

METEOROLOGICAL OFFICE

CLIMATOLOGICAL SERVICES (M.O.3)

CLIMATOLOGICAL MEMORANDA No. 30

RAIN AND/OR LOW TEMPERATURE AS FACTORS INTERRUPTING EXTERNAL
BUILDING WORK IN THE GLASGOW AREA

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INTRODUCTION

This is an investigation of the same type as that described for the London and Manchester areas in Climatological Memoranda No. 27 and No. 29 respectively.

Weather factors most commonly responsible for interrupting external building work in the British Isles, are probably rain and/or coldness. Building contractors sometimes wish to know (e.g. when estimating the completion date of a contract) the monthly percentage frequencies of time likely to be 'lost' due to rainfall or low air temperature, or to these factors in combination.

It is probable that the critical rate (or intensity) of precipitation which would be likely to cause external work to be interrupted, varies with a number of other meteorological factors including the direction and strength of wind, temperature (not restricted to a suggested threshold of 34° F. as used in this particular analysis), state of ground (e.g. flooded, snow-covered, frozen), thick fog, etc., and also with a number of non-meteorological factors. However, it was considered that helpful results would be obtained by finding the percentage of time during the day that the rate of precipitation was 0.5 mm per hour or more.

The results of this investigation are considered to be applicable without appreciable error to the Glasgow area as a whole, although the data used was for the Renfrew (Glasgow) Airport.

Although this is a continuation of Memoranda No. 27 and No. 29, it may be used separately; therefore the sections PRECIPITATION, TEMPERATURE and COMMENT of those memoranda will be repeated.

DATA

Hourly observations (on punched cards) for Renfrew (Glasgow) Airport for the 12-hour period 06-18 G.M.T. daily during the ten year period 1949 - 1958 were used.

PRECIPITATION

Intensity or rate of fall is the determining factor in classifying precipitation (rain, drizzle, snow or hail) as slight, moderate or heavy, not the total fall over a period of an hour or more, and the rate of 0.5 mm. per hour corresponds to the upper limit of slight rain. This scale of intensity needs to be increased when applied to showers, for a threshold rate of 0.5 mm./hr. would probably cause practically all showers to be included in the frequencies of "appreciable" precipitation in this investigation. Special observational techniques are used to measure rainfall when all the precipitation has occurred as snow; as a rough approximation, a rate of rainfall of 0.5 mm./hr. would correspond to an accumulation of snow at a rate of 6.0 mm./hr., and it seems unlikely that external building operations would have to cease because of slight snow falling for a relatively short period at this rate (perhaps with the air temperature being 34° F. or just above).

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In the absence of any experimental evidence, and after discussion with the Building Research Station, D.S.I.R., it was decided that the lower limit of precipitation contributing to time lost in the building industry through inclement weather should be set at this rate of 0.5 mm./hr. Since this figure was somewhat arbitrarily fixed, no advantage was to be gained by attempting to refine the procedure or to apply weighting factors to the results in order to allow for the unnecessary inclusion of slight showers or occasions of slight snow; it seems reasonable to suppose that, as an average figure for each month over the whole year, and bearing in mind the complexity of the basic problem, the rate of 0.5 mm./hr. is not likely to be very wrong.

TEMPERATURE

Air temperatures were punched on the cards in whole degrees Fahrenheit, and that part of the analysis which deals with temperatures less than 34°F. actually uses a threshold temperature of 33.6°F, i.e. 33.6°F would be "rounded-up" and punched as 34 whilst 33.5°F. would be punched as 33. The temperature criterion of 34°F (actually 33.6°F) would seem to be quite reasonable, but it must be remembered that there will be occasions when the ground is frozen for several hours with the air temperature 33.6°F. or higher; perhaps the number of these occasions will be approximately counter-balanced by the number of occasions when external work is able to proceed even though the air temperature is below 33.6°F.

COMMENT

It seems likely that the criteria of rain and temperature conditions liable to interrupt external building work will be more or less the same over the British Isles, although the critical rate of rainfall may show a seasonal variation, e.g. perhaps a rate of 0.7 mm/hr. may be generally tolerable in the summer whereas a rate of 0.4 mm/hr. might often induce men to take shelter in the winter.

As previously stated, there are other meteorological factors, of which wind direction and speed are thought to be most important, and many non-meteorological factors which could not be considered but which were referred to in a letter received from a firm of building contractors:-

"... we would expect to find variations between the persistency of different gangs reflecting the different types of work being done, the extend to which protective clothing had been issued, the tenacity of the foreman, and even on whether the men were on bonus or not".

Polythene shelters to cover the building site, or part of the site, obviate loss of working time due to inclement weather, and this note may help contractors to decide for particular jobs whether it is an economic proposition to use them.

The effect of weather on building materials is a separate problem.

TABULATION OF RESULTS

Table 1 gives the number of hours with air temperature less than 34°F whether or not precipitation was occurring, the total number of hours (from 6.00 a.m. - 6.00 p.m. G.M.T. daily) each month in the ten-year period, and the percentage frequency of hours with temperature less than 34°F. (irrespective of precipitation)

Table 2 gives the total duration, in hours and tenths, of precipitation at a rate of 0.5 mm./hr. or more, the percentage duration, and the total number of occasions.

Table 3 gives the total duration of precipitation at a rate of 0.5 mm./hr. or more with temperature simultaneously less than 34°F.

Tables 2 and 3 also give the average duration for each month with precipitation and for each month with precipitation and low temperature, respectively.

CRITICISM OF RESULTS

In Tables 2 and 3 it should be stressed that the average durations have been computed from the hourly duration of rainfall at a rate of 0.5 mm./hr. or more in hourly observations on punched cards: the number of occasions is the number of cards which have rainfall of this rate punched on them. Hence if a period of rain of rate 0.5 mm./hr. or more occurs between, for example, 8.30 a.m. and 9.30 a.m. this will be reported on two cards as 30 minutes duration on each. Thus the 'average' duration is computed as 30 minutes whereas it should be 60 minutes. Thus it will be seen that the average durations quoted will be somewhat low. The average durations have been included in this memoranda, however, to make the results comparable with those given in Climatological Memoranda No. 27 and No. 29 for the London and Manchester areas. It should be noted that the above criticism does not apply to total duration or to percentage duration.

The number of occasions in Table 3 is too small in November to allow a significant average duration to be computed and for those computed for other months the number of occasions is too small to make them very useful.

DISCUSSION OF RESULTS

This investigation includes all days ignoring week-ends or holidays and it should be remembered that all the results refer to the period 6 a.m. to 6 p.m. G.M.T.

Consider the three simplified tabulations:-

Table (a) Temperature below 34°F. no precipitation at or above the rate of 0.5 mm./hr.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Percentage Hours	19.9	14.6	4.9	0.8	-	-	-	-	0.1	1.2	5.7	13.0

Table (b) Appreciable precipitation (i.e. at rate of 0.5 mm./hr. or more) with no restriction on temperature.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Percentage Hours	8.9	7.4	5.3	4.7	5.2	4.7	5.9	6.4	7.6	7.3	7.6	10.2

Table (c) Temperature below 34°F. and/or precipitation at rate of 0.5 mm./hr. or more

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Percentage Hours	28.8	22.0	10.2	5.5	5.2	4.7	5.9	6.4	7.7	8.5	13.3	23.2

The above results are shown in the form of a histogram in Figure 1,

The 30-year average for 1921 - 1950 of the mean temperature over Scotland for the winter months December, January and February is 39.7°F. while the 10-year average for these months for 1949 - 1958 is 38.9°F. thus the ten winters considered in this investigation may be regarded as

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reasonably representative of long term average temperature conditions. The annual rainfall over Scotland during the 35-year period 1916-1950 was 52.37 inches. The rainfall in inches during the years 1949-1958 were:-

<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>
54.4	57.3	54.8	47.1	48.7	64.0	41.0	51.4	53.4	50.7

giving an average for 1949 - 1958 of 52.3 inches: thus for rainfall the ten years 1949 - 1958 may also be regarded as reasonably representative of long term average conditions.

There is no reason to suspect that temperature and rainfall data at Renfrew Airport for the period 1949 - 1958 inclusive are not reasonably representative of long term average conditions in the greater Glasgow area.

The results in Table (c) above show that the time 'lost' through low temperature and/or rainfall is between 4.7 and 7.7 per cent. in the Glasgow area between April and September inclusive and is 22 per cent. or over between December and February inclusive.

Table (b) shows that the annual variation of monthly percentage hours 'lost' through precipitation (with no restriction on temperature) is from 4.7 per cent. in April and June to 10.2 per cent. in December in the Glasgow area. The months April to June inclusive are the best for building purposes in the Glasgow area from the aspect of rainfall as well as from the aspect of both rainfall and low temperature.

The right-hand column of Table 2 gives the average duration of rain at the rate of 0.5 mm./hr. or more, the average for the year being just under 32 minutes. The criticism of these results is described in the preceding section.

It may be computed from Table 3 that the percentage of hours 'lost' when the temperature is below 34°F. and also precipitation is occurring at the rate of 0.5 mm./hr. or more is given by (expressing the number of occasions as a percentage of the total hours):-

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Percentage Hours	1.2	0.9	0.3	-	-	-	-	-	-	-	0.1	0.6

COMPARISON WITH DATA FOR LONDON AND MANCHESTER AREAS

The results in this investigation will be compared with those of similar investigations for the London and Manchester areas in Climatological Memoranda No. 27 and No. 29. For convenience Tables (a) (b) and (c) for the three areas will be repeated:-

Table (a) Temperature below 34°F., no precipitation at or above the rate of 0.5 mm./hr.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
London Percentage Hours ..	15.1	17.1	5.9	0.2	-	-	-	-	-	1.4	3.7	10.2
Manchester "	19.0	18.1	7.1	0.5	-	-	-	-	-	0.9	4.4	11.0
Glasgow "	19.9	14.6	4.9	0.8	-	-	-	-	0.1	1.2	5.7	13.0

/Table (b)

Table (b) Appreciable precipitation at the rate of 0.5 mm./hr. or more with no restriction on temperature.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
London Percentage Hours ..	3.8	5.9	3.2	2.7	3.2	2.8	3.4	3.5	3.3	4.2	4.9	3.9
Manchester "	5.9	5.8	5.2	4.2	4.4	4.8	5.2	6.7	5.4	5.6	6.3	7.2
Glasgow "	8.9	7.4	5.3	4.7	5.2	4.7	5.9	6.4	7.6	7.3	7.6	10.2

Table (c) Temperature below 34°F. and/or precipitation at rate of 0.5 mm./hr. or more

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
London Percentage Hours	18.9	23.0	9.1	2.9	3.2	2.8	3.4	3.5	3.3	5.6	8.6	14.1
Manchester "	24.9	23.9	12.3	4.7	4.4	4.8	5.2	6.7	5.4	6.5	10.7	18.2
Glasgow "	28.8	22.0	10.2	5.5	5.2	4.7	5.9	6.4	7.7	8.5	13.3	23.2

Examining Table (a) in this section it will be seen that the percentage hours 'lost' due to the temperature being below 34°F. with no precipitation at or above the rate of 0.5 mm./hr. is greater at Manchester than at London in all months (when they occur) except October. However the hours 'lost' for the same reason at Glasgow are only greater than those at Manchester for the months September to January inclusive and April: the hours 'lost' for this reason in February and March are less than those for the Manchester and London areas.

Examining Table (b) in this section giving the hours 'lost' due to precipitation at rate 0.5 mm./hr. or more irrespective of temperature it will be seen that the percentage hours 'lost' are greater for Glasgow than for Manchester for every month except June and August. The hours 'lost' for this reason in the Glasgow area are appreciably greater than in the London area for every month e.g. in December the hours 'lost' are 3.9 per cent. in the London area against 10.2 per cent. in the Glasgow area.

Finally looking at Table (c) it can be seen that in general there is an increase in the hours 'lost' due to temperature being below 34°F. and/or precipitation at a rate of 0.5 mm./hr. or more from London to Manchester to Glasgow. However, here again we get exceptions. The best months for external building work from the aspect of low temperature (less than 34°F.) and/or precipitation (equal to or greater than 0.5 mm./hr.) are April to October inclusive for the London, Manchester and Glasgow areas.

Table 1 Frequency of hours with temperature less than 34°F. irrespective of precipitation.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Total hours	3720	3384	3720	3600	3720	3600	3720	3720	3600	3720	3600	3720
No. of hours with temp. less than 34°F.	785	523	191	30	-	-	-	-	3	43	207	506
Percentage hours	21.1	15.5	5.1	0.8	-	-	-	-	0.1	1.2	5.8	13.6

/Table 2

Table 2 Duration of precipitation at rate 0.5 mm./hr. or more irrespective of temperature.

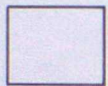
Month	Total hours 06-18 GMT.	Rainfall duration at rate 0.5 mm./hr. or more in hours and tenths	Percentage duration	No. of occasions	Average duration of rain at rate 0.5 mm./hr. or more per occasion in mins.
Jan.	3720	331.4	8.9	598	33
Feb.	3384	250.9	7.4	461	33
Mar.	3720	199.0	5.3	328	36
Apr.	3600	170.7	4.7	350	29
May	3720	195.2	5.2	382	31
June	3600	170.4	4.7	319	32
July	3720	217.9	5.9	406	32
Aug.	3720	237.1	6.4	469	30
Sep.	3600	273.5	7.6	547	30
Oct.	3720	271.7	7.3	506	32
Nov.	3600	274.8	7.6	515	32
Dec.	3720	379.0	10.2	696	33

Table 3 Duration of precipitation at rate 0.5 mm./hr. or more with temperature less than 34° F.

Month	Total hours 06-18 GMT	Rainfall duration at rate 0.5 mm./hr. or more and temperature below 34° F	No. of occasions	Average duration of rain at rate 0.5 mm./hr. or more per occasion in mins.
Jan.	3720	33.8	44	46
Feb.	3384	23.8	30	48
Mar.	3720	8.5	10	51
Nov.	3600	0.9	2	-
Dec.	3720	15.7	22	43



Temperature below 34°F.



Appreciable precipitation; rate 0.5 mm/hr. or more

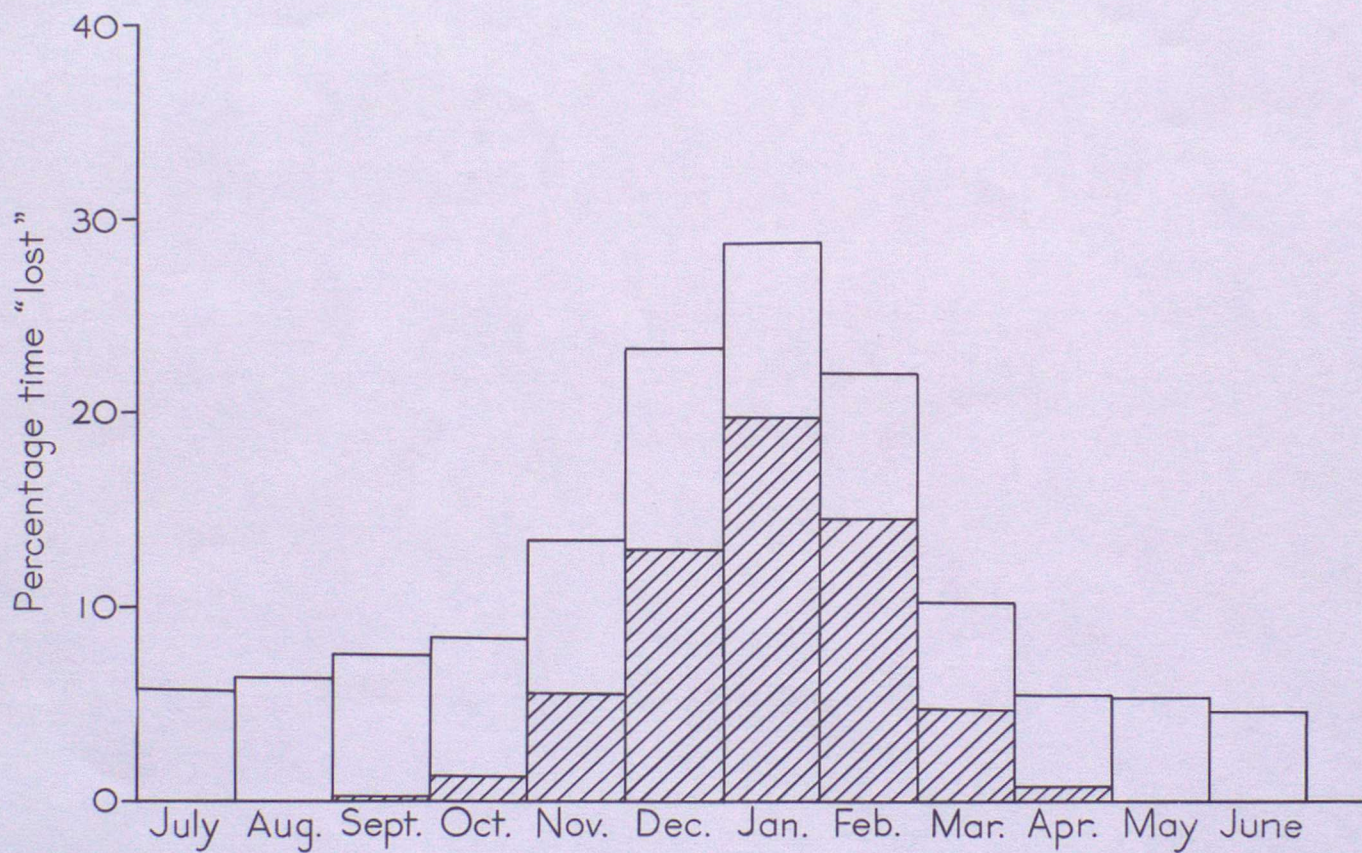


Fig.1 Percentage time "lost" due to rain and / or low temperature interrupting external building work in the Glasgow area.