TEMPERATURE RECORDING STATIONS IN EDINBURGH

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
BLACKFORD HILL (altitude 441 feet) 72 years from 1896 to 1967													
Absolute Highest in each Month	58	60	68	72	76	83	84	83	85	76	67	58	85*
Absolute Lowest in each Month	14	15	15	20	29	36	37	40	33	28	18	19	14**
ROYAL BOTANIC GARDEN (altitude 74 feet) 29 years from 1939 to 1967													
Absolute Highest in each Month	59	59	72	71	76	85	83	82	78	76	69	61	85*
Absolute Lowest in each Month	4	11	11	21	29	34	40	36	28	26	16	12	4**
DAVIDSON'S MAINS (altitude 200 feet) 34 years from 1934 to 1967													
Absolute Highest in each Month	57	58	69	72	76	86	82	83	77	76	67	59	86*
Absolute Lowest in each Month	13	11	12	25	29	35	39	38	30	27	19	14	11**
TURNHOUSE AIRPORT (altitude 114 feet) 19 years from 1949 to 1967													
Absolute Highest in each Month	58	59	69	68	75	82	81	83	77	76	59	58	83*
Absolute Lowest in each Month	5	1	13	22	29	32	37	35	27	23	16	8	1**

* = Absolute Highest during Whole Period

** = Absolute Lowest during Whole Period

TABLE 2C

STATISTICS OF MONTHLY AND ANNUAL MEAN [½(MAX. + MIN.)] TEMPERATURES IN DEGREES FAHRENHEIT FOR THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH (72 YEARS FROM 1896 TO 1967)

Statistics of Monthly Mean Temperatures

Month	Highest Monthly Mean °F.	Monthly Mean Seldom* Above °F.	Median+ °F.	Monthly Mean Seldom* Below °F.	Lowest Monthly Mean °F.
January	44.1 in January 1898	40.4	38.3	36.7	32.1 in January 1941 and 1963
February	44.1 in February 1945	40.9	38.7	36.1	29.1 in February 1947
March	47.7 in March 1938	43.2	41.1	38.3	34.2 in March 1947
April	48.7 in April 1914, 1943 and 1960	46.8	44.4	42.3	40.0 in April 1917
May	53.5 in May 1960	50.8	49.3	47.5	45.2 in May 1902
June	60.1 in June 1940	56.0	54.7	53.2	50.7 in June 1927
July	61.9 in July 1933 and 1934	59.2	57.7	56.5	53.7 in July 1965
August	61.6 in August 1959	58.8	57.5	55.8	53.0 in August 1912
September	57.7 in September 1949 and 1958	55.7	53.9	52.4	49.7 in September 1918 and 1952
October	53.8 in October 1908	49.9	48.4	47.1	41.9 in October 1896
November	46.8 in November 1899	44.9	42.8	41.1	36.5 in November 1919
December	44.7 in December 1924	42.1	39.5	37.8	33.7 in December 1950

*Seldom = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.

+Median = the "middle" value, i.e. half the mean temperatures exceed it and half fall below it.

Statistics of Annual Mean Temperatures

Period of Record	Highest Annual Mean °F.	Annual Mean Seldom* Above °F.	Median+ °F.	Annual Mean Seldom* Below °F.	Lowest Annual Mean °F.
72 years	49.3 in 1959	48.0	47.1	46.4	45.6 in 1919

*Seldom = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.

+Median = the "middle" value, i.e. half the mean temperatures exceed it and half fall below it.

TABLE 2D

STATISTICS OF ANNUAL MAXIMUM AND MINIMUM TEMPERATURES IN DEGREES FAHRENHEIT FOR TEMPERATURE RECORDING STATIONS IN THE EDINBURGH AREA

		Annual Maximum Temperatures					Annual Minimum Temperatures			
	Period of Record	Highest	Seldom* Above	Median+	Seldom* Below	Lowest	Lowest	Seldom* Below	Median+	Highest
BLACKFORD HILL (altitude 441 feet)	72 years	85	81	77	75	70	14	19	22	28
ROYAL BOTANIC GARDEN (altitude 74 feet)	29 years	85	80	78	75	73	4	12	17	23
DAVIDSON'S MAINS (altitude 200 feet)	34 years	86	81	78	76	72	11	14	19	25
TURNHOUSE AIRPORT (altitude 114 feet)	19 years	83	81	78	75	71	1	7	13	20
BOGHALL near Hillend (altitude 639 feet)	25 years	84	81	76	75	71	6	14	19	26

*Seldom = 20 per cent of occasions or 1 year in 5; the figures given are the upper and lower quintiles.

+Median = the "middle" value, i.e. half the temperatures exceed it and half fall below it.

TABLE 2E

PERCENTAGE AMOUNT OF TIME WITH AIR ("SHADE") TEMPERATURES BELOW CERTAIN LIMITS IN DEGREES FAHRENHEIT AT TURNHOUSE (EDINBURGH) AIRPORT

(computed from hourly readings of air temperature made at each hour on the hour during the 9 years from 1952-1960)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
	%	%	%	%	%	%	%	%	%	%	%	%	%
32°F. or below	24.8	21.9	7.3	3.3	0.2	0.0	0.0	0.0	0.1	1.6	7.1	12.9	6.5
34°F. or below	34.3	33.1	12.4	5.6	1.1	0.0	0.0	0.0	0.3	2.8	9.4	19.0	9.7
36°F. or below	44.9	46.2	19.4	9.1	2.1	0.1	0.0	0.1	0.5	4.4	13.5	26.3	13.7
38°F. or below	57.6	57.9	29.0	14.1	4.0	0.3	0.1	0.1	0.9	6.4	19.9	36.4	18.7
40°F. or below	67.8	67.4	42.2	20.7	6.9	0.9	0.1	0.3	2.0	9.9	28.1	49.1	24.5
42°F. or below	76.3	74.8	55.6	29.7	10.3	2.1	0.4	0.7	4.1	14.3	37.8	62.0	30.5
44°F. or below	82.3	81.2	67.5	39.9	15.4	3.7	0.9	1.4	6.7	20.2	50.2	72.5	36.5
46°F. or below	88.3	87.1	77.9	51.8	24.1	7.3	1.8	2.9	10.4	27.6	64.1	81.1	43.5
48°F. or below	92.9	91.8	86.4	63.4	35.7	13.7	3.5	5.4	15.4	39.2	77.5	87.5	50.7
50°F. or below	97.0	96.1	92.0	73.1	49.8	23.5	7.0	9.9	23.4	51.8	86.9	93.0	58.3
52°F. or below	99.2	98.9	96.1	82.6	61.5	34.7	12.9	17.4	34.4	65.7	94.7	97.1	66.1
54°F. or below	99.8	99.8	98.6	89.2	71.6	47.5	23.6	27.8	47.5	77.8	97.8	98.9	73.1
56°F. or below	99.9	99.9	99.3	94.5	80.3	60.7	38.2	41.7	61.3	87.5	99.2	99.7	80.1
58°F. or below	100.0	99.9	99.7	97.5	86.3	72.3	53.2	57.1	74.0	93.2	99.7	100.0	86.0
60°F. or below		100.0	99.9	98.8	91.5	82.1	66.6	69.4	83.3	96.1	100.0		90.5
62°F. or below			99.9	99.4	95.0	88.3	78.0	80.1	89.8	98.4			93.9
64°F. or below			99.9	99.7	97.1	92.5	86.1	87.7	93.9	99.4			96.3
66°F. or below			100.0	99.9	98.5	95.3	91.8	92.9	96.4	99.7			97.7
68°F. or below				100.0	99.2	97.5	95.2	96.5	98.1	99.9			98.7
70°F. or below					99.6	98.7	97.2	98.2	99.1	99.9			99.3
72°F. or below					100.0	99.3	98.3	99.0	99.6	99.9			99.5
74°F. or below						99.7	99.1	99.5	99.9	99.9			99.6
76°F. or below						99.9	99.5	99.8	100.0	100.0			99.7
78°F. or below						99.9	99.8	99.9					99.8
80°F. or below						100.0	99.9	100.0					99.9
82°F. or below							100.0						100.0

TABLE 2F

NUMBER OF DAYS WITH MAXIMUM AIR TEMPERATURES EXCEEDING 60°F., 65°F., 70°F., 75°F. and 80°F. at TURNHOUSE AIRPORT - 15 YEARS FROM 1953 TO 1967

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Number of Days with Maximum Air Temperatures Exceeding 60°F.												
1953			2	1	19	16	30	29	17	2			116
1954					9	15	27	19	12	5			87
1955				3	4	18	28	30	22	6			111
1956				2	17	14	22	16	12	2			85
1957			1	3	12	22	28	25	12	4			107
1958				4	6	16	25	27	27	2			107
1959				3	13	22	31	30	24	13			136
1960				5	22	28	28	26	14	2			125
1961			1	5	8	25	28	27	23	7			124
1962				3	3	25	16	25	8	7			87
1963				2	4	16	21	21	12	4			80
1964				1	8	22	27	24	19	2			103
1965			2	2	6	22	19	25	14	2			92
1966				2	10	21	30	20	20	1			104
1967				3	4	22	28	27	19	2			105
15-year average	0	0	<1	3	10	20	26	25	17	4	0	0	105
	Number of Days with Maximum Air Temperatures Exceeding 65°F.												
1953				1	5	7	14	17	4				48
1954					4	1	5	7	3				20
1955				1	2	9	24	24	10	1			71
1956					3	7	10	1	4				25
1957					1	13	13	10	1				38
1958				1	1	6	12	13	10				43
1959				1	3	9	24	23	14	7			81
1960					11	19	17	12	6				65
1961					2	6	9	14	10	1			42
1962				1	1	10	11	5	2				30
1963						3	8	5	3				19
1964					1	9	17	11	8				46
1965			2	0	2	12	3	11	2	1			33
1966				1	5	9	14	5	6				40
1967				2	0	7	18	13	4				44
15-year average	0	0	<1	1	3	8	13	11	6	1			43

TABLE 2F (contd.)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Number of Days with Maximum Air Temperatures Exceeding 70°F.												
1953					2	3	0	4	3				12
1954									1				1
1955							14	11	1				26
1956					1	2	1						4
1957						6	5	1					12
1958					1	0	4	1	2				8
1959						3	10	13	8	1			35
1960					1	5	1	2					9
1961						2	0	3	1				6
1962						3							3
1963						1	4	1					6
1964						2	4	2	1				9
1965					2	2	0	3					7
1966					2	0	3						5
1967						4	5	4					13
15-year average	0	0	0	0	1	2	3	3	1	<1	0	0	10
	Number of Days with Maximum Air Temperatures Exceeding 75°F.												
1953						1	0	1					2
1954													0
1955							6	3					9
1956						1							1
1957						1							1
1958							1						1
1959						1	2	3	2	1			9
1960						3							3
1961								1					1
1962						3							3
1963							1						1
1964													0
1965													0
1966							1						1
1967						1	0	1					2
15-year average	0	0	0	0	0	1	1	1	<1	<1	0	0	3

Note: During the 15 years from 1953 to 1967 there was a total of 5 days on which the maximum air temperature at Turnhouse Airport reached or exceeded 80°F. viz:-

16th July 1955 = 80°F.
27th July 1955 = 81°F.
1st August 1955 = 80°F.
4th June 1960 = 80°F.
29th August 1961 = 83°F.

TABLE 2G

NUMBER OF DAYS OF AIR FROST (MINIMUM AIR TEMPERATURE LESS THAN 32°F.) AT BLACKFORD HILL AND TURNHOUSE AIRPORT DURING 13 YEARS FROM 1955 TO 1967

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
BLACKFORD HILL - Altitude 441 feet													
1955	17	21	12	0	1	0	0	0	0	4	2	11	68
1956	17	20	7	1	0	0	0	0	0	0	3	5	53
1957	5	13	0	0	1	0	0	0	0	0	1	8	28
1958	16	13	18	5	0	0	0	0	0	0	2	6	60
1959	23	9	0	0	0	0	0	0	0	0	1	3	36
1960	10	16	2	0	0	0	0	0	0	0	1	12	41
1961	12	3	1	2	0	0	0	0	0	0	5	21	44
1962	5	8	15	4	0	0	0	0	0	0	9	12	53
1963	23	27	6	2	0	0	0	0	0	0	5	7	70
1964	7	7	7	0	0	0	0	0	0	1	2	10	34
1965	12	8	11	1	0	0	0	0	0	0	14	8	54
1966	14	12	3	7	0	0	0	0	0	0	4	8	48
1967	10	2	1	3	2	0	0	0	0	0	3	12	33
13-year average	13	12	6	2	<1	0	0	0	0	<1	4	9	46
TURNHOUSE AIRPORT - Altitude 114 feet													
1955	17	24	23	9	6	0	0	0	0	10	6	12	107
1956	18	21	7	11	3	0	0	0	0	3	8	6	77
1957	15	15	3	4	1	0	0	0	1	0	9	12	60
1958	18	13	17	7	3	0	0	0	0	1	6	12	77
1959	26	11	5	4	3	0	0	0	0	1	6	6	62
1960	18	21	6	2	1	0	0	0	0	2	10	15	75
1961	18	8	3	4	1	0	0	0	0	0	10	22	66
1962	9	7	18	7	0	1	0	0	0	3	11	17	73
1963	22	25	5	1	0	0	0	0	0	2	8	13	76
1964	9	9	8	2	0	0	0	0	1	5	9	14	57
1965	15	10	14	4	1	0	0	0	0	4	17	14	79
1966	13	12	5	7	0	0	0	0	0	2	8	13	60
1967	11	6	3	5	3	0	0	0	0	1	7	14	50
13-year average	16	14	9	5	2	<1	0	0	<1	3	9	13	71

TABLE 2H

AVERAGE NUMBER OF DAYS OF AIR FROST (MINIMUM AIR TEMPERATURE LESS THAN 32°F.)
AT TEMPERATURE RECORDING STATIONS IN THE EDINBURGH AREA
13 YEARS FROM 1955 TO 1967

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
BLACKFORD HILL - altitude 441 feet	13	12	6	2	<1	0	0	0	0	<1	4	9	46
ROYAL BOTANIC GARDEN - altitude 74 feet	15	13	8	4	1	0	0	0	0	1	8	13	63
TURNHOUSE AIRPORT - altitude 114 feet	16	14	9	5	2	<1	0	0	<1	3	9	13	71
DAVIDSON'S MAINS - altitude 200 feet	15	14	7	3	1	0	0	0	0	1	7	13	61
BUSH HOUSE - altitude 605 feet	18	16	11	6	2	<1	0	0	<1	2	9	15	79
PENICUIK - altitude 620 feet	18	17	11	7	2	<1	0	0	<1	3	10	15	83

Note: Temperature records commenced at Turnhouse Airport in the winter of 1948/49 and the longest period on record in which temperatures did not rise above freezing point is $6\frac{1}{2}$ days in January 1955 i.e. for $6\frac{1}{2}$ days, air temperatures were continuously below freezing point.

TABLE 2I

AVERAGE AND EXTREME DATES OF FIRST AND LAST AIR FROSTS AT TEMPERATURE RECORDING STATIONS IN THE EDINBURGH AREA DURING THE 13 YEARS FROM 1955 TO 1967

	Average Date of First Air Frost	Average Date of Last Air Frost
Blackford Hill	9th November	11th April
Royal Botanic Garden	28th October	26th April
Turnhouse Airport	16th October	7th May
Davidson's Mains	31st October	19th April
Bush House	19th October	12th May
Penicuik	17th October	13th May

	Earliest Date of First Air Frost	Latest Date of Last Air Frost
Blackford Hill	10th October	16th May
Royal Botanic Garden	10th October	28th May
Turnhouse Airport	21st September	1st June
Davidson's Mains	15th October	21st May
Bush House	21st September	1st June
Penicuik	21st September	1st June

TABLE 2J

HOURLY TEMPERATURE READINGS ON A VERY WARM DAY IN EDINBURGH

Hourly "Build-up" and Decline of Air Temperature at Turnhouse Airport on 29th August 1961 with Associated Values of Wet Bulb Temperature, Vapour Pressure and Relative Humidity. (The maximum air temperature of 83°F. recorded at Turnhouse Airport on 29th August 1961 is the highest air temperature recorded at the Airport during the 19 years from 1949 to 1967).

Date: 29th August 1961

Time of Observation Greenwich Mean Time	Dry Bulb °F.	Wet Bulb °F.	Vapour Pressure millibars	Relative Humidity per cent
0000	63	58	14.2	71
0100	63	58	14.1	71
0200	60	56	13.6	77
0300	59	57	14.3	83
0400	58	56	14.2	87
0500	56	54	13.7	89
0600	55	54	13.7	93
0700	58	56	14.6	89
0800	62	59	15.3	81
0900	72	63	15.8	59
1000	75	64	15.3	51
1100	76	66	17.0	55
1200	78	67	18.3	56
1300	80	68	17.7	50
1400	79	67	17.6	52
1500	83	68	16.7	43
1600	80	66	15.7	44
1700	77	66	17.2	54
1800	75	66	18.1	61
1900	72	64	17.0	64
2000	69	62	15.5	64
2100	66	62	17.0	79
2200	63	60	16.8	84
2300	65	60	16.1	77

Note: One noteworthy feature of the weather at Turnhouse Airport on 29th August 1961 is that the temperature of 83°F. recorded at 1500 hours was associated with an average wind speed as high as 23 m.p.h. from direction 190 degrees i.e. the fresh southerly winds had a long track over the high ground to the south of the Airport.

TABLE 2K

HOURLY TEMPERATURE READINGS ON A VERY COLD NIGHT IN EDINBURGH

Hourly Decline and Increase of Air Temperature at Turnhouse Airport on the night of 14th/15th February 1966 with Associated Values of Wet Bulb Temperature, Vapour Pressure and Relative Humidity. (The minimum air temperature of 1°F. recorded by a self-registering minimum thermometer at Turnhouse Airport during the night of 14th/15th February 1966 is the lowest air temperature recorded at the Airport during the 19 years from 1949 to 1967).

Time of Observation Greenwich Mean Time	Dry Bulb °F.	Wet Bulb °F.	Vapour Pressure millibars	Relative Humidity per cent
Date: 14th February 1966				
1200	34	31	5.0	76
1300	32	30	5.1	84
1400	32	31	5.4	86
1500	31	30	5.3	90
1600	31	30	5.3	90
1700	28	27	4.8	94
1800	28	28	4.9	93
1900	23	23	4.0	96
2000	19	19	3.3	93
2100	17	17	3.0	93
2200	16	16	2.8	92
2300	13	13	2.5	90
Date: 15th February 1966				
0000	6	6	1.7	87
0100	4	4	1.6	86
0200	5	5	1.6	86
0300	11	11	2.0	78
0400	11	11	2.1	82
0500	12	12	2.3	86
0600	13	13	2.4	87
0700	14	13	2.4	84
0800	14	14	2.5	87
0900	20	19	2.9	80
1000	26	26	4.5	94
1100	29	29	5.0	90
1200	33	30	4.6	73

Note: An examination of the thermograph records for Turnhouse Airport reveals that the minimum temperature of 1°F. occurred between 0100 and 0200 hours on 15th February 1966. The surface wind at Turnhouse Airport was calm (speed less than 1 m.p.h.) throughout the entire night period of 14th/15th February 1966.

TABLE 2L

AVERAGES AND EXTREMES OF SOIL TEMPERATURE IN DEGREES FAHRENHEIT FROM READINGS MADE ONCE-DAILY AT 0900 HOURS G.M.T. FROM THERMOMETERS EXPOSED AT DEPTHS OF FOUR INCHES AND EIGHT INCHES BELOW A SURFACE OF BARE SOIL AT EAST CRAIGS, CORSTORPHINE - ALTITUDE 200 FEET

(Type of soil: 18 inches of medium loam)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
At 4 inches													
Monthly Mean of Daily Readings	34.2	35.7	38.3	43.5	50.9	57.5	59.0	56.9	53.0	46.2	39.4	35.6	45.9
Absolute Highest Daily Reading	43.7	45.5	48.2	55.0	60.6	68.9	67.1	67.0	60.1	55.0	49.0	46.3	68.9
Absolute Lowest Daily Reading	24.7	26.5	31.8	34.0	41.9	48.4	51.1	49.8	42.4	35.9	30.2	28.4	24.7
At 8 inches													
Monthly Mean of Daily Readings	35.1	36.5	39.0	43.1	49.8	56.6	58.4	57.0	53.7	47.8	41.1	36.7	46.2
Absolute Highest Daily Reading	42.8	45.0	47.1	53.2	59.1	68.0	65.3	65.0	60.1	55.4	48.7	47.9	68.0
Absolute Lowest Daily Reading	29.2	30.5	32.2	32.6	42.4	48.8	50.3	51.2	46.2	39.4	33.1	31.4	29.2

Note:

1. The averages and extremes of soil temperature quoted above are based on only 10 years of records i.e. from 1958 to 1967.

TABLE 2M

AVERAGES AND EXTREMES OF EARTH TEMPERATURE IN DEGREES FAHRENHEIT FROM READINGS MADE ONCE-DAILY AT 0900 HOURS G.M.T. FROM THERMOMETERS EXPOSED AT DEPTHS OF ONE FOOT AND FOUR FEET UNDER A SHORT GRASS-COVERED SURFACE AT THE ROYAL BOTANIC GARDEN, PENICUIK AND BUSH HOUSE

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Royal Botanic Garden, Edinburgh - altitude 74 feet													
(Soil: Black soil 18" deep, sandy below)	At One Foot (30 cm.)												
Monthly Mean of Daily Readings	36.9	36.9	39.9	45.1	51.1	56.7	59.7	59.2	55.2	49.1	42.4	39.0	47.7
Highest Monthly Mean of Daily Readings	38.5	39.7	44.4	47.8	54.5	59.9	62.6	62.6	58.3	51.1	44.2	40.8	62.6
Lowest Monthly Mean of Daily Readings	33.4	32.7	36.3	43.3	50.7	55.6	57.6	56.1	53.2	48.6	41.2	35.8	32.7
Absolute Highest Daily Reading	43.0	45.0	46.8	51.8	58.5	63.9	66.0	66.4	61.0	57.7	49.6	47.1	66.4
Absolute Lowest Daily Reading	31.5	31.8	28.9	38.8	45.5	51.4	54.7	53.8	47.7	41.0	35.2	32.2	28.9
Penicuik - altitude 620 feet													
(Soil: Friable loam with sandy subsoil)	At One Foot (30 cm.)												
Monthly Mean of Daily Readings	36.3	36.1	38.8	43.2	49.3	55.0	57.9	57.7	54.0	48.2	41.7	37.9	46.4
Highest Monthly Mean of Daily Readings	37.9	38.1	42.4	46.0	53.8	60.3	59.9	60.6	56.7	50.7	44.2	41.5	60.6
Lowest Monthly Mean of Daily Readings	33.6	32.2	31.6	41.2	47.7	53.2	54.9	54.5	51.6	46.2	39.0	34.5	31.6
Absolute Highest Daily Reading	44.4	43.3	46.6	50.5	57.7	66.0	64.8	64.8	60.1	56.1	49.6	46.0	66.0
Absolute Lowest Daily Reading	32.2	31.6	30.4	35.1	40.8	49.6	52.2	52.3	46.4	38.8	34.2	33.1	30.4

TABLE 2M (contd.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Bush House - altitude 605 feet (Soil: Light loam with gravel beneath)													
						At One Foot (30 cm.)							
Monthly Mean of Daily Readings	35.8	36.0	38.7	43.5	49.6	56.1	59.5	58.8	54.3	47.8	41.4	37.6	46.6
Highest Monthly Mean of Daily Readings	37.2	38.5	43.2	45.7	51.8	57.9	62.6	62.4	57.0	50.0	43.2	39.2	62.6
Lowest Monthly Mean of Daily Readings	33.1	32.5	34.5	41.0	48.4	54.0	55.8	54.7	52.3	47.5	39.7	35.4	32.5
Absolute Highest Daily Reading	42.1	41.7	46.0	49.5	59.2	62.6	66.4	66.7	60.3	54.7	48.2	46.0	66.7
Absolute Lowest Daily Reading	31.8	31.6	30.6	36.0	44.2	48.9	52.0	51.6	48.0	39.9	34.2	33.3	30.6
						At Four Feet (122 cm.)							
Monthly Mean of Daily Readings	39.4	38.3	39.4	42.3	46.8	51.6	55.2	56.8	55.8	51.4	46.6	42.3	47.1
Highest Monthly Mean of Daily Readings	40.3	38.8	41.9	44.1	48.0	53.1	56.1	59.4	57.4	53.2	47.7	43.3	59.4
Lowest Monthly Mean of Daily Readings	37.6	36.0	36.9	39.9	45.3	50.2	52.5	54.0	53.4	50.7	45.1	39.7	36.0
Absolute Highest Daily Reading	41.7	39.9	43.0	46.0	50.4	55.0	59.4	59.9	59.7	55.0	50.5	45.9	59.9
Absolute Lowest Daily Reading	36.3	35.4	34.9	37.6	43.3	47.3	51.3	53.6	52.2	48.6	41.5	38.8	34.9

Notes:

1. The periods of records of earth temperature readings which have been used to calculate the averages and extremes in Table 2M are as follows:

   Royal Botanic Garden = 13 years from 1953 to 1965
   Penicuik = 15 years from 1944 to 1950 and from 1953 to 1960
   Bush House = 11 years from 1955 to 1965

2. Readings of Earth Temperature at a depth of 4 feet are not available from the Royal Botanic Garden and Penicuik.

3. The standard period for Averages of Earth Temperature in current use in the Meteorological Office is the 30 years from 1931 to 1960. It can be seen from Note 1 above that actual records are not available for the complete 30 year period. Accordingly the "Monthly Means of Daily Readings" have been obtained by applying a small adjustment to the means obtained from the periods of available records to relate them to the standard period.

4. The "Highest and Lowest Monthly Means" and the "Absolute Highest and Lowest Daily Readings" relate to the actual periods of records shown in Note 1 above.

5. The "Highest and Lowest Monthly Means of Daily Readings" relate to the single January, February, March etc. which had the highest or lowest monthly mean of daily readings during the periods shown in Note 1.

6. The "Absolute Highest and Lowest Daily Readings" are the absolute highest and lowest daily readings recorded during the periods shown in Note 1.

TABLE 2N

TOTAL NUMBER OF DAYS IN EACH MONTH WITH AN HOURLY AIR TEMPERATURE READING OF LESS THAN 35.6°F BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
							Number of Days						
1958	15	13	18	7	0	0	0	0	0	1	7	9	70
1959	25	11	7	3	0	0	0	0	0	1	3	6	56
1960	21	20	6	2	0	0	0	0	1	3	7	16	76
1961	12	7	4	4	0	0	0	0	0	1	13	23	64
1962	11	13	18	8	0	0	0	0	0	2	11	19	82
1963	28	28	8	3	0	0	0	0	0	2	8	11	88
1964	7	12	15	2	0	0	0	0	2	8	9	15	70
1965	18	17	17	5	1	0	0	0	0	7	16	17	98
1966	16	15	6	10	0	0	0	0	0	4	9	11	71
1967	9	8	4	5	1	0	0	0	0	4	7	12	50
10 year mean	16.2	14.4	10.3	4.9	0.2	0.0	0.0	0.0	0.3	3.3	9.0	13.9	72.5

TOTAL NUMBER OF HOURS BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME IN EACH MONTH WITH AIR TEMPERATURES LESS THAN 35.6°F AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
							Number of Hours						
1958	110	76	73	18	0	0	0	0	0	2	23	67	369
1959	190	79	13	3	0	0	0	0	0	2	9	24	320
1960	98	131	18	2	0	0	0	0	1	5	35	114	404
1961	56	20	6	7	0	0	0	0	0	1	39	190	319
1962	55	44	65	10	0	0	0	0	0	5	67	116	362
1963	198	206	28	8	0	0	0	0	0	4	40	64	548
1964	44	45	38	2	0	0	0	0	3	14	40	101	287
1965	113	76	79	5	2	0	0	0	0	13	96	83	467
1966	108	109	11	22	0	0	0	0	0	7	31	54	342
1967	63	22	6	5	1	0	0	0	0	5	25	88	215
10 year mean	103.5	80.8	33.7	8.2	0.3	0.0	0.0	0.0	0.4	5.8	40.5	90.1	363.3
10 year mean expressed as percentage of total working time	33%	29%	11%	3%	<1%	0%	0%	0%	<1%	2%	14%	29%	10%

TABLE 20

TOTAL NUMBER OF DAYS IN EACH MONTH WITH AN HOURLY AIR TEMPERATURE READING OF LESS THAN 33.6°F BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
						Number of Days							
1958	14	11	14	5	0	0	0	0	0	1	6	8	59
1959	22	10	5	1	0	0	0	0	0	1	2	4	45
1960	11	19	5	2	0	0	0	0	0	2	7	14	60
1961	7	4	3	3	0	0	0	0	0	0	9	21	47
1962	7	6	16	3	0	0	0	0	0	1	10	16	59
1963	23	26	6	1	0	0	0	0	0	2	7	8	73
1964	6	6	9	1	0	0	0	0	1	4	8	13	48
1965	11	9	13	1	1	0	0	0	0	3	15	11	64
1966	11	13	4	6	0	0	0	0	0	1	6	6	47
1967	8	4	2	5	1	0	0	0	0	1	5	11	37
10 year mean	12.0	10.8	7.7	2.8	0.2	0.0	0.0	0.0	0.1	1.6	7.5	11.2	53.9

TOTAL NUMBER OF HOURS BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME IN EACH MONTH WITH AIR TEMPERATURES LESS THAN 33.6°F AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
						Number of Hours							
1958	96	63	51	8	0	0	0	0	0	1	14	43	276
1959	151	49	6	1	0	0	0	0	0	1	6	14	228
1960	48	87	10	2	0	0	0	0	0	3	24	91	265
1961	34	9	3	5	0	0	0	0	0	0	23	146	220
1962	39	16	44	3	0	0	0	0	0	2	38	83	225
1963	112	135	22	3	0	0	0	0	0	2	32	44	350
1964	34	21	15	1	0	0	0	0	1	7	35	57	171
1965	69	40	52	1	1	0	0	0	0	4	66	57	290
1966	61	75	6	12	0	0	0	0	0	3	22	42	221
1967	43	14	4	5	1	0	0	0	0	1	14	68	150
10 year mean	68.7	50.9	21.3	4.1	0.2	0.0	0.0	0.0	0.1	2.4	27.4	64.5	239.6
10 year mean expressed as percentage of total working time	22%	18%	7%	1%	<1%	0%	0%	0%	<1%	1%	9%	21%	7%

TABLE 2P

TOTAL NUMBER OF DAYS IN EACH MONTH WITH AN HOURLY AIR TEMPERATURE READING OF LESS THAN 31.6°F BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
						Number of days							
1958	11	9	12	3	0	0	0	0	0	0	4	6	45
1959	19	6	2	1	0	0	0	0	0	0	1	2	31
1960	6	15	3	0	0	0	0	0	0	0	5	11	40
1961	6	2	0	3	0	0	0	0	0	0	7	16	34
1962	6	2	12	3	0	0	0	0	0	0	6	10	39
1963	12	17	5	1	0	0	0	0	0	0	6	5	46
1964	5	5	2	1	0	0	0	0	1	2	5	8	29
1965	10	7	6	1	0	0	0	0	0	0	11	7	42
1966	9	4	1	3	0	0	0	0	0	1	4	5	27
1967	6	3	1	1	0	0	0	0	0	0	3	10	24
10 year mean	9.0	7.0	4.4	1.7	0.0	0.0	0.0	0.0	0.1	0.3	5.2	8.0	35.7

TOTAL NUMBER OF HOURS BETWEEN 0700 AND 1700 HOURS GREENWICH MEAN TIME IN EACH MONTH WITH AIR TEMPERATURES LESS THAN 31.6°F AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
						Number of Hours							
1958	72	39	28	5	0	0	0	0	0	0	11	28	183
1959	111	37	2	1	0	0	0	0	0	0	4	8	163
1960	22	60	6	0	0	0	0	0	0	0	16	75	179
1961	25	2	0	3	0	0	0	0	0	0	12	95	137
1962	29	7	31	3	0	0	0	0	0	0	25	42	137
1963	68	81	20	1	0	0	0	0	0	0	23	33	226
1964	28	16	5	1	0	0	0	0	1	2	26	35	114
1965	50	28	22	1	0	0	0	0	0	0	37	35	173
1966	42	19	1	5	0	0	0	0	0	2	12	26	107
1967	22	8	1	1	0	0	0	0	0	0	7	48	87
10 year mean	46.9	29.7	11.6	2.1	0.0	0.0	0.0	0.0	0.1	0.4	17.3	42.5	150.6
10 year mean expressed as percentage of total working time	15%	11%	4%	1%	0%	0%	0%	0%	<1%	<1%	6%	14%	4%

TABLE 20

TABLE FOR CONVERTING DEGREES FAHRENHEIT TO DEGREES CENTIGRADE

°F	°C	°F	°C	°F	°C
0	minus 17.8	32	0.0	64	17.8
2	minus 16.7	34	1.1	66	18.9
4	minus 15.6	36	2.2	68	20.0
6	minus 14.4	38	3.3	70	21.1
8	minus 13.3	40	4.4	72	22.2
10	minus 12.2	42	5.6	74	23.3
12	minus 11.1	44	6.7	76	24.4
14	minus 10.0	46	7.8	78	25.6
16	minus 8.9	48	8.9	80	26.7
18	minus 7.8	50	10.0	82	27.8
20	minus 6.7	52	11.1	84	28.9
22	minus 5.6	54	12.2	86	30.0
24	minus 4.4	56	13.3	88	31.1
26	minus 3.3	58	14.4		
28	minus 2.2	60	15.6		
30	minus 1.1	62	16.7		

3. RELATIVE HUMIDITY

In the Edinburgh area as elsewhere in the British Isles, the relative humidity reaches 90 per cent or thereabouts on most nights of the year. As an approximate rule, the highest values of relative humidity occur in association with the lowest air temperatures of the day, i.e. usually around dawn, while the lowest values of relative humidity occur in association with the highest air temperatures of the day, i.e. usually in the middle of the afternoon. The main departures from this general rule occur in misty or foggy weather or when rain is falling.

In addition to the well marked diurnal range of relative humidity, there is also a change from season to season and the mean relative humidity is highest during the winter months and lowest in the months of April to June.

When averaged over a long period, there is no significant difference in relative humidity from place to place in the Edinburgh area although considerable differences can exist at a particular time of day depending on the local weather prevailing at the time. For example, if as happens on some occasions, the lower lying parts of the city are shrouded in mist or fog while the higher southern outskirts are in sunshine, then clearly the relative humidity in the city will be higher than in the outskirts. The direction and penetration of local sea breezes is also a factor which should be kept in mind because the onset of a sea breeze, particularly during the spring and summer months, can lead to a marked drop in air temperature coinciding with a sharp rise in relative humidity.

During the summer in Edinburgh, high values of relative humidity are seldom associated with high values of air temperature and therefore "muggy" days with warm damp air are rare. On the other hand, during the winter and spring months, fresh easterly winds on days with high relative humidities and low air temperatures bring a touch of "rawness" to the climate.

In the Meteorological Office, values of relative humidity are obtained from simultaneous readings of dry and wet bulb temperatures registered by thermometers exposed outdoors inside a ventilated thermometer screen at a height of four feet

above ground level. Thus, depending on heating, ventilation and other factors, considerable differences can occur between the relative humidity outdoors and the relative humidity indoors. The heating season in Edinburgh and other places in Scotland often lasts considerably longer than it does in Southern England and although no systematic records are available, experience suggests that the general level of relative humidity inside buildings, particularly centrally-heated buildings, is lower in Edinburgh during the heating season than it is in the South.

Averages and Extremes of Relative Humidity and Air Temperature for each hour of the day are given on a monthly basis in Table 3. These data are based on hourly values recorded at Turnhouse Airport, the only location in Edinburgh for which this type of information is available.

The Percentage Amounts of Time with Relative Humidities between Certain Limits are given in Table 3A.

The Percentage Amounts of Time with Wet Bulb Temperatures between Certain Limits are given in Table 3B.

The Absolute Highest Values of Wet Bulb Temperature and the Highest Values of Wet Bulb Temperature Associated with Relative Humidities of 100 per cent are given in Table 3C.

TABLE 3

HOURLY AVERAGES AND EXTREMES OF AIR TEMPERATURE AND RELATIVE HUMIDITY FOR TURNHOUSE (EDINBURGH) AIRPORT - FROM HOURLY OBSERVATIONS MADE AT EACH HOUR ON THE HOUR DURING THE 10 YEARS FROM 1957 TO 1966

Time of Observation G.M.T.	JANUARY						FEBRUARY						Time of Observation G.M.T.
	Air Temperature °F			Relative Humidity per cent			Air Temperature °F			Relative Humidity per cent			
	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	
0000	36	56	12	87	100	59	37	51	6	85	100	48	0000
0100	36	55	13	87	100	60	36	51	4	85	100	55	0100
0200	36	55	12	87	100	61	36	52	5	86	100	53	0200
0300	35	54	12	87	100	61	36	52	11	86	100	63	0300
0400	35	54	13	87	100	60	36	52	11	86	100	53	0400
0500	35	54	12	87	100	61	36	52	12	86	100	58	0500
0600	35	54	13	87	100	60	36	52	13	86	100	64	0600
0700	35	53	14	87	100	62	36	53	13	87	100	63	0700
0800	35	53	13	87	100	64	36	53	13	86	100	54	0800
0900	35	53	13	86	100	58	36	53	15	85	100	58	0900
1000	36	54	16	85	100	56	38	53	17	83	100	54	1000
1100	38	54	20	83	100	50	40	54	20	79	100	43	1100
1200	39	56	21	82	100	51	41	56	23	77	100	45	1200
1300	40	57	24	80	100	50	42	57	25	75	100	34	1300
1400	40	56	23	79	100	56	42	58	27	75	100	34	1400
1500	40	58	25	80	100	53	42	56	28	76	100	35	1500
1600	39	57	23	82	100	57	41	55	27	77	100	38	1600
1700	38	56	19	84	100	54	40	55	24	80	100	31	1700
1800	37	55	16	85	100	56	39	53	19	82	100	41	1800
1900	37	55	15	85	100	54	38	53	14	84	100	46	1900
2000	37	56	15	85	100	60	38	53	11	84	100	40	2000
2100	36	56	13	86	100	57	37	52	10	85	100	42	2100
2200	36	56	13	86	100	61	37	50	9	85	100	48	2200
2300	36	54	12	86	100	60	37	50	10	85	100	49	2300
Average for Month	37	-	-	85	-	-	38	-	-	83	-	-	
Extremes for Month	-	58	12	-	100	50	-	58	4	-	100	31	

TABLE 3 (Contd.)

Time of Observation G.M.T.	MARCH Air Temperature °F Average °F	MARCH Air Temperature °F Absolute Maximum °F	MARCH Air Temperature °F Absolute Minimum °F	MARCH Relative Humidity per cent Average %	MARCH Relative Humidity per cent Absolute Maximum %	MARCH Relative Humidity per cent Absolute Minimum %	APRIL Air Temperature °F Average °F	APRIL Air Temperature °F Absolute Maximum °F	APRIL Air Temperature °F Absolute Minimum °F	APRIL Relative Humidity per cent Average %	APRIL Relative Humidity per cent Absolute Maximum %	APRIL Relative Humidity per cent Absolute Minimum %	Time of Observation G.M.T.
0000	40	55	21	85	100	53	42	56	27	85	100	57	0000
0100	39	54	22	85	100	55	42	55	26	86	100	56	0100
0200	39	53	19	86	100	56	41	56	25	87	100	54	0200
0300	39	52	16	86	100	56	41	55	23	88	100	57	0300
0400	39	52	17	86	100	51	41	54	24	88	100	57	0400
0500	38	52	15	86	100	49	41	53	24	88	100	60	0500
0600	38	52	16	87	100	58	41	53	24	88	100	42	0600
0700	38	52	14	86	100	57	42	54	26	86	100	54	0700
0800	39	52	16	85	100	58	44	55	27	82	100	49	0800
0900	41	54	19	82	100	45	46	57	31	77	100	53	0900
1000	42	57	24	78	100	45	48	61	33	73	100	37	1000
1100	44	61	27	74	99	40	49	63	34	70	100	41	1100
1200	45	66	30	71	98	29	50	66	31	68	100	38	1200
1300	46	68	31	70	98	25	50	68	35	67	100	34	1300
1400	46	68	32	70	98	24	51	68	36	66	100	33	1400
1500	46	67	31	70	97	28	51	67	35	67	100	31	1500
1600	45	65	32	71	97	33	50	67	35	67	100	24	1600
1700	45	65	31	73	98	27	49	66	33	69	100	38	1700
1800	43	60	30	76	98	30	48	63	33	72	99	41	1800
1900	42	57	27	80	98	40	47	61	31	76	100	43	1900
2000	41	55	25	82	98	45	45	58	32	80	100	47	2000
2100	41	53	25	82	99	51	44	57	31	82	100	52	2100
2200	40	53	22	83	100	49	43	55	30	84	100	48	2200
2300	40	53	21	84	100	50	43	55	28	85	100	61	2300
Average for Month	41	-	-	80	-	-	45	-	-	78	-	-	
Extremes for Month	-	68	14	-	100	24	-	68	23	-	100	24	

TABLE 3 (Contd.)

Time of Observation G.M.T.	MAY						JUNE						Time of Observation G.M.T.
	Air Temperature °F			Relative Humidity per cent			Air Temperature °F			Relative Humidity per cent			
	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	
0000	46	56	33	86	100	62	51	63	36	88	100	59	0000
0100	45	57	33	87	100	56	51	62	33	89	100	57	0100
0200	45	57	33	88	100	54	50	62	33	90	100	56	0200
0300	44	55	32	88	100	61	50	62	32	90	100	56	0300
0400	44	55	31	89	100	63	49	61	34	91	100	60	0400
0500	44	55	30	89	100	63	50	62	36	90	100	59	0500
0600	45	56	32	87	100	57	51	63	39	88	100	61	0600
0700	48	57	33	83	100	50	53	64	43	84	100	50	0700
0800	50	59	35	78	100	43	55	66	45	79	100	51	0800
0900	51	63	38	74	100	38	57	69	46	75	100	45	0900
1000	53	67	38	71	100	37	58	71	46	72	100	39	1000
1100	54	70	39	69	100	31	59	74	47	70	100	35	1100
1200	55	72	40	67	100	30	60	76	47	68	99	36	1200
1300	55	73	41	65	100	35	60	78	47	67	99	35	1300
1400	56	73	42	65	99	34	61	78	47	67	98	31	1400
1500	56	74	42	66	98	35	60	78	47	67	98	31	1500
1600	55	74	41	67	99	28	60	79	47	68	100	32	1600
1700	54	74	41	68	99	34	60	79	47	69	100	32	1700
1800	53	73	41	70	100	33	59	76	47	71	100	38	1800
1900	52	70	40	73	100	35	57	75	45	74	100	40	1900
2000	50	65	40	77	100	41	56	71	45	78	100	43	2000
2100	49	60	39	81	100	46	54	66	45	82	100	53	2100
2200	48	58	36	83	100	52	53	65	45	85	100	51	2200
2300	47	57	35	85	100	58	52	64	42	87	100	57	2300
Average for Month	50	-	-	77	-	-	55	-	-	79	-	-	
Extremes for Month	-	74	30	-	100	28	-	79	32	-	100	31	

TABLE 3 (Contd.)

Time of Observation G.M.T.	JULY Air Temperature °F Average °F	Absolute Maximum °F	Absolute Minimum °F	JULY Relative Humidity per cent Average %	Absolute Maximum %	Absolute Minimum %	AUGUST Air Temperature °F Average °F	Absolute Maximum °F	Absolute Minimum °F	AUGUST Relative Humidity per cent Average %	Absolute Maximum %	Absolute Minimum %	Time of Observation G.M.T.
0000	53	64	42	89	100	55	53	67	41	90	100	67	0000
0100	52	63	40	90	100	67	53	67	39	90	100	68	0100
0200	52	63	39	91	100	55	52	66	38	91	100	70	0200
0300	51	63	40	91	100	58	52	66	37	91	100	71	0300
0400	51	63	38	91	100	66	52	66	37	91	100	64	0400
0500	52	64	39	91	100	63	52	66	36	92	100	61	0500
0600	53	66	41	89	100	61	52	65	37	91	100	65	0600
0700	55	67	45	85	100	51	53	66	39	90	100	68	0700
0800	57	68	49	80	100	52	56	68	44	85	100	58	0800
0900	58	69	50	76	100	42	58	72	50	80	100	47	0900
1000	59	73	50	73	100	47	59	75	51	76	100	48	1000
1100	60	75	50	72	100	43	60	76	51	74	100	48	1100
1200	61	77	49	70	99	38	61	78	52	72	99	45	1200
1300	62	77	49	68	100	31	61	80	51	71	99	43	1300
1400	62	78	49	68	100	37	62	79	51	71	98	33	1400
1500	62	78	47	68	99	35	62	83	50	70	100	39	1500
1600	62	78	47	69	99	37	61	80	50	71	98	37	1600
1700	61	79	46	70	99	39	61	77	50	73	100	42	1700
1800	60	77	46	72	100	43	59	75	49	75	100	44	1800
1900	59	73	46	75	100	39	58	72	49	79	100	50	1900
2000	58	71	46	79	100	53	56	69	47	83	100	57	2000
2100	56	67	45	83	100	62	55	67	46	86	100	58	2100
2200	55	64	45	86	100	63	54	67	45	88	100	60	2200
2300	54	64	44	87	100	64	54	67	43	89	100	62	2300
Average for Month	57	-	-	80	-	-	57	-	-	82	-	-	
Extreme for Month	-	79	38	-	100	31	-	83	36	-	100	33	

TABLE 3 (Contd.)

Time of Observation G.M.T.	SEPTEMBER						OCTOBER						Time of Observation G.M.T.
	Air Temperature °F			Relative Humidity per cent			Air Temperature °F			Relative Humidity per cent			
	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	
0000	51	63	35	89	100	65	47	58	32	89	100	58	0000
0100	51	63	34	90	100	64	47	59	30	89	100	61	0100
0200	50	63	34	90	100	65	47	59	30	89	100	60	0200
0300	50	63	34	90	100	66	46	59	30	89	100	60	0300
0400	50	63	31	90	100	67	46	60	30	89	100	59	0400
0500	50	64	31	91	100	68	46	60	29	89	100	60	0500
0600	49	64	30	91	100	69	46	60	29	89	100	55	0600
0700	50	63	31	90	100	67	46	61	28	90	100	60	0700
0800	52	63	35	88	100	65	47	61	27	88	100	58	0800
0900	55	67	40	83	100	59	49	62	32	86	100	55	0900
1000	57	70	48	78	99	53	51	64	36	83	100	50	1000
1100	58	71	49	74	99	49	53	66	38	79	100	52	1100
1200	59	72	46	72	99	48	53	69	41	77	100	45	1200
1300	59	75	48	71	100	41	54	75	42	75	100	44	1300
1400	59	76	47	70	100	37	54	76	42	74	100	40	1400
1500	59	76	48	71	100	36	54	75	41	75	100	43	1500
1600	59	75	48	72	100	38	53	73	40	77	100	50	1600
1700	58	73	48	74	100	42	52	69	38	80	100	51	1700
1800	57	71	47	78	100	48	50	67	35	83	100	56	1800
1900	55	64	44	82	100	50	49	62	34	85	100	62	1900
2000	53	63	43	85	100	53	48	61	33	86	100	56	2000
2100	53	64	41	87	100	64	48	61	31	87	100	60	2100
2200	52	64	40	88	100	63	47	59	31	88	100	58	2200
2300	51	64	37	89	100	65	47	59	31	88	100	60	2300
Average for Month	54	-	-	83	-	-	49	-	-	84	-	-	
Extreme for Month	-	76	30	-	100	36	-	76	27	-	100	40	

TABLE 3 (Contd.)

Time of Observation G.M.T.	NOVEMBER						DECEMBER						Time of Observation G.M.T.
	Air Temperature °F			Relative Humidity per cent			Air Temperature °F			Relative Humidity per cent			
	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average %	Absolute Maximum %	Absolute Minimum %	
0000	41	56	21	88	100	56	37	52	14	87	100	61	0000
0100	41	56	22	89	100	61	37	52	13	87	100	62	0100
0200	41	55	22	89	100	51	37	53	13	87	100	57	0200
0300	40	55	21	89	100	52	37	53	13	87	100	49	0300
0400	40	55	21	89	100	55	37	54	9	87	100	51	0400
0500	40	55	21	88	100	59	37	52	9	86	100	57	0500
0600	40	54	19	88	100	57	37	54	9	86	100	57	0600
0700	40	54	20	89	100	57	37	54	11	86	100	54	0700
0800	40	56	21	88	100	59	37	51	15	87	100	41	0800
0900	41	56	21	88	100	59	37	51	16	87	100	43	0900
1000	42	57	25	86	100	49	38	51	18	86	100	53	1000
1100	44	58	28	84	100	47	39	52	22	84	100	53	1100
1200	45	57	28	82	100	41	40	53	25	82	100	54	1200
1300	45	57	27	80	100	46	41	53	27	81	100	54	1300
1400	46	58	30	80	99	50	41	54	28	81	100	50	1400
1500	45	56	29	81	100	51	40	53	27	83	100	50	1500
1600	44	56	28	83	100	59	39	53	25	85	100	59	1600
1700	43	56	26	85	100	58	38	52	23	85	100	48	1700
1800	42	56	23	86	100	61	38	53	20	85	100	43	1800
1900	42	56	22	87	100	59	38	54	15	86	100	55	1900
2000	41	56	21	87	100	56	38	53	15	87	100	56	2000
2100	41	55	22	88	100	54	38	53	14	86	100	60	2100
2200	41	56	22	88	100	59	37	53	14	86	100	58	2200
2300	41	55	22	89	100	57	37	52	14	87	100	53	2300
Average for Month	42	-	-	86	-	-	38	-	-	85	-	-	
Extreme for Month	-	58	19	-	100	41	-	54	9	-	100	41	

TABLE 3A

PERCENTAGE AMOUNT OF TIME WITH RELATIVE HUMIDITY BETWEEN CERTAIN LIMITS AT TURNHOUSE (EDINBURGH) AIRPORT - 10 years from 1957 to 1966

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
	%	%	%	%	%	%	%	%	%	%	%	%	%
0-20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-24%	0.0	0.0	0.0+	0.0+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0+
25-29%	0.0	0.0	0.1	0.0	0.0+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0+
30-34%	0.0	0.1	0.1	0.1	0.1	0.1	0.0+	0.0+	0.0	0.0	0.0	0.0	0.0+
35-39%	0.0	0.1	0.5	0.3	0.6	0.5	0.1	0.0+	0.1	0.0	0.0	0.0	0.2
40-44%	0.0	0.2	0.6	1.1	0.9	1.0	0.4	0.2	0.1	0.1	0.0+	0.1	0.4
45-49%	0.0	0.5	1.1	2.1	2.2	2.3	1.6	1.0	0.2	0.1	0.1	0.0+	0.9
50-54%	0.1	0.6	2.2	3.6	3.9	4.2	3.7	2.5	1.4	0.6	0.2	0.2	1.9
55-59%	0.4	1.6	3.3	4.6	5.5	5.4	5.6	3.8	3.2	1.5	0.7	0.4	3.0
60-64%	1.2	3.2	5.1	6.1	7.5	6.8	5.6	5.1	5.3	2.8	1.5	1.4	4.3
65-69%	3.7	5.9	6.9	7.3	8.3	6.9	7.4	5.8	6.6	4.7	3.2	3.2	5.8
70-74%	7.3	8.3	8.9	9.1	9.6	8.3	9.2	7.2	7.2	6.9	5.6	5.5	7.8
75-79%	12.9	12.5	12.2	11.1	11.4	9.7	9.8	9.9	9.8	11.7	9.3	11.1	10.9
80-84%	17.9	17.9	15.6	14.1	12.5	12.0	11.8	11.3	13.4	16.0	14.9	19.9	14.8
85-89%	23.0	20.3	17.7	15.5	14.0	13.9	14.8	16.8	17.8	20.2	21.6	23.4	18.3
90-94%	21.0	17.0	15.9	14.6	13.5	13.8	15.2	19.3	18.3	18.0	23.6	20.4	17.6
95-98%	10.5	8.9	8.7	7.9	7.4	10.1	11.4	14.0	13.0	12.6	15.7	11.9	11.0
99%	1.1	0.9	0.6	1.3	1.3	2.8	2.3	2.1	2.2	2.5	2.6	1.5	1.8
100%	0.9	2.0	0.5	1.2	1.3	2.2	1.1	1.0	1.4	2.3	1.0	1.0	1.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 3B

PERCENTAGE AMOUNT OF TIME WITH WET BULB TEMPERATURES BELOW CERTAIN LIMITS - DEGREES FAHRENHEIT at TURNHOUSE (EDINBURGH) AIRPORT - 9 years 1952-1960

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
	%	%	%	%	%	%	%	%	%	%	%	%	%
32°F or below	31.3	30.2	10.8	4.1	0.6	0.0	0.0	0.0	0.3	2.1	8.3	16.3	8.6
34°F or below	43.0	44.2	18.8	7.6	1.6	0.0	0.0	0.0	0.5	3.8	11.8	23.9	12.8
36°F or below	55.6	57.0	29.1	12.3	3.3	0.1	0.0	0.0	0.7	5.4	17.2	33.5	17.7
38°F or below	66.5	66.9	42.1	20.9	6.2	0.5	0.0	0.1	1.5	9.1	24.9	46.7	23.6
40°F or below	75.4	74.4	56.3	31.9	10.4	1.4	0.2	0.4	3.1	14.3	36.4	60.3	30.2
42°F or below	82.2	81.1	69.1	45.5	16.6	3.4	0.5	1.0	5.9	20.0	49.3	71.9	37.0
44°F or below	88.2	87.1	81.3	58.5	26.1	6.6	1.3	2.0	9.5	28.3	64.5	80.9	44.3
46°F or below	92.8	92.2	89.9	72.3	38.8	14.0	2.6	4.0	15.1	40.2	77.2	87.3	52.0
48°F or below	96.8	96.8	95.2	83.4	55.0	25.4	5.8	8.1	24.7	53.6	87.3	92.5	60.2
50°F or below	99.2	99.3	97.8	92.2	72.2	40.1	12.6	16.4	37.1	68.2	95.0	96.7	68.8
52°F or below	99.9	99.9	99.5	97.4	83.8	54.8	23.5	29.9	52.7	80.8	98.4	98.7	76.5
54°F or below	100.0	100.0	99.8	99.2	91.6	70.5	41.4	44.7	66.9	89.8	99.9	99.7	83.6
56°F or below			100.0	99.7	96.1	83.5	62.6	66.2	79.3	95.2	100.0	100.0	89.9
58°F or below				99.8	97.9	91.4	80.3	78.9	89.5	97.7			94.7
60°F or below				100.0	99.3	95.1	89.6	89.1	95.5	99.2			97.4
62°F or below					99.9	97.9	94.9	95.7	98.1	99.9			99.0
64°F or below					99.9	99.4	97.5	97.9	99.3	100.0			99.6
66°F or below					100.0	99.9	99.0	99.4	99.7				99.9
68°F or below						99.9	99.7	99.8	99.9				99.9
70°F or below						100.0	99.9	100.0	100.0				99.9
72°F or below							99.9						99.9
74°F or below							100.0						100.0

TABLE 3C

Absolute Highest Values of Wet Bulb Temperature and Highest Values of Wet Bulb Temperature Associated with Relative Humidities of 100 per cent extracted from Hourly Readings of Wet Bulb Temperature made at TURNHOUSE (EDINBURGH) AIRPORT during the 9 years from 1952 to 1960 - (degrees Fahrenheit)

	Absolute Highest Value of Wet Bulb Temperature	Highest Value of Wet Bulb Temperature Associated with Relative Humidity of 100 per cent
	°F.	°F.
January	54	52
February	54	52
March	56	54
April	60	54
May	66	62
June	70	66
July	74	66
August	70	66
September	70	66
October	64	62
November	56	56
December	56	56
Year	74	66

4. SUNSHINE

In common with other places on the east coast of Scotland, Edinburgh has a good sunshine record especially when its northerly latitude is taken into account. The average duration of sunshine in Edinburgh per year is very similar to the average duration in central London. For example, the annual average durations for Blackford Hill and the Royal Botanic Garden are 1,384 hours and 1,330 hours respectively, compared with the London districts of Kingsway and Regents Park which have 1,359 hours and 1,353 hours per year respectively. There is a seasonal difference between Edinburgh and London in that Edinburgh has a longer duration of sunshine during the winter and early spring but London has the better record in the summer.

Monthly Average and Daily Mean Durations of Sunshine for a number of places in the Edinburgh area are given in Table 4. The standard period for sunshine averages in current use in the Meteorological Office is the 30 years from 1931 to 1960. The averages quoted for Blackford Hill in Table 4 are actual averages over this period of 30 years but the averagesquoted for the other locations have been estimated from shorter periods or broken periods of records.

Edinburgh is a hilly city and it should be realised that all the sunshine recorder sites for which averages are quoted in Table 4 have relatively free horizons with no obstructing hills, buildings or trees (with an elevation exceeding about 3 degrees) to cut off the sunshine.

It can be seen from Table 4 that at unobstructed sites there is not a great deal of difference in the duration of sunshine between one place and another in the Edinburgh area. Local patches of low cloud enveloping the crests of the Pentland Hills are probably responsible for the lower durations at Boghall and Balerno but Blackford Hill at a lower elevation does not seem to suffer appreciably from this effect.

Blackford Hill has a slightly longer duration of sunshine than lower lying places in Edinburgh. This is partly due to the fact that atmospheric pollution over the lower lying and more densely built-up parts of the city reduces the amount

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of sunshine particularly during the winter months when more fuel is used for heating purposes. However, in fairness to Edinburgh, it should be mentioned that the loss of sunshine in Edinburgh because of atmospheric pollution is only a fraction of that lost in cities like Glasgow and London. For example, as mentioned earlier, the central London district of Regents Park has an annual average sunshine duration of 1,353 hours compared with an annual average of 1,516 hours for Croydon on the southern outskirts of London. A secondary cause of the difference between the sunshine durations at Blackford Hill and locations in the lower lying districts of Edinburgh may be that lower lying areas, particularly districts near to the Firth of Forth are rather more prone to the incidence of sea fog ("haar") than is Blackford Hill.

Statistics of Monthly and Annual Sunshine Durations for Blackford Hill based on recordings made during the 67 years from 1901 to 1967 are given in Table 4A.

Frequencies of Daily Durations and Maximum Daily Durations of Sunshine are given for Turnhouse Airport in Table 4B.

The path of the sun across the sky depends on the latitude and the time of year. Figure 2 is a solar chart for Edinburgh (latitude 56 degrees North) which shows the altitude and azimuth of the sun at various times of day, for the solstices, equinoxes and for certain intermediate dates. For a given site, the various obstructions can be plotted on the chart and their effect in cutting off the sun's radiation at various times can then be evaluated. For example, it can be seen from Figure 2 that at 8.30 a.m. on 23rd August, the sun is at an altitude of 30 degrees with an azimuth of 117 degrees. It can also be seen that on 22nd December, the maximum altitude of the sun is $10\frac{1}{2}$ degrees at 12 noon with an azimuth of 180 degrees. Thus, in midwinter, a hill to the south in Edinburgh with an altitude greater than $10\frac{1}{2}$ degrees would cut off practically all the sunshine. A good example of this "cut-off" effect in winter is Swanston Village at the foot of the northern slopes of the Pentlands but there are several other places in the Edinburgh area where the sunshine is obstructed by nearby hills or ridges e.g. the area immediately to the north of Blackford Hill.

TABLE 4

Averages of Sunshine Duration in Hours - Monthly Totals and Daily Means over 30 year period from 1931 to 1960 at places in the EDINBURGH Area

	Jan. hr.	Feb. hr.	Mar. hr.	Apr. hr.	May hr.	Jun. hr.	Jul. hr.	Aug. hr.	Sep. hr.	Oct. hr.	Nov. hr.	Dec. hr.	Year hr.
BLACKFORD HILL - altitude 441 feet													
Monthly Total	54	76	111	146	181	188	162	143	126	96	57	44	1,384
Daily Mean	1.75	2.69	3.57	4.85	5.84	6.26	5.23	4.62	4.21	3.10	1.91	1.41	3.79
BOGHALL - altitude 639 feet													
Monthly Total	49	70	100	136	168	173	147	133	114	87	54	37	1,268
Daily Mean	1.58	2.48	3.23	4.53	5.41	5.78	4.74	4.30	3.80	2.82	1.80	1.19	3.48
ROYAL BOTANIC GARDEN - altitude 74 feet													
Monthly Total	44	65	97	145	181	188	169	146	125	88	50	32	1,330
Daily Mean	1.42	2.31	3.14	4.83	5.85	6.27	5.44	4.70	4.17	2.83	1.66	1.03	3.64
DAVIDSON'S MAINS - altitude 200 feet													
Monthly Total	47	71	101	142	174	175	151	135	117	87	54	39	1,293
Daily Mean	1.52	2.54	3.26	4.72	5.60	5.85	4.88	4.35	3.89	2.82	1.79	1.24	3.54
TURNHOUSE AIRPORT - altitude 114 feet													
Monthly Total	47	71	101	142	181	183	159	135	119	87	54	36	1,315
Daily Mean	1.53	2.53	3.26	4.72	5.85	6.09	5.14	4.36	3.96	2.79	1.81	1.17	3.60
LIBERTON - altitude 200 feet													
Monthly Total	51	78	110	141	166	172	151	146	124	95	54	26	1,314
Daily Mean	1.63	2.78	3.55	4.70	5.35	5.74	4.88	4.70	4.15	3.06	1.81	.85	3.60
BALERNO - altitude 700 feet													
Monthly Total	46	69	101	140	183	187	158	139	115	88	51	37	1,314
Daily Mean	1.48	2.48	3.27	4.67	5.91	6.24	5.10	4.48	3.82	2.84	1.72	1.18	3.60

TABLE 4A

STATISTICS OF MONTHLY AND ANNUAL SUNSHINE DURATIONS FOR THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH
(Period of Record = 67 years from 1901 to 1967)

Statistics of Monthly Sunshine Durations

Month	Highest Sunshine Duration	Sunshine Duration Seldom* Above	Median†	Sunshine Duration Seldom* Below	Lowest Sunshine Duration
January	83 hours in January 1959	61 hours	51 hours	40 hours	18 hours in January 1917
February	125 hours in February 1907	86 hours	71 hours	57 hours	41 hours in February 1940
March	176 hours in March 1929	128 hours	109 hours	92 hours	58 hours in March 1928 and 1964
April	225 hours in April 1914	172 hours	142 hours	109 hours	85 hours in April 1941
May	248 hours in May 1955	205 hours	179 hours	138 hours	108 hours in May 1933
June	278 hours in June 1940	224 hours	191 hours	149 hours	77 hours in June 1912
July	291 hours in July 1955	186 hours	159 hours	140 hours	99 hours in July 1931
August	225 hours in August 1947	174 hours	144 hours	120 hours	58 hours in August 1912
September	185 hours in September 1906	148 hours	131 hours	106 hours	64 hours in September 1962
October	139 hours in October 1931	113 hours	100 hours	83 hours	44 hours in October 1960
November	99 hours in November 1947	69 hours	61 hours	52 hours	33 hours in November 1912
December	65 hours in December 1929	52 hours	46 hours	35 hours	16 hours in December 1912

Statistics of Annual Sunshine Durations

Period of Record	Highest Annual Sunshine Duration	Annual Sunshine Duration Seldom* Above	Median†	Annual Sunshine Duration Seldom* Below	Lowest Annual Sunshine Duration
67 years	1738 hours in 1955	1455 hours	1378 hours	1279 hours	1071 hours in 1912

*Seldom = 20 per cent of occasions or one year in 5; the figures given are the upper and lower quintiles.
†Median = the "middle" value, i.e. half the sunshine durations exceed it and half fall below it.

TABLE 4B

FREQUENCIES OF DAILY SUNSHINE DURATIONS IN HOURS AT TURNHOUSE (EDINBURGH) AIRPORT (17 YEARS FROM 1951 TO 1967)

Limits of Daily Durations	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	All Months
(Hours)							(Days)						
16.1 to 17.0													0
15.1 to 16.0					1	1	3						5
14.1 to 15.0					12	16	13						41
13.1 to 14.0					9	15	10	4					38
12.1 to 13.0				5	19	27	12	11					74
11.1 to 12.0			1	26	30	22	18	14					111
10.1 to 11.0			5	17	39	22	27	22	10				142
9.1 to 10.0		1	9	33	34	36	23	28	20	3			187
8.1 to 9.0		7	29	37	33	22	30	20	34	23	1		236
7.1 to 8.0		15	34	42	37	34	33	39	41	29	1		305
6.1 to 7.0	11	28	33	37	31	30	36	35	40	42	18		341
5.1 to 6.0	30	29	45	31	38	36	43	33	36	39	28	14	402
4.1 to 5.0	35	43	34	43	50	32	44	46	45	39	31	34	476
3.1 to 4.0	41	52	39	46	35	36	32	49	46	42	57	54	529
2.1 to 3.0	56	44	45	50	24	38	48	38	42	65	47	52	549
1.1 to 2.0	65	52	54	40	36	44	44	49	54	48	66	56	608
0.1 to 1.0	101	88	80	62	54	48	67	72	70	105	99	118	964
Days with No Sunshine	188	121	119	41	45	51	44	67	72	92	162	199	1201
Total Number of Days in 17 years	527	480	527	510	527	510	527	527	510	527	510	527	6209

Example: In the 17 Januarys during the years from 1951 to 1967, there was a total of 30 days on which the daily sunshine duration was between 5.1 and 6.0 hours.

ABSOLUTE MAXIMUM DAILY DURATIONS OF SUNSHINE RECORDED AT TURNHOUSE (EDINBURGH) AIRPORT IN EACH MONTH DURING THE 17 YEARS FROM 1951 TO 1967

Month		Absolute Maximum Daily Duration	Date(s) of Occurrence
January	=	7.0 hours	on 25th January 1953 and 24th January 1959
February	=	9.1 hours	on 23rd February 1963
March	=	11.2 hours	on 28th March 1957
April	=	12.9 hours	on 22nd April 1953 and 21st April 1965
May	=	15.1 hours	on 22nd May 1957
June	=	15.1 hours	on 3rd June 1963
July	=	15.6 hours	on 4th July 1952
August	=	13.7 hours	on 2nd August 1957
September	=	11.0 hours	on 7th September 1955
October	=	9.6 hours	on 5th October 1962
November	=	8.1 hours	on 4th November 1955
December	=	5.8 hours	on 27th December 1965

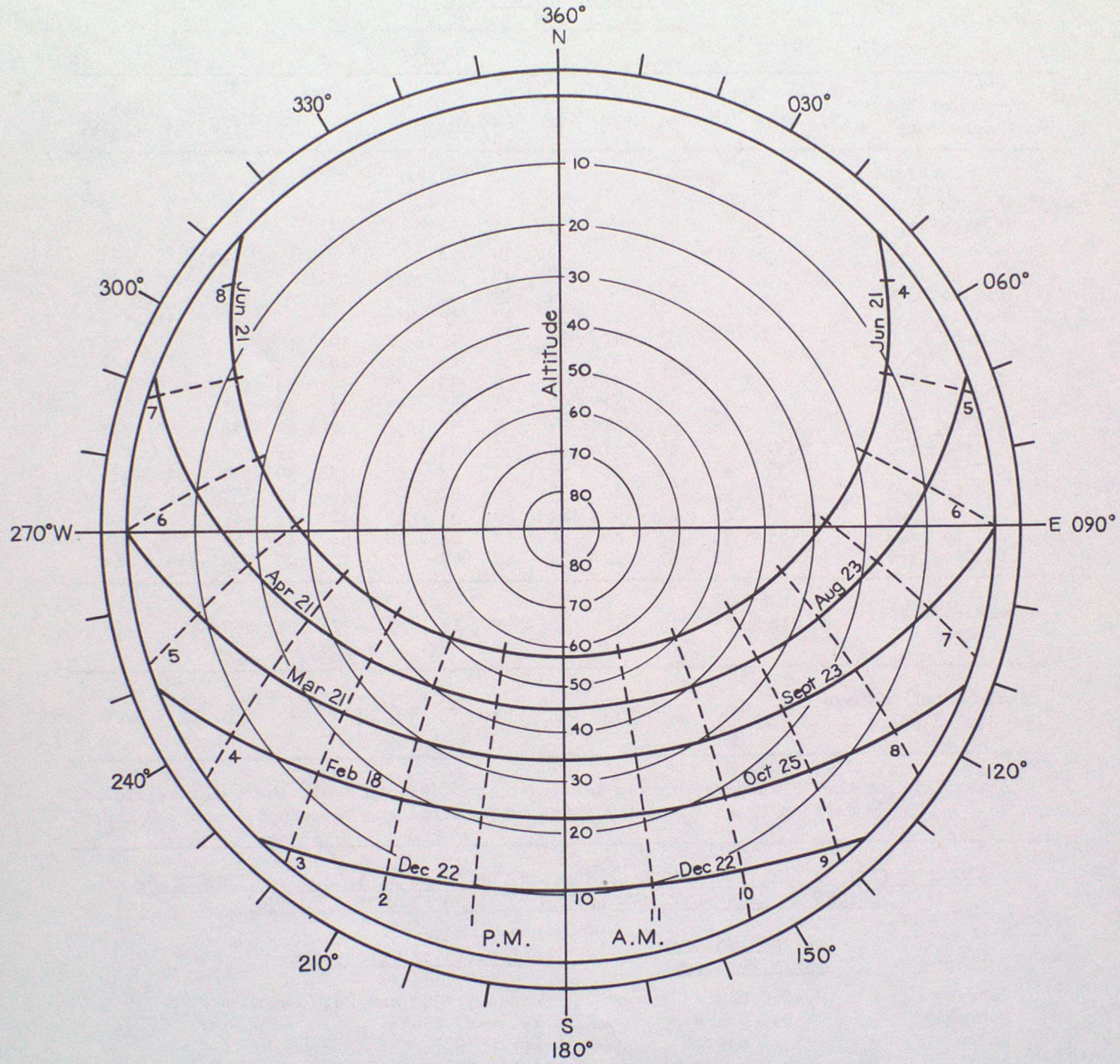

Fig 2. SOLAR CHART FOR EDINBURGH Latitude 56°N

5. WINDS

At an open level site in the Edinburgh area, the average wind speed is about 12 mph, which is high compared with averages for other cities in the British Isles. The topography of the city exposes much of it to the full effect of the wind, and local increases in the general wind speed are experienced on ridges or where features of the landscape form a wind funnel. It is not surprising, therefore, that visitors to the city, especially city dwellers from the south, find Edinburgh "a windy place".

It is difficult to generalise about the winds in the built-up area of any city as the winds near the ground tend to follow the directions of the streets, being channelled up or down the streets between the buildings on either side and giving rise to gustiness at street intersections and corners. Buildings act as wind breaks so reducing the mean speed of strong winds, and in the more densely built-up parts of a city the hourly mean speeds may be of the order of 10 mph lower than in the more exposed outskirts. However, although buildings tend to reduce the mean wind speed, the "rough" surface of a built-up area increases the gustiness and the maximum gust speeds may well approximate to those experienced at an open site on the fringe of the built-up area.

In a hilly city like Edinburgh the picture is even more complicated, for in addition to the local effects produced by buildings and streets, there is a considerable variation in shelter from the wind from place to place depending on the lie and orientation of the high ground. Moreover, in addition to some twenty 18-hole golf courses within the city boundary, there are numerous open spaces in Edinburgh and the overall "openness" of the city is well demonstrated by the fact that less than half a million people occupy a municipal area of about 52 square miles compared with Glasgow where a population of about one million occupy about 60.5 square miles.

Thus the "open" nature of the city, the wide streets, and the fact that the high ridges within the city are orientated in a roughly west to east direction adds support to the contention that strong winds from a westerly point are able to bring something like their full effect into the heart of the city.

At Turnhouse Airport which is a fairly flat "open" site on the western boundary of the city, surface winds from directions between about south-west and west are

/abnormally

abnormally strong, but the Pentland Hills immediately to the south of the Airport give some shelter to strong winds from the south. Considerably stronger winds are recorded at the Royal Observatory at Blackford Hill which lies on a very exposed ridge at an altitude of 450 feet on the south side of the city but the wind directions at Blackford Hill are broadly similar to those at Turnhouse Airport. However, there is one marked difference in that very strong winds from the south are experienced at Blackford Hill and some of the highest gusts on record at the Royal Observatory come from a southerly point; this is no doubt due to the fact that the Pentland Hills end rather abruptly at Hillend just to the south of Blackford Hill, and in contrast to Turnhouse Airport, winds from the south have a comparatively long uninterrupted fetch over undulating country.

Annual wind direction frequencies for Turnhouse Airport and Blackford Hill show that about 45 to 50 per cent of all winds blow from directions in the quadrant between south and west. However, in common with other places on the east coast of Scotland, both locations show a remarkably high frequency of winds from between north-east and east in the spring and early summer, and during this period of the year the frequency of easterly winds can be higher than winds from any other point of the compass.

Although the Royal Observatory at Blackford Hill lies on an exposed ridge, the site of the wind recording instrument is sheltered to the east by the Observatory buildings. It is unfortunate that Turnhouse Airport is also rather sheltered to the east because there is little doubt that places on east-facing ridges, exposed places along the Forth coastline and on the eastern fringe of Edinburgh, experience much high speeds from the east than those recorded at Blackford Hill and Turnhouse Airport.

A rather unpleasant characteristic of the winds in Edinburgh, particularly in districts on the southern and western outskirts of the city, is the very high gustiness of winds blowing from the quadrant between south and west. Indeed, fine sunny days in the summer are often marred by the boisterous nature of the winds. The gustiness is usually greatest in the middle of the afternoon when the speed reached in gusts is often twice the average wind speed. In contrast, easterly winds usually blow at a steady speed with a relative absence of gustiness.

/The

The Exceptionally Severe Gale of 15 January 1968

The westerly gale which affected the central belt of Scotland during the early hours of 15 January 1968 was the worst in living memory and caused enormous damage and considerable loss of life. Nineteen people were killed during the gale, nine in Glasgow alone, and further fatalities occurred to workmen repairing roof damage in the extremely difficult weather conditions which followed the gale.

Greenock, Glasgow and many other towns in the Clyde/Forth Valley were particularly hard-hit and the damage to buildings alone has been assessed at £18m. In addition, some 17,000 acres of woodland, representing about 40m. cubic feet of timber, were devastated.

In Edinburgh as elsewhere, the main damage was to the roofs of buildings particularly to tiled roofs and the chimney stacks of many buildings were lost or badly damaged, especially those of houses on the more exposed ridges to the west and south of the city. The gale also took a heavy toll of trees and woodland in Edinburgh and the surrounding districts.

Continuous recordings of wind directions and speeds from places in the central belt are very few and far between and the only location in the Edinburgh area for which detailed records of the directions and speeds during the night of 14/15 January 1968 are available is the Meteorological Office at Turnhouse Airport. The directions and speeds recorded at Turnhouse Airport are quoted in Table 5C.

It can be seen from Table 5C that the gale reached its peak strength between 0400 and 0500 hours GMT on 15 January 1968 with an average wind speed at Turnhouse Airport over this period of 60 minutes, of 71 mph from direction 250 degrees (west-south-west) and a highest gust of 104 mph at 0430 hours GMT.

A wind recording instrument maintained by the Harbour Authorities at Leith and sited on the harbour wall near the entrance to Newhaven Harbour recorded a highest gust during the gale of 111 mph but the highest hourly mean speed of 66 mph recorded at Newhaven was rather less than the 71 mph recorded at Turnhouse Airport.

Another privately-maintained wind recording instrument sited on the centre span of the Forth Road Bridge, about 240 feet above the waters of the Forth, recorded a

/highest

highest hourly mean speed of 78 mph but at the height of the gale during the early hours of 15 January 1968, the instrument at the Bridge was not switched to the extended scale and therefore the precise value of the highest gust was not registered by the recording pen. However, the highest gust recorded at the Bridge was at least 108 mph.

In the complete absence of detailed and reliable wind records from places in the central belt of Scotland over a very long period of years, it is very difficult to assess the frequency with which a gale of the severity of that experienced on 15 January 1968 is likely to occur. However, judged on the basis of the recorded highest hourly mean speeds, the gale during the early hours of 15 January 1968 is something like a once-in-100 years occurrence or perhaps an even more rare event.

Extreme Wind Speeds

The most detailed and complete records of wind direction and speed are provided by an anemograph, i.e. an instrument which gives a continuous record of wind direction and speed in the form of inked traces on a graduated chart. The inked traces are analysed on a routine basis to obtain values of wind direction and speed averaged over each hour of the day and night together with certain information about the frequency and speed of high gusts of wind.

At the Meteorological Office at Turnhouse Airport, an anemograph was first brought into operation on 1 January 1962 and therefore the period of anemograph records available from the Airport is very short. Before 1962, the Meteorological Office at Turnhouse Airport was equipped with a type of instrument which registered wind directions and speeds on dials only, in contrast to the permanent traces of direction and speed provided by an anemograph. Thus, the wind records available from the Airport before January 1962 are relatively brief and "non-continuous" consisting mainly of average directions and speeds observed from the dials at the routine time of weather observations.

An anemograph was first brought into commission at the Royal Observatory on Blackford Hill in 1915 although there are some rather serious gaps in the records for some years. Due to the installation of a new telescope at the Observatory, the anemograph had to be dismantled and recordings were terminated in March 1967. A suitable alternative site with a similar exposure has not yet been found.

/In

In the absence of detailed wind records over a very long period of years, values of extreme wind speeds are usually obtained from a statistical treatment of the highest hourly mean wind speeds (i.e. the highest wind speeds averaged over the 60 minutes between hours) and the highest gusts recorded by an anemograph in each year over a reasonably long period. The period of anemograph records available from Turnhouse Airport is too short to permit a reliable statistical treatment of this type although the reader will have noted (from Table 5C) the highest hourly mean speed and highest gust recorded at the Airport during the gale of 15 January 1968. However, about 50 years of anemograph records are available from the Royal Observatory and a statistical treatment of the highest hourly mean speeds and highest gusts recorded at the Observatory in each year up to the termination of the records in March 1967 yields the following results:-

A. Maximum Hourly Mean Wind Speeds at 33 feet (10 metres) above the ground likely to be exceeded on the average only once in the stated number of years:

10 years	20 years	50 years	100 years
59 mph	62 mph	66 mph	69 mph

B. Maximum Gust Speeds at 33 feet (10 metres) above the ground likely to be exceeded on the average only once in the stated number of years:

10 years	20 years	50 years	100 years
99 mph	103 mph	110 mph	114 mph

Clearly, it is highly desirable that any set of extreme wind speeds for Edinburgh should take into account the very high speeds of 15 January 1968. In this respect it is unfortunate that wind recordings at the Royal Observatory were terminated in March 1967 and that the period of records used to determine the maximum speeds at 'A' and 'B' above does not include 15 January 1968. However, it would be reasonable to assume that the maximum wind speeds experienced at the Observatory on 15 January 1968 were at least as high as those recorded at Turnhouse Airport and it is considered that a better estimate of extreme wind speeds for Edinburgh can be obtained by combining the maximum speeds recorded at the Observatory in each year during the 50 years ending in March 1967 with the maximum speeds recorded at Turnhouse Airport on 15 January 1968. A statistical treatment of these "combined" records yields the following results:-

/C.

C. Maximum Hourly Mean Wind Speeds at 33 feet (10 metres) above the ground likely to be exceeded on the average only once in the stated number of years:

10 years	20 years	50 years	100 years
60 mph	64 mph	69 mph	72 mph

D. Maximum Gust Speeds at 33 feet (10 metres) above the ground likely to be exceeded on the average only once in the stated number of years:

10 years	20 years	50 years	100 years
99 mph	104 mph	111 mph	115 mph

This would seem an appropriate point at which to remind the reader of the meaning of the values at 'A' 'B' 'C' and 'D' above. For example, the maximum gust speed at 33 feet above the ground likely to be exceeded on the average only once in 50 years is often referred to as the "1 in 50 year gust" but is actually that gust which is likely to be exceeded with a probability of 0.02 = $\frac{1}{50}$ (or a 2 per cent probability) in any one year. Similarly, the "1 in 100 year" maximum hourly mean speed is that speed likely to be exceeded with a probability of 0.01 = $\frac{1}{100}$ (or a 1 per cent probability) in any one year.

Earlier in this Report, some very general observations were made about the behaviour of winds in built-up areas but as far as Edinburgh is concerned, there is no way of knowing at the present time whether the apparently sheltered or more densely built-up parts of the city do in fact experience extreme gust speeds appreciably less than those recorded at places like the Royal Observatory and Turnhouse Airport which lie on the outskirts. Moreover, the unusually rugged topography of Edinburgh and its environs and the large areas of open ground within the city add to the complexity of the problem. However, one very clear lesson to be learnt from the damage to buildings which occurred in the gale of 15 January 1968 and previous severe gales is that very strong winds, particularly high gusts of wind, are able to bring something like their full effect into quite densely built-up areas in or near the heart of the city.

Estimation of Maximum Wind Speeds for Building Design Purposes

In his paper on "Extreme Wind Speeds over the United Kingdom for periods ending

/1963"

1963" (11), H. C. Shellard points out that the current British Standards Institution "Code of Practice" concerned with the calculation of wind loadings on buildings is being revised. The new draft code is nearing publication and until it becomes available, Local Authorities have been advised to use the Building Research Station Digest (12) which largely duplicates the new draft code as it now exists. Both documents specify a wind "averaging time" which has been associated by B.R.S. with the maximum dimensions (length or height) of a building or structure. The "averaging time" is 3 seconds for buildings whose largest dimensions are less than 20 metres (66 feet), 5 seconds for buildings in the range of dimensions from 20 metres to 50 metres, and 15 seconds for buildings whose largest dimensions exceed 50 metres (164 feet). An averaging time of 3 seconds is also used for cladding, glazing, roofing and fixing of all buildings irrespective of size.

Estimation of Maximum Wind Speeds averaged over short periods of time

A wind speed averaging time is the time interval over which an average wind speed has been taken. Thus, a "3 second gust" means "a gust with an averaging time of 3 seconds" and this is the average speed of the wind in a 3 second period. Similarly, the hourly mean wind speed has an averaging time of 1 hour and a 15 second "gust" or 15 second wind speed are synonymous with an average wind speed in a 15 second period of time. The standard anemograph is designed so that in 1 hour the paper graph or chart moves only one inch and in this period of time the wind speed fluctuates so rapidly and with such an amplitude that it is not practicable to extract average values for a period as short say as 1 minute or 15 seconds. However, hourly mean speeds can be measured with comparative ease and the largest speed deflection in a given period of time, called a "gust", can also be read from the graph. It is thought that for high values, this gust represents an average speed over a period of 2 or 3 seconds and is thus referred to as the "3 second gust". As has been seen, these two quantities (hourly mean speed and 3 second gust) have been analysed statistically at 'A', 'B', 'C' and 'D' above.

In order to obtain speeds averaged over a time interval between 1 hour and 3 seconds, use has been made of a series of special measurements which, in the first instance, were analysed to calculate the ratio of the wind speed averaged over a

/given

given period of seconds to the hourly mean speed. These data have shown that if the ratio of the 3 second maximum gust to the maximum hourly mean speed is known, then so also is the ratio of the maximum 5 second or 15 second gust to the maximum hourly mean speed. It should also be borne in mind that the roughness of the environment is reflected in the ratio of the maximum gust to the maximum hourly mean speed and Shellard has used these data to classify four categories of environment which are described in the B.R.S. Digest as follows:-

Category 1 - Level surfaces with no significant obstructions, e.g. grassland, moorland and farmland with only scattered trees or low hedges.

Category 2 - Rolling or level surfaces broken by obstructions such as dense hedges, scattered windbreaks of trees and occasional buildings up to two storeys.

Category 3 - Surfaces covered by numerous large obstructions, e.g. parkland and farmland with numerous woods and large windbreaks of tall trees; towns and outskirts of large cities.

Category 4 - Surfaces broken by very large and frequent obstructions e.g. centres of large cities.

In the B.R.S. Digest and the new code of practice, however, the 3 second gust speed of 33 ft above the ground in open level country, which is likely to be exceeded on the average only once in 50 years, is taken as the starting point, and the values of the wind speed averaged over other short periods of time are related to this basic 3 second gust speed. For simplicity, the effects of the different averaging times and the separate environmental influences are combined to provide factors with which to multiply the basic 3 second speed to obtain design wind speeds for the four categories of environment and the three "building sizes" associated by B.R.S. with the winds averaged over 3 seconds, 5 seconds and 15 seconds. The resulting estimate, however, applies to a height of 33 ft (10 metres) above ground level only, and further adjustments have to be made to obtain the design winds at other heights.

Corrections to Extreme Wind Speeds for heights in excess of 33 feet (10 metres) above ground level

The method of estimating extreme wind speeds at heights other than 33 feet

/(10 metres)

(10 metres) above the ground is to use a well established formula for strong winds called the "power law profile" formula:-

$$V_H = V_{33}\left(\frac{H}{33}\right)^{\alpha} \quad \left(\text{or } V_H = V_{10}\left(\frac{H}{10}\right)^{\alpha}\right)$$

where

H is the height in feet at which a speed V_H is required

V_{33} is the speed already known for 33 feet above the ground, and

α is called the power law exponent.

(The formula in brackets is the appropriate equivalent when heights are measured in metres, and $V_{33} = V_{10}$ if both are measured in the same unit of speed e.g. mph).

The power law exponent varies with surface roughness and also with averaging time. Typically, in open level country the exponent is 0.085 for extreme 3 second gusts and 0.17 for extreme hourly mean speeds but Shellard has used varying values for the exponent in combination with environment and averaging time to obtain a set of factors with which to multiply the maximum 3 second gust speed likely to be exceeded on the average only once in 50 years at 33 feet above ground level in order to obtain estimates of the appropriate design wind speeds at other given heights above ground level.

The reader will notice from the statistics of extreme gust speeds quoted at 'D' above that at the Edinburgh wind recording station, the maximum gust speed likely to be exceeded on the average only once in 50 years at a height of 33 feet above ground level has a value of 111 mph (50 metres per second). However, before proceeding to combine the Shellard factors quoted in the B.R.S. Digest with this values of gust speed, it should be emphasised that because of the openness of the City of Edinburgh, the values quoted for "city exposures" (viz. Category 4 of the B.R.S. Digest) are not applicable to Edinburgh or its environs and it is considered that Edinburgh and the surrounding area are more closely related to Categories 1 to 3 with the following classifications of environment:-

Category 1 - Open fairly level country outside the city boundary i.e. the "country" districts of Midlothian, East Lothian and West Lothian.

Category 2 - Districts on the outskirts of Edinburgh or on or near the fringe of the main built-up areas.

/Category 3

Category 3 - Parts of the City of Edinburgh in which the existing buildings are fairly high and closely packed together, particularly the more densely built-up districts near the city centre.

Basic Design Wind Speeds for Edinburgh

Having established these relationships, design wind speeds for averaging times of 3 seconds, 5 seconds and 15 seconds at given heights above ground level in the Edinburgh area can be calculated by combining the appropriate Shellard factors for each environment Category with the gust speed of 50 metres per second (111 mph). The calculated values are given below at 'E' with heights expressed in metres with the equivalent heights in feet and wind speeds in metres per second with the equivalent speeds in miles per hour.

E. ESTIMATES OF MAXIMUM 3 SECOND, 5 SECOND AND 15 SECOND GUSTS AT SPECIFIED HEIGHTS ABOVE GROUND LEVEL IN EDINBURGH AND THE SURROUNDING DISTRICTS, LIKELY TO BE EXCEEDED ON THE AVERAGE ONLY ONCE IN 50 YEARS

Surface Category		1. Open country in Midlothian, East Lothian and West Lothian						2. Outskirts of Edinburgh or districts on or near the fringe of the main built-up areas						3. More densely built-up areas particularly near city centre					
Height above ground level		3-sec gust		5-sec gust		15-sec gust		3-sec gust		5-sec gust		15-sec gust		3-sec gust		5-sec gust		15-sec gust	
metres	feet	m/s	mph	m/s	mph	m/s	mph	m/s	mph	m/s	mph	m/s	mph	m/s	mph	m/s	mph	m/s	mph
5 or less	16 or less	47	105	44	98	42	94	46	103	43	96	40	90	45	101	42	94	39	87
10	33	50	112	48	107	45	101	49	110	46	103	44	98	47	105	43	96	40	90
15	49	52	116	50	112	47	105	51	114	48	107	46	103	48	107	44	98	42	94
20	66	53	119	51	114	49	110	52	116	49	110	47	105	49	110	46	103	44	98
30	98	55	123	53	119	51	114	54	121	52	116	49	110	53	119	50	112	48	107
40	131	57	128	55	123	53	119	56	125	53	119	51	114	54	121	51	114	49	110
50	164	58	130	56	125	54	121	57	128	54	121	52	116	55	123	52	116	51	114
60	197	58	130	57	128	56	125	57	128	55	123	54	121	56	125	54	121	52	116
80	263	60	134	59	132	57	128	59	132	57	128	55	123	57	128	55	123	54	121
100	328	61	137	60	134	59	132	60	134	58	130	57	128	59	132	56	125	55	123
120	394	62	139	61	137	60	134	61	137	59	132	58	130	60	134	57	128	56	125
140	459	63	141	62	139	61	137	62	139	60	134	59	132	60	134	58	130	57	128
160	525	64	143	63	141	62	139	62	139	61	137	60	134	61	137	59	132	58	130
180	591	64	143	64	143	63	141	63	141	62	139	61	137	62	139	60	134	59	132
200	656	65	145	64	143	64	143	63	141	62	139	62	139	62	139	60	134	60	134

NOTE: In the above table, speeds of half a metre per second have been rounded upwards to the nearest whole metre per second and the speeds in miles per hour are the equivalents of the rounded-up metres per second values.

Effect of Topography

In addition to the set of factors combining roughness of environment, height and averaging time, Shellard also recommends the application of certain factors which are designed to take into account the disturbing influences of local topography. A note of the Shellard topography factors is included in the B.R.S. Digest but for ease of reference the factors are shown below:-

Topography	Factor
Site sheltered topographically from all wind directions	0.9
Flat terrain with no effective topographic shelter	1.0
Site adversely affected by the hill or valley configuration	1.1 or 1.2

Of the three factors listed above, the hill or valley configuration factor of 1.1 or 1.2 would seem to be the most appropriate factor to use for the Edinburgh area as a whole. However, it should be borne in mind that the statistics of maximum wind speeds quoted at 'A', 'B', 'C' and 'D' earlier in this Report are based almost exclusively on wind speeds recorded on the exposed ridge on which the Royal Observatory at Blackford Hill stands. Thus, the statistics already have a "built-in" topographical factor and therefore, in the great majority of cases, no further allowance need be made for topography. Certainly, a factor of 1.2 is unlikely to be called for.

Clearly, the speeds quoted at 'E' (page 87) for the three separate "regions" of the Edinburgh area are very generalised but nevertheless they should provide a good guide for the design of most buildings and building components. However, if there are any unusual features either of exposure and local topography or of the structure itself, advice on the appropriate extreme gust speed to be used may be sought from the Meteorological Office and in these cases the topography factor may be used to increase speeds or decrease speeds as necessary.

Terms used by the Meteorological Office for describing the wind strength

Term	Average speed near the ground
Calm	less than 1 mph (1 knot)
Light	1 to 12 mph (1 to 10 knots)
Moderate	13 to 18 mph (11 to 16 knots)
Fresh	19 to 24 mph (17 to 21 knots)
Strong	25 to 38 mph (22 to 33 knots)
Gale	39 to 46 mph (34 to 40 knots)
Severe Gale	over 46 mph (over 40 knots)

The average speeds quoted above would be considerably exceeded in gusts. For example, in a gale, gusts of over 50 mph are common and may exceed 100 mph at exposed places in a severe gale. A gale warning is issued when the gusts are expected to reach 50 mph or more even if the average speed may be rather less than the limits shown in the above table.

As mentioned previously, the duration of a high gust of wind is of the order of three seconds but nevertheless, gusts are usually responsible for the more common types of "gale damage" e.g. the removal of roof tiles and chimney pots, blown down fences and hoardings, damage to trees, crops and glass window panes etc.

Most gales in Edinburgh blow from directions in the quadrant between south and west but easterly gales, although much less frequent are not uncommon. Details of the very severe westerly gale of 15 January 1968 have already been given in this Report but one of the worst easterly gales in Edinburgh during recent years occurred around midday on 20 January 1963 when the anemograph at Turnhouse Airport recorded a highest hourly mean wind speed of 48 mph from a due easterly direction with a highest gust of 76 mph also from due east. Gales can occur in Edinburgh in any month of the year but the months of December, January and February usually have the highest frequencies and July and August the lowest.

A special mention should be made of winds from directions between about north-west through north round to north-east as strong winds from this sector are sometimes responsible for flooding and other types of damage at low lying

places along the southern coastline of the Firth of Forth, particularly when strong winds from this sector coincide with the times of high water. The strip of coast to the east of Leith is likely to suffer most on these occasions as the north and easterly winds have a longer uninterrupted track over the widening part of the Firth of Forth.

Annual and Monthly Frequencies of Wind Direction and Velocity for Turnhouse Airport are given in Tables 5 and 5A.

The Actual and Average Numbers of Days of Gales at Turnhouse Airport are given in Table 5B.

The Wind Directions and Speeds recorded at Turnhouse Airport during the Very Severe Gale of 15th January 1968 are given in Table 5C.

The Numbers of Days and Hours with Gusts to 39 mph or more and 55 mph or more during the 10 years from 1958 to 1967 are given in Tables 5D and 5E.

The Directions from which High Gusts of Wind blow at the Royal Observatory and Turnhouse Airport are compared in Table 5F.

High Winds as a Factor Interrupting Outdoor Building Work in the Edinburgh Area

Strong winds often lead to hazardous working conditions on building sites particularly at sites where men are working on ladders or have precarious hand and footholds above ground level. Perhaps equally dangerous are the risks to workmen who are handling materials which are likely to be snatched off or blown about by the wind.

With the increasing use of tower cranes in recent years, the incidence of strong winds has become an even more important factor affecting the time lost in building work, because when strong winds are blowing, the tower cranes have to cease operating, the hoisting of building materials is stopped and nearly all work may be brought to a standstill.

It is not possible to decide a precise threshold of wind speed above which work on a building site would be hampered or have to stop, because this will clearly depend on a number of factors including the exposure of the building site, e.g. whether it is sheltered from the wind by nearby buildings, the height above

ground level at which men are working, the type of work, the materials being used etc. Similar considerations would have to be taken into account in trying to assess the probable amount of time in which the use of a tower crane would be restricted or have to cease.

During a gale (average wind speed near the ground of 39 mph or more with frequent gusts to 50 mph or more) tower cranes cannot operate and probably most other types of outdoor building work would be brought to a standstill. However, a gale represents extreme wind conditions and there is no doubt that high gusts of wind of say 40 mph or more associated with average speeds considerably less than 39 mph could also lead to dangerous working conditions and would also seriously restrict the use of tower cranes.

Records showing the incidence of gusts of 40 mph or more in each hour of the working part of the day are not readily available for the Edinburgh area. However, records of average wind speeds observed from anemometer dials at each hour on the hour, are available from Turnhouse Airport over a fairly long period of years.

A study of the average wind speeds and associated gust speeds recorded at Turnhouse Airport reveals that gusts of 40 mph or more, first start to occur when the average wind speed reaches the level of about 20 mph and that gusts to 40 mph or more become quite frequent with average speeds of 25 mph or more. Accordingly, in view of the gusty nature of the winds in Edinburgh and the surrounding districts, statistics showing the incidence of average wind speeds of 25 mph or more should serve as a good indication of the incidence of fairly frequent gusts to 40 mph or more.

Table 5G gives the total number of days at Turnhouse Airport on which an average wind speed of 25 mph or more was recorded between 0700 and 1700 hours Greenwich Mean Time (0800 and 1800 hours British Standard Time) on each day during the 10 years from 1958 to 1967. Table 5G also gives the total number of hours in which average speeds of 25 mph or more were recorded between 0700 and 1700 hours GMT during the same 10 year period. It is considered that the values given in

Table 5G should provide a reasonably reliable guide for planning purposes to the probable amount of time in which outdoor work or the use of tower cranes might be hampered or have to cease at exposed places in the Edinburgh area.

It should be borne in mind when studying Table 5G that the average wind speeds of 25 mph or more were recorded at Turnhouse Airport at a height of 33 feet above ground level and that considerably higher speeds could be experienced at heights in excess of 33 feet above ground level, e.g. on exposed multi-storey buildings or high up on tower cranes. For example, using the power law corrections for height mentioned earlier, an hourly mean speed of 25 mph or more with gusts to 40 mph or more at a height of 33 feet above ground level would become something like an hourly mean speed of 30 mph or more with gusts to 45 mph or more at a height of 150 feet above the ground at an exposed site in Edinburgh. When consulting Table 5G it should be noted that the figures relate to a 7-day working week and not to a 5-day working week.

A table for converting miles per hour to metres per second is at Table 5H.

TABLE 5

ANNUAL PERCENTAGE FREQUENCY OF WIND DIRECTION AND VELOCITY AT TURNHOUSE (EDINBURGH) AIRPORT - (10 YEARS 1957 TO 1966)

Mean Wind Speed (mph)	Wind Directions in Degrees (true)												
	350-10	20-40	50-70	80-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	All Directions
0	-	-	-	-	-	-	-	-	-	-	-	-	15.9%
1- 3	0.3	0.4	0.5	0.4	0.2	0.2	0.2	0.3	0.8	0.9	0.3	0.3	4.8%
4- 7	0.6	1.5	2.3	1.5	0.6	0.4	0.4	0.8	2.7	2.4	0.7	0.5	14.4%
8-12	0.7	2.0	5.2	2.6	1.1	0.6	0.7	2.2	6.5	3.6	0.9	0.8	26.9%
13-18	0.4	0.8	2.8	1.6	0.7	0.3	0.7	3.0	6.8	3.1	0.6	0.4	21.2%
19-24	0.1	0.2	0.7	0.6	0.2	0.1	0.4	2.0	4.5	2.4	0.2	0.1	11.5%
25-31	0^+	0^+	0.1	0.1	0.1	0^+	0.1	0.9	1.7	0.9	0^+	0^+	3.9%
32-38			0^+	0^+	0^+	0^+	0^+	0.3	0.4	0.3	0^+		1.0%
39-46				0^+			0^+	0.1	0.1	0.1			0.3%
47-54							0^+	0^+	0^+	0^+			0.0^+%
55-63								0^+		0^+			0.0^+%
Total	2.1	4.9	11.6	6.8	2.9	1.6	2.5	9.6	23.5	13.7	2.7	2.1	99.9%

Notes

1. Wind directions are measured in degrees from True North and relate to the direction from which the wind is blowing. For example:

Direction	360	degrees	=	wind	blowing	from North
"	090	"	=	"	"	" East
"	180	"	=	"	"	" South
"	270	"	=	"	"	" West

2. Adding the columns of the above table vertically gives the percentage amount of time in the year with winds from the stated directions.

3. Adding the columns of the above table horizontally gives the percentage amount of time in the year with winds in the stated speed ranges.

TABLE 5A

MONTHLY PERCENTAGE FREQUENCIES OF WIND DIRECTION AND VELOCITY AT TURNHOUSE (EDINBURGH) AIRPORT (10 YEARS FROM 1957 TO 1966)

Mean Wind Speed (mph)	Wind Direction in Degrees (True)												All Directions
	350-10	20-40	50-70	80-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	
JANUARY													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	25.2%
4-12	1.5	2.6	2.8	3.2	1.8	1.2	1.1	2.5	9.2	6.9	1.6	1.2	35.6%
13-24	0.8	1.2	1.6	3.2	1.0	0.7	1.5	5.9	11.4	3.1	0.5	0.4	31.3%
25-38		0+	0.1	0.3	0+	0.1	0.4	2.1	2.8	1.2	0.1	0.1	7.2%
39 or more				0.1			0.1	0.2	0.3	0.1			0.8%
Total	2.3	3.8	4.5	6.8	2.8	2.0	3.1	10.7	23.7	11.3	2.2	1.7	100.1%
FEBRUARY													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	22.0%
4-12	1.3	2.3	4.0	5.1	1.7	0.8	0.7	1.8	8.4	6.2	1.8	1.7	35.8%
13-24	0.3	0.7	3.4	5.7	1.5	0.3	0.8	4.4	10.5	4.7	0.9	0.8	34.0%
25-38			0.3	0.3	0.1		0.2	2.2	2.6	1.7	0+	0+	7.4%
39 or more							0+	0.2	0.4	0.4			1.0%
Total	1.6	3.0	7.7	11.1	3.3	1.1	1.7	8.6	21.9	13.0	2.7	2.5	100.2%
MARCH													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	17.1%
4-12	1.2	3.4	8.7	6.1	3.2	1.5	1.5	2.3	5.7	3.6	1.3	1.2	39.7%
13-24	0.5	0.6	5.2	3.9	3.8	0.7	1.3	4.2	10.4	4.8	1.3	0.8	37.5%
25-38			0+	0.2	0.3	0+	0.1	1.0	2.3	1.3	0.1	0+	5.3%
39 or more									0.1	0+			0.1%
Total	1.7	4.0	13.9	10.2	7.3	2.2	2.9	7.5	18.5	9.7	2.7	2.0	99.7%
APRIL													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	16.2%
4-12	1.4	3.3	9.0	4.6	1.7	1.0	1.0	2.7	7.1	5.1	1.6	1.4	39.9%
13-24	0.5	1.0	6.0	4.4	1.0	0.6	1.2	5.4	10.2	6.4	1.0	0.4	38.1%
25-38		0+	0.2	0+	0+	0+	0.2	1.2	2.0	1.7	0+	0+	5.3%
39 or more									0.1	0+			0.1%
Total	1.9	4.3	15.2	9.0	2.7	1.6	2.4	9.3	19.4	13.2	2.6	1.8	99.6%

TABLE 5A Continued

MONTHLY PERCENTAGE FREQUENCIES OF WIND DIRECTION AND VELOCITY AT TURNHOUSE (EDINBURGH) AIRPORT (10 YEARS FROM 1957 TO 1966)

Mean Wind Speed (mph)	Wind Direction in Degrees (True)												All Directions
	350-10	20-40	50-70	80-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	
MAY													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	17.0%
4-12	1.5	4.9	11.7	5.7	1.9	0.7	1.1	3.0	7.4	4.7	1.6	1.6	45.8%
13-24	0.3	1.1	6.2	1.2	0.5	0.4	1.4	5.4	8.2	6.3	1.0	0.3	32.3%
25-38					0+		0.2	1.0	2.0	1.1	0+		4.3%
39 or more								0+	0.1	0.1			0.2%
Total	1.8	6.0	17.9	6.9	2.4	1.1	2.7	9.4	17.7	12.2	2.6	1.9	99.6%
JUNE													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	15.9%
4-12	1.2	5.5	13.6	4.0	0.8	0.5	0.8	3.1	8.2	5.7	1.5	1.1	46.0%
13-24	0.4	1.6	4.5	0.6	0.3	0.1	0.6	4.0	12.3	8.6	0.6	0.3	33.9%
25-38			0.1				0.1	0.9	1.6	1.6			4.3%
39 or more								0.1	0+	0+			0.1%
Total	1.6	7.1	18.2	4.6	1.1	0.6	1.5	8.1	22.1	15.9	2.1	1.4	100.2%
JULY													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	17.7%
4-12	1.2	4.9	11.5	3.3	1.1	0.5	0.6	3.2	11.4	8.0	2.4	1.4	49.5%
13-24	0.1	0.9	4.1	0.5	0.1	0+	0.6	3.3	10.9	8.2	0.6	0.2	29.5%
25-38	0+		0+				0+	0.1	1.6	1.0	0+	0+	2.7%
39 or more									0.1				0.1%
Total	1.3	5.8	15.6	3.8	1.2	0.5	1.2	6.6	24.0	17.2	3.0	1.6	99.5%
AUGUST													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	19.2%
4-12	1.1	4.3	9.3	3.0	1.5	0.9	1.1	3.1	10.3	7.9	1.9	1.1	45.5%
13-24	0.3	1.1	2.9	0.4	0.2	0.3	0.7	4.4	11.8	8.4	0.5	0.4	31.4%
25-38						0+	0+	0.7	2.1	1.1			3.9%
39 or more									0.1	0+			0.1%
Total	1.4	5.4	12.2	3.4	1.7	1.2	1.8	8.2	24.3	17.4	2.4	1.5	100.1%

TABLE 5A Continued

MONTHLY PERCENTAGE FREQUENCIES OF WIND DIRECTION AND VELOCITY AT TURNHOUSE (EDINBURGH) AIRPORT
(10 YEARS FROM 1957 TO 1966)

Mean Wind Speed (mph)	Wind Direction in Degrees (True)												All Directions
	350-10	20-40	50-70	80-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	
SEPTEMBER													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	23.4%
4-12	1.1	2.9	6.7	3.4	1.4	1.3	1.8	4.4	11.2	6.7	1.4	1.3	43.6%
13-24	0.3	0.7	2.1	0.9	0.4	0.6	1.1	5.9	11.0	5.1	0.6	0.2	28.9%
25-38		0+	0.1		0+	0+	0.1	0.8	1.6	0.9	0+		3.5%
39 or more								0.1	0.2	0.1			0.4%
Total	1.4	3.6	8.9	4.3	1.8	1.9	3.0	11.2	24.0	12.8	2.0	1.5	99.8%
OCTOBER													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	22.3%
4-12	1.0	2.6	6.1	4.0	1.7	1.1	1.5	3.6	10.3	4.5	1.0	1.4	38.8%
13-24	0.7	0.5	2.2	1.5	0.9	0.6	0.6	6.1	14.4	5.0	0.5	0.9	33.9%
25-38	0+	0+				0.1	0.2	1.4	2.1	0.7	0.1	0.1	4.7%
39 or more							0+	0.1	0.1	0+			0.2%
Total	1.7	3.1	8.3	5.5	2.6	1.8	2.3	11.2	26.9	10.2	1.6	2.4	99.9%
NOVEMBER													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	26.7%
4-12	1.4	2.7	4.1	3.9	1.7	1.3	1.8	2.9	10.3	5.9	1.6	1.7	39.3%
13-24	0.9	1.1	2.4	2.3	0.6	0.6	1.2	4.8	11.2	2.7	0.9	0.6	29.3%
25-38	0+	0.1	0.2	0.4	0+	0+	0.1	1.4	1.8	0.8	0+		4.8%
39 or more								0.1	0+	0+			0.1%
Total	2.3	3.9	6.7	6.6	2.3	1.9	3.1	9.2	23.3	9.4	2.5	2.3	100.2%
DECEMBER													
Under 4	-	-	-	-	-	-	-	-	-	-	-	-	25.9%
4-12	1.3	2.2	2.2	2.9	1.4	1.0	1.3	3.5	10.9	6.5	1.7	1.0	35.9%
13-24	0.3	0.7	1.7	2.3	0.8	0.4	1.4	6.3	12.6	3.1	0.8	0.5	30.9%
25-38			0.1	0.3	0.1	0+	0.2	1.7	3.1	1.4	0+	0+	6.9%
39 or more							0+	0.2	0.2	0.1			0.5%
Total	1.6	2.9	4.0	5.5	2.3	1.4	2.9	11.7	26.8	11.1	2.5	1.5	100.1%

TABLE 5B

ACTUAL AND AVERAGE NUMBER OF DAYS WITH GALES DURING THE 19 YEARS FROM 1949 TO 1967 AT TURNHOUSE (EDINBURGH) AIRPORT

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
1949	6	4	2	2	0	1	0	1	0	1	0	1	18
1950	0	2	0	0	1	0	0	0	1	2	1	0	7
1951	0	1	0	2	0	0	0	0	0	0	0	4	7
1952	3	1	0	0	0	0	0	1	2	3	0	1	11
1953	3	1	0	2	0	0	0	0	1	0	1	0	8
1954	6	2	0	0	0	0	0	0	0	2	6	7	23
1955	1	2	1	0	1	1	0	0	0	0	0	6	12
1956	3	0	2	0	0	1	0	1	1	0	2	4	14
1957	8	2	1	1	0	0	0	1	1	2	1	3	20
1958	2	2	1	0	2	0	0	0	1	1	0	1	10
1959	1	4	0	0	0	1	0	0	0	0	2	3	11
1960	0	2	0	2	0	1	0	0	0	0	1	1	7
1961	2	3	2	0	0	1	1	1	2	1	0	0	13
1962	5	4	0	1	2	1	0	1	0	0	0	3	17
1963	1	0	2	1	0	0	0	0	1	2	1	1	9
1964	1	2	0	0	2	0	1	0	0	0	0	3	9
1965	1	2	0	1	1	1	0	0	0	1	1	1	9
1966	0	0	2	0	0	1	0	0	1	0	1	1	6
1967	0	4	6	1	0	0	0	0	0	0	0	0	11
19 years average	2	2	1	1	1	1	1	1	1	1	1	2	12

TABLE 5C

THE VERY SEVERE GALE OF 15TH JANUARY 1968

Hourly Mean Wind Directions and Speeds and Speeds of Highest Gusts recorded at the Meteorological Office at Turnhouse (Edinburgh) Airport between 2100 hours GMT on 14 January 1968 and 1500 hours GMT on 15 January 1968

Hour - Greenwich Mean Time	Wind Direction averaged over 60 minutes	Wind Speed averaged over 60 minutes	Highest Gust during 60 minutes
Date: 14 January 1968			
Between 2100 and 2200 hours	From 220 degrees	23 mph	43 mph
" 2200 " 2300 "	" 220 "	29 "	53 "
" 2300 " 2400 "	" 230 "	29 "	54 "
Date: 15 January 1968			
Between 0000 and 0100 hours	From 230 degrees	38 mph	71 mph
" 0100 " 0200 "	" 230 "	51 mph	86 mph
" 0200 " 0300 "	" 230 "	57 "	90 "
" 0300 " 0400 "	" 240 "	63 "	92 "
" 0400 " 0500 "	" 250 "	71 "	104 "
" 0500 " 0600 "	" 260 "	67 "	101 "
" 0600 " 0700 "	" 260 "	60 "	94 "
" 0700 " 0800 "	" 260 "	52 "	83 "
" 0800 " 0900 "	" 260 "	44 "	66 "
" 0900 " 1000 "	" 260 "	40 "	59 "
" 1000 " 1100 "	" 260 "	39 "	62 "
" 1100 " 1200 "	" 260 "	37 "	65 "
" 1200 " 1300 "	" 260 "	33 "	54 "
" 1300 " 1400 "	" 260 "	31 "	50 "
" 1400 " 1500 "	" 260 "	29 "	41 "

Note:

The highest gust of 104 mph was recorded at 0430 hours GMT.

TABLE 5D

NUMBER OF DAYS AND HOURS WITH GUSTS OF 39 MPH OR MORE AT WIND RECORDING STATIONS IN EDINBURGH*
(10 YEARS FROM 1958 TO 1967)

Year		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
1958	Days	7	6	2	2	4	1	0	2	2	9	1	4	40
	Hours	33	18	10	3	19	1	0	6	18	27	6	33	174
1959	Days	4	11	6	10	1	7	4	5	1	8	12	15	84
	Hours	19	118	15	42	5	64	17	25	4	50	63	114	536
1960	Days	7	14	2	6	2	5	0	0	0	2	6	12	56
	Hours	47	57	8	63	7	23	0	0	0	2	35	77	319
1961	Days	8	16	17	1	3	9	5	7	5	13	6	7	97
	Hours	75	129	103	3	39	42	41	48	34	106	30	12	662
1962	Days	16	15	3	5	4	9	2	14	4	9	4	12	97
	Hours	126	140	7	37	43	60	5	89	26	51	7	81	672
1963	Days	5	3	9	6	9	2	0	2	10	10	7	6	69
	Hours	26	17	49	40	61	5	0	4	53	62	62	40	419
1964	Days	10	6	5	10	12	7	10	5	12	3	13	12	105
	Hours	58	45	23	52	89	23	96	26	35	11	87	84	629
1965	Days	14	4	6	7	3	9	1	5	4	5	7	8	73
	Hours	72	31	32	39	23	61	1	27	17	57	50	15	425
1966	Days	9	10	13	3	5	2	1	1	8	2	7	11	72
	Hours	38	55	61	12	29	10	4	9	45	3	47	86	399
1967	Days	5	12	26	10	3	6	4	2	3	15	5	6	97
	Hours	16	126	292	83	13	33	11	4	16	81	32	40	747
10-year means	Days	8.5	9.7	8.9	6.0	4.6	5.7	2.7	4.3	4.9	7.6	6.8	9.3	79.0
	Hours	51.0	73.6	60.0	37.4	32.8	32.2	17.5	23.8	24.8	45.0	41.9	58.2	498.2

*1958 to 1961 - Royal Observatory, Blackford Hill
1962 to 1967 - Turnhouse Airport

TABLE 5E

NUMBER OF DAYS AND HOURS WITH GUSTS OF 55 MPH OR MORE AT WIND RECORDING STATIONS IN EDINBURGH*
(10 YEARS FROM 1958 TO 1967)

Year		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
1958	Days	3	0	0	0	0	0	0	0	1	2	1	1	8
	Hours	7	0	0	0	0	0	0	0	1	2	2	1	13
1959	Days	1	6	0	2	0	1	0	0	0	2	5	4	21
	Hours	5	12	0	2	0	1	0	0	0	2	13	24	59
1960	Days	1	2	0	3	0	1	0	0	4	0	2	3	16
	Hours	2	9	0	26	0	2	0	0	5	0	5	3	52
1961	Days	4	6	3	0	1	1	2	1	2	2	2	1	25
	Hours	13	13	10	0	4	1	4	5	12	10	2	1	75
1962	Days	7	6	0	1	2	1	0	1	1	2	0	3	24
	Hours	27	48	0	1	17	12	0	6	2	3	0	14	130
1963	Days	1	0	3	1	2	0	0	0	1	4	3	0	15
	Hours	7	0	9	1	3	0	0	0	7	7	6	0	40
1964	Days	1	3	1	1	3	0	2	1	0	0	3	6	21
	Hours	3	7	1	1	9	0	5	2	0	0	6	14	48
1965	Days	5	2	1	1	1	3	0	1	0	2	1	1	18
	Hours	7	9	2	1	2	4	0	1	0	4	6	1	37
1966	Days	1	2	3	1	1	1	0	1	1	0	2	4	17
	Hours	1	3	7	2	1	3	0	1	14	0	5	14	51
1967	Days	0	3	14	4	0	0	0	0	0	2	2	1	26
	Hours	0	16	52	10	0	0	0	0	0	5	2	2	87
10-year means	Days	2.4	3.0	2.5	1.4	1.0	0.8	0.4	0.5	1.0	1.6	2.1	2.4	19.1
	Hours	7.2	11.7	8.1	4.4	3.6	2.3	0.9	1.5	4.1	3.3	4.7	7.4	59.2

*1958 to 1961 - Royal Observatory, Blackford Hill
1962 to 1967 - Turnhouse Airport.

TABLE 5F

DIRECTIONS FROM WHICH HIGH GUSTS OF WIND BLOW AT THE ROYAL OBSERVATORY, BLACKFORD HILL, EDINBURGH AND AT THE METEOROLOGICAL OFFICE AT TURNHOUSE (EDINBURGH) AIRPORT
(5 years from 1962 to 1966 - see footnote)

BLACKFORD HILL	Direction of Gusts Measured in Degrees from True North												
Speed of Gusts (mph)	350-010	020-040	050-070	080-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	Total
31 to 40													0
41 to 50	1								1	1			3
51 to 60	1	1				1	3	3	3				12
61 to 70					2	2	6	1	4	1			16
71 to 80						1	7	3	4				15
81 to 90						1	5	3	2				11
91 to 100						1	1						2
101 to 110							1						1
Total	2	1	0	0	2	6	23	10	14	2	0	0	60
% Total	3	2	0	0	3	10	38	17	23	3	0	0	100%

TURNHOUSE AIRPORT	Direction of Gusts Measured in Degrees from True North												
Speed of Gusts (mph)	350-010	020-040	050-070	080-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	Total
31 to 40			1							1			2
41 to 50	1		1	1				2	3	1			9
51 to 60					1		3	5	10	2			21
61 to 70							1	1	7	10			19
71 to 80				1				1	3	2			7
81 to 90							1			1			2
91 to 100													0
101 to 110													0
Total	1	0	2	2	1	0	5	9	23	17	0	0	60
% Total	2	0	3	3	2	0	8	15	38	28	0	0	100 %

Note: The data used to calculate the above frequencies were the highest gusts (direction and speed) recorded at Blackford Hill and Turnhouse Airport in each month during the 5 year period from 1962 to 1966 inclusive, i.e. 5 years x 12 months = 60 highest monthly gusts.

TABLE 5G

NUMBER OF DAYS ON WHICH THE AVERAGE WIND SPEED REACHED 25 MPH OR MORE BETWEEN 0700 HOURS AND 1700 HOURS GREENWICH MEAN TIME AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
						Number of Days							
1958	8	11	3	11	7	0	1	4	1	7	1	5	59
1959	2	9	8	11	1	9	7	5	0	6	6	7	71
1960	5	7	4	7	2	8	2	2	2	1	4	6	50
1961	6	12	18	1	7	9	5	12	6	8	1	1	86
1962	13	13	2	6	3	7	2	12	4	6	2	8	78
1963	4	3	6	9	9	3	2	3	9	8	5	6	67
1964	8	4	5	8	10	6	10	6	8	2	8	5	80
1965	6	3	5	7	3	6	1	5	3	3	4	2	48
1966	2	5	11	2	3	1	3	1	5	1	5	6	45
1967	3	10	22	9	1	4	3	1	4	9	4	3	73
10-year mean	5.7	7.7	8.4	7.1	4.6	5.3	3.6	5.1	4.2	5.1	4.0	4.9	65.7

NUMBER OF HOURS BETWEEN 0700 HOURS AND 1700 HOURS GREENWICH MEAN TIME DURING WHICH THE AVERAGE WIND SPEED REACHED 25 MPH OR MORE AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
						Number of Hours							
1958	33	27	15	42	44	0	2	9	8	22	1	11	214
1959	6	53	19	40	2	39	26	29	0	17	18	33	282
1960	18	27	14	36	6	24	2	3	5	1	12	16	164
1961	23	37	67	3	23	35	27	34	22	31	2	4	308
1962	52	65	4	28	22	23	7	52	14	18	4	35	324
1963	15	13	17	30	31	7	3	3	31	32	25	23	230
1964	23	26	19	37	49	22	55	23	28	6	27	15	330
1965	20	16	15	23	16	25	2	14	11	13	26	8	189
1966	16	15	46	6	14	5	5	3	15	1	17	34	177
1967	5	61	120	42	8	13	6	1	14	32	14	13	329
10-year mean	21.1	34.0	33.6	28.7	21.5	19.3	13.5	17.1	14.8	17.3	14.6	19.2	254.7
10-year mean expressed as percentage of total working time	7%	12%	11%	10%	7%	6%	4%	6%	5%	6%	5%	6%	7%

TABLE 5H

TABLE FOR CONVERTING MILES PER HOUR TO METRES PER SECOND

(1 mile per hour = 0.44704 metres per second)

Miles per Hour	0	1	2	3	4	5	6	7	8	9
	Metres per Second									
0	0.0	0.4	0.9	1.3	1.8	2.2	2.7	3.1	3.6	4.0
10	4.5	4.9	5.4	5.8	6.3	6.7	7.2	7.6	8.0	8.5
20	8.9	9.4	9.8	10.3	10.7	11.2	11.6	12.1	12.5	13.0
30	13.4	13.9	14.3	14.8	15.2	15.6	16.1	16.5	17.0	17.4
40	17.9	18.3	18.8	19.2	19.7	20.1	20.6	21.0	21.5	21.9
50	22.4	22.8	23.2	23.7	24.1	24.6	25.0	25.5	25.9	26.4
60	26.8	27.3	27.7	28.2	28.6	29.1	29.5	30.0	30.4	30.8
70	31.3	31.7	32.2	32.6	33.1	33.5	34.0	34.4	34.9	35.3
80	35.8	36.2	36.7	37.1	37.6	38.0	38.4	38.9	39.3	39.8
90	40.2	40.7	41.1	41.6	42.0	42.5	42.9	43.4	43.8	44.3
100	44.7	45.2	45.6	46.0	46.5	46.9	47.4	47.8	48.3	48.7
110	49.2	49.6	50.1	50.5	51.0	51.4	51.9	52.3	52.8	53.2
120	53.6	54.1	54.5	55.0	55.4	55.9	56.3	56.8	57.2	57.7
130	58.1	58.6	59.0	59.5	59.9	60.4	60.8	61.2	61.7	62.1
140	62.6	63.0	63.5	63.9	64.4	64.8	65.3	65.7	66.2	66.6
150	67.1	67.5	68.0	68.4	68.8	69.3	69.7	70.2	70.6	71.1

6. FOG

This would appear to be an appropriate heading under which to discuss Edinburgh's nickname of "Auld Reekie". It is significant that the origin of this nickname dates back into history long before atmospheric pollution became the menace it is today. In early days, country folk travelling to Edinburgh had probably never seen another city of Edinburgh's size and the pall of haze and smoke hanging over their destination could well have been their first and lasting impression of the city. There is the further point that unlike many other cities, Edinburgh can be seen from a considerable distance across the Forth from places in Fife or from high vantage points in clear air particularly on the southern side of the city, and this makes what smoke there is much more apparent. However, there is little doubt that if the nickname of "Auld Reekie" was being allocated on merit to a major city in the British Isles today, then Edinburgh would appear well down the list if not near the bottom.

On the whole, most of the east coast of Scotland experiences very good visibility and its remoteness from the industrial and populous areas of Great Britain and their smoke-soiled air means that smoke fogs are relatively unknown except in the immediate surroundings of Edinburgh, Dundee and Aberdeen. Although thick fogs (visibility less than 220 yards) do occur in Edinburgh on average about 22 days per year, the persistence of thick fog in the city for more than a few hours is a fairly rare event especially when Edinburgh is compared, say, with Glasgow, London or a large town in the Midlands of England.

Perhaps the most unpleasant fogs which occur in Edinburgh are not the smoke, radiation or sea fogs of winter but the haars (North Sea fogs) which occur from time to time during the period from April to September and which often ruin potentially brilliantly fine days during the spring and summer. The basic cause of these haars is the moistening and cooling of warm air from the Continent by the cold waters of the North Sea and the Firth of Forth. Haars are especially prevalent during the spring and summer following a particularly cold winter when the sea temperature of the coastal waters is well below average. The haar is normally fairly shallow. When it

/occurs

occurs at ground level in the lower parts of the city, the higher parts may be in sunshine above it. Frequently, by the time it reaches Edinburgh, it has lifted into an unbroken layer of low stratus cloud, obscuring the higher buildings and higher ground, particularly the high ground on the south side of the city, but with reasonably good visibility beneath it. Where it reaches the ground, visibilities of less than 25 yards are not unknown. Occasionally the haar may have sufficient depth to give rise to drizzle, particularly where it encounters rising ground. During daylight hours the sun's heat tends to "burn off" the haar. The thinner haars may disappear with dramatic suddenness leaving a cloudless sky, but they are likely to reform again towards sunset. The deeper haars may persist all day, a frustrating situation which is not helped by the knowledge that places a few miles further west or further inland are enjoying glorious sunshine. It was perhaps this particular aspect which led Robert Louis Stevenson to describe Edinburgh's climate as "a downright meteorological purgatory in the spring". (13)

The areas most prone to winter fogs are the lower lying more densely built-up parts of the city particularly those near the Forth, and sometimes in winter, commuters from the south side of Edinburgh do not encounter fog on their journey into the city until reaching the foot of the slopes to the high ground e.g. Morningside, Slateford, Meggetland etc. There are a few occasions in some winters when low cloud enveloping the Pentlands sometimes reduces visibility on the roads traversing the high ground on the southern side of the city particularly before 9 a.m., but visibility on these occasions is seldom bad enough seriously to impede the flow of traffic.

Fogs in Edinburgh during the winter half-year from October to March usually occur on days with no wind, but light westerly winds sometimes thicken the fogs with industrial and domestic smoke from Grangemouth, Falkirk and other industrial towns in the Forth/Clyde valley. Similarly, when light easterly winds are blowing, smoke is carried from the more densely built-up parts of Edinburgh to Turnhouse Airport and other districts on the rural western fringe of the city.

/Fogs

Fogs in Edinburgh during the summer half-year also occur most often on days with no wind or on days with light easterly winds, particularly from the sector between east and northeast, bringing in-shore the troublesome haar from the Firth of Forth.

At this point it should be explained that in the Meteorological Office, a fog is said to occur when the visibility falls to below 1,100 yards. A fog becomes "thick" when the visibility falls to less than 220 yards and "dense" when the visibility falls to below 55 yards.

Fogs with visibilities between about 500 and 1,100 yards hamper the movements of aircraft at Turnhouse Airport but have little effect on the normal life of the city. However, when visibility falls to around the half mile mark, it is beginning to have a serious effect on the movement of ships in the Forth though still allowing the free movement of road traffic in the city. When visibility falls to less than 220 yards the flow of road traffic is slowed down and with dense fogs of visibility less than 55 yards, the movement of road traffic is very seriously impeded especially at night time. However, as far as dense fogs are concerned Edinburgh is much more fortunate than many other cities of comparable size and, on the average, the city has only about four dense fogs per year, the average duration of these dense fogs being less than three hours.

Fog can be polluted, and from a health point of view, a polluted fog can be very damaging to the respiratory system, especially the more highly polluted thick and dense fogs of the winter months. The extensive smoke-controlled zones established in Edinburgh during recent years have led to a substantial reduction in atmospheric pollution, and the elimination of the smoke nuisance from the St. Margaret's Locomotive Works in the Meadowbank district is a particularly good example of how the amenity of the city can be brightened.

Percentage Frequencies of Occurrence of Visibilities less than 1,100 yards and 220 yards according to month and hour are given in Tables 6 and 6A. It can be seen from these Tables that there is a fairly well marked diurnal variation in poor visibility with the highest frequency of fogs occurring between midnight and about

/8 a.m.

8 a.m. The figures for June demonstrate the relatively high frequency of haar during the month, also the tendency for the haar to "burn off" during the middle of the day and to re-form again during the evening.

The Variation of Poor Visibility with Wind Direction is shown in Table 6B.

The Number of Days and Hours with "Fog", "Thick Fog" and "Dense Fog" are given in Tables 6C and 6D.

In the preceding paragraphs, the incidence of fog in Edinburgh has been discussed at some length. However, it should be emphasised that the city has a relatively low frequency of fog, and thick and dense fogs are by no means one of the characteristic features of the local climate. Indeed, there are far more days with good visibility than bad visibility, and on the clearest days, the views to the west, north and east of Edinburgh are magnificent, particularly from vantage points on the slopes of the Pentland Hills. On some days for example, it is possible to distinguish Ben Lomond and other hills over 50 miles distant. However, outstanding visibilities to the west and north of the city are often restricted or impaired by a pall of haze and smoke over the Forth and although no systematic records are available, the occasions of outstanding visibilities to the west and north seem to be much less frequent than they used to be. The pall of haze and smoke over the Forth can often be traced by eye to the Grangemouth/Falkirk/Kincardine-on-Forth region and the lower incidence of outstanding visibilities is no doubt due to the growing concentration of industry in this area.

/TABLE 6

TABLE 6

PERCENTAGE FREQUENCY OF OCCURRENCE OF VISIBILITIES LESS THAN 1,100 YARDS ACCORDING TO MONTH AND HOUR AT TURNHOUSE (EDINBURGH) AIRPORT
(10 YEARS 1957 TO 1966*)

Time - G.M.T.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
	%	%	%	%	%	%	%	%	%	%	%	%	%
00h. midnight	5.2	3.9	1.3	2.3	3.5	5.3	2.3	2.3	3.0	5.2	4.7	4.5	3.6
01h.	4.8	4.3	1.3	2.7	2.3	7.0	2.6	2.3	2.7	5.8	4.7	4.2	3.7
02h.	3.5	5.0	1.9	3.3	3.2	8.3	3.2	1.9	2.3	8.1	4.3	4.2	4.1
03h.	3.5	5.3	1.9	3.0	3.5	9.0	4.2	2.6	3.3	8.1	4.0	3.9	4.4
04h.	3.9	6.0	2.3	3.7	5.2	10.7	3.9	3.2	3.3	7.7	4.0	2.9	4.7
05h.	3.2	4.6	3.2	2.7	4.5	8.0	2.9	3.2	5.7	9.0	3.3	3.2	4.5
06h.	2.3	4.6	2.9	3.0	2.6	6.3	2.6	2.3	5.3	7.4	3.3	3.5	3.8
07h.	3.2	4.6	4.5	4.3	1.6	5.3	1.9	1.6	4.7	9.0	4.0	2.9	4.0
08h.	2.6	4.6	2.9	2.3	1.3	3.3	0.6	0.6	4.0	7.4	6.3	3.5	3.3
09h.	3.9	6.0	1.9	0.7	0.3	3.3	1.3	1.0	1.3	4.2	6.7	4.8	2.9
10h.	3.9	6.4	1.3	0.7	0.3	1.3	0.6	0.3	0.7	3.5	6.3	4.5	2.5
11h.	3.2	6.0	1.3	1.0	0.6	1.0	0.3	0.3	0.3	2.3	4.7	4.5	2.1
12h. noon	5.2	4.6	0.3	1.3	0.0	0.7	0.3	0.0	0.3	1.9	3.7	5.8	2.0
13h.	3.2	3.9	0.3	1.0	0.3	0.7	0.0	0.0	0.3	1.6	2.7	7.1	1.8
14h.	2.6	3.2	0.0	0.7	0.0	0.0	0.3	0.3	0.0	1.3	3.7	6.1	1.5
15h.	2.6	1.8	0.0	1.0	0.0	0.3	0.3	0.0	0.0	1.9	4.3	7.7	1.7
16h.	4.5	2.5	0.3	0.7	0.6	1.0	0.6	0.0	0.3	1.9	4.7	8.4	2.1
17h.	5.8	3.5	1.3	0.7	0.6	1.7	1.3	0.3	0.3	1.9	5.7	7.4	2.5
18h.	3.5	3.2	1.9	0.7	0.3	2.0	1.6	0.6	1.3	2.6	6.0	6.1	2.5
19h.	3.5	2.8	1.6	1.3	0.6	2.3	1.3	0.6	1.3	2.3	5.3	5.8	2.4
20h.	2.9	3.2	0.3	1.3	1.9	4.0	1.0	0.0	1.0	3.2	5.0	6.1	2.5
21h.	2.6	3.2	0.6	1.0	2.3	3.7	1.3	0.3	2.0	4.2	5.3	4.8	2.6
22h.	4.5	4.3	1.9	1.0	2.6	5.3	1.0	0.6	2.0	4.8	6.3	4.5	3.2
23h.	3.9	3.9	1.6	1.3	3.5	5.0	0.3	1.0	2.3	6.8	6.3	4.5	3.4

Percentage Amount of Total Time in Each Month with Visibilities less than 1,100 yards at TURNHOUSE (EDINBURGH) AIRPORT

%	%	%	%	%	%	%	%	%	%	%	%	%
3.7	4.2	1.5	1.7	1.7	4.0	1.5	1.1	2.0	4.7	4.8	5.0	3.0

*Note: The above frequencies have been calculated from observations of visibility made at each hour on the hour during the 10 year period from 1957 to 1966.

/TABLE 6A

TABLE 6A

PERCENTAGE FREQUENCY OF OCCURRENCE OF VISIBILITIES LESS THAN 220 YARDS ACCORDING TO MONTH AND HOUR AT TURNHOUSE (EDINBURGH) AIRPORT (10 YEARS 1957 TO 1966*)

Time - G.M.T.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
	%	%	%	%	%	%	%	%	%	%	%	%	%
00h. midnight	1.3	1.1	0.0	1.3	0.0	0.7	0.0	0.3	1.0	2.3	1.0	2.3	0.9
01h.	1.6	1.1	0.0	1.3	0.3	0.7	1.0	0.3	1.3	2.3	1.3	2.6	1.1
02h.	1.3	2.5	0.6	1.7	0.0	2.3	0.6	0.3	1.3	2.3	1.0	1.6	1.3
03h.	1.6	2.8	1.3	1.7	0.3	2.9	0.3	0.3	1.3	3.2	0.7	1.0	1.5
04h.	1.3	1.4	0.6	0.7	1.0	2.3	0.3	0.3	1.0	3.2	1.0	1.6	1.2
05h.	1.0	1.4	0.6	1.3	0.6	1.3	0.0	0.3	2.0	2.6	1.3	1.6	1.2
06h.	0.3	1.8	1.3	1.0	0.3	1.3	0.0	0.0	3.3	2.9	0.7	2.6	1.3
07h.	1.0	2.8	1.0	1.0	0.0	0.3	0.0	0.3	2.0	3.9	1.0	2.6	1.3
08h.	0.6	3.2	1.0	0.7	0.0	0.0	0.0	0.3	0.3	4.2	1.7	2.3	1.2
09h.	1.3	1.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.7	3.5	0.9
10h.	1.6	2.1	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.6	1.7	2.9	0.8
11h.	1.0	2.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.3	2.6	0.7
12h. noon	0.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.6	0.5
13h.	0.3	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.9	0.4
14h.	0.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.9	0.4
15h.	0.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.5	0.6
16h.	1.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	3.2	0.6
17h.	1.0	1.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	3.0	2.9	0.7
18h.	1.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.3	2.9	0.8
19h.	1.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.7	2.9	0.7
20h.	1.3	1.1	0.0	0.3	0.0	0.3	0.6	0.0	0.3	1.0	3.0	2.9	0.9
21h.	0.6	1.1	0.0	0.3	0.3	0.7	0.3	0.0	0.3	1.6	2.7	2.3	0.9
22h.	0.6	1.4	0.0	0.3	0.3	1.0	0.0	0.0	0.3	1.3	3.0	1.6	0.8
23h.	1.6	1.1	0.0	0.7	0.3	1.3	0.0	0.0	1.0	2.3	2.0	1.9	1.0

Percentage Amount of Total Time in Each Month with Visibilities less than 220 yards at TURNHOUSE (EDINBURGH) AIRPORT

%	%	%	%	%	%	%	%	%	%	%	%	%
1.0	1.5	0.3	0.5	0.1	0.6	0.1	0.1	0.6	1.6	1.8	2.5	0.9

*Note: The above frequencies have been calculated from observations of visibility made at each hour on the hour during the 10 year period from 1957 to 1966.

/TABLE 6B

TABLE 6B

VISIBILITY AT TURNHOUSE (EDINBURGH) AIRPORT DURING THE WINTER HALF-YEAR (OCTOBER TO MARCH) AND THE SUMMER HALF-YEAR (APRIL-SEPTEMBER), ACCORDING TO WIND DIRECTION*

	Winter Half-Year % probability			Summer Half-Year % probability		
Wind Direction	Visibility less than 440 yards	Visibility less than 1100 yards	Visibility less than 2200 yards	Visibility less than 440 yards	Visibility less than 1100 yards	Visibility less than 2200 yards
(degrees)	%	%	%	%	%	%
350-010	0.2	0.7	3.1	0.0	0.3	1.7
020-040	0.8	3.2	8.3	0.8	1.9	6.2
050-070	0.6	2.2	7.2	2.3	7.2	14.4
080-100	0.2	0.8	2.8	1.3	5.1	9.9
110-130	0.6	1.0	2.1	0.0	0.0	0.6
140-160	1.1	1.8	3.2	0.4	0.4	0.8
170-190	0.3	0.9	1.6	0.0	0.0	0.0
200-220	0.2	0.6	0.8	0.1	0.2	0.2
230-250	0.4	0.6	1.3	0.1	0.1	0.2
260-280	0.7	1.2	3.2	0.0	0.2	0.4
290-310	1.0	1.5	2.0	0.2	0.2	0.7
320-340	0.2	0.4	3.0	0.0	0.0	0.0
Calms	7.1	13.2	26.2	4.6	8.0	12.6

*Calculated from hourly observations during the 5 years, 1963 to 1967.

/TABLE 6C

TABLE 6C

NUMBER OF DAYS WITH "FOG", "THICK FOG" AND "DENSE FOG" AT ANY TIME OF DAY*
AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years from 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
Number of Days with "Fog" - Visibility less than 1,100 yards													
1958	6	5	2	2	2	10	6	3	8	2	12	6	64
1959	13	10	3	1	5	5	1	1	6	10	3	5	63
1960	5	11	4	1	3	3	1	7	3	9	12	10	69
1961	7	4	1	6	2	0	2	0	1	5	7	14	49
1962	6	2	5	3	0	0	3	0	5	7	5	6	42
1963	5	6	4	3	0	10	6	1	1	5	6	2	49
1964	9	2	6	6	9	4	2	3	4	10	7	3	65
1965	3	1	7	2	3	6	5	6	5	11	5	6	60
1966	8	7	0	3	4	11	1	1	5	5	1	2	48
1967	2	2	1	1	2	7	2	1	8	1	6	0	33
10-year mean	6.4	5.0	3.3	2.8	3.0	5.6	2.9	2.3	4.6	6.5	6.4	5.4	54.2
Number of Days with "Thick Fog" - Visibility less than 220 yards													
1958	0	0	1	1	1	6	1	1	4	1	6	2	24
1959	3	8	0	0	2	1	0	0	3	6	3	0	26
1960	1	3	1	0	1	1	1	3	0	5	5	6	27
1961	1	2	0	3	1	0	0	0	0	1	4	7	19
1962	4	0	1	2	0	0	0	0	2	3	0	2	14
1963	1	3	2	0	0	3	0	0	0	3	3	2	17
1964	3	1	1	3	2	2	1	0	4	5	6	1	29
1965	3	0	1	1	1	1	0	3	1	9	3	4	27
1966	5	3	0	0	0	6	1	0	2	2	0	0	19
1967	1	1	0	0	1	4	0	1	5	0	4	0	17
10-year mean	2.2	2.1	0.7	1.0	0.9	2.4	0.4	0.8	2.1	3.5	3.4	2.4	21.9
Number of Days with "Dense Fog" - Visibility less than 55 yards													
1958	0	0	0	0	0	0	0	0	1	0	1	1	3
1959	0	2	0	0	1	0	0	0	3	1	0	0	7
1960	0	1	0	0	0	1	0	0	0	2	2	4	10
1961	0	0	0	1	0	0	0	0	0	0	2	2	5
1962	1	0	1	0	0	0	0	0	0	0	0	0	2
1963	0	0	1	0	0	0	0	0	0	0	0	1	2
1964	0	0	0	1	0	0	0	0	0	0	2	0	3
1965	0	0	0	0	0	1	0	0	0	5	1	0	7
1966	1	0	0	0	0	0	0	0	0	0	0	0	1
1967	0	0	0	0	0	0	0	1	1	0	0	0	2
10-year mean	0.2	0.3	0.2	0.2	0.1	0.2	0.0	0.1	0.5	0.8	0.8	0.8	4.2

*Calculated from hourly observations of visibility made at each hour on the hour.

/TABLE 6D

TABLE 6D

NUMBER OF HOURS* WITH "FOG", "THICK FOG" AND "DENSE FOG"
AT TURNHOUSE (EDINBURGH) AIRPORT
(10 years 1958 to 1967)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
Number of Hours with "Fog" - Visibility less than 1,100 yards													
1958	10	19	5	7	10	55	28	17	34	5	60	40	290
1959	47	121	16	1	9	20	1	2	17	56	19	22	331
1960	22	59	13	4	6	12	5	16	8	32	71	125	373
1961	25	13	1	36	6	0	4	0	1	15	58	98	257
1962	50	4	17	22	0	0	9	0	19	57	13	27	218
1963	19	24	18	4	0	69	29	1	2	53	35	19	273
1964	43	11	24	36	63	11	12	9	41	43	67	8	368
1965	14	7	12	4	13	23	12	18	9	91	34	29	266
1966	42	28	0	8	10	90	6	1	12	13	1	2	213
1967	9	6	1	1	3	28	4	5	58	2	46	0	163
10-year mean	28.1	29.2	10.7	12.3	12.0	30.8	11.0	6.9	20.1	36.7	40.4	37.0	275.2
Number of Hours with "Thick Fog" - Visibility less than 220 yards													
1958	0	0	1	4	1	17	1	2	14	3	16	21	80
1959	9	72	0	0	3	1	0	0	10	26	11	0	132
1960	2	13	6	0	1	2	1	7	0	10	22	97	161
1961	4	2	0	8	0	0	0	0	0	1	27	31	73
1962	35	0	1	10	0	0	0	0	3	19	0	12	80
1963	3	8	7	0	0	13	0	0	0	24	12	18	85
1964	9	4	7	14	4	3	2	0	23	12	45	1	124
1965	3	0	1	1	2	4	0	5	1	35	12	7	71
1966	21	9	0	0	0	19	4	0	3	2	0	0	58
1967	1	3	0	0	2	9	0	3	35	0	18	0	71
10-year mean	8.7	11.1	2.3	3.7	1.3	6.8	0.8	1.7	8.9	13.2	16.3	18.7	93.5
Number of Hours with "Dense Fog" - Visibility less than 55 yards													
1958	0	0	0	0	0	0	0	0	1	0	2	1	4
1959	0	11	0	0	1	0	0	0	5	3	0	0	20
1960	0	4	0	0	0	1	0	0	0	3	2	19	29
1961	0	0	0	2	0	0	0	0	0	0	6	4	12
1962	2	0	1	0	0	0	0	0	0	0	0	0	3
1963	0	0	1	0	0	0	0	0	0	0	0	2	3
1964	0	0	0	1	0	0	0	0	0	0	25	0	26
1965	0	0	0	0	0	1	0	0	0	10	1	0	12
1966	2	0	0	0	0	0	0	0	0	0	0	0	2
1967	0	0	0	0	0	0	0	1	1	0	0	0	2
10-year mean	0.4	1.5	0.2	0.3	0.1	0.2	0.0	0.1	0.7	1.6	3.6	2.6	11.3

*Calculated from hourly observations of visibility made at each hour on the hour.

/In

7. SNOW

In Edinburgh, as elsewhere in the British Isles, the incidence of snow falling and the persistence of snow cover are two of the most variable of all the meteorological elements. For example, in the severe winter of 1962/63 there were 39 mornings with snow lying on the ground at Turnhouse Airport compared with only 2 mornings during the following winter of 1963/64.

At Turnhouse Airport, there are, on average, about 30 days per year with snow or sleet falling. The highest number of days in a year during the 19 years from 1949 to 1967 with snow or sleet falling is 46 days during 1965 and the lowest number of days in a year is 11 days during 1953. Most of the days with snowfall occur in December, January, February and March but snow can fall on low ground in Edinburgh as late as May or as early as October, although snow falling in May or October seldom lies on the ground for any length of time. Up to heights of about 200 feet, there is not much variation from place to place in the incidence of snowfall, and therefore the Turnhouse Airport figures of the number of days of snow or sleet falling can be taken as reasonably representative of most of the lower lying and more densely built-up districts of Edinburgh. The Meteorological Office at Turnhouse Airport is the only weather station in the Edinburgh area keeping a 24 hour watch on the weather, and is therefore the only weather station for which complete records of snow falling at any time of the day or night are available. However, the number of days with snow falling increases fairly rapidly with height above sea level, and as a good approximate rule, there is one day more per year with snow falling for each 50 feet of elevation above 200 feet up to an altitude of about 1,000 feet.

Whether snow will lie, after it has fallen, in sufficient depth to cause difficulty to transport, depends on a number of complex factors but a greater height above sea level and a north or east facing aspect of the surface will certainly increase the number of days with snow lying. As the general lie of the ground in Edinburgh is on a north facing slope, down from the Pentlands, the persistence of snow cover can be a nuisance particularly in the high southern outskirts of the City.

/During

During a severe winter with snow lying on the ground, the partial thaws during the daytime do little to clear the roads at higher levels on the south side of the City where the snow becomes compacted and even more treacherous to road users, especially at night when the compacted snow or wet parts of the road have an icy surface. There is the further point that the daily expansion and contraction caused by the freezing and thawing processes plays havoc with the tarmacadam road surfaces which often need extensive repairs after a severe winter. Partly because of its ability to penetrate into the snow, rain is much the best thawing agent but it should be remembered that precipitation falling in temperatures up to about 36 degrees Fahrenheit will almost certainly be in the form of snow.

After a fall of snow in Edinburgh, the variation in snow cover and depth between the lower lying flatter parts of the City near the Forth and the high suburbs in the southern outskirts if often quite remarkable. During the severe winter of 1962/63 for example, there were periods when only isolated thin patches of snow lay in the Granton and Newhaven districts whereas at Lothianburn Golf Course on the northern slopes of the Pentlands near Fairmilehead, there was a complete covering of snow in sufficient depth for skiing from about Christmas Day 1962 until near the end of the first week in March 1963. Similarly, the roads traversing the high ground on the south side of Edinburgh are sometimes affected by appreciable falls of snow when at the same time, rain or sleet is falling in the lower lying parts of the City.

The snowfall in Edinburgh during the morning of 2nd April 1968 deserves a special mention. This fall was the worst April snowfall in living memory, and Edinburgh was virtually cut off for a period with roads being blocked by either snow or stationary traffic for almost two hours. The snow first started to fall intermittently in the city about 8.30 a.m. British Standard Time but became continuous by 10 a.m. and was particularly heavy between 11 a.m. and 12 noon. The snow had ceased by 1 p.m. but by this time the depth of snow over most of the city was between four and six inches. Air temperatures during that morning were

/continuously

continuously below freezing point. Consequently, pedestrian and motor traffic compacted the snow into a treacherous icy surface. Bus services in Edinburgh were badly disrupted with long delays and in the city centre, buses were caught in traffic jams caused by abandoned vehicles. Salting of the roads was severely hampered by the volume of stationary traffic blocking the streets but by late afternoon all main roads were reasonably clear and commuters were able to get to their homes in the suburbs without too much difficulty.

It should perhaps be mentioned that in the Meteorological Office, a 'day with snow lying' is counted only when half or more of the ground surrounding the weather station is covered with snow and the snow depth is only measured on these occasions. The depths of snow measured daily at 9 a.m. relate to the uniform "undrifted" depth. The criterion "half or more than half the ground covered" is difficult to apply at stations where the view is restricted, and small depths of snow may accumulate to cover more than half the ground locally in a sheltered site when it would not do so at an open airfield. This may well account for the occasional considerable differences between Turnhouse and the Royal Botanic Garden (see Table 7B) particularly in the smaller depths where general considerations would lead one to expect similar figures at both places.

The Actual and Average Numbers of Days with Snow or Sleet Falling are given in Table 7.

The Average Number of Days with Snow Lying are given in Table 7A.

The Numbers of Mornings per Winter with Snow Lying at Specified Depths are given in Table 7B.

Monthly Frequencies of Snow Depths are given in Table 7C.

Water Yield from Snow

At the present time, there is a distinct lack of records providing the actual water equivalents of sample depths of melted snow. However, as one would expect, the available evidence indicates that the water yield from "wet" snow falling in temperatures above freezing point is considerably higher than the water yield from an

/equivalent

equivalent depth of "dry" snow falling in temperatures below freezing point. In fact there is a steady increase with temperature in the water yield per inch of snow and a sharp increase around freezing point. (16)

The most commonly occurring water yield from samples of melted snow is one inch of water from about 12 inches of snow and until further evidence becomes available, it is suggested that this modal yield be used for general planning purposes. However, it should be emphasised that the suggested yield of one inch of water from 12 inches of snow should only be taken as a very approximate guide because one inch of water has been obtained by melting depths of snow as low as 5 inches and as high as 35 inches.

/TABLE 7

TABLE 7

ACTUAL AND AVERAGE NUMBER OF DAYS WITH SNOW OR SLEET FALLING AT TURNHOUSE (EDINBURGH) AIRPORT - 19 YEARS FROM 1949 TO 1967

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
1949	2	2	4	1							1	5	15
1950	3	5	2	3	1						3	9	26
1951	8	8	10	7								5	38
1952	13	3	5								3	10	34
1953	2	7	0	1								1	11
1954	5	7	3	1	1						2	3	22
1955	7	14	8	0	3					1	0	6	39
1956	8	14	4	1	1						3	4	35
1957	7	7	1								1	4	20
1958	9	8	13	2								7	39
1959	7	1	1							1	2	1	13
1960	9	10	2									2	23
1961	5	4	2	1							3	10	25
1962	3	8	6	4							2	9	32
1963	17	16	0	1							4	5	43
1964	3	6	6	1	1						1	8	26
1965	11	4	12	1	1						12	5	46
1966	9	12	4	10							2	7	44
1967	6	4	9	1	2					1	1	7	31
19 year average	7	7	5	2	1	0	0	0	0	< 1	2	6	30

/TABLE 7A

TABLE 7A

AVERAGE NUMBER OF DAYS WITH SNOW LYING ON THE GROUND AT 0900 HOURS G.M.T. AT LOCATIONS IN THE EDINBURGH AREA
(16 years from 1952 to 1967)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year Total
	Average Number of Days												
TURNHOUSE AIRPORT - Altitude 114 feet	6	5	1	<1	0	0	0	0	0	0	<1	2	14
DAVIDSON'S MAINS - Altitude 200 feet	7	7	2	<1	0	0	0	0	0	0	1	2	19
ROYAL BOTANIC GARDEN - Altitude 74 feet	7	6	1	<1	0	0	0	0	0	0	1	2	17
ROYAL OBSERVATORY, BLACKFORD HILL - Altitude 441 feet	7	7	2	<1	<1	0	0	0	0	0	1	2	19
BUSH HOUSE - Altitude 605 feet	10	9	4	<1	0	0	0	0	0	<1	1	4	28
PENICUIK - Altitude 620 feet	10	9	4	<1	<1	0	0	0	0	<1	2	5	30

Note: A "day with snow-lying" is counted when half or more of the ground surrounding the weather station is covered with snow at 0900 hours GMT.

/TABLE 7B

TABLE 7B

NUMBER OF DAYS WITH SNOW LYING AT 0900 HOURS GMT AT DEPTHS BETWEEN SPECIFIED LIMITS - AT PLACES IN THE EDINBURGH AREA

TURNHOUSE AIRPORT - Altitude 114 feet								Maximum Depth = 6 inches	
Depth - Inches	0-1	2	3-4	5-6	7-8	9-12	13-16	Over 16	Total
Winter of:									
1956-57	4								4
1957-58	11	1	1	2					15
1958-59	10	1							11
1959-60	1	4	6	2					13
1960-61	1	1							2
1961-62	7	2	4						13
1962-63	17	11	6	5					39
1963-64	1	1							2
1964-65	7	8	3						18
1965-66	20	3	1						24
1966-67	5	1							6
1967-68	11	2							13
Total	95	35	21	9					160
% Total	59	22	13	6					100%
ROYAL BOTANIC GARDEN - Altitude 74 feet								Maximum Depth = 9 inches	
Winter of:									
1949-50	2								2
1950-51	14	4	3						21
1951-52	20	3	4						27
1952-53	5								5
1953-54	6								6
1954-55	8	4	15		4	2			33
1955-56	18		5						23
1956-57	1								1
1957-58	18		2						20
1958-59	11								11
1959-60	14	2	3						19
1960-61	2	1							3
1961-62	15		1						16
1962-63	34	14	8						56
1963-64	1								1
1964-65	12	6	4						22
1965-66	21	1							22
1966-67	4		1						5
1967-68	10	1							11
Total	216	36	46	0	4	2			304
% Total	71	12	15	0	1	1			100%

/(contd.)

TABLE 7B (contd.)

BUSH HOUSE - Altitude 605 feet								Maximum Depth = 11 inches	
Depth - Inches	0-1	2	3-4	5-6	7-8	9-12	13-16	Over 16	Total
Winter of:									
1956-57	7		2						9
1957-58	22	3	7	2					34
1958-59		1	16						17
1959-60	6	7	6	2	2	1			24
1960-61	2	2	2						6
1961-62	16	6	6	1					29
1962-63	7	1	5	17	20	26			76
1963-64	9								9
1964-65	13	2	6	7	1				29
1965-66	28	7		1					36
1966-67	6		1		1	1			9
1967-68	18	6	6	3					33
Total	134	35	57	33	24	28			311
% Total	43	11	18	11	8	9			100%
PENICUIK - Altitude 620 feet								Maximum Depth = 12 inches	
Winter of:									
1956-57	6	3	1						10
1957-58	15	4	11	1	3				34
1958-59	5	1	15						21
1959-60	7	2	10	3	3	2			27
1960-61	8	4							12
1961-62	21	9	8						38
1962-63	9	5	4	19	31	16			84
1963-64	10	1	2						13
1964-65	10	10	7	4	1				32
1965-66	31	9	6						46
1966-67	11		4						15
1967-68	29	6	8	1					44
Total	162	54	76	28	38	18			376
% Total	43	14	20	8	10	5			100%

/TABLE 7C

TABLE 7C

ROYAL BOTANIC GARDEN - Altitude 74 feet

Monthly Frequencies for Each Year during the Eighteen Years from 1950 to 1967 of Days with Snow Lying at 0900 hours GMT. at Depths between the Specified Limits

DEPTH : Inches	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	Total
NOVEMBER																			
0-1													1			6			7
2																1			1
3-4																			0
5-6																			0
7-8																			0
9-12																			0
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	8
DECEMBER																			
0-1	5	1	3			4	1					10	2		3	4	2	2	37
2	2												2						4
3-4	2				1							1	1						5
5-6																			0
7-8																			0
9-12																			0
TOTAL	9	1	3	0	1	4	1	0	0	0	0	11	5	0	3	4	2	2	46
JANUARY																			
0-1	2	8	15	1	3	2	3		8	11	3	1	4	23		2	3	2	91
2		1	3			2					1			1					8
3-4		1	4			10								1		3			19
5-6																			0
7-8																			0
9-12																			0
TOTAL	2	10	22	1	3	14	3	0	8	11	4	1	4	25	0	5	3	2	118

/FEBRUARY

TABLE 7C (contd.)

DEPTH : Inches	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	Total
FEBRUARY																			
0-1		1	3	1	3	3	11		5		10	1	1	8	1	1	7		56
2						1					1	1		11		4			18
3-4						4	5		2		3			6				1	21
5-6																			0
7-8						4													4
9-12						2													2
TOTAL	0	1	3	1	3	14	16	0	7	0	14	2	1	25	1	5	7	1	101
MARCH																			
0-1			1			3			5		1					6			16
2		1				1										2			4
3-4																1			1
5-6																			0
7-8																			0
9-12																			0
TOTAL	0	1	1	0	0	4	0	0	5	0	1	0	0	0	0	9	0	0	21
APRIL - ALL DEPTHS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1*	0	1

*Depth = 0-1 inches.

/8. THUNDERSTORMS

8. THUNDERSTORMS

In common with all the other major centres of population in Scotland, Edinburgh has a low incidence of thunderstorms and damaging hail. On the long term average, Edinburgh has about 7 days with thunderstorms per year compared with 8 days in Glasgow, 14 days in Birmingham and 16 days in London. Thunderstorms can occur in Edinburgh in any month of the year but the frequency during the months of October to April is very low and thunderstorms occur most often in the months of May to September but even in these months the long term average works out at only one day per month with a thunderstorm.

There are no systematic records of thunderstorms over the high ground to the south of the city but there is no doubt that the frequency of thunderstorms over the hills and high moorland areas of the Pentlands, Moorfoots and Lammermuirs is appreciably higher than in Edinburgh itself.

The Number of Days with Thunderstorms at Turnhouse (Edinburgh) Airport are quoted in Table 8.

/TABLE 8

TABLE 8

NUMBER OF DAYS WITH THUNDERSTORMS AT TURNHOUSE (EDINBURGH) AIRPORT
19 YEARS FROM 1949 TO 1967

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1949	0	0	0	0	0	1	0	1	3	0	0	0	5
1950	0	1	0	0	1	1	0	1	0	1	0	0	5
1951	0	0	0	0	2	3	3	0	1	0	0	0	9
1952	1	0	0	0	2	0	0	1	0	0	0	0	4
1953	0	0	0	2	1	1	4	2	0	0	0	0	10
1954	1	0	0	0	5	0	1	2	1	2	0	1	13
1955	0	0	0	0	0	0	0	0	0	0	0	1	1
1956	0	0	0	0	1	3	0	1	2	1	0	1	9
1957	0	0	0	0	1	0	0	0	0	0	0	0	1
1958	0	0	0	0	1	3	3	4	2	0	0	0	13
1959	0	0	0	1	3	0	2	0	0	0	1	0	7
1960	0	0	0	0	0	1	1	3	0	0	0	1	6
1961	0	2	0	0	0	0	0	1	4	2	0	0	9
1962	0	0	0	1	0	0	2	0	2	0	0	0	5
1963	0	0	0	1	1	2	0	1	2	0	1	0	8
1964	0	0	0	0	1	2	0	1	0	0	0	0	4
1965	1	0	0	1	3	1	1	2	1	0	0	0	10
1966	0	0	1	1	0	6	2	2	0	2	0	0	14
1967	0	0	0	0	4	0	0	1	1	0	0	0	6
19 year average	<1	<1	<1	<1	1	1	1	1	1	<1	<1	<1	7

/9. BAROMETRIC PRESSURE

9. BAROMETRIC PRESSURE

Maps of average barometric pressure corrected to mean sea level show that pressure increases fairly uniformly from north to south over the British Isles. For example, the annual average mean sea level pressure at Lerwick in the Shetlands at 0900 hours GMT is 1010.1 millibars, at Aberdeen 1012.0 millibars, at Edinburgh 1012.7 millibars, at Manchester 1014.4 millibars, at Birmingham 1015.2 millibars and at Plymouth 1015.9 millibars. However, although average barometric pressures in Scotland are lower than in England, the range of pressure in Scotland is greater than in England and it is worthy of note that both the highest and lowest pressures ever recorded in the British Isles (1054.7 millibars and 925.5 millibars respectively) were both recorded in Scotland.

Monthly averages of mean sea level barometric pressure at 0900 hours GMT (in millibars and inches) for Turnhouse (Edinburgh) Airport are given in Table 9.

Extremes of Barometric Pressure

Hourly readings of barometric pressure have been made at Turnhouse Airport from 1 January 1957 onwards and there have been several occasions during the past ten years or so when the barometric pressure corrected to mean sea level has exceeded 1045 millibars (30.86 inches), the absolute highest pressure on record at Turnhouse Airport being 1047.5 millibars (30.93 inches) on 27 January 1963. The absolute lowest mean sea level pressure on record at Turnhouse Airport is 948.9 millibars (28.02 inches) on 1 December 1966. The period of records of hourly pressure readings available from Turnhouse Airport is very short and it is highly probable that pressures in excess of the extremes recorded at Turnhouse Airport have occurred in Edinburgh in former years. However, the highest and lowest mean sea level pressures known to have been recorded at meteorological stations in the British Isles making readings of pressure at one or more fixed hours of the day are given in Table 9A and these extreme values should give a good indication of the range within which pressure in Edinburgh may be expected to lie in any particular month.

/Large

Large Changes of Barometric Pressure in Short Periods of Time

The maximum rates (in millibars per hour) at which pressure is likely to change in the Edinburgh area are as follows:-

	Period in Hours								
	1 hour	3 hours	6 hours	9 hours	12 hours	24 hours	36 hours	48 hours	72 hours
Maximum Rate in mb./hour	8.0	5.5	4.5	3.9	3.3	2.2	1.6	1.3	1.0

It should be emphasised that large pressure changes can in some circumstances occur in very short periods of time. For example, at Croydon near London on 27 June 1947 during a violent squall accompanied by a thunderstorm and heavy rain, the pressure rose 7 millibars within a few minutes and then fell 5 millibars.

/TABLE 9

TABLE 9

ESTIMATED MONTHLY AVERAGES OF MEAN SEA LEVEL BAROMETRIC PRESSURE IN MILLIBARS AND INCHES FOR TURNHOUSE (EDINBURGH) AIRPORT 30 YEARS FROM 1931 TO 1960

	Average Pressure at 0900 hours GMT	
	millibars	equivalent in inches
January	1010.6	29.84
February	1012.8	29.91
March	1014.0	29.94
April	1013.8	29.94
May	1016.2	30.01
June	1014.7	29.96
July	1012.3	29.89
August	1012.7	29.90
September	1013.2	29.92
October	1012.4	29.90
November	1010.4	29.84
December	1009.6	29.81
Year	1012.7	29.90

/TABLE 9A

TABLE 9A

HIGHEST AND LOWEST MEAN SEA LEVEL PRESSURES (IN MILLIBARS AND INCHES) RECORDED IN THE BRITISH ISLES FROM 1870 TO 1965

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Highest												
Pressure	1054.7 mb 31.15 in	1051.1 mb 31.04 in	1047.1 mb 30.92 in	1044.5 mb 30.84 in	1042.2 mb 30.78 in	1043.1 mb 30.80 in	1038.3 mb 30.66 in	1036.7 mb 30.61 in	1038.6 mb 30.67 in	1045.6 mb 30.88 in	1044.5 mb 30.84 in	1051.9 mb 31.06 in
Place	Aberdeen	Aberdeen Nairn Sumburgh	Valentia	Eskdalemuir	Dublin	Clones	North Shields	Pembroke	Oxford Kew	Dyce	Benbecula	Wick
Date	1902	1902	1900	1938	1943	1959	1911	1949	1906	1956	1956	1926
Lowest												
Pressure	925.5 mb 27.33 in	942.3 mb 27.83 in	946.2 mb 27.94 in	952.9 mb 28.14 in	968.0 mb 28.58 in	976.8 mb 28.84 in	967.9 mb 28.58 in	967.0 mb 28.56 in	957.1 mb 28.26 in	946.8 mb 27.96 in	939.7 mb 27.75 in	927.2 mb 27.38 in
Place	Ochtertyre	Cork	Wick	Malin Head	Sealand	Wick	Sule Skerry	Cape Wrath	Claremorris	Cawdor Castle	Monach Lighthouse	Belfast
Date	1884	1951	1876	1948	1943	1944	1964	1957	1953	1891	1877	1886
Range in millibars	129.2	108.8	100.9	91.6	74.2	66.3	70.4	69.7	81.5	98.8	104.8	124.7

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