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**INDUSTRIAL
HEALTH RESEARCH BOARD**
(Formerly The Industrial Fatigue Research Board).

REPORT No. 62.

**Two Studies of Absenteeism
in Coal Mines**

**I. The Absenteeism of Miners in Relation to
Short Time and other Conditions.**

By H. M. VERNON and T. BEDFORD
(assisted by C. G. WARNER).

**II. A Study of Absenteeism at certain Scottish
Collieries.**

By T. BEDFORD and C. G. WARNER.

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PREFACE.

The Board have previously published several reports dealing with the relation of the physical environment of the coal miner to his well-being and efficiency.¹

The two studies here presented, whilst forming parts of the same picture, were originated under different circumstances ; Part I being a continuation of previous work done by the authors on the relation of environmental conditions underground to absenteeism, Part II and the Appendix being the outcome of an inquiry recommended by the Miners' Health Advisory Committee into the morbidity statistics of certain selected pits with reference to conditions both on the surface and underground.

As the Board have pointed out before, the question of causes of absenteeism is difficult and involved, bringing in besides the physiological factors which it was the principal object of the Board to study, a number of social and economic factors, to isolate from which the parts played by sickness and unfavourable environment is a task of considerable complexity.

The industry, moreover, is one in which the data which it has been found possible to collect are frequently insusceptible of conclusive statistical treatment and comparison as regards cause and effect.

The results of the present inquiries, which demonstrate these limitations, should not be considered as necessarily representative of the industry as a whole. In so far as they are positive, however, they are considered to be of value, and to be well worth the attention of the industry.

(¹) I.H.R.B. Report No. 39.
I.H.R.B. Report No. 51.

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I.—THE ABSENTEEISM OF MINERS IN RELATION TO SHORT TIME AND OTHER CONDITIONS.

BY

H. M. VERNON, M.D., AND T. BEDFORD, PH.D. (ASSISTED BY
C. G. WARNER, B.Sc.).

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1.—INTRODUCTION.

In a previous report (No. 51, 1928) we gave a detailed account of the absenteeism shown by the 18,455 underground men and 4,456 surface men working at a group of ten collieries, all of which are situated within ten miles of one another. Absenteeism from sickness, accidents, and voluntary causes was studied in relation to underground conditions, more especially the atmospheric ones, and to some of the surface conditions such as labour turnover and distance of the homes of the miners from the collieries. Our "total absenteeism" data were for the period 1920-6, but our accident data related only to the two years 1924 and 1925, and our sickness data to the 21 months between August, 1924 and April, 1926. The dispute which began on 1st May, 1926, and lasted for nearly seven months, not only prevented us from getting any reliable data until 1927, but it caused considerable changes in the conditions under which the miners worked. It is the object of the present investigation to study the influence of these altered conditions on absenteeism, with a view to tracing still further the various factors concerned in its causation.

The most obvious change of working conditions in the district investigated was the substitution of a $7\frac{1}{2}$ -hour working day for the previous 7-hour day. Allowing half-an-hour for the time spent in winding, this means that the men are now 8 hours underground instead of the previous $7\frac{1}{2}$ hours. A still more important change of conditions was induced by the diminished demand for coal, for this led, not only to a reduction in the possible number of shifts worked, but to a lowering in the scale of wage payments. The total weekly earnings of the men were therefore liable to serious diminution, though the area in which our investigation was made was not so badly hit as most other areas. Another change of conditions was the erection of pithead baths, though this affected only half of the collieries investigated.

All the new data to be described relate to the two complete years 1927 and 1928. In order to obtain thoroughly reliable information it was necessary to omit statistics from several of the collieries previously studied. For instance, the pithead baths at collieries M and Q were erected piecemeal, so there was no definite date before and after which the absenteeism figures could be readily compared. At colliery P there were various special arrangements about wage payments which differed from those in force at the other collieries, whilst at colliery B the sickness data were not considered to be thoroughly reliable. But even when the statistics from these collieries were omitted the body of information remaining was of sufficient bulk to yield trustworthy results.

2.—ABSENTEEISM OF UNDERGROUND MEN IN RELATION TO WAGES AND POSSIBLE SHIFTS.

In our previous report we stated that during the 1924-6 period investigated a 10 per cent. diminution in the average wage payments of the men working at the coal face was accompanied by a fall in the total absenteeism from 17·3 per cent. to 16·0 per cent. It might therefore be expected that the more considerable reduction of wage payments experienced in 1927-8 would be accompanied by a further fall of absenteeism. Wage payment depends on the number of shifts worked per week and on the wages scale of the district. According to the national wage agreements of 1921 and 1924 this scale depends on a *basis rate*, which is fixed on the spot for the work which the particular miner has to do, and a *percentage addition* thereto which depends on an ascertainment, district by district, of the gross proceeds of the industry and of the costs of production other than wages. Of the difference between these two sums, described as net proceeds, 87 per cent. is treated as representing the share of labour, but it is provided that, whatever the result of the ascertainment, the wages paid should be at a rate which always

TABLE I.—ABSENTEEISM IN RELATION TO FLUCTUATIONS OF WAGES SCALE AND OF POSSIBLE SHIFTS.

	1924 (4)	1925				1926 (1)	Mean 1924- 6	1927				1928				Mean 1927- 8
		(1)	(2)	(3)	(4)			(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
Wages scale	156.5	159.0	155.1	146.7	146.7	146.7	151.8	151.7	142.9	136.0	136.0	132.0	132.0	132.0	132.0	136.8
Coal face workers :—																
Per cent. absenteeism from voluntary causes.	9.7	9.3	8.4	9.6	8.7	9.4	9.2	7.3	6.6	7.5	6.8	6.0	5.0	6.5	5.7	6.4
Per cent. absenteeism from sickness	3.9	4.3	3.7	4.4	4.2	5.0	4.2	3.2	3.1	3.6	3.3	3.2	3.3	3.0	3.1	3.2
Per cent. absenteeism from accidents.	2.7	2.8	2.8	2.9	2.5	2.4	2.7	1.9	2.3	2.8	2.6	2.8	2.8	2.5	2.8	2.6
Possible shifts per week	5.1	5.4	4.7	4.9	5.0	5.3	5.1	4.7	4.5	4.7	4.8	4.7	4.0	4.3	4.5	4.5
Wages product	80	86	73	72	74	78	77	71	64	64	65	62	53	57	59	62
Others underground :—																
Per cent. absenteeism from voluntary causes.	4.6	4.5	4.8	6.0	5.5	5.9	5.2	4.5	3.9	4.8	3.6	3.4	3.1	3.6	3.1	3.7
Per cent. absenteeism from sickness	3.5	3.7	3.0	3.3	3.4	3.6	3.4	2.9	2.5	2.9	2.5	2.3	2.6	2.7	2.5	2.6
Per cent. absenteeism from accidents.	2.0	1.8	2.0	1.7	1.3	1.4	1.7	1.1	1.3	1.4	1.5	1.3	1.3	1.4	1.5	1.4
Possible shifts per week	5.4	5.7	5.0	5.2	5.2	5.6	5.4	5.2	4.9	5.2	5.2	5.1	4.4	4.8	4.9	5.0
Wages product	85	91	78	76	76	82	81	79	70	69	69	67	58	63	65	67

reaches a certain minimum standard. The colliers are mostly on piece rates, and earn more than basis rate *plus* percentage addition, but the piece rate prices are subject to the fluctuations of district percentage addition.

It will be seen from Table I that in the district where our investigations were made the wages scale reached a maximum of 159.0 in the first quarter of 1925 and fell to 146.7 in subsequent quarters. After the dispute it rose to 151.7 for three months, and then fell to the minimum of 132.0, which it maintained throughout 1928. The number of possible shifts for the men at the coal face varied from 5.4 to 4.7 per week in the pre-dispute period and averaged 5.1, but in the post-dispute period it averaged only 4.5, and in one quarter fell as low as 4.0. The product of wages scale and shifts (which may be divided by 10 in order to reduce it to a convenient figure) accordingly varied from 86 to 72 in the pre-dispute period, and from 71 to 53 in the subsequent period. It is not permissible to regard these wages product figures as representing any fixed cash value, but the magnitude of the fall

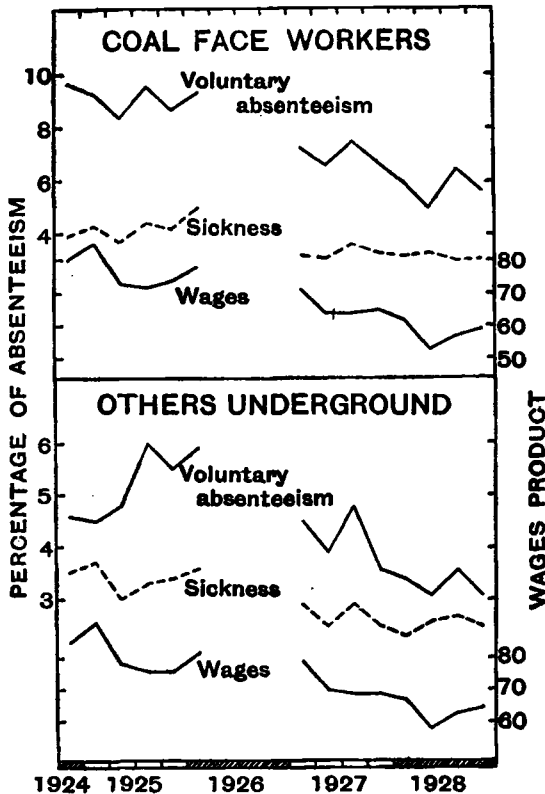


FIG. I.—Fluctuations of absenteeism in relation to wages product.

in wages is perhaps more realisable if we think of a hewer who could earn £4 6s. 0d. in the first quarter of 1925, and who found that in the second quarter of 1928 his maximum possible earnings (supposing that he continued to work at the same speed as before) were reduced to £2 13s. 0d. a week. The other underground men, who were mostly concerned in haulage and repair work, were not quite so badly affected, for we see from the table that their wages product never fell below 58 for any quarter; but it must be remembered that their basis rate is usually considerably below that of the coal face workers.

The variations in wages product are plotted in Fig. 1, and the percentage losses of time from voluntary causes and from sickness are likewise recorded. It will be seen that if the pre- and post-dispute periods are compared as a whole, there was a considerable reduction in both of these causes of absenteeism in the latter period, in correspondence with the reduction of wages. Thus a fall of 19 per cent. in the wages product of the coal face workers was accompanied by a fall of 30 per cent. in voluntary absenteeism and of 24 per cent. in sickness absenteeism, whilst a fall of 17 per cent. in the wages product of the other underground men was accompanied by falls of 29 and 24 per cent. in voluntary and sickness absenteeism respectively. If the results are compared quarter by quarter, it will be seen that the variations in the loss of time of the coal face workers from voluntary causes synchronise well with the variations of wages, during both the pre- and the post-dispute periods, but for the other underground men the correspondence holds only during the post-dispute period. The sickness figures, on the other hand, show but little correspondence, and it will be seen from the table that the time lost by the coal face men from accidents was apparently not affected at all by wages, as it was practically the same in the post- and pre-dispute periods. However, the other underground men show a distinct reduction in the post-dispute period.

If the absenteeism data are plotted in relation to fluctuations of wages scale only or of possible shifts only, it will be found that they show considerably less correspondence than that observed with the wages product.

The results recorded in Table I were obtained at collieries A(1), N, J, A(2), K, and L, and they relate to 10,076 underground men in all, of whom about half worked at the coal face. At colliery J the possible shifts fell so low in 1928 that the men were estimated to earn unemployment benefit for 9, 22 and 22 days respectively in the second, third and fourth quarters. This benefit (which was at the rate of 4s. 6d. or 4s. 8d. a day for a collier with a wife and two children) was estimated to be roughly equivalent to the wages obtained in 0·2 shift per week in the second quarter, and to 0·5 shift in the third and fourth quarters, so it

was substantial enough to have some influence on the time lost voluntarily, and perhaps on that lost from sickness. Still, the influence on the average figures recorded in Table I would be so small that no correction has been applied. The shifts worked at the other five collieries very seldom fell to the unemployment benefit level, so the data obtained there are rather more reliable for our purpose. They have an additional interest in that the wages fluctuations at the individual collieries in 1927 and 1928 were by no means synchronous, so we can determine whether variations in absenteeism correspond with those in wages irrespective of the time of year. In Fig. 2 we have plotted the average

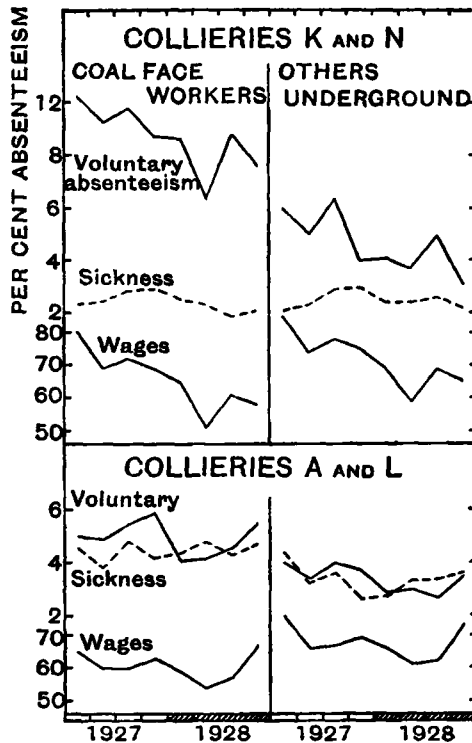


FIG. 2.—Fluctuations of absenteeism in relation to wages product at two pairs of collieries.

variations shown by the men working (a) at collieries K and N, and (b) at collieries L, A(1), and A(2). As these two latter collieries are joined underground they may conveniently be designated as colliery A. It will be seen that the wages curves at the two groups of collieries differ considerably in form, and that the voluntary absenteeism curves for the most part vary synchronously with them, both in regard to the coal face workers and the others underground. Even the sickness curves show some sort of correspondence with the wages curves, though it is not nearly so close.

The numerical relationship between wages product and absenteeism is shown in Table II and Fig. 3. The results obtained in all the quarters (from 1924 to 1928) in which the wages product

TABLE II.—ABSENTEEISM IN RELATION TO POSSIBLE EARNINGS.

Cause of absenteeism.	Per cent. absenteeism in best paid quarters.	Relative absenteeism when wages product was—			
		80 or more (mean, 82 or 86).	79 to 70 (mean, 74).	69 to 60 (mean, 65).	59 or less (mean, 56).
Coal face workers :—					
All causes	17.9	100	98	77	66
Voluntary	11.1	100	94	67	52
Sickness	4.2	100	100	86	76
Accidents	2.7	100	107	104	107
Others underground :—					
All causes	11.0	100	83	72	—
Voluntary	5.8	100	79	62	—
Sickness	3.5	100	86	80	—
Accidents	1.8	100	89	83	—

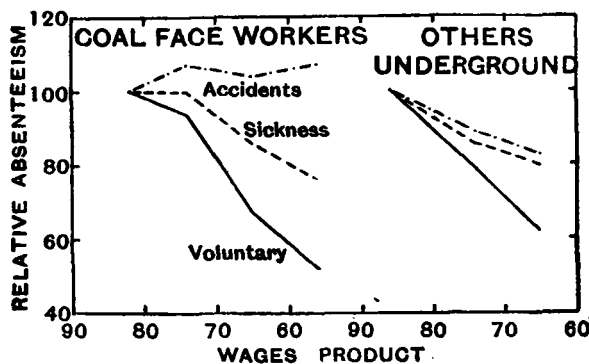


FIG. 3.—Relative absenteeism in relation to wages product.

was 80 or more, 79 to 70, 69 to 60, or 59 and less, were averaged, and they are recorded in a relative form. Taking the absenteeism from each cause in the best paid quarters as 100, we see that the voluntary absenteeism of the coal face men sank, in the worst paid quarters, to approximately half, whilst the sickness absenteeism sank to three-quarters. The other underground men did

not, except in one quarter, experience a wage product of less than 60, and this exception has been averaged in the 69 to 60 group. The smaller reductions of wages experienced by these men affected their voluntary and sickness absenteeism considerably more than the corresponding reductions affected the coal face men. Even the time lost from accidents was reduced by 11 per cent. when the mean wages product fell from 86 to 74, and by 17 per cent. when it fell to 65. Under similar conditions of wages reduction the coal face men showed slight increases of accident time, so it follows that the total absenteeism of the coal face men was considerably less affected by wage reductions than that of the other underground men. In fact, we see from the table that at wages products of 74 and 65 it showed reductions of only 2 and 23 per cent. respectively, whilst the total absenteeism of the other underground men showed reductions of 17 and 28 per cent. respectively.

The varying degrees of reaction shown by the coal face men and the other underground men to reduction of wages are mainly dependent on two considerations, namely, the economic pressure caused by the reduction of income, and the possibility of relieving this pressure by curtailment of the times lost by absenteeism from various causes. The basis rate of the other underground men was less than that of the coal face men, so they were naturally more sensitive to the reductions in wages. Of the various causes of absenteeism, it is evident that if the term "voluntary" is accurate, the men could, if they wished, entirely avoid this source of reduced earnings. The mere fact that the coal face men cut it down to half in the worst paid quarters suggests that the designation is a reasonably valid one. On the other hand, it might be thought that if the time nominally lost from sickness or accidents correctly represents the specified causes of absenteeism, no sort of compulsion, economic or otherwise, would be able to cut it down. As a matter of fact, the period of absence entailed by a sickness is inevitably influenced by all sorts of conditions. A man can seldom say definitely that he feels too sick to work on one day, and that he is quite fit the next day. Usually he is convalescent for several days, and can therefore return to work at various stages of fitness and unfitness. The time lost from accidents is not so susceptible of being reduced as is that lost from sickness, but we showed in our previous report that under certain conditions it is subject to great variations. Further information on this matter is recorded in a subsequent section of the present report. As has already been pointed out, the accident time of the coal face workers was practically unaltered when wages were reduced, but it must be remembered that there was an additional factor operating during most of the reduced wages periods, namely, an increase in the length of the working day from $7\frac{1}{2}$ to 8 hours. How far this may have been responsible for the increase of accident time is discussed further on.

3.—ABSENTEEISM OF SURFACE MEN IN RELATION TO WAGES AND POSSIBLE SHIFTS.

The surface men are less well paid than the underground men, so we might expect to find an even closer correspondence in the fluctuations of absenteeism and wages than was observed with the latter group. It will be seen from Fig. 4 that voluntary absenteeism

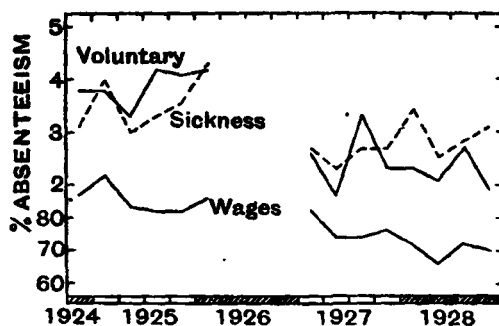


FIG. 4.—Fluctuations in the absenteeism of surface workers in relation to wages product.

corresponded with wages product to about the same extent as that indicated in Fig. 1 for the two groups of underground men, whilst sickness absenteeism corresponded somewhat better. The absenteeism figures on which these curves are based relate to six collieries (i.e., all the collieries mentioned in Report No. 51 except A, M and Q). The data for colliery A were omitted as there was some doubt about the accuracy of the number of shifts worked, but the absenteeism figures are reliable, so they were included when calculating the mean results recorded in Table III.

TABLE III.—ABSENTEEISM OF SURFACE MEN.

	Statistical period.		Per cent. re-duction.
	1924-6.	1927-8.	
Number of surface men investigated	4,456	2,734	
Per cent. of time lost by surface men from—			
Voluntary causes	3.7	2.3	38
Sickness	3.3	2.8	15
Accidents	0.7	0.6	14
All causes	7.7	5.7	26
Per cent. of time lost from all causes by—			
Coal face workers	17.1	12.9	25 } 26
Others underground	10.7	7.7	
	13.9	10.3	

From Table III it will be seen that in 1927-28 the surface workers showed a reduction of 38 per cent. in their voluntary absenteeism as compared with 1924-6. This figure compares favourably with the reductions of 30 and 29 per cent. shown by the coal face men and the other underground men respectively (cf. Table I), and it is the more noteworthy in that the surface men, even in 1924-6, lost only half as much time voluntarily as the underground workers. The surface men reduced their sickness absenteeism slightly less than the underground workers, but taking absenteeism as a whole, we see that the surface men showed exactly as much reduction in 1927-8 as the underground men; i.e., the compulsion of greater economic pressure was balanced by the smaller margins of absenteeism open to reduction.

The relationships between absenteeism and wages product at the individual collieries are shown in Table IV. All the available quarters for 1924-8 are divided into three groups, according to the wages product, and the averages shown in the table and plotted in Fig. 5 indicate that whilst voluntary absenteeism was 41 per cent. less when the wages product was 64 than when it was 89, the sickness absenteeism was 23 per cent. less.

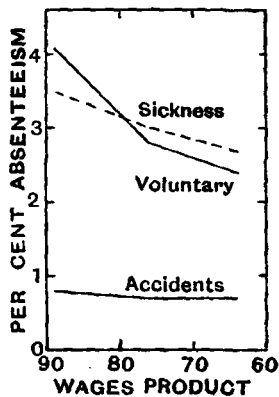


FIG. 5.—Mean absenteeism of surface men in relation to wages product.

4.—THE INFLUENCE OF PITHEAD BATHS ON ABSENTEEISM.

In five of the ten collieries investigated, pithead baths were erected during the course of the selected statistical periods, or before them, whilst the remaining five collieries were bathless throughout. We therefore had an opportunity of determining what effect, if any, was induced in absenteeism rates when the large majority of the miners at certain collieries took to bathing at the pithead instead of at home. This bathing would tend to reduce the chances of the men catching cold on their journey from pit to home, and the doctor attached to one of the collieries

TABLE IV.—PERCENTAGES OF TIME LOST BY SURFACE MEN IN RELATION TO POSSIBLE EARNINGS.

Colliery.	Wages product, 85 or more.				Wages product, 84 to 70.				Wages product, 70 or less.			
	Voluntary causes.	Sick-ness.	Acci-dents.	Wages product.	Voluntary causes.	Sick-ness.	Acci-dents.	Wages product.	Voluntary causes.	Sick-ness.	Acci-dents.	Wages product.
N	5.1	3.0	1.0	92	3.7	3.2	0.7	77	3.0	2.7	0.4	65
L	5.4	4.3	0.9	90	2.7	4.4	0.7	72	2.3	4.4	1.1	64
B	4.0	2.1	0.3	89	2.7	1.5	0.3	77	3.0	1.1	0.6	65
J	2.5	4.1	1.0	86	2.0	2.8	0.8	77	1.8	3.0	0.8	63
K	3.3	3.9	0.8	86	3.0	3.1	0.7	76	1.6	2.4	0.7	65
Mean	4.1	3.5	0.8	89	2.8	3.0	0.7	76	2.4	2.7	0.7	64

informed us that in his experience the incidence of certain skin affections such as boils was distinctly diminished, and such as did occur became more amenable to treatment because of the increased cleanliness of the skin. We therefore might expect some improvement in general health, though it does not follow that it can be demonstrated statistically. We have seen that the amount of sickness absenteeism, and still more that of voluntary absenteeism, is influenced by all sorts of conditions, and some of them might override the genuinely beneficial effects produced by the baths. For instance, the miner who bathed and changed into his clean clothes at the pithead would be more likely to go straight to refreshment rooms and to various places of amusement than the unwashed miner, who would naturally go home first. Increased opportunity for distractions might result in an increase of voluntary absenteeism, and possibly of sickness absenteeism.

As already stated, the baths at two of the collieries were erected piecemeal, and are therefore useless for our present purpose, whilst at another colliery, colliery J, the time of opening of the baths was a year and a half later than at the remaining two. We were therefore reduced to two collieries with bath installations suited to our purpose, namely, colliery K, where the baths were opened on 26th September, 1925, and colliery N, where they were opened on 1st November, 1925. Since these dates about four-fifths of the (approximately) 5,000 men attached to the collieries have bathed regularly. Of the bathless collieries which were needed for comparison, two had to be excluded because the sickness data were not thoroughly reliable, so we were left with collieries A(1), A(2) and L. Here about 5,600 men were at work, so we had two approximately equal groups of men for comparison. We divided our absenteeism statistics into four periods: (a) a 14-month period when neither group of collieries had baths; (b) the succeeding 6-month period when the baths had just been erected at two collieries, and (c) and (d) two 12-month periods which came after the prolonged dispute in 1926.

In Table V we record the average amount of time lost from sickness, from voluntary causes and from all causes in the pre-bath period (a). We see that it was somewhat smaller at the collieries where baths were subsequently erected than at the others, so it follows that there was less available margin for subsequent reduction. The remaining three lines of the table record the *differences* in the absenteeism figures during periods (b), (c) and (d) from those experienced in period (a), reckoned as percentages. We see that in period (b) the total absenteeism was practically the same as in period (a) at both groups of collieries, but in period (c) it was considerably smaller at the bathless collieries than at the others, the average reduction being 29 per cent. as against 12 per cent. This considerable difference is dependent chiefly on economic causes, for the wages product at the bathless collieries was only 67, as compared with a figure of 77 at the

TABLE V.—VARIATIONS IN ABSENTEEISM OF ALL MEN (UNDERGROUND AND SURFACE) AT COLLIERIES WITH AND WITHOUT BATHS.

Statistical period.	Wages product at collieries.		Collieries K and N (with baths).			Collieries A and L (without baths).		
	K and N.	A and L.	Sick-ness.	Volun-tary.	All causes.	Sick-ness.	Volun-tary.	All causes.
(a) August, 1924, to September, 1925 (absenteeism with no baths at either pair of collieries).	83	86	3·0	7·3	12·2	4·4	7·5	13·8
(b) November, 1925, to April, 1926 (per cent. difference from (a) at collieries with and without baths).	78	82	+11	+ 2	+ 2	+12	- 5	0
(c) January to December, 1927	77	67	-14	-12	-12	- 8	-47	-29
(d) January to December, 1928	65	64	-17	-36	-27	- 7	-55	-30

collieries with baths. In the subsequent (*d*) period, when the wages product was practically the same at both groups of collieries, the reduction of total absenteeism was likewise nearly the same.

Our data render it evident that if the introduction of baths did have a favourable influence on total absenteeism, it is completely hidden by the effects of differences in wages and in the smaller margins of absenteeism available for reduction. However, the sickness absenteeism figures are more encouraging. We see that though the alteration of sickness in period (*b*) was practically the same at both groups of collieries, in periods (*c*) and (*d*) there was a reduction of sickness which was distinctly more marked in the bath-provided collieries than in the bathless collieries, the average reductions being 16 per cent. and 8 per cent. respectively. Hence our data do undoubtedly suggest that the introduction of baths diminished the time lost from sickness, though the time lost from voluntary causes showed a much smaller reduction at the collieries with baths than at those without them.

In order to obtain thoroughly reliable evidence, it would be necessary to obtain comparison periods for groups of collieries in which the amount of short time was practically the same, or better still, was non-existent. Also the percentages of time lost from various causes in the pre-bath comparison period ought to be approximately the same at both groups of collieries.

5.—ABSENTEEISM IN RELATION TO ATMOSPHERIC CONDITIONS.

(a) *Temperature.*

In order to investigate the relation of absenteeism to the atmospheric conditions experienced underground, we made a large number of observations on the dry and wet bulb temperatures at each of the ten collieries, whilst the cooling power of the air—from which the air velocity could be calculated—was determined by means of the kata-thermometer. The results of these observations are fully recorded in our previous report, but we reproduce some of them in Table VI, in order to indicate their relationship to the absenteeism figures obtained in 1927–8. At three of the collieries the temperatures now quoted are slightly different from the previous ones, as the distribution of the men working at various places underground was different. Colliery A(1) is quoted twice, as we obtained separate data for each of the two seams. As before, we do not quote the sickness figures for collieries P and B, because of their unreliability. Also we omit all reference to collieries M and Q.

The collieries are arranged in the table according to the depth of the workings, which varied from 616 ft. to 2,269 ft., and it will be seen that the temperatures rose considerably with increase of depth. At the same time the absenteeism showed a tendency to

TABLE VI.—MEAN ATMOSPHERIC CONDITIONS AND ABSENTEEISM AT VARIOUS COLLIERIES.

Colliery.	Coal Face Men.											Other Underground Men.										
	Temperature		Air Velocity (ft. per min.).	Percentage Absenteeism in 1927-8.				Differences from 1924-6 data.				Temperature.		Air Velocity (ft. per min.).	Percentage Absenteeism in 1927-8.				Differences from 1924-6 data.			
	Dry Bulb.	Wet Bulb.		Sickness.	Accidents.	Voluntary.	Total.	Sickness.	Accidents.	Voluntary.	Total.	Dry Bulb.	Wet Bulb.		Sickness.	Accidents.	Voluntary.	Total.	Sickness.	Accidents.	Voluntary.	Total.
A(1), C	64.6	62.2	18	2.7	2.5	3.4	8.6	-0.6	+0.8	-4.8	-4.9	61.9	58.3	128	2.3	1.0	2.2	5.5	-0.2	0.0	-1.4	-2.0
N ..	69.0	65.4	51	2.3	2.8	9.8	14.9	-0.7	+0.3	-1.9	-2.3	68.1	63.1	102	2.3	1.8	5.0	9.1	0.0	0.0	-1.3	-1.3
A(1), D	77.3	71.6	20	4.4	3.9	5.3	13.6	-1.1	-0.6	-3.6	-5.2	72.3	65.8	158	3.2	1.0	2.4	6.6	-1.1	-0.4	-0.8	-2.2
J ..	76.7	68.8	80	2.5	1.4	2.8	6.7	-1.7	-0.6	-1.1	-3.4	75.1	65.3	79	1.4	0.8	2.6	4.8	-1.7	-0.4	-0.4	-2.5
P ..	77.9	72.7	276	—	2.9	—	17.2	—	+1.3	—	-2.2	72.6	65.4	211	—	1.5	—	9.3	—	-0.2	—	-4.7
K ..	80.0	74.5	31	2.5	2.4	9.7	14.6	-0.9	-0.1	-1.6	-2.6	73.2	65.2	153	2.6	1.5	4.4	8.5	-0.5	-0.3	-1.6	-2.4
A(2) ..	81.9	76.5	20	3.3	2.1	2.9	8.3	-0.6	-0.1	-4.1	-4.8	72.4	62.7	196	2.5	0.9	1.3	4.7	-0.8	-0.3	-1.5	-2.6
B ..	82.7	74.8	37	—	3.0	—	12.1	—	-0.2	—	-6.7	78.8	67.9	98	—	1.8	—	5.8	—	+0.5	—	-2.6
L ..	82.2	74.0	71	5.5	3.4	6.1	15.0	-0.6	+0.1	-6.4	-6.9	77.1	68.1	264	4.1	1.7	4.9	10.7	-0.9	-0.5	-3.9	-5.3
Means of complete sets of data			3.3	2.7	5.7	11.7	-0.9	0.0	-3.4	-4.3					2.6	1.2	3.3	7.1	-0.7	-0.2	-1.6	-2.6

increase, though it was not so marked as in 1924-6. The percentages of time lost by absenteeism from sickness, accidents and voluntary causes in 1927-8 are quoted, whilst the 1924-6 figures are given in the form of differences from these later figures. It will be seen that, on an average, the coal face men lost 3.3 per cent. of their shifts from sickness in 1927-8. This was 0.9 less than the 1924-6 figure, which accordingly amounted to 4.2 per cent. The time lost from accidents was unchanged, whilst that lost from voluntary causes was 3.4 per cent. less in 1927-8 than in 1924-6. The other underground men showed smaller reductions of sickness absenteeism and voluntary absenteeism in 1927-8 than the coal face men, but they differed from them in showing some reduction of time lost from accidents.

In order to demonstrate more clearly the relationship of sickness absenteeism to underground temperatures, we split the data into three or four groups, according to the mean temperatures experienced by the men. The ranges of temperature of the groups were the same as those recorded in our previous report, so it is unnecessary to quote them again, but the means of each group, and the associated sickness absenteeism figures, are plotted in Fig. 6. The 1924-6 data obtained at the same six collieries are

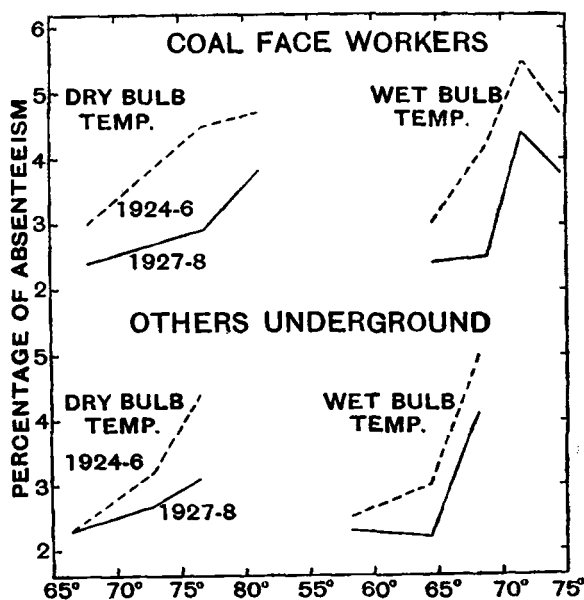


FIG. 6.—Absenteeism from sickness in relation to temperature.

given for comparison, and it will be seen that the new data correspond fairly well with them, except that the sickness experienced at all temperatures was about 1 per cent. less. We suggested that the substantial increase of sickness which is

TABLE VII.—ACCIDENT RATES OF COAL FACE WORKERS AND OTHER UNDERGROUND MEN.

Colliery and Seam.*	Coal Face Workers.										Others Underground.											
	Tempera- ture.		Air Velo- city in ft. per min.	Accident Frequency per 100,000 man shifts.				Accident Severity (days lost per 1,000 hours worked).				Tempera- ture.		Air Velo- city in ft. per min.	Accident Frequency per 100,000 man shifts.				Accident Severity (days lost per 1,000 hours worked).			
	Dry Bulb.	Wet Bulb.		Falls of ground.	Other Causes.	All Causes (1927-8).	All Causes (1924-5).	Falls of ground.	Other Causes.	All Causes (1927-8).	All Causes (1924-5).	Dry Bulb.	Wet Bulb.		Falls of ground.	Other Causes.	All Causes (1927-8).	All Causes (1924-5).	Falls of ground.	Other Causes.	All Causes (1927-8).	All Causes (1924-5).
N, H ..	61.5	60.0	31	64	73	137	103	2.4	2.4	4.8	3.8	59.4	56.0	69	11	40	51	42	0.7	1.3	2.0	1.7
A(1), C ..	64.6	62.2	18	34	58	92	63	2.0	2.8	4.8	3.5	61.9	58.3	128	5	37	42	37	0.4	1.2	1.6	1.6
N, G ..	65.6	62.3	54	51	44	95	83	2.0	1.7	3.7	3.3	64.6	60.1	90	15	34	49	49	0.4	1.7	2.1	2.1
A(1), D ..	77.3	71.6	20	48	47	95	97	2.8	2.0	4.8	4.9	72.3	65.8	158	4	25	29	38	0.3	1.2	1.5	1.7
N, E ..	75.8	70.9	68	61	82	143	111	2.3	2.7	5.0	3.8	72.4	66.6	126	12	54	66	61	0.4	2.0	2.4	2.3
J, E ..	76.8	68.8	80	52	69	121	128	1.6	1.9	3.5	4.1	75.1	65.3	79	12	44	56	51	0.4	1.7	2.1	1.7
K, D ..	78.7	74.4	24	48	99	147	152	1.9	3.1	5.0	4.3	73.0	64.6	115	11	53	64	76	0.4	2.0	2.4	2.5
A(2), D ..	81.9	76.5	20	29	46	75	91	1.5	1.5	3.0	4.1	72.4	62.7	196	1	36	37	43	0.1	1.4	1.5	1.8
P, E ..	77.9	72.7	276	32	47	79	72	1.2	1.2	2.4	2.4	72.6	65.4	211	20	52	72	53	0.8	2.3	3.1	2.2
B, D ..	83.4	74.8	33	70	75	145	139	2.3	2.6	4.9	5.2	80.0	68.6	94	7	66	73	64	0.3	2.3	2.6	1.9
K, F ..	81.3	74.6	33	41	76	117	119	1.4	2.2	3.6	3.3	73.5	66.2	230	25	73	98	104	1.0	2.2	3.2	3.4
B, F ..	85.4	75.7	59	35	66	101	131	1.4	3.4	4.8	4.5	81.9	69.6	148	12	59	71	98	0.6	1.9	2.5	2.9
L, E ..	82.2	74.0	71	83	90	173	161	3.3	3.0	6.3	5.0	77.1	68.1	264	26	57	83	90	1.0	1.9	2.9	2.7

* The first letter refers to the colliery and the second letter to the seam.

associated with increase of underground temperature may be due to the men getting more overheated, and on that account being more liable to catch a chill on coming to the surface.

The relationship of the 1927-8 accident data to atmospheric conditions was worked out on the same lines as those described in our previous report for the two complete years 1924 and 1925 (i.e., not for the 21-month period (August, 1924-April, 1926) concerned in the results just described). It will be seen from Table VII that our present results relate to the men working in 13 different localities, and they indicate the accident frequency rates from falls of ground and from other causes, reckoned per 100,000 man-shifts worked. They also indicate the accident severity rates in terms of days lost per 1,000 hours worked, taking the maximum absence entailed by any accident to be 150 days, and assuming that a working day meant 8 hours underground. The accident frequency and severity rates from all causes in 1924-5 are given for comparison.

It will be seen that the results obtained in the two statistical periods correspond fairly well in most of the localities, but in order to demonstrate clearly the relationship of accidents to temperature it is necessary to re-classify the data in temperature groups. With the object of making the new accident frequency data directly comparable with those obtained in 1924-5, we have calculated all of them in terms of accidents per million hours worked, and they are quoted in this form in Table VIII. Here we see that at dry bulb temperatures of less than 70° the coal face

TABLE VIII.—ACCIDENT RATES IN RELATION TO DRY BULB TEMPERATURE.

Temperature range	Mean temperature.	Accident Frequency per 100,000 man shifts.		Accident Severity (days lost per 1,000 hours worked).		Days Lost per Accident.	
		1924-5.	1927-8.	1924-5.	1927-8.	1924-5.	1927-8.
Coal Face Workers							
Under 70° ..	63·9°	104	133	3·5	4·4	33	33
70° to 79° ..	77·3	144	144	3·6	3·8	25	26
80° or more ..	82·8	184	173	4·5	4·8	24	28
Others Underground							
Under 70° ..	62·0	58	57	1·84	1·79	32	31
70° to 74° ..	72·7	87	81	2·41	2·45	28	30
75° or more ..	78·5	100	92	2·29	2·63	23	29

workers suffered 133 accidents in 1927-8 as against 104 in 1924-5. At temperatures of 70° to 79° the frequency experienced in the two periods was exactly the same, but at temperatures of 80° and upwards it was 173 in 1927-8 as against 184 in 1924-5. That is

TABLE IX.—ACCIDENT DISABILITY IN RELATION TO TEMPERATURE.

Duration of Absence.	1924—1925.						1927—1928.					
	Frequency at			Relative frequency at			Frequency at			Relative frequency at		
	Under 70°	70° to 79°	80° or more.	Under 70°	70° to 79°	80° or more.	Under 70°	70° to 79°	80° or more.	Under 70°	70° to 79°	80° or more.
(Mean Temperature)	64.4°	77.3°	82.1°				63.9°	77.3°	82.8°	—	—	—
Coal Face Men—												
Under 10 days	14.0	31.4	49.9	100	224	356	13.6	37.3	37.5	100	274	276
10 to 19 days	34.6	56.6	59.6	100	164	172	43.9	45.1	49.9	100	103	114
20 to 59 days	39.8 } 55.2	44.6 } 55.6	61.9 } 74.5	100 } 100	112 } 101	156 } 135	58.2 } 75.1	47.9 } 61.2	70.2 } 85.5	100 } 100	82 } 81	121 } 114
60 or more days	15.4 } 55.2	11.0 } 55.6	12.6 } 74.5	100 } 100	71 } 101	82 } 135	16.9 } 75.1	13.3 } 61.2	15.3 } 85.5	100 } 100	79 } 81	91 } 114
	Under 70°	70° to 74°	75° or more.	Under 70°	70° to 74°	75° or more.	Under 70°	70° to 74°	75° or more.	Under 70°	70° to 74°	75° or more.
(Mean Temperature)	62.6°	72.3°	77.0°	—	—	—	62.0°	72.7°	78.5°	—	—	—
Other Underground Men—												
Under 10 days	5.1	16.4	24.6	100	322	482	6.5	14.1	20.6	100	217	317
10 to 19 days	19.8	29.6	36.8	100	149	198	18.5	26.3	25.5	100	142	138
20 to 59 days	26.8 } 32.7	33.7 } 41.0	33.0 } 38.8	100 } 100	126 } 125	123 } 119	26.7 } 32.0	31.9 } 40.9	37.1 } 45.7	100 } 100	119 } 128	139 } 143
60 or more days	5.9 } 32.7	7.3 } 41.0	5.8 } 38.8	100 } 100	124 } 125	98 } 119	5.3 } 32.0	9.0 } 40.9	8.6 } 45.7	100 } 100	170 } 128	162 } 143

to say, in both statistical periods a rise of temperature was associated with a rise of accident frequency, but the rate of rise was not half as great in the later period as in the earlier one. The severity rates of the coal face men showed an even greater diminution of response to temperature in the later statistical period, but the other underground men showed the reverse relationship, as their severity rates responded more to temperature in 1927-8 than they did in 1924-5. Their frequency rates did not differ much in the two periods.

In the last two columns of the table we quote the average number of days of absence entailed by each accident incurred. It will be seen that in both statistical periods both groups of men took fewer days off from work after an accident incurred in a hot place than after one incurred in a cool place, but the difference in the response to temperature was much smaller in 1927-8 than in 1924-5. The reasons of these apparent changes in the severity of the accidents incurred at various temperatures are to some extent revealed by the method of tabulating the data now to be described. This method is based on the period of disablement, and we classified the accidents according as they induced disablement lasting for less than 10 days, 10 to 19 days, 20 to 59 days, and 60 days or more.

In Table IX we have recorded the actual frequency (per million hours worked) of the accidents incurred at low, medium, and high dry bulb temperatures, and also the relative frequency, taking those incurred at low temperatures as 100. We see, for instance, that of the accidents incurred in 1927-8 by coal face men at temperatures under 70° only a small number (10 per cent. of the whole) consisted of minor accidents causing less than 10 days' disablement, whilst the majority of them caused 10 to 19 or 20 to 59 days' disablement. At higher temperatures, however, the proportion of minor accidents was much greater, being 26 and 22 per cent. of the whole number. This increase of minor accidents is best realised by taking relative numbers, and we see that for each 100 of these accidents incurred by coal face men at low temperatures, no less than 276 were incurred at high temperatures. As we pass to the more severe accidents we find that the increase at high temperatures was smaller and smaller, till the most severe accidents of all (causing 60 or more days' disablement) were slightly less numerous at high temperatures than at low ones. In our previous report we showed that when the relative accident frequency in 1924-5 of the two groups of men from falls of ground and from other causes was compared at the low and the high temperatures (both wet and dry bulb), the following average results were obtained :—

For each 100 accidents (less than 10 days' disablement) at low temperatures there were 434 at high temperatures.

For each 100 accidents (more than 60 days' disablement) at low temperatures there were 97 at high temperatures.

The results recorded in Table IX are not so striking as this, for we see that for each 100 minor accidents incurred at low temperatures in 1927-8 there were 276 and 317, or 297 on an average, at high temperatures. The corresponding figures for 1924-5 (for the same collieries) are also recorded in the table, and they give an average of 419 at high temperatures. When we pass to the severe accidents causing 60 or more days' disablement we find that in 1927-8 the coal face men suffered rather fewer accidents at high dry bulb temperatures than at low ones, just as they did in 1924-5, but the other underground men showed a considerable rise at high temperatures in 1927-8. This erratic result may be due to paucity of data, for the actual number of severe accidents incurred by these men in 1927-8 was only 13 at low temperatures and 101 at high temperatures. If we add the accidents causing 20 to 59 days' disablement to these severe accidents, we find that the 1927-8 results do not differ much from those obtained in 1924-5. Thus in 1927-8 the relative frequencies for coal face men and for others underground at high temperatures were 114 and 143 respectively, or 128 on an average, as compared with an average value of 127 experienced in 1924-5. We have plotted the relative accident frequencies for the two statistical periods in Fig. 7, so the differences and the similarities can be seen at a glance.

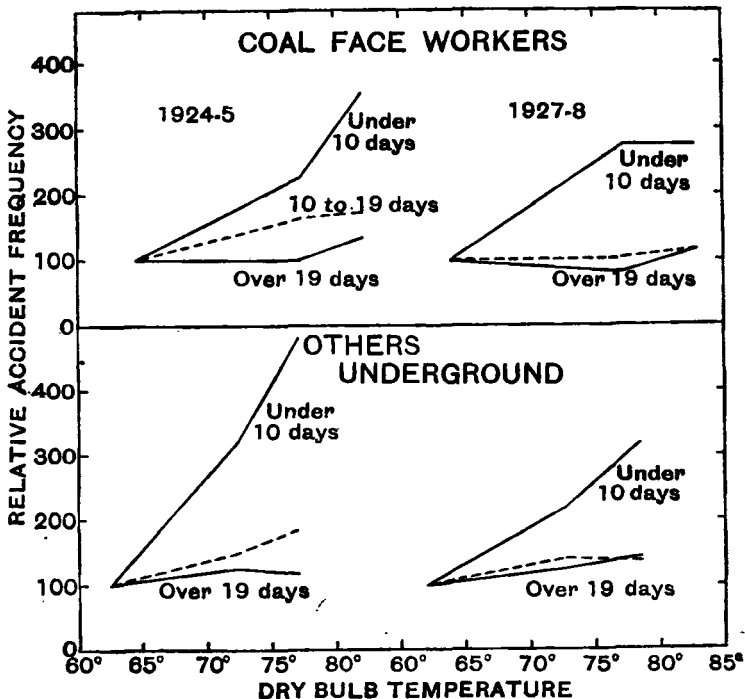


FIG. 7.—Accident disability in relation to temperature.

The explanation given by us in our previous report for the extraordinary rise of minor accidents at high temperatures was founded on a suggestion of the Coal Commission (1926). The Commissioners pointed out, with reference to the increase of minor accidents recorded in Great Britain in 1922-5 (when wages were low) over those in 1920-1 (when wages were high), that "there is some, though not conclusive ground, for connecting their number with the state of employment: the prospect of low and irregular earnings tends to keep the men on compensation longer than they would be if employment were plentiful and wages high." That is to say, the decision of the miner to go on to compensation and to remain on compensation is influenced by considerations other than those dependent on the plain facts of incurring an injury and of recovery from it. A man who incurs an injury sufficient to cause more than 60 days' disablement inevitably has to go on compensation, whether he received his injury when working under cool and comparatively pleasant underground conditions, or under hot and unpleasant ones. If he receives a minor injury he in any case gets no compensation for the first three days, and at the end of that time he may have so far recovered that his decision to return to work immediately, or otherwise, is influenced—consciously or unconsciously—by his recollection of the conditions under which he was working. If they were unpleasantly hot and induced extra fatigue he may decide to take a few days more off in which to recuperate. He consequently goes on compensation, and his accident is officially notified.

The pressure of economic circumstances appears to act in two diametrically opposed ways. We have seen that men working on short time and at a low rate of pay tend to cut down the time lost by voluntary absenteeism and sickness absenteeism as much as possible. They may also to some extent refrain from going on to accident compensation, thereby reducing the accident frequency. This point is indicated by the accident absenteeism data of "others underground" recorded in Table II, and it is shown more fully by the data given in Table X. From the figures here recorded it can be calculated that during the course of the four years investigated the wages scale fell 19 per cent., whilst the number of shifts worked by the coal face men fell 10 per cent., and by the other underground men, 11 per cent. The accident frequency (per million hours worked) of the coal face men was apparently uninfluenced by these reductions of wages, but that of the other underground men fell from 99 to 84. On the other hand, both coal face men and other underground men remained an increasing number of days on compensation pay for each accident experienced, though the data recorded in the last two columns of Table VIII showed that this increase occurred only at high temperatures. It will be remembered that these data offered still another problem for our solution, namely, the considerably shorter time required for recovery from accidents incurred at

TABLE X.—ACCIDENTS IN RELATION TO WAGES SCALE AND SHIFTS WORKED.

	1924.	1925.	1927.	1928.
Wages scale	163·0	151·9	141·7	132·0
Coal face workers :—				
Accident frequency ..	163	171	163	169
Accident severity	4·1	4·4	4·4	5·0
Days lost per accident ..	25	26	27	30
Shifts worked per man per year.	223	218	211	201
Others underground :—				
Accident frequency ..	99	87	87	84
Accident severity	2·4	2·2	2·4	2·6
Days lost per accident ..	25	25	28	31
Shifts worked per man per year.	255	251	238	228

high temperatures than for those incurred at low temperatures. The explanation is revealed by the disablement data above described, which showed that the group of high temperature accidents contains a much larger proportion of *recorded* minor accidents than the group of low temperature accidents. We saw that in 1927–8 the excess of minor high temperature accidents was not so great as in 1924–5, and on this account the difference in the average duration of absences from high and low temperature accidents was not so marked.

The fact that the coal face men working at low temperatures incurred a greater number of accidents in 1927–8 than in 1924–5 may be due to the extra fatigue incident to the prolongation of the working day from 7½ to 8 hours. Evidence supporting the existence of this extra fatigue is adduced in the next section of this report. It may be suggested, however, that if fatigue increased the number of low temperature accidents it ought to have had a still greater effect on the number of high temperature accidents. Probably it did do so, but we have seen that—owing to the effects of economic pressure—the men were less liable to go on compensation in 1927–8 than in 1924–5 when they incurred minor accidents at high temperatures.

(b) *Air Velocity.*

In our previous report we showed that absenteeism from sickness was apparently influenced considerably by the velocity of the air currents in which the men worked, being greater at high velocities than at low ones. In Table XI we record the 1927–8 sickness absenteeism data obtained at the six collieries previously mentioned, and we give the corresponding 1924–6 data

TABLE XI.—ABSENTEEISM FROM SICKNESS IN RELATION TO AIR VELOCITY.

Range of velocity.	Mean velocity.	Mean dry bulb temperature.	Number of men.	Percentage of time lost.	
				1924-6.	1927-8.
Coal face workers :—		°			
Under 30 ft. per min. . .	20	74·3	785	4·1	3·4
30 to 59 " " . .	39	75·7	2,286	3·2	2·4
60 or more " " . .	74	80·2	1,910	5·5	4·4
Others underground :—					
Under 120 ft. per min.	90	71·6	1,797	2·7	1·8
120 to 159 " "	148	70·8	1,247	3·1	2·6
160 to 199 " "	196	72·4	284	3·3	2·5
200 or more " "	264	77·1	1,765	5·0	4·1

for comparison. It will be seen that during both statistical periods the coal face workers showed a minimum degree of sickness at medium air velocities of 30 to 59 ft. per min., the sickness observed at velocities under 30 ft. being about a third as much again. Probably this is a genuine result, for we see that the mean dry bulb temperature of the air was nearly the same at both velocities. The considerable increase of sickness observed at high velocities is, however, due in part to the fact that the temperature of the air was 4·5° higher than that observed at medium velocities, and it can be gathered from Fig. 6 that such an increase of temperature was associated with an increase of the sickness absenteeism shown in the two statistical periods from an average of 3·5 per cent. to one of 4·1 per cent. This is a much smaller difference than the average increase from 2·8 to 4·95 per cent. which was found to accompany the rise of air velocity, but it is sufficient to throw some doubt on the interpretation of the results. Again, the men working at velocities over 60 ft. per min. averaged 39 years of age, or five years more than those working at the lower velocities. We showed, in our previous report, that a similar rise of age was associated with an increase of sickness absenteeism from 4·3 per cent. to 5·1 per cent.

The other underground workers showed an increase of sickness with increase of air velocity in both statistical periods, though the air temperature was fairly steady at all velocities below 200 ft. per min. Hence this result seems to be genuine, but a portion of the more considerable rise of sickness observed at velocities of over 200 ft. must have been due to the higher air temperature. Also it was due partly to age, which averaged three years more in the men working at the higher velocities than in those working at the lower ones.

The frequency rate (per 100,000 shifts) and severity rate of accidents in relation to air velocity are recorded in Table XII for both statistical periods, and it will be seen that the data are

TABLE XII.—ACCIDENT RATES IN RELATION TO AIR VELOCITY.

Range of Velocity.	Mean Velocity (1927-8)	Accident Frequency (all causes).		Accident Severity (all causes).		Mean temperature (1927-8)	Number of shifts worked (1927-8)
		1924-5	1927-8	1924-5	1927-8		
Coal Face Workers:—							
Per min.							
Under 30 ft. ..	22	101	117	4.2	4.5	76.5	663,105
30 to 39 ft. ..	33	107	129	3.4	4.2	78.5	520,086
40 to 59 ft. ..	56	104	94	3.6	3.6	72.2	181,767
60 to 80 ft. ..	73	140	151	4.2	5.1	79.3	929,119
Others Underground:—							
Per min.							
Under 100 ft. ..	83	53	59	1.8	2.2	73.8	803,808
100 to 149 ft. ..	123	67	62	2.3	2.3	71.3	717,350
150 to 199 ft. ..	183	65	34	2.1	1.5	72.4	218,987
200 to 249 ft. ..	218	63	82	2.3	3.1	73.0	411,410
250 ft. or more ..	264	89	83	2.7	2.9	77.1	767,143

complicated by differences of air temperature. We see that in 1927-8 the coal face workers attained a minimum accident frequency of 94 when the air velocity was 40 to 59 ft. per min. and its temperature was 72.2°. In air at a velocity of 30 to 39 ft. the frequency was 129, but the temperature was 78.5°, and arguing from the data recorded in Table VIII this rise of temperature would increase the accident frequency 7 per cent. Apparently therefore, the observed difference of accident frequency could have been due only in small part to a temperature effect, and the same thing is true of the much greater accident frequency observed at velocities of 60 to 80 ft. The other underground men showed, in 1927-8, a much smaller accident frequency at velocities of 150 to 199 ft. than at either lower or higher velocities, though the 1924-5 data showed a minimum frequency at the lowest velocities. Both statistical periods showed their maximum frequency at the highest velocities, though part of this excess of accidents was due to higher air temperature.

The accident severity rates ran roughly parallel with the frequency rates in both statistical periods, so we may conclude that both classes of workers showed a genuine increase of accidents at high air velocities. It is probable, though less certain, that they attained their minimum accident frequency at moderate air velocities and suffered an increase of accidents at low velocities. This second conclusion is what we should expect, for it is well known that men engaged on heavy work are more efficient if

the cooling power of the air is raised by increasing the degree of air movement. The rise of accidents experienced at higher velocities may be due to the fact that the men often have to wait for periods of several minutes at a time owing to shortage of tubs, etc., and as they are very lightly clad they are apt to get chilled and stiff, and on that account more clumsy and liable to accident. The coal face men usually wear less clothes than the other underground men, and therefore respond to air currents of lower velocity.

(c) *The Age of the Men.*

The incidence of accidents in men of various ages may fitly be discussed in this section dealing with the effects of atmospheric conditions, for we shall see that such conditions distinctly influence the effects of age. The age distributions used are those of the men who signed on after the coal dispute in 1926, and as these distributions closely resemble those previously obtained in 1921, it is probable that they hold for 1927-8. The numbers of men in each age group and the frequency and severity of their accidents are recorded in Table XIII for 1927-8, and for the same group of collieries in 1924-5. The frequency rates are in the form of number of accidents per 1,000 men per year, and the severity rates, in terms of the number of days lost per man per year. The variations of accident rates are plotted in Fig. 8, and we

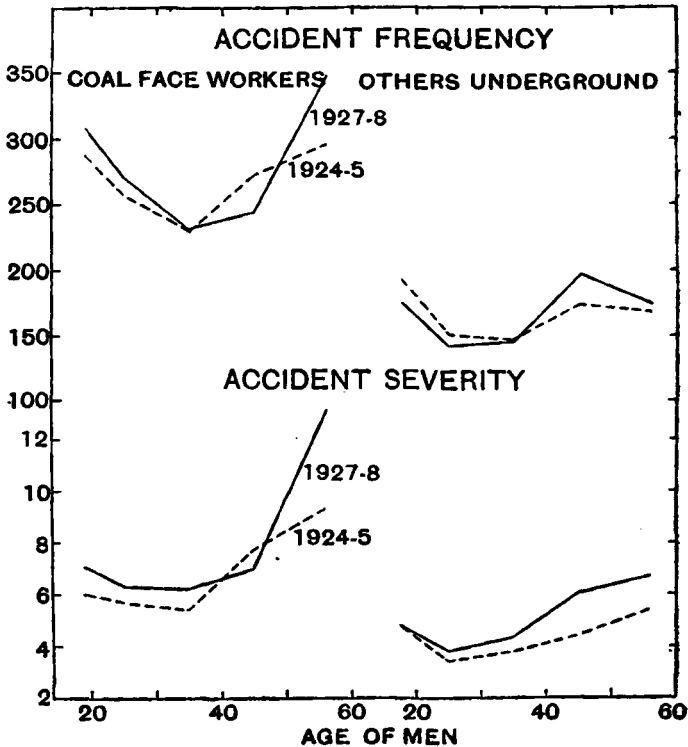


FIG. 8.—Accident rates in relation to the age of the men.

TABLE XIII.—ACCIDENTS IN RELATION TO THE AGE OF THE MEN.

Age group.				1924-5.				1927-8.				
				Number of men employed.	Accident frequency.	Accident severity.	Days lost per accident.	Number of men employed.	Accident frequency.	Accident severity.	Days lost per accident.	
Coal face workers aged	Under 20	174	288	6·0	21	209	309	7·1	23
				20 to 29	2,073	258	5·7	22	2,113	271	6·3	23
				30 to 39	2,037	230	5·4	23	1,929	232	6·2	27
				40 to 49	1,508	272	7·7	28	1,420	244	7·0	29
				50 or more	821	296	9·3	31	822	349	13·1	38
Other underground men aged	Under 20	2,524	192	4·8	25	2,244	175	4·8	27
				20 to 29	1,858	150	3·4	23	1,652	141	3·8	27
				30 to 39	1,017	147	3·8	26	853	145	4·3	30
				40 to 49	834	173	4·4	25	728	197	6·0	30
				50 or more	779	168	5·4	32	729	174	6·7	39

see that in both statistical periods the coal face workers attained minimum frequency and severity rates when aged 30 to 39, whilst the other underground men usually attained them when aged 20 to 29. It will be noted that the frequency and severity rates of the coal face workers observed in the two statistical periods corresponded fairly well at all ages up to 49, but the men of 50 and upwards showed a considerable excess of accidents in the 1927-8 period. This excess amounted to an increase of 18 per cent. in frequency and of 41 per cent. in severity, over the corresponding 1924-5 figures. The other underground men showed a moderate excess of accidents in 1927-8 for all men of 40 and upwards.

In consequence of the severity rates of the older men rising more rapidly than the frequency rates, we find that each accident incurred entailed a longer and longer absence the greater the age. The percentage increase of days lost per accident by men of 50 or more as compared with men of 29 or less was as follows:—

	<u>In 1924-5.</u>		<u>In 1927-8.</u>	
Coal face workers . .	42	}	65	
Others underground	39		44	
	40 per cent.		54 per cent.	

It will be seen that the increase was considerably greater in 1927-8 than in the earlier statistical period.

As we pointed out in our previous report, the excess of accidents experienced by the younger men over those of medium age is probably due chiefly to their inexperience. The older men are more skilful and more careful than they are, but on the other hand they get fatigued more easily, and this fatigue effect is greater and greater the older the men. We saw that it was more marked in 1927-8 than in 1924-5, both in respect of accident frequency, accident severity, and duration of absence for each accident incurred, and it looks as if the increase in the length of the working day was responsible for these changes. The fact that the other underground men showed a smaller reaction to age variations than the coal face workers may be due to their work being, for the most part, of considerably less strenuous a character.

The influence of temperature on the accident frequency of men of various ages is most clearly seen by combining the data obtained in the two statistical periods, 1924-5 and 1927-8. The figures relating to coal face workers are recorded in Table XIV, and if the frequency of accidents shown by men aged 30 to 39 when working at various temperatures is taken as 100 in each instance, it appears that at temperatures under 70° the men aged less than 30 had a slight excess of accidents—probably due to inexperience—but the men of 30 and upwards showed practically no age effect. At temperatures of 70° and upwards the young men again showed some excess of accidents, but the older men reacted very differently from those working at the lower temperatures. Thus the men of 40 to 49 showed a moderate rise of accident frequency over the

**TABLE XIV.—ACCIDENT FREQUENCY OF COAL FACE WORKERS
IN RELATION TO AGE AND TEMPERATURE.**

Age Group.	Accidents per 1,000 men per year at			Relative accident frequency at			
	Under 70°	70° to 79°	80° or more.	Under 70°	70° to 79°	80° or more.	Temps. above 70°
Under 30 years	203	263	289	109	120	115	117.5
30 to 39 years	186	219	251	100	100	100	100
40 to 49 years	180	232	299	97	106	119	112.5
50 or more years	191	331	344	103	151	137	144

men of 30 to 39, whilst the old men of 50 and upwards showed a very striking rise. This is well shown in Fig. 9, where the average results obtained at temperatures above and below 70° are plotted.

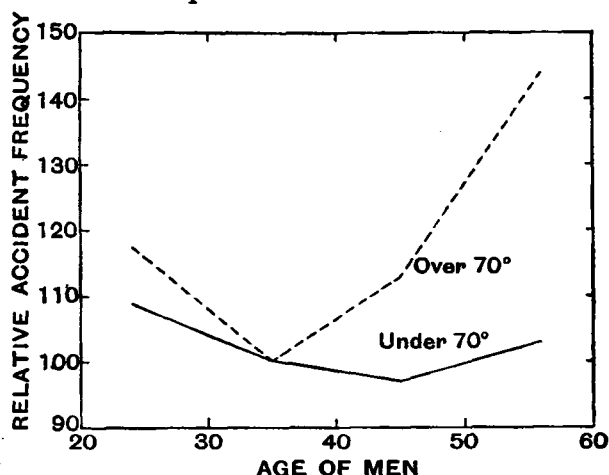


FIG. 9.—Relative accident frequency of coal face workers in relation to age and temperature.

It follows that the changes of accident rate with age which are recorded in Table XIII and Fig. 8 relate chiefly to men who were working at temperatures over 70°, and do not apply to those working in cooler atmospheres. The pronounced temperature effect observed by us helps to explain why our results differ from those of previous investigators, who have usually found that accident rates diminish steadily with increase of age and experience. Their observations relate mostly to men working at ordinary temperatures on less strenuous work than coal mining, and consequently the fatigue effect on the older men would be less considerable.

It must be remembered that the accident frequencies recorded by us do not necessarily represent the numbers of accidents incurred. We saw that the men who incurred minor accidents

when working at high temperatures claimed accident compensation three or four times more frequently than the men incurring minor accidents at low temperatures. We concluded that this was due to the increased disinclination of the men to work under the more unpleasant and fatiguing conditions. Now the older men would probably experience this disinclination more strongly than the younger men, and this may account for the apparent excess of their accidents at high temperatures. But whatever the true explanation of our results, they clearly suggest that the older men were specially fatigued by working at high temperatures.

We did not attempt to work out the influence of temperature on the accident rates of the "other underground men" of various ages, as the data are not very suitable for the purpose. These men do not form a homogeneous group like the coal face men, for the younger men are very largely pony drivers and haulage hands, whilst the older men are mostly engaged on repair and general work. These several occupations entail different degrees of fatigue and different risks of accident.

6.—OTHER CAUSES AFFECTING VOLUNTARY ABSENTEEISM.

We have seen that absenteeism from voluntary causes is very sensitive to changes in economic conditions such as the earnings of the men, and in fact it appears to be influenced by all the miners' conditions of life, both above ground and below ground. A good many of these conditions were referred to in our previous report and need not be mentioned again, but we thought it to be of interest to adduce fresh information relating to three of the conditions. The first of them is *labour turnover*. As a measure of this turnover we previously took a mean between the number of men who left, reckoned as a percentage of the average number on the books, and the number of new men signed on, reckoned as a similar percentage. We have now adopted what we consider to be a fairer estimate, namely, the number of men who left and who were replaced. That is to say, we have taken the smaller of the two percentages, signed on or left, as the index of labour turnover.

In Table XV we record the labour turnover of the whole body of underground men in the two statistical periods, and the associated voluntary absenteeism of the individual groups of coal face workers and other underground men. The collieries have been split up into three groups according to the average turnover in the two statistical periods, and we see that the averages of these groups varied in the same way during both periods, though the actual extent of the turnover was only about two-thirds as great in 1927-8 as in the previous period. The voluntary absenteeism of both groups of underground men varied more or less with the extent of the labour turnover, though not in such marked proportion. Hence we may conclude that when the miner finds his conditions of life, both above ground and below ground, to suit him so well that he does not leave his job and try for work elsewhere, he loses but little time from voluntary absenteeism,

TABLE XV.—VOLUNTARY ABSENTEEISM IN RELATION TO LABOUR TURNOVER.

Colliery.	Labour turnover in		Percentage of time lost by coal face workers in		Percentage of time lost by others underground in		Distance in yards walked underground by coal face workers.
	1924-5.	1927-8.	1924-6.	1927-8.	1924-6.	1927-8.	
A(1)C	8.1	3.0	8.2	3.4	3.6	2.2	1,000
A(2)	4.9	4.5	7.0	2.9	2.8	1.3	1,500
A(1)D	5.6	8.3	8.9	5.3	3.2	2.4	2,000
L	19.4	16.8	12.5	6.1	8.8	4.9	2,420
J	18.0	11.2	3.9	2.8	3.0	2.6	2,500
K	28.3	15.1	11.3	9.7	6.0	4.4	2,770
N.. .. .	25.8	20.8	11.7	9.8	6.3	5.0	2,860

especially if he is on short time as in 1927-8. On the other hand, if he finds his conditions of life somewhat unpleasant, as indicated by his rather high labour turnover, he shows his feeling of unrest by greatly increasing the time lost by voluntary absenteeism. Thus in the 1927-8 period the voluntary absenteeism of the men in the group of collieries with the greatest labour turnover was three times larger than in that with the least turnover.

One of the important factors which go to make up the conditions of work is the distance the men have to walk underground in order to reach their working place. According to the evidence furnished to the Royal Commission (Vol. 3, p. 314, 1926), the miners take on an average 23 minutes to get from pit bottom to coal face, but the time may be as long as 60 minutes, and a long time spent in transit means a reduced time in which to get coal and a diminution of earnings, so it might be expected to cause discontent. In the last column of the above table we record the average distance, in yards, walked underground by the coal face workers, and we see that it varies in close correspondence with the labour turnover and with the voluntary absenteeism. It is possible, therefore, that the labour turnover and the voluntary absenteeism are both due in chief part to this factor.

Another condition of life which influences voluntary absenteeism is the distance of the homes of the men from the colliery. We measured this distance on a large scale map, and found that it ranged from 1.4 to 3.0 miles for the men employed at the various collieries. We see from Table XVI that voluntary absenteeism varied in correspondence with the distance, the relationship being specially well marked in the 1927-8 period. As we showed in our previous report, the relation of voluntary absenteeism to distance of homes is due partly to the fact that the older men live a good deal nearer the colliery than the younger ones, and we found that, as would naturally be expected, the older men had a considerably lower labour turnover than the younger men.

TABLE XVI.—VOLUNTARY ABSENTEEISM IN RELATION TO DISTANCE OF HOMES FROM COLLIERY.

Colliery.	Average distance of homes from pit in miles.	Per cent. of time lost by coal face workers in		Per cent. of time lost by others underground in	
		1924-6.	1927-8.	1924-6.	1927-8.
A(2)	1.39		7.0	2.8	1.3
J	1.80	3.9	2.8	3.0	2.6
A(1), D	1.81 } 1.85	8.9	5.3 } 3.8	3.2	2.4
A(1), C	1.94	8.2	3.4	3.6	2.2
L	2.13	12.5	6.1	8.8	4.9
K	2.89 } 2.67	11.3	9.7 } 8.5	6.0	4.4
N	3.00	11.7	9.8	6.3	5.0

7.—SUMMARY.

The absenteeism of over 10,000 miners working underground, and of 2,700 surface men, was investigated for the years 1927-8, and the results compared with the absenteeism previously observed in 1924-6. The men were often on short time and were paid on a considerably lower wages scale than before. Also they were working 8 hours underground instead of 7½ hours.

Absenteeism is greatly influenced by economic conditions, for when the possible earnings of the coal face workers fell 32 per cent., the time lost by voluntary absenteeism fell to a half, and that lost by sickness fell to three-fourths, but absenteeism from accidents was slightly increased. The other underground men were still more affected, for when their possible earnings fell 24 per cent. their absenteeism from voluntary causes, sickness, and accidents fell 38, 20 and 17 per cent. respectively. Surface men showed intermediate reductions.

The absenteeism of the 5,000 men employed at two collieries was investigated before and after the introduction of pithead baths, whilst two bathless collieries, with 5,600 men, were used as a control. The evidence is not very strong, but so far as it goes the baths appeared to be associated with a reduction in the time lost from sickness, and an increase in that lost voluntarily.

The 1927-8 data confirm those obtained in 1924-6 in showing that with rise of underground temperature there was a considerable increase of sickness absenteeism. There was likewise a marked increase of accident frequency. As before, the increase related chiefly to minor accidents, those entailing less than 10 days' disablement being three times more numerous at an underground temperature of 81° than at one of 63°. On the other hand major accidents causing 60 or more days' disability were rather less numerous, in coal face workers, at high temperatures than at low temperatures.

The accident rates for the younger men corresponded fairly well with those observed in 1924-5, but the coal face men of 50 and upwards showed an 18 per cent. increase in frequency rate, and a 41 per cent. increase in severity rate, over the 1924-5 figures. The other underground men of 40 and upwards showed increases of 9 and 30 per cent. on the 1924-5 figures. These increases may have been due to the greater fatigue incident to the longer working day. They related especially to the men working at temperatures above 70°, and each accident to the older men entailed an absence from work which was, on an average, 22 per cent. greater than in 1924-5.

Voluntary absenteeism appeared to be closely associated with the labour turnover at the various collieries, and with the distance the men had to walk underground from pit bottom to working place. It was also related to the distance of the homes of the men from the colliery.

PART II.—A STUDY OF ABSENTEEISM AT CERTAIN
SCOTTISH COLLIERIES.

By T. BEDFORD, Ph.D., and C. G. WARNER, B.Sc.

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1.—INTRODUCTION.

At the request of the Mines Department, the Medical Research Council some seven years ago instituted an inquiry into the incidence of sickness amongst Scottish coal miners. The object of the inquiry was to compare the sickness rates of individual pits or groups of pits. Data, which related to 3,208 coal face workers distributed over 17 pits, were obtained from the records of a large Approved Society for the year 1922. About 25 per cent. of all miners were insured through this Society, and this proportion was said to apply to the individual pits. Statistical analysis showed that there were significant differences between the sickness rates for different groups of pits, both for the aggregate and for important sub-groups of diseases. It was concluded that the differences between the experiences of the pits were such as to establish at least a *prima facie* case in favour of the view that there was a real difference between the environmental conditions.

The Health Advisory Committee of the Mines Department decided that a field inquiry should be made at certain selected mines in order to see if any factor or factors might be traced which would account for the divergent sickness rates observed. The present report describes the results of such an inquiry.

A previous report (1928) and Part I of the present report deal with the absenteeism of mineworkers in a certain English coalfield. The absenteeism rate in this coalfield is high, and it was thought desirable that the subject should be further investigated in Scotland, where the amount of absenteeism, according to the published figures, is very small. A study of absenteeism amongst miners at the selected collieries is included in this report.

2.—SICKNESS RATES IN RELATION TO ENVIRONMENTAL CONDITIONS.

The collieries selected for the field inquiry were seven in number, five being situated in Fifeshire and two in Midlothian. Of the former group, four of the pits are within a radius of three miles of each other, while the remaining one is about eleven miles distant from the others. The two collieries forming the latter group are four miles apart.

The surface environmental conditions of the workers engaged at these pits have recently been studied by Cathcart and Taylor, the results of which study are published as an Appendix to this Report. After a careful investigation of housing conditions and of the distribution of men from the various pits in the different localities, it was concluded that the possibility that social environment plays an important rôle in the variation of sickness rate is well-nigh excluded.

Following on the work of Cathcart and Taylor, we have investigated the underground conditions at the selected collieries. The original statistical study of the sickness experience is now some seven years old, and this causes particular difficulty in dealing with underground conditions. In the intervening period some seams have been worked out, or work in them abandoned, while other seams have been opened up. For this reason it is impossible to say with accuracy what were the conditions which existed at the time of the sickness experience. At two of the collieries the ventilation systems have been altered during the last five or six years, but for the other collieries our data probably give a fairly true idea of the average conditions as they were in 1922.

The average numbers of men employed underground at the various pits in 1927-9, and the numbers of seams being worked at the time of our investigations in 1930, are shown in Table I. The number of seams worked varied from one at the smallest colliery to six at the larger ones.

The seams are generally steeply inclined, gradients of 1 in 5 to 1 in 2 being quite common, while at Colliery G, at the time of the sickness experience, coal was worked in parts where the seam was vertical or slightly inverted. The thickness of the coal varies from 1 ft. 8 in. to about 8 ft. Generally speaking, the pits are wet. There is much water in the shafts, and along the roads at most of the pits water occurs. Conditions at the face vary, even at the

TABLE I.—THE COLLIERIES INVESTIGATED.

Locality.	Colliery.	Mean number of workers below ground in 1927-9.	Number of seams being worked in 1930.	Sickness rate in 1922.
Fifeshire ..	A	550	3	} Relatively low.
	B	259	2	
	C	1,158	6	} Relatively high.
	D	858	6	
	E	196	1	
Midlothian ..	F	1,469	5	Relatively low.
	G	675	3	Relatively high.

same colliery. In some parts the face appeared to be quite dry, while in others much water dripped from the roof. Along one face at Colliery G we encountered colliers sitting at work clad in oil-skins and sou'westers. Of the two Midlothian pits it is of interest to note that Colliery G, where the coal face was very wet in parts, is one of the high sickness group, while Colliery F, which was about the driest pit we visited, is amongst the low sickness group. Water occurred to much the same extent in all the Fifeshire pits, and we cannot say that the pits in one sickness group are either drier or wetter than those in the other group.

(a) *Atmospheric Conditions.*

At each colliery we made a survey of the atmospheric conditions, both at the coal face and at working points along the haulage roads. At one of the collieries observations were made by one of us in 1923, in conjunction with H.M. Vernon (1924). As some of these observations relate to districts not at present being worked, they have been used in the present instance so as to obtain averages more nearly representing the conditions existing in 1922.

In all, 190 sets of observations were made, an average of 27 per colliery. Of these observations 137 were made at the coal face and the remaining 53 in the haulage roads. Generally, a set of observations consisted in the determination of dry and wet bulb temperatures by means of sling hygrometers, and in the measurement of dry and wet kata cooling powers. From the dry kata readings air velocities were calculated. In some of the haulage roads the velocities were measured directly by vane anemometer.

Table II shows the mean atmospheric conditions at the coal face for each colliery. These averages have been weighted according to the numbers of men employed in each seam or district. By weighting in this way we have been able to assess, with fair accuracy, the atmospheric conditions to which the average coal face worker is exposed, but, owing to the number of seams worked and to their steep inclination, there are considerable variations

TABLE II.—MEAN ATMOSPHERIC CONDITIONS AT THE COAL FACE.

Locality.	Sickness group.	Colliery.	Mean depth (ft.).	Mean atmospheric conditions.						Remarks.	
				Temperature		Cooling power.		Air velocity in feet per minute.	Grains of water vapour per 1 lb. dry air.		Relative humidity.
				Dry bulb.	Wet bulb.	Dry.	Wet.				
Fifeshire ..	Low	A	1,114	66.6	64.8	6.4	16.3	41	84	90	Much firedamp. Open lights, cool, pleasant conditions. Firedamp in deeper seams. Very humid. Firedamp in deeper seams. Very humid. New fan installed and ventilation much improved in last six years. Open lights. Ventilated by return air from another colliery. Open lights until recently. Large airways and brisk ventilation. Ventilation completely altered in last 5 years. Formerly much blackdamp. Open lights.
		B	672	62.7	61.2	7.2	17.9	38	76	92	
	High	C	1,384	71.8	70.8	5.5	14.9	49	105	95	
		D	1,425	73.5	72.7	5.3	14.6	60	113	96	
		E	932	68.6	66.8	6.7	18.4	65	91	91	
Midlothian	Low ..	F	2,300	72.9	71.8	8.7	21.8	227	106	95	
	High ..	G	887	60.5	59.6	8.1	19.8	47	72	95	

from these averages at individual parts of the coal face. We do not know how the sample of workers in 1922, who comprised the population at risk of the sickness experience, were distributed in the different seams of the collieries. A comparison of their sickness rates with atmospheric conditions in 1930 assumes that they were distributed in the same proportions as the total numbers of men employed in 1930, since the mean atmospheric conditions have been weighted on this basis.

From Table II it will be seen that of the Fifeshire pits, those with low sickness rates (A and B) had lower average temperatures than the others, and their cooling powers were higher than those at Collieries C and D. At these two latter collieries the air was more humid than at Collieries A and B. In many parts of the travelling roads at Collieries C and D the air was quite misty through condensation of moisture. The air velocities shown for Collieries D and E are somewhat higher than those at the low sickness Collieries (A and B), but, as is noted in the Table, during the last six years a new fan has been installed at Colliery D and the ventilation has been greatly improved generally. The velocity in 1922 would be distinctly lower than that shown in the Table, the temperatures would tend to be higher and the cooling powers lower.

Although the temperatures at the other colliery with a high sickness rate (Colliery E) are rather higher than at Collieries A and

B, the cooling powers are much the same, and it cannot be suggested that the physical qualities of the atmosphere account for any difference in the sickness rates. Colliery E is connected underground with a larger colliery owned by the same company, and is ventilated by the spent air from this other colliery. It seems very doubtful whether this fact is sufficient to account for the higher sickness rate observed, but this is the only respect in which the atmospheric conditions appear to be inferior to those at Collieries A and B.

Turning to the two Midlothian collieries, it is seen that, although the cooling powers are much the same, Colliery F, with the lower sickness rate, is distinctly better ventilated than Colliery G. The air velocity at the coal face at the former pit averaged 227 feet per minute, as compared with an average of 47 feet at the latter. During the period to which the sickness experience relates the difference would be much more marked, for in the last five years the ventilation of Colliery G has been completely reorganised and greatly improved. Previously, this colliery was ventilated by the return air from another colliery, but within the last five years a shaft has been driven from the surface to act as an intake to the various seams. In former years there was much blackdamp, and when the atmospheric pressure was at all low men frequently had to leave the pit in the dark because their lights had failed. It can confidently be said that at the time of the sickness experience the cooling power of the air would be distinctly lower at Colliery G than at Colliery F.

(b) *Distance of Homes from Colliery.*

At the various collieries we were able to ascertain the proportions of the employees living in different localities, and by measuring the distances on ordnance maps we were able to calculate the average distance at which men live from the colliery. These distances are shown in Table III. Although the data relate to 1930, they may probably be taken as approximately correct for 1922, for the residential distribution varies little from year to year.

TABLE III.—DISTANCE OF HOMES FROM COLLIERY.

Locality.	Colliery.	Average distance of homes from colliery.	Sickness group.
Fifeshire	A	1·2 miles	} Low.
	B	1·0 "	
	C	0·6 "	} High.
	D	1·2 "	
	E	1·1 "	
Midlothian	F	0·5 "	Low
	G	2·6 "	High.

In the case of the Fifeshire pits, the average distance of the men's homes from the pit was practically the same at all the collieries, as it varied only from 0·6 to 1·2 miles. There was no advantage in favour of the low sickness group. This, coupled with the point mentioned by Cathcart and Taylor in their report, that the men from collieries with high and low sickness rates live side by side with each other, makes it clear that housing cannot be accountable for the differences in sickness rates in this area.

On the other hand, in Midlothian, the men belonging to Colliery F, with the low sickness rate, live an average distance of only 0·5 mile from the pit, while those at Colliery G live 2·6 miles away. Of the men at Colliery F, 94 per cent. live in the adjacent colliery village where housing is excellent, while those at Colliery G are widely scattered and undoubtedly live under worse conditions.

3.—RECORDS OF ABSENTEEISM.

From the quarterly statistical summaries of the Mines Department it can be calculated that the annual absenteeism rates for Scotland for the years 1927-9 were 2·82, 3·01 and 3·10 per cent. of possible shifts, as compared with rates of 6·55, 6·43 and 7·49 per cent. for England and Wales. The amounts of absenteeism for the various coalfields during the quarter ended 30th June, 1925, are given in the Report of the Royal Commission on the Coal Industry (1926, Vol. 3, p. 4). The percentage absenteeism for Scotland is 3·57, and for Great Britain 7·60.

The figures on which these percentages are based are built up from monthly returns supplied by the colliery owners, in which the number of shifts actually worked, and the number of shifts lost that could have been worked, are set out. The instructions regarding the method of ascertaining the number of shifts lost is that this number should include all shifts lost from whatever cause except when the pit is standing. Clearly, this implies that absences on account of sickness and accident are to be included, and in the quarterly summaries published by the Mines Department since the beginning of 1926, the number of shifts lost has definitely been said to include those lost owing to these causes.

At the English pits investigated this instruction is carried out. In compiling their returns, the colliery owners in the coalfield concerned sub-divide the absenteeism under causes, showing absences on account of sickness and accident as distinct from those due to other causes. In the Scotch pits investigated, however, the returns are not compiled in the same way. We have obtained records of absenteeism from the seven collieries referred to in the preceding section, and have also enquired into the method of compiling returns at two of the largest groups of collieries in another area. At these collieries the general custom is to exclude from the absenteeism returns all shifts lost on account of accident. In most cases shifts known to have been lost on account of sickness are also excluded, but sometimes they are included as absenteeism. Generally, it appears that short period sickness, of only a day or two, is counted as absenteeism, but that longer absences are excluded.

At the English pits visited by us, if a man falls ill or incurs an accident his name is generally kept on the books until he recovers, or until it becomes known that he is unlikely to return to his employment, and in the statistical returns he is included in the number of employees. On the other hand, in the Scotch pits visited by us a man generally ceases to be included amongst the number of persons employed when he becomes a casualty. In both coalfields the absenteeism appears to be returned correctly with regard to the persons counted as employees, but in the Scotch pits visited by us the register generally includes only men actively employed, whereas at the English pits referred to the sick and injured are also counted.

The difference between the absenteeism rates recorded for Scotland and those for other coalfields is largely explained by the way in which the statistics are compiled. Table IV compares the absenteeism rates of all mineworkers at the seven Scottish collieries with the rates for a group of four collieries in the English coalfield. The Scottish figures relate to 6,600 workers and the English figures to about 10,000.

*TABLE IV.—ABSENTEEISM IN TWO GROUPS OF COLLIERIES.

Group.	Percentage absenteeism of all workers above and below ground.			
	1927.	1928.	1929.	Mean.
Seven Scottish collieries	3·7	4·0	4·6	4·1
Four English collieries—				
Sickness	3·3	3·2	4·1	3·5
Accident	1·8	2·1	2·2	2·0
Other causes	5·9	5·1	5·6	5·6
All causes	11·0	10·4	11·9	11·1

The average absenteeism for the Scottish pits was 4·1 per cent. as compared with 11·1 per cent. for the English ones. Of this 11·1 per cent. absenteeism in the latter group, 5·5 per cent. was due to sickness and accident, and 5·6 per cent. to other causes. Since in the Scottish figures absenteeism on account of sickness and accident is practically excluded, the absenteeism rate is fairly comparable with the rate for "other causes" in the English pits. When the absenteeism rates are compared on this basis, the rate for the Scottish group of pits is still 1·5 per cent. below that for the English pits, and it is probably true that avoidable absenteeism is less in the Scottish group of pits than in

* NOTE.—It was unfortunate that particulars were not available of the kinds of sickness causing absenteeism, which might have shown how far they were related to conditions of work, and how far unrelated by being due to such conditions as epidemic disease: e.g. the rise in percentage absenteeism for all workers above and below ground in both Scottish and English collieries, shown in the Table for the year 1929, was probably due to the prevalent epidemic of influenza which would affect coal miners quite irrespective of their occupational conditions.

TABLE V.—THE ABSENTEEISM RATES AT CERTAIN COLLIERIES.

Colliery.	Average number employed.		Absenteeism as percentage of possible shifts.																
	Below ground.	Above ground.	Coal face workers.				Other underground workers.				All underground workers.				Surface workers.				
			1927	1928	1929	Mean	1927	1928	1929	Mean	1927	1928	1929	Mean	1927	1928	1929	Mean	
A	550	148	11·7	13·5	16·5	13·9	7·1	6·5	9·7	7·8	9·1	9·7	13·0	10·6	2·4	1·5	1·4	1·8	
B	259	122	2·1	2·4	2·1	2·2	2·2	3·5	2·7	2·8	2·2	2·9	2·4	2·5	1·2	1·8	1·7	1·6	
C	1,158	209	2·5	3·4	3·8	3·2	2·3	3·2	4·1	3·2	2·4	3·3	3·9	3·2	4·8	4·5	4·8	4·7	
D	858	221	Not available.									0·8	0·8	0·9	0·8	0·8	1·6	2·1	1·5
E	196	45	2·8	2·1	2·9	2·6	2·3	2·0	2·6	2·3	2·5	2·0	2·7	2·4	2·0	4·7	5·6	4·1	
F	1,469	568	5·9	5·9	7·5	6·4	4·3	5·2	4·2	4·6	4·7	5·4	5·1	5·1	5·2	4·2	5·6	5·0	
G	675	119	6·3	5·6	6·6	6·2	3·0	3·1	3·6	3·2	4·8	4·4	5·2	4·8	2·7	2·2	2·3	2·4	

the English ones. This comparison, however, only includes a few collieries. The Mines Department figures already referred to show that the average absenteeism of all mine workers in Scotland for the period 1927-9 was 2·98 per cent. as compared with 6·82 per cent. for England and Wales. The Coal Mining Organisation Committee (1915) concluded that 5 per cent. was an ample allowance for unavoidable absenteeism due to sickness and accident. If the absenteeism shown for England and Wales includes that due to these unavoidable causes, as it does in the area investigated by us, the difference of 3·84 per cent. between the absenteeism rate for Scotland and that for England and Wales may be due entirely to the partial exclusion of unavoidable absenteeism from the Scottish returns.

4.—THE ABSENTEEISM RATES AT CERTAIN COLLIERIES.

Table V shows the absenteeism rates recorded at the selected collieries. The rates vary widely, particularly in the case of underground workers.

The underground workers at Colliery A had an absenteeism rate of 10·6 per cent. as compared with only 0·8 per cent. for similar men at Colliery D. The difference between these extremes is due partly to differences in the method of accounting absenteeism. The figure for Colliery D excludes all absenteeism due to accidents and known sickness. At Colliery A, when a man incurs an accident or is known to be sick, if it seems probable that he will be off work for a month or so he is immediately excluded from the number of employees and his lost shifts are not counted. On the other hand, if it is thought likely that he will be back at work within a month his name is retained on the roll and his lost shifts counted as absences. This difference in recording will not account for more than about half the 9·8 per cent. difference between the absenteeism rates. The remaining discrepancy is probably due to differences in the men employed. At Colliery D only steady workers are employed. If a man is addicted to bad time-keeping or is otherwise unsatisfactory, he is discharged. Colliery A is a very gassy pit, and the average type of worker in this area, who has been accustomed to working in open light pits, dislikes safety lamps and will not willingly work in a gassy pit. We were informed that efforts had been made to induce miners from other parts of the district to work at the colliery, but, although some made a start, few remained at work there. The consequence is that the men employed there are largely those who have drifted from other districts. The labour turnover is said to be high in comparison with other pits, but accurate statistics were not available.

At the remaining collieries, where the absenteeism for underground workers varied from 2·4 to 5·1 per cent. those shifts lost on account of accident and known sickness are excluded, but differences may occur in the frequency with which men at the different collieries notify their sickness.

The absenteeism of surface workers varied between 1.5 and 5.0 per cent. We are not able to suggest the causes of this variability, but it is interesting to note that at Colliery A, where the underground workers' absenteeism amounted to 10.6 per cent., the surface workers lost only 1.8 per cent. of possible time. The objection to working at a gassy pit does not apply in the case of surface workers, and they probably form a good deal more stable population than the underground workers.

5.—ABSENTEEISM IN RELATION TO WAGES AND POSSIBLE SHIFTS OF WORK.

In Part I of this report it was shown that absenteeism, particularly avoidable absenteeism, was greatly affected by changes in wages, and by fluctuations in the number of shifts that could be worked. We have examined the influence of these factors on the absenteeism rates at the Scottish group of collieries. The absenteeism rate for each quarterly period has been calculated, together with the possible number of shifts of work per man per week. The twelve quarterly periods have been divided into four groups of three, those three quarters with the highest number of possible shifts forming one group, those three with the lowest number another group, and the remaining quarters forming two intermediate groups. Table VI shows the relative absenteeism for each colliery arranged in this way.

TABLE VI.—ABSENTEEISM IN 1927-29.

Colliery.	Mean of 12 quarters expressed as percentage of possible shifts.		Mean absenteeism in quarters grouped according to number of possible shifts per man per week, expressed as percentage of mean absenteeism for whole period.							
			Underground workers.				Surface workers.			
	Under-ground workers.	Surface workers.	Quarters in which possible shifts were.							
			Lowest.	Low.	High.	Highest.	Lowest.	Low.	High.	Highest.
A ..	10.6	1.8	120	100	94	86	92	66	127	115
B ..	2.5	1.6	83	109	101	107	83	60	148	109
C ..	3.2	4.7	88	89	97	127	111	93	90	106
D ..	0.8	1.5	93	106	104	97	48	92	107	153
E ..	2.4	4.1	88	89	99	124	81	124	88	107
F ..	5.1	5.0	95	99	99	107	111	125	83	81
G ..	4.8	2.4	91	96	102	111	86	120	116	78
Mean			94	98	100	108	88	97	108	107
Mean possible shifts per man per week			5.29	5.59	5.78	6.07	5.59	5.88	6.12	6.40

The figures for the individual collieries are erratic, but on the average there is a decrease in absenteeism as the number of possible shifts of work decreases. This decrease is rather more in the case of the surface workers than with the underground workers.

The rate of wages did not vary much throughout the statistical period. The percentage addition to the basic scale was 133.3 in the first quarter of 1927, in the second quarter it averaged 117.8,

and for the remainder of the period it was 110. Since the variation in the rate of wages is so small, the product of possible shifts per week and wages scale (termed "wages product" in Part I) bears practically the same relation to absenteeism as the number of possible shifts alone.

It might, perhaps, be thought that a more precise account of the relationship between the different factors could be obtained by the use of the method of correlation, and we have, in fact, made some calculations of that kind, using statistics from various coalfields issued by the Mines Department during the years 1921 to 1929. But these data form time-series and relate to a period during which economic conditions were changing rapidly, so that, *inter alia*, the population exposed to risk at the end of the period may differ fundamentally from that at the beginning of the period; therefore it will be realised that the statistical material is essentially unsatisfactory. Even where such difficulties do not present themselves, the interpretation of correlations between time-series belongs to one of the most controversial parts of the theory of statistics, and it is at least certain that coefficients of correlation so deduced are not directly comparable with those derived from other variates. We therefore conclude that the analysis cannot justifiably be carried further.

6.—ABSENTEEISM ON ACCOUNT OF ACCIDENTS.

Although the time lost on account of accidents is practically excluded from the absenteeism returns of the collieries visited by us, we were able to obtain records of accidents for which compensation was paid, i.e., all those entailing an absence from work of over three days. The accident rates of all underground workers at the collieries investigated are shown in Table VII. They are given in the form of frequency rates (number of accidents per million hours worked), and as severity rates (days lost per thousand hours worked). For the purpose of calculating the number of hours worked, a working shift has been taken to mean $8\frac{1}{2}$ hours underground. For comparison, the accident rates for the group of English collieries dealt with in Part I are included in the Table.

TABLE VII.—THE ACCIDENT RATES OF ALL UNDERGROUND WORKERS AT TWO GROUPS OF COLLIERIES.

Group.	Accident frequency per million hours worked.			Accident severity, days lost per thousand hours worked.		
	Falls of ground.	Other causes.	All causes.	Falls of ground.	Other causes.	All causes.
Seven Scottish collieries (1927-9)	32	62	94	1·2	2·1	3·3
Eight English collieries (1927-8)	42	76	118	1·3	2·0	3·3

The accident frequency at the group of Scottish collieries is less than at the English group. In both groups falls of ground were responsible for about one-third of the accidents. The severity of accidents from all causes was exactly the same in the two groups of collieries, 3·3 days being lost per 1,000 hours worked. The severity rates for the two classes of accidents were practically the same in the two groups.

TABLE VIII.—ACCIDENT DISABILITY OF ALL UNDERGROUND WORKERS IN TWO GROUPS OF COLLIERIES (ALL CAUSES).

Group.	Number of accidents per million hours worked entailing absence of			
	Less than 10 days.	10 to 19 days.	20 to 59 days.	60 days and over.
Seven Scottish collieries (1927-9) . .	14·1	28·1	37·9	13·8
Eight English collieries (1927-8) . .	25·2	35·6	45·6	11·4

Table VIII shows the frequency rates of accidents causing various periods of disability. Serious accidents entailing absences of 60 days or more were rather more frequent in the Scottish collieries than in the English group, but minor accidents were much less frequent. In the Scottish group of pits the frequency of accidents causing absences of less than 10 days was 14·1, as compared with 25·2 in the English group.

It was not found possible to calculate accident rates for each separate seam at the different collieries. At some collieries as many as six seams were being worked, with the natural conditions, which so largely influence accidents, varying from seam to seam. Because of this difficulty we have not made comparisons between the accident rates of the different collieries.

In the earlier report (No. 51) it was stated that the decision of the miner to remain on compensation or go back to work is influenced by considerations other than those dependent on the plain question of recovery from an injury. At one of the collieries visited, the management had become disturbed by the increasing cost of claims for compensation. It appeared to them that some men were remaining on compensation longer than was strictly necessary for recovery from their injuries. Early in 1928 they began to bring pressure to bear on the men with the object of inducing them to avoid unnecessary absence after accidents, and it was made known that any case in which there was suspicion of malingering would be regarded seriously. It is claimed by the management that the effect of this pressure was shown in the accident rates. The accident frequency rates for all under-

ground workers for the years 1927, 1928 and 1929 were 84, 67, and 45 respectively, and the corresponding severity rates were 2.5, 1.7, and 1.0. The accident severity rates fell by a greater proportion than the frequency rates, showing that while the number of claims for compensation decreased the average period of absence also diminished. The frequency of accidents causing different periods of disablement is shown in Table IX. On the right of the Table the rates for 1928 and 1929 are expressed as percentages of the corresponding figures for 1927.

TABLE IX.—ACCIDENT DISABILITY OF ALL UNDERGROUND WORKERS AT A CERTAIN COLLIERY.

Year.	Number of accidents per million hours causing disability of					Relative frequency of accidents causing disability of				
	Under 10 days.	10 to 19 days.	20 to 59 days.	60 days and over.	All durations.	Under 10 days.	10 to 19 days.	20 to 59 days.	60 days and over.	All durations.
1927 ..	18.3	28.1	27.2	10.7	84.8	100	100	100	100	100
1928 ..	18.2	22.0	21.7	5.0	66.9	100	78	80	47	79
1929 ..	10.4	16.4	15.6	2.3	44.7	57	58	57	21	53

In 1929 the frequency of accidents entailing absences of under 60 days was reduced by 42–43 per cent., but the longer absences were reduced by 79 per cent. It is, of course, possible that some of the men returned to work before they had fully recovered from their injuries, but the large reduction in compensation claims suggests that a substantial part of the absence on account of accidents was, strictly speaking, avoidable.

7.—CONCLUSIONS.

Particular difficulties are attached to the investigation of the causes of the variations in sickness rates between different collieries, in that the sickness experience covered only a portion of the men employed, and that some years had elapsed between the statistical and field inquiries. In view of these difficulties, any conclusions that may be drawn can only be regarded as suggestive.

While it is not possible to point to any single environmental factor, e.g., an excessively high temperature, as being responsible for the differences between the sickness rates at the various collieries, it does seem possible that these differences may be attributable to the combined operation of the environmental factors discussed. The atmospheric conditions were generally not as good at the collieries with high sickness rates as at those with low rates. Though the differences observed were not great it is possible that prolonged exposure to such inferior conditions, while arduous work is being done, may account to some extent for the higher sickness rates observed. Other conditions also may be partly responsible for the differences between the sickness rates of Collieries F and G. The men at Colliery F are much the better housed, and live nearer to their work. It has also been mentioned that, while there was a good deal of water along some of the coal

faces at Colliery G, Colliery F was fairly dry, also, the work of coal getting was probably more exacting in the vertical workings of Colliery G than in the more moderately inclined workings of Colliery F.

It is, of course, possible that differences in economic conditions, such as wages and the incidence of short time working, may have influenced the number and duration of sickness claims, but we were unable to study this question as the necessary data were not available.

The investigation of absenteeism shows that the rates recorded for the Scottish coalfield are vitiated by the difficulty of obtaining complete figures of unavoidable absenteeism. The method of compiling the statistics varies at different collieries, but, in the collieries visited by us, absences due to accident or illness were commonly excluded. Our enquiries show the desirability for a more uniform statistical method.

8.—SUMMARY.

An investigation was made into the possible causation of varying sickness rates at a group of seven Scottish collieries, five in Fifeshire and two in Midlothian. An inquiry was also made into the causes of the low absenteeism rates recorded for Scotland as compared with those for other coalfields.

It is suggested that the varying sickness rates may be due to the operation of certain environmental factors. Generally, the atmospheric conditions at the collieries with high sickness rates were inferior to those at the collieries where the sickness rates were low. In the Midlothian group, other factors such as housing, proximity of homes to the pit, and the wetness of working places may have contributed.

The low absenteeism rates for Scotland can be to some extent accounted for by the partial exclusion from the returns of absences on account of sickness and accident. Attention is drawn to the desirability for a more uniform statistical method.

The accident rates at the selected collieries are compared with the rates for a group of English collieries. Although the accident frequency is less in the Scottish pits than in the English ones, the accident severity is the same in the two groups.

9.—REFERENCES.

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APPENDIX.

REPORT OF AN INVESTIGATION INTO THE POSSIBLE CAUSATION OF VARYING SICKNESS RATES IN CERTAIN SCOTTISH COLLIERIES.

By E. P. CATHCART, C.B.E., F.R.S., and JAMES TAYLOR, M.B.

(SEPTEMBER, 1929.)

As the result of a statistical investigation (unpublished) carried out by the late Mr. A. Henry in 1922-23 on the sickness rates in certain Scottish collieries, it would appear that in the same coalfield certain pits had a definitely higher rate of sickness than others. The data used were obtained from a perfectly reliable source, viz., the Scottish Miners' Federation Approved Society. Unfortunately this approved society is not the sole society in which the miners in the particular coal fields selected are insured. It would seem that the data represented only about 25 per cent. of the men employed in the selected pits. Enquiry has shown that this is the case and that if a further statistical enquiry be desired the cards of many approved societies will have to be searched with great labour.

The Health Advisory Committee of the Mines Department decided that in place of such a statistical enquiry certain selected mines from the area utilised in the statistical investigation of 1922-23 should be subjected to intensive study in order to see if any causal factor or factors could be detected to account for the apparent divergence in sickness rate.

In accordance with this decision a partial enquiry into the environmental conditions of the workers engaged in the pits selected by them has been carried out. It will be noted that the word partial has been employed. When our enquiry started it was our intention to carry out our survey both into above and underground conditions but just as it was begun we accidentally discovered that Dr. H. M. Vernon and Dr. T. Bedford proposed to utilise the same series of pits in a continuation of their studies of absenteeism. As this work entailed a thorough investigation of underground conditions, far more thorough than we could have aspired to, we agreed to confine our attention to surface environmental factors.

Owing to the difficulty, mentioned above, of obtaining morbidity statistics, and of showing from them the incidence of disease by causes, which might be separated into those connected with occupation, and others, such as epidemic complaints obviously independent of occupation, it was impossible to get figures showing the variations in the sickness-rates involved, or their significance, or to do more, therefore, than roughly to divide the pits investigated into those with apparently high or low sickness rates.

In considering the report which follows, in the light of Mr. Henry's earlier statistical enquiry, it must be borne in mind that the original study is now some seven years old and that the data then obtained only referred to a fraction of the men employed in the different pits. If the differences in sickness rate really exist then it is obvious that they may be due either to physical environmental conditions (*a*) on the surface or (*b*) underground, to racial differences and even possibly to psychological differences in the mining population.

The pits selected by the Committee were four in the Fife area from those with apparently a relatively high sickness rate, viz., Collieries C₁* (two pits), E₁ and D₁, and two pits from the group with a relatively low sickness rate, viz., Collieries A₂ and B₂. In the Haddington area one pit, G₁, from the relatively high sickness group and the other, F₂, from the relatively low sickness group.

FIFE AREA.

The following data as regards the mines may here be given as they are not uniform either as regards depth or working conditions.

Colliery.	Depth of Shaft Fathoms.	Number of Seams opened.	Number of seams working or recently worked.	Remarks.
A ₂	215	10	5	Wet in deep seams. Firedamp. Part of workings (now unused) run under sea.
B ₂	190	13	9	All seams wet. No firedamp. Naked lights used.
C ₁	216	15	9	Blackdamp and Firedamp. Safety lamps and naked lights used.
D ₁	292	10	9	Firedamp abundant especially in deep seams. Safety lamps.
E ₁	200	12	10	Blackdamp and Firedamp. Safety lamps and naked lights used.

Accidents in these collieries from January, 1928, to April, 1929, were as follows:—

Colliery.	Fatal.		Severe Non-fatal.	
	No.	Ratio per 1,000.	No.	Ratio per 1,000.
A ₂ ..	1	1.3	5	6.4
B ₂ ..	2	6.05	1	3.0
C ₁ ..	4	2.9	8	5.9
D ₁ ..	7	8.1	2	2.3
E ₁ ..	0	0	1	3.9

There would appear then to be certain underground differences which may or may not play a material role in the sickness rate.

* The letters correspond to those allotted to the collieries mentioned in the main report and the numbers attached to the letter show whether the colliery fell into the low or high sickness group (1 indicating high and 2 indicating low).

It is obvious that the difference in sickness rate might be ascribed to differences in housing conditions either as regards the building site or the nature of the house occupied. Each of the collieries in the Fife coalfield has a village attached to it. These villages vary in size and housing conditions. As regards size their population is approximately as follows:—

Village attached to A ₂	2,700	
„	„	„ B ₂	..	600
„	„	„ C ₁	..	7,100
„	„	„ D ₁	..	6,800
„	„	„ E ₁	..	2,500

As regards housing conditions it is found that the dwelling houses of the miners in villages B₂, C₁, D₁ and E₁ are in long rows of brick dwellings. These houses consist of two rooms—back and front—with scullery and outside W.C. Unless in very exceptional cases bathrooms are not provided. The majority of the houses were built 25 to 35 years ago. In villages B₂ and C₁ many of the houses are in a poor state and they have no gardens attached. In the case of village E₁, since 1923, a considerable number of old unsanitary houses have been demolished and there are others at present vacant awaiting demolition. Village A₂ is divided into two parts, High and Low A₂. In the high part is found the usual type of old fashioned miner's house but in the low part a much more modern and excellent type of dwelling is found. In the majority of instances bathrooms are provided.

As it turned out little stress could be laid on the dwelling houses as a causal factor in relation to the sickness incidence in any one pit as it was soon found that the workers in a selected pit did not necessarily live in the adjacent village. The distribution of the workers is shown in the following table:—

Colliery.	Number of men employed.	Number who stay in adjacent village.	Remainder
A ₂	780	502 or 64·3 per cent.	(Within 1-5 miles).
B ₂	331	220 or 66·4 per cent.	(Within 2 miles).
C ₁	1,348	1,248 or 92·5 per cent.	(Within 1-5 miles).
D ₁	872	520 or 59·6 per cent.	172, 1½ miles away. 27, 2½ miles away. 91, 3½ miles away. 62 within 5 miles.
E ₁	264	91 or 34·4 per cent.	(Within 2½ miles).

As a very large number of miners are resident in one township, which may be regarded as a typical Fife mining centre, a few particulars regarding it are added.

The township has a population of 16,000. The majority of the dwelling houses, approximately 60 per cent. of which are two-roomed, were built some 30 years ago, but almost all have modern sanitary conveniences, and only 15 houses have no water supply. Rebuilding and modernisation are in progress. The death rate in 1928 was 9·84 per 1,000, respiratory and cardiac disease along with cerebral hæmorrhage being the outstanding causes of death. Alcoholism is not common.

As regards the type of men who are employed in these various pits they seem to be in the main steady and industrious. The marked exception is in Colliery A. A possible explanation of this exception is that in Collieries B₁, C₁, D₁ and E₁ the pits utilise mechanical coal cutters and conveyors. Each of these machines has a crew of twelve or more men who have to acquire a working knowledge of the machine and the presence of the whole crew is practically indispensable for its proper management and working. Even in the event of the absence of one man of the team the work of coal getting is hampered. Hence it follows that men working on these machines have to account strictly for any absence from work and are therefore, in order to retain their places in the team, virtually compelled to be steady. In the exceptional case of A₁ manual labour in coal getting alone is employed and many of these miners are Irishmen. Obviously under the conditions prevailing in A₁ the absence of a man or two is of little import to the welfare of the other workers. The general impression, too, is that these miners do live below the standard of the average Fifeshire miner and three or four days' work a week will suffice to provide him with all he demands.

It was almost impossible to extract data as to the actual takings even of the average miner, but we believe it to be approximately 8s. to 10s. a day. It is probably a little higher in Colliery A₁.

HADDINGTON AREA.

In this area the H.A. committee selected two pits: Colliery G₁, which belongs to the group with a relatively high sickness rate, lies in an isolated position among fields and Colliery F₁, with a relatively low sickness rate, lies within a town area. As in the Fife area collieries these two pits differ as regards the nature, depth and number of seams worked.

Colliery.	Depth of shaft. Fathoms.	Number of seams opened.	Number of seams working or recently worked.	Remarks.
F ₁	268	16	7	Working dry but dusty. Excellent ventilation. Very little firedamp. Electric safety lamps replacing naked lights.
G ₁	122	11	6	Working damp. No firedamp. Naked lights only. Infested with rats.

The accidents which took place in these two collieries between January, 1928, and April, 1929, are as follows :—

<i>Colliery.</i>	<i>Fatal.</i>		<i>Severe Non-fatal.</i>	
	No.	Ratio per 1,000.	No.	Ratio per 1,000.
F ₂	3	3·1	8	8·4
G ₁	1	1·3	11	14·1

In contradistinction to the Fife area collieries a very marked difference exists between the two pits in the Haddington area. Colliery G₁ as already mentioned lies in an isolated position in fields with no housing accommodation near it. Colliery F₂ is situated in a township of just over 6,000 inhabitants where the housing is really excellent and where public amenities like park and recreation grounds are available.

As regards the place of residence, in the case of Colliery F₂ out of 950 men 893, or 94·0 per cent., live in the town ; the remainder within 1-3 miles away. In the case of Colliery G₁ none of the men stay there. The 782 workers are distributed widely at distances of from one to six miles or more.

It must be concluded then from the investigation of the environment, other than the actual working conditions in the pits which we have left to Dr. Bedford, that if the variation in sickness rate did or does exist there is no evidence yet available which will allow of any definite causal factor being assigned. The fact that the mine workers are so widely distributed in area and men belonging to pits with a low sickness rate are living along side men of pits with a high sickness rate the possibility that social environment plays an important role in the variation in sickness rate is well-nigh excluded. It must, of course, be admitted that the conditions now obtaining cannot be held to be identical with the conditions existing in 1922-23 but the changes which are likely to have taken place in the intervening years are related for the most part to the pits and not to the above ground environment. Since 1923 certain seams have been closed and others opened up, although at the same time there has in certain areas been a replacement of old houses by new.

That differences still exist in the various pits despite the fact that the mining population of the different pits live so closely intermingled is shown by certain absenteeism figures which we were able to have access to. These figures for the month of April, 1929, are as follows :—

Colliery A ₂	B ₂	C ₁	E ₁
10·56 per cent.	4·55 per cent.	3·82 per cent.	3·25 per cent.

It is probable that the high rate in Colliery A is at least in part due to the cause previously mentioned and yet this is one of the pits listed with a relatively low sickness rate.

OTHER REPORTS OF THE BOARD.*

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First to March 31st, 1920.	<i>Price 6d. net (7d.)</i>
Second to September 30th, 1921 (with Analysis of Published Work).	<i>Price 1s. 6d. net (1s. 8d.)</i>
Third to September 30th, 1922.	<i>Price 2s. net (2s. 2d.)</i>
Fourth to December 31st, 1923.	<i>Price 1s. 3d. net (1s. 4d.)</i>
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REPORTS CLASSIFIED ACCORDING TO SUBJECT MATTER.

(i). *Hours of Work, Rest Pauses, etc.*

- No. 1.—The Influence of Hours of Work and of Ventilation on Output in Tinplate Manufacture, by H. M. Vernon, M.D. (1919.)
Price 6d. net (7d.)
- No. 2.—The Output of Women Workers in relation to Hours of Work in Shell-making, by Ethel E. Osborne, M.Sc. (1919.)
Price 6d. net (7d.)
- No. 5.—Fatigue and Efficiency in the Iron and Steel Industry, by H. M. Vernon, M.D. (1920.)
Price 3s. net (3s. 2d.)
- No. 6.—The Speed of Adaptation of Output to altered Hours of Work, by H. M. Vernon, M.D. (1920.)
Price 1s. net (1s. 2d.)
- No. 24.—A Comparison of different Shift Systems in the Glass Trade, by E. Farmer, M.A., R. C. Brooks, M.A., and E. G. Chambers, B.A. (1923.)
Price 1s. 6d. net (1s. 7d.)
- No. 25.—Two Studies on Rest Pauses in Industry, by H. M. Vernon, M.D., T. Bedford, and S. Wyatt, M.Sc. (1924.)
Price 1s. 6d. net (1s. 7d.)
- No. 32.—Studies in Repetitive Work with special reference to Rest Pauses, by S. Wyatt, M.Sc., assisted by J. A. Fraser, M.A. (1925.)
Price 2s. 6d. net (2s. 7d.)
- No. 41.—Rest Pauses in Heavy and Moderately Heavy Industrial Work, by H. M. Vernon, M.D., and T. Bedford, B.Sc., assisted by C. G. Warner. (1927.)
Price 9d. net (10d.)
- No. 42.—Rest Pauses in Industry (A Review of the Results obtained), by S. Wyatt, M.Sc. (1927.)
Price 9d. net (10d.)
- No. 47.—Two Studies on Hours of Work. I—Five-Hours Spells for Women with reference to Rest Pauses, by H. M. Vernon, M.D., and M. D. Vernon, M.A., assisted by I. Lorrain-Smith, M.A. II—The Two-Shift System in certain Factories, by May Smith, M.A., and M. D. Vernon, M.A. (1928.)
Price 1s. 3d. net (1s. 4d.)
- No. 56.—The Effects of Monotony in Work, by S. Wyatt, M.Sc., M.Ed., and J. A. Fraser, M.A., assisted by F. G. L. Stock (1929.)
Price 2s. net (2s. 1d.)

(ii). *Industrial Accidents.*

- No. 4.—The Incidence of Industrial Accidents, with special reference to Multiple Accidents, by Major M. Greenwood and Hilda M. Woods. (1919.)
Price 6d. net (7d.)
- No. 19.—Two Contributions to the Study of Accident Causation, by Ethel E. Osborne, M.Sc., H. M. Vernon, M.D., and B. Muscio, M.A. (1922.)
Price 1s. 6d. net (1s. 8d.)

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- No. 34.—A Contribution to the Study of the Human Factor in the Causation of Accidents, by E. M. Newbold, B.A. (1926.)
Price 5s. net (5s. 2d.)
- No. 38.—A Psychological Study of Individual Differences in Accident Rates, by E. Farmer, M.A., and E. G. Chambers, M.A. (1926.)
Price 2s. 6d. net (2s. 7d.)
- No. 55.—A Study of Personal Qualities in Accident Proneness and Proficiency, by Eric Farmer, M.A., and E. G. Chambers, M.A. (1929.)
Price 3s. net (3s. 2d.)

(iii). *Atmospheric Conditions.*

- No. 11.—Preliminary Notes on Atmospheric Conditions in Boot and Shoe Factories, by W. D. Hambly, B.Sc., and T. Bedford. (1921.)
Price 3s. net (3s. 2d.)
- No. 18.—Two Investigations in Potters' Shops, by H. M. Vernon, M.D., and T. Bedford. (1922.)
Price 2s. 6d. net (2s. 8d.)
- No. 20.—A Study of Efficiency in Fine Linen Weaving, by H. C. Weston, M.J.Inst.E. (1922.)
Price 1s. 6d. net (1s. 8d.)
- No. 21.—Atmospheric Conditions in Cotton Weaving, by S. Wyatt, M.Sc. (1923.)
Price 2s. net (2s. 2d.)
- No. 35.—A Physiological Comparison of Ventilating and Heating Systems in Certain Factories, by H. M. Vernon, M.D., and T. Bedford (assisted by C. G. Warner). (1926.)
Price 3s. net (3s. 2d.)
- No. 37.—Fan Ventilation in a Humid Weaving Shed. An Experiment carried out for the Department Committee of Humidity in Cotton Weaving, by S. Wyatt, M.Sc., assisted by J. A. Fraser, M.A., and F. G. L. Stock. (1926.)
Price 1s. 9d. net (1s. 10d.)
- No. 39.—The Relation of Atmospheric Conditions to the Working Capacity and the Accident Rate of Miners, by H. M. Vernon, M.D., and T. Bedford, Ph.D., assisted by C. G. Warner. (1927.)
Price 1s. 3d. net (1s. 4d.)
- No. 46.—A Physiological Investigation of the Radiant Heating in Various Buildings, by H. M. Vernon, M.D., M. D. Vernon, M.A., assisted by Isabel Lorrain-Smith, M.A. (1928.)
Price 2s. net (2s. 2d.)
- No. 48.—Artificial Humidification in the Cotton Weaving Industry. Its Effect upon the Sickness Rates of Weaving Operatives, by A. Bradford Hill, Ph.D. (1927.)
Price 2s. 6d. net (2s. 8d.)
- No. 58.—A Study of Heating and Ventilation in Schools, by H. M. Vernon, M.D., and T. Bedford, Ph.D., assisted by C. G. Warner. (1930.)
Price 2s. 6d. net (2s. 8d.)
- No. 59.—Sickness amongst Operatives in Lancashire Cotton Spinning Mills, by A. B. Hill, D.Sc., Ph. D. (1930.)
Price 1s. 6d. net (1s. 7½d.)

References to atmospheric conditions occur also in Reports Nos. 1, 5, 22, 24, 51.

(iv). *Vision and Lighting.*

The Relation between Illumination and Efficiency in Fine Work (Typesetting by Hand), by H. C. Weston, M.J.Inst.E., and A. K. Taylor, M.I.E.E., A.M.I.C.E. Joint Report of the Industrial Fatigue Research Board and the Illumination Research Committee. (1926.)
Price 6d. net (7d.)

The Effect of Different Systems of Lighting on Output and Accuracy in Fine Work (Typesetting by Hand), by H. C. Weston, M.J.Inst.E., and A. K. Taylor, M.I.E.E., A.M.I.C.E. Joint Report of the Industrial Fatigue Research Board and the Illumination Research Committee. (1928.)
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References to vision or lighting occur also in Reports Nos. 9, 20, 23.

- No. 40.—The Effect of Eyestrain on the Output of Linkers in the Hosiery Industry, by H. C. Weston, M.J.Inst.E., and S. Adams, M.Sc. (1927.) *Price 1s. net (1s. 1d.)*
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- No. 16.—Three Studies in Vocational Selection, by B. Muscio, M.A., and E. Farmer, M.A. (1922.) *Price 1s. 6d. net (1s. 8d.)*
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- No. 61.—The Nervous Temperament, by Millais Culpin, M.D., F.R.C.S., and May Smith, M.A., D.Sc. (1930.) *Price 1s. net (1s. 1d.)*

(vi). *Time and Movement Study, Occupation Analysis, etc.*

- No. 3.—A Study of Improved Methods in an Iron Foundry, by C. S. Myers, C.B.E., M.D., F.R.S. (1919.) *Price 2d. net (2½d.)*
- No. 7.—Individual Differences in Output in the Cotton Industry, by S. Wyatt, M.Sc. (1920.) *Price 6d. net (7d.)*
- No. 8.—Some Observations on Bobbin Winding, by S. Wyatt, M.Sc., and H. C. Weston, M.J.Inst.E. (1920.) *Price 1s. 6d. net (1s. 8d.)*
- No. 9.—A Study of Output in Silk Weaving during the Winter Months, by P. M. Elton, M.Sc. (1920.) *Price 2s. 6d. net (2s. 8d.)*
- No. 14.—Time and Motion Study, by E. Farmer, M.A. (1921.) *Price 2s. net (2s. 2d.)*
- No. 15.—Motion Study in Metal Polishing, by E. Farmer, M.A. (1921.) *Price 2s. net (2s. 2d.)*
- No. 17.—An Analysis of the Individual Differences in the Output of Silk-Weavers, by P. M. Elton, M.Sc. (1922.) *Price 1s. 6d. net (1s. 8d.)*
- No. 22.—Some Studies in the Laundry Trade, by May Smith, M.A. (1922.) *Price 2s. 6d. net (2s. 8d.)*
- No. 23.—Variations in Efficiency in Cotton Weaving, by S. Wyatt, M.Sc. (1923.) *Price 3s. net (3s. 2d.)*
- No. 30.—An Experimental Investigation into Repetitive Work, by Isabel Burnett, M.A. (1925.) *Price 2s. 6d. net (2s. 7d.)*

(vii). *Posture and Physique.*

- No. 29.—The Effects of Posture and Rest in Muscular Work, by E. M. Bedale, M.A., and H. M. Vernon, M.D. (1924.) *Price 2s. 6d. net (2s. 7d.)*
- No. 36.—On the Design of Machinery in relation to the Operator, by L. A. Legros, M.I.Mech.E., and H. C. Weston, M.J.Inst.E. (1926.) *Price 1s. 3d. net (1s. 4d.)*

- No. 44.—The Physique of Women in Industry (A Contribution towards the Determination of the Optimum Load), by Professor E. P. Cathcart, C.B.E., M.D., F.R.S., E. M. Bedale, M.A., C. Blair, M.B., K. Macleod, M.B., and E. Weatherhead, B.Sc., with a special section by Sybil G. Overton, M.B., H.M. Medical Inspector of Factories. (1927.) *Price 5s. net (5s. 3d.)*
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- References to posture, etc., occur also in Reports Nos. 15 and 16.*

(viii). *Miscellaneous.*

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- No. 13.—A Statistical Study of Labour Turnover in Munition and other Factories, by G. M. Broughton, M.A., E. M. Newbold, B.A., and E. C. Allen. (1921.) *Price 3s. net (3s. 2d.)*
- No. 26.—On the Extent and Effects of Variety in Repetitive Work, by H. M. Vernon, M.D., S. Wyatt, M.Sc., and A. D. Ogden, M.R.San.I. (1924.) *Price 1s. 6d. net (1s. 7d.)*
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- No. 28.—The Function of Statistical Method in Scientific Investigation, by G. Udny Yule, C.B.E., F.R.S. (1924.) *Price 6d. net (7d.)*
- No. 45.—Two Contributions to the Experimental Study of the Menstrual Cycle. I—Its Influence on Mental and Muscular Efficiency, by S. C. M. Sowton and C. S. Myers, M.D., F.R.S. II—Its Relation to General Functional Activity, by E. M. Bedale, M.A. (1928.) *Price 2s. 6d. net (2s. 7d.)*
- No. 51.—A Study of Absenteeism in a Group of Ten Collieries, by H. M. Vernon, M.D., and T. Bedford, Ph.D. (assisted by C. G. Warner, B.Sc.). (1928.) *Price 2s. 6d. net (2s. 8d.)*
- No. 52.—The Comparative Effects of Variety and Uniformity in Work, by S. Wyatt, M.Sc., M.Ed., and J. A. Fraser, M.A., B.Ed. (assisted by F. G. L. Stock). (1929.) *Price 1s. 3d. net (1s. 4d.)*
- No. 54.—An Investigation into the Sickness Experience of Printers (with special reference to the Incidence of Tuberculosis, by A. Bradford Hill, D.Sc., Ph.D. (1929.) *Price 4s. 6d. net (4s. 8d.)*
- No. 60.—The Atmospheric Conditions in Pit-head Baths, by H. M. Vernon, M.D., and T. Bedford, Ph.D. (assisted by C. G. Warner, B.Sc.) (1930.) *Price 9d. net (10d.)*

REPORTS CLASSIFIED ACCORDING TO INDUSTRY.†

NOTE.—Most of the reports in the following list deal exclusively with the industries under which they are placed. In certain instances, however, reports have been prepared on some general subject, but yet make sufficient reference to a particular industry to justify inclusion under the appropriate heading. These reports are distinguished by an *.

A.—MINING INDUSTRY.

- No. 39.—The Relation of Atmospheric Conditions to the Working Capacity and Accident Rates of Miners. *Price 1s. 3d. net (1s. 4d.)*
- No. 51.—A Study of Absenteeism in a Group of Ten Collieries. *Price 2s. 6d. net (2s. 8d.)*
- No. 60.—The Atmospheric Conditions in Pit-head Baths. *Price 9d. net (10d.)*

† A short account of the principal practical conclusions reached up to 1924 will be found in Report No. 27 (Results of Investigation in Certain Industries).

B.—METAL AND ENGINEERING INDUSTRIES.

- No. 1.—The Influence of Hours of Work and of Ventilation on Output in Tinsplate Manufacture. *Price 6d. net (7d.)*
- No. 2.—The Output of Women Workers in Relation to Hours of Work in Shell-making. *Price 6d. net (7d.)*
- No. 3.—A Study of Improved Methods in an Iron Foundry. *Price 2d. net (2½d.)*
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- *No. 6.—The Speed of Adaptation to Altered Hours of Work. *Price 1s. net (1s. 2d.)*
- No. 15.—Motion Study in Metal Polishing. *Price 2s. net (2s. 2d.)*

C.—TEXTILE INDUSTRIES.

- No. 7.—Individual Differences in Output in the Cotton Industry. *Price 6d. net (7d.)*
- No. 8.—Some Observations on Bobbin Winding. *Price 1s. 6d. net (1s. 8d.)*
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- No. 17.—An Analysis of the Individual Differences in the Output of Silk-Weavers. *Price 1s. 6d. net (1s. 8d.)*
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- *No. 49.—On the Relief of Eyestrain amongst Persons Performing very Fine Work. *Price 1s. 3d. net (1s. 4d.)*
- No. 59.—Sickness among Operatives in Lancashire Cotton-Spinning Mills. *Price 1s. 6d. net (1s. 7½d.)*

D.—BOOT AND SHOE INDUSTRY.

- No. 10.—Preliminary Notes on the Boot and Shoe Industry. *Price 1s. 6d. net (1s. 8d.)*
- No. 11.—Preliminary Notes on Atmospheric Conditions in Boot and Shoe Factories. *Price 3s. net (3s. 2d.)*
- *No. 25.—Two Contributions to the Study of Rest Pauses in Industry. *Price 1s. 6d. net (1s. 7d.)*
- *No. 26.—On the Extent and Effects of Variety in Repetitive Work. *Price 1s. 6d. net (1s. 7d.)*
- *No. 35.—A Physiological Study of the Ventilation and Heating in Certain Factories. *Price 3s. net (3s. 2d.)*

E.—POTTERY INDUSTRY.

- No. 18.—Two Investigations in Potters' Shops. *Price 2s. 6d. net (2s. 8d.)*

F.—LAUNDRY INDUSTRY.

- No. 22.—Some Studies in the Laundry Trade. *Price 2s. 6d. net (2s. 8d.)*
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G.—GLASS INDUSTRY.

- No. 24.—A Comparison of Different Shift Systems in the Glass Trade. *Price 1s. 6d. net (1s. 7d.)*

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 No. 26.—On the Extent and Effects of Variety in Repetitive Work.
Price 1s. 6d. net (1s. 7d.)
 No. 30.—An Experimental Investigation into Repetitive Work.
Price 2s. 6d. net (2s. 7d.)
 No. 32.—Studies in Repetitive Work with special reference to Rest Pauses.
Price 2s. 6d. net (2s. 7d.)
 No. 52.—The Comparative Effects of Variety and Uniformity in Work.
Price 1s. 3d. net (1s. 4d.)

K.—MUSCULAR WORK.

- No. 29.—The Effects of Posture and Rest in Muscular Work.
Price 2s. 6d. net (2s. 7d.)
 No. 41.—Rest Pauses in Heavy and Moderately Heavy Industrial Work.
Price 9d. net (10d.)
 No. 44.—The Physique of Women in Industry. (A Contribution towards
 the Determination of the Optimum Load).
Price 5s. net (5s. 3d.)
 No. 50.—The Physiological Cost of the Muscular Movements involved in
 Barrow Work.
Price 1s. net (1s. 1d.)

L.—GENERAL AND MISCELLANEOUS.

- No. 4.—The Incidence of Industrial Accidents, with special reference to
 Multiple Accidents. *Price 6d. net (7d.)*
 No. 6.—The Speed of Adaptation of Output to altered Hours of Work.
Price 1s. net (1s. 2d.)
 No. 12.—Vocational Guidance (A Review of the Literature).
Price 1s. net (1s. 2d.)
 No. 13.—A Statistical Study of Labour Turnover in Munition and other
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 No. 16.—Three Studies in Vocational Selection. *Price 1s. 6d. net (1s. 8d.)*
 No. 19.—Two Contributions to the Study of Accident Causation.
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 No. 28.—The Function of Statistical Method in Scientific Investigation.
Price 6d. net (7d.)
 No. 31.—Performance Tests of Intelligence. *Price 2s. 6d. net (2s. 7d.)*
 No. 33.—A Study in Vocational Guidance. *Price 4s. net (4s. 2d.)*
 No. 34.—A Contribution to the Study of the Human Factor in the Causation
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 No. 35.—A Physiological Study of the Ventilation and Heating in certain
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- No. 38.—A Psychological Study of Individual Differences in Accident Rates. *Price 2s. 6d. net (2s. 7d.)*
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- No. 56.—The Effects of Monotony in Work. A Preliminary Inquiry. *Price 2s. net (2s. 1d.)*
- No. 58.—A Study of Heating and Ventilation in Schools. *Price 2s. 6d. net (2s. 8d.)*
- No. 61.—The Nervous Temperament. *Price 1s. net (1s. 1d.)*

OTHER PUBLICATIONS ISSUED IN 1929.

- FRASER, J. A. : The Machine and the Worker : An Experiment. *J. Nat. Inst. Ind. Psychol.*, July, 1929.
- HILL, A. B. : An Investigation of Sickness in Various Industrial Occupations. *J. Roy. Stat. Soc.*, 92, 183.
- PEAR, T. H. : The Human Factor in Industry. *Journ. of Society of Chemical Industry*, 38, August, 1929.
- PEAR, T. H. : Acquisition of Skill. *Interim Report of British Association, Section L, Committee on Formal Training, South Africa*, 1929.
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