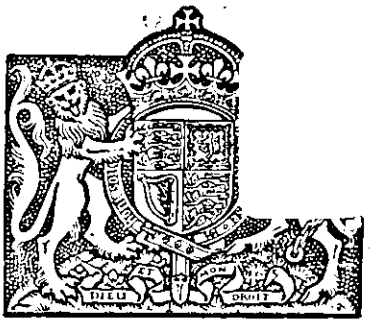
THE PERSONAL FACTOR IN ACCIDENTS

Emergency Report No. 3



MEDICAL RESEARCH COUNCIL
INDUSTRIAL HEALTH RESEARCH BOARD

THE PERSONAL FACTOR IN ACCIDENTS

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. Stationery Office at the following addresses:
York House, Kingsway, London, W.C.2; 13a Castle Street, Edinburgh, 2;
39-41 King Street, Manchester, 2; 1 St. Andrew's Crescent, Cardiff;
Tower Lane, Bristol, 1; 80 Chichester Street, Belfast
OR THROUGH ANY BOOKSELLER
1942
(*Reprinted* 1947
Price 4*d*. net

THE BOARD

THE RIGHT HON. THE EARL DE LA WARR, P.C. (*Chairman*).

F. C. BARTLETT, M.A., F.R.S. (Professor of Psychology in the University of Cambridge).

BRIGADIER-GENERAL A. C. BAYLAY, D.S.O. (Engineering and Allied Employers National Federation).

A. N. DRURY, M.D., F.R.S. (Medical Research Council).

T. FERGUSON, M.D., D.Sc., F.R.C.P.E., F.R.S.E. (Deputy Chief Medical Officer, Department of Health for Scotland).

M. W. GOLDBLATT, M.D., Ph.D. (Imperial Chemical Industries (Dyestuffs) Ltd.).

A. BRADFORD HILL, D.Sc., Ph.D. (Reader in Epidemiology and Vital Statistics, University of London).

DONALD HUNTER, M.D., F.R.C.P. (Physician to the London Hospital).

ESTHER M. KILLICK, M.D. (Professor of Physiology, University of London).

AIR VICE-MARSHAL SIR DAVID MUNRO, K.C.B., C.I.E., M.B., F.R.C.S.E. (Chief Medical Officer, Ministry of Supply).

J. L. SMYTH (Secretary, Social Insurance Dept., Trade Union Congress).

R. S. F. SCHILLING, M.B., B.S. (*Secretary*).

TERMS OF REFERENCE

(*Revised* 1942)

To advise and assist the Medical Research Council in promoting scientific investigations into problems of health among workers, including occupational and environmental factors in the causation of ill-health and disease, and the relation of methods and conditions of work to the functions and efficiency of body and mind; and in making known such results of these researches as are capable of useful application to practical needs.

PREFACE

The Industrial Health Research Board is part of the organisation of the Medical Research Council (under the Committee of Privy Council for Medical Research). It was formerly called the Industrial Fatigue Research Board and was first appointed in direct succession to the Committee on the Health of Munition Workers, set up during the war of 1914–18. A general summary of the Board's investigations between two wars, particularly in so far as they have immediate applicability to the war effort, is given in Emergency Report No. 1 (H.M. Stationery Office, 1940; reprinted 1941). Emergency Report No. 2, dealing with questions of hours of work, lost time and labour wastage, was published in 1942. In the preface to that report an extract was given from the Twenty-first Report (Session 1940–41) of the Select Committee on National Expenditure, in which it was recommended that the Board during the war should " work in the closest co-operation with the Production Departments, should advise them, and should be strengthened so as to be able to carry out investigations on a wide scale into the main problems of industrial health and efficiency ". This recommendation was endorsed in the comments made on behalf of H.M. Government, which were published in the Twenty-fifth Report of the Select Committee and, as a step towards its implementation, the Medical Research Council have since reconstituted the Board on a wider basis and with the revised terms of reference given on p. ii; it will be seen that these relate not only to the physiological and psychological aspects of industrial health and environment but also—to a greater extent than previously—to the prevention and relief of illness resulting from the particular health hazards to which industrial workers may be exposed.

Both the former and the present terms of reference of the Board stress the necessity for making widely known—in industry and elsewhere—the results of such completed researches as are capable of useful application to practical needs, and the present series of Emergency Reports is directed to that end. In some cases, as in this instance, they are based on work which has been published *in extenso* in earlier Reports of the Board, and the aim has been to state the conclusions as simply as possible, with a minimum of technical detail, so that their practical implications may be easily understood by a reader without specialised knowledge.

The importance of efforts to lessen the number of accidents on the roads and in industry hardly needs emphasis, and the following pages indicate the personal factors which need to be considered in this regard. The statistical establishment of " accident proneness " as an unfortunate characteristic of a section of mankind—and the finding that this is to some extent predictable by psychological tests—is due largely to original researches by former and present members of the Board's staff. Much remains to be done from the point of view of increasing the scope and efficiency of the tests, and the Board's investigators hope for opportunities to extend their researches, in respect of some of the bigger industries under war conditions. Such studies of the personal factor in accidents should be an effective and powerful ancillary to the preventive and protective regulations of the Ministry of Labour and National Service, and to the valuable propaganda of the Royal Society for the Prevention of Accidents, now part of the Ministry's organisation. Safety Regulations and propaganda necessarily relate to the conditions and dangers to which groups of operatives, or, it may be, the whole population are exposed. The personal studies discussed

in Part II of this report deal, instead, with the particular case of the worker who—intrinsically and through no fault of his own—may be a danger to himself or others under certain conditions, and the chief object of the studies described is to find means of diagnosing his failing in advance so that he may be transferred to a safer type of work before his misfortune has manifested itself in a serious accident to himself or to others. The application of the psychological tests necessarily demands trained personnel, who may not always be available, but it is pointed out that the accident prone may often be identified by the simpler expedient of a careful system of accident records, since those who have many minor accidents also tend to have major ones. Suggestions as to how these records should be kept are given in the report ; and if its publication stimulates interest in the matter and leads to a better system of industrial record keeping in regard to accidents, and to the consequent transfer of those shown to be accident prone to tasks involving a lesser degree of danger, it will represent a noteworthy step towards the solution of an urgent problem of to-day.

28th July, 1942

THE PERSONAL FACTOR IN ACCIDENTS

CONTENTS

INTRODUCTION

During the present war there has been a considerable increase in industrial accidents. This is partly due to the employment of greater numbers of people, many of them inexperienced, on work of a dangerous nature. It is also a fact, as shown by H.M. Chief Inspector of Factories in his report for 1936, that as the numbers in employment rise, there is a more than proportional increase in accidents.

The inevitable association of these happenings with the war effort may make people willing to accept a high accident rate as a regrettable necessity—a view which may be strengthened by the idea that since the men in the Forces are taking every kind of risk, civilians ought not to bother much about their own safety. The Chief Inspector of Factories in his report for 1940 refers to this opinion, and comments with regard to it that " the Services are most carefully trained not to take unnecessary risk ". The difference between these two attitudes is fundamental; and there can be little doubt that the Services' attitude is the proper one, particularly in war-time. Accident prevention is necessary, if for no other reason, because a civilian casualty is an additional burden on the community.

The study of factory accident causation may be considered from the point of view of the operation or of the operative. The intrinsic dangers of the operation itself are mainly dealt with in the Factories Act and Ministry of Labour Regulations, the object of which is to reduce general accident liability to the lowest limit compatible with efficient production. Apart from legal requirements, advice about dangerous practices is also given by the Factory Inspectors and the Royal Society for the Prevention of Accidents, who now form part of the organisation of the Ministry of Labour.

This report is written from the point of view of the operative, and an attempt is made to present in non-technical language the results of some of the investigations of the Industrial Health Research Board of the Medical Research Council.

Part I concerns the general factors affecting the response made by all individuals, though in different degrees, to factory conditions. Part II deals with individual differences which make the responses of individuals dissimilar, when exposed to the same working conditions, however good or bad the latter may be.

PART I—GENERAL FACTORS

Under this head we have to consider environmental conditions (hours of work, heating and ventilation, lighting), certain personal factors of a general kind (experience, age, fitness for work), technical aspects (speed of work, organisation), and preventive influences (attitude of management, attitude of workpeople).

Some of the environmental factors affecting the incidence of accidents are :—

1. Hours of Work

During the war of 1914–18 investigations showed that excessively long hours resulted in an increase in the accident rate, and, allowing for other factors, there was evidence that fatigue played a considerable part in accidents. It not only reduces the speed and accuracy of muscular movements, but also affects mental alertness. A fatigued person may appear to be careless because his body and mind are working less accurately. Such apparent carelessness is due not to unwillingness to take care, but to an inability to do so because of excessive strain. In war-time longer working hours are necessary, but the effects may be partially mitigated by rest pauses in the middle of a spell of work, by change of occupation, by alternating sitting and standing when possible, and by adjusting working benches and machines to the worker, so that the whole of the worker's energy can be directed to constructive work and not to overcoming unnecessary discomforts and hindrances.

2. Heating and Ventilation

Atmospheric conditions play an important part in accident rates. In munition works in the war of 1914–18 the number of cuts and minor accidents was at a minimum when the shop temperature was 65°–69° F., and it rose considerably when the temperature was much below or above that range. In coal mines the accident rate was found to increase as the temperature became uncomfortably high.

Many processes are of such a kind as to generate much radiant heat, but this is no excuse for oppressive atmospheric conditions. Often the worker can be protected by a screen from the direct source of radiant heat, and this will lower the temperature round his body. Even a too warm atmosphere may be rendered innocuous if rapid air currents are set up.

Adequate ventilation should not be regarded as a side issue, only to be attended to when complaints become too numerous to overlook. In hot weather adequate ventilation which keeps the air in circulation, and the workers comfortably cool, will prevent many accidents.

3. Lighting

Lighting may be a contributory cause of accidents if it is so inadequate that the worker cannot see his work clearly, or if there is glare. An efficient lighting system should ensure that lights are so placed as not to cause glare. Too great a variation in lighting must also be avoided. When a worker passes from the highly lit bench to an insufficiently lit passage, it will take some time for his eyes to adapt to the lower illumination. During this period his vision is seriously impaired, so that objects are not clearly seen and, in consequence, accidents may result.

Natural lighting, *i.e.* daylight, is ideal when there is enough of it.

4. Experience

Inexperience is a fruitful cause of accidents. A worker may be inexperienced in the sense that he is not used to factory life. Such workers may be either young entrants, or older people new to industrial work, or who have returned to it after a long absence. These workers are unaccustomed to general factory conditions, where people and objects are moving quicker than is usual outside a factory, and they are thus specially liable to sustain accidents. A short time only is necessary to accustom people to factory conditions; but by seeing that they are not exposed to special danger during the first week or so of their employment, many accidents may be avoided.

The other type of inexperience is that of the factory worker who has changed from one occupation to another, and has not yet become skilled in the new one. Workers of this kind are familiar with the general dangers of factory life, but they have not formed the necessary mental and muscular habits to do their new work without faulty movements.

It is a great advantage if new entrants can be trained on a non-production basis, rather than being allowed to pick up the technique of their new occupation in the ordinary course of production. The benefit of such training schemes is that the worker more easily acquires the necessary habit formations of his new occupation if he is taught them by an expert and allowed to work without regard to speed. If the speed factor is introduced, as it must be when working on a production basis, the worker may acquire a set of faulty movements from which he will not easily free himself later, and which will hinder his full productive efforts. Such faulty methods of work are likely to lead to accidents, since they consist of clumsy muscular movements, which are the basis of most accidents.

Training schemes for simple industrial processes may appear to be wasteful of time, but they have been shown to save time in the end, by turning out workers who are more productive and less liable to accidents.

5. Age

Young people are more liable than older people to sustain accidents, quite apart from their inexperience. The accident rate falls steeply from the age of 14 to 23, after which for practical purposes it may be regarded as stationary. There is a small rise in accident rate in middle age, followed by a fall.

Youth is the age of irresponsibility, and however much young people are cautioned they will naturally never have the same sense of responsibility as older people. Again, young people have less control over their muscles. This muscular inco-ordination is part of their immaturity and cannot be overcome until they are fully adult.

Young people quickly become tired when their work is repetitive for long periods. If their work can be changed from time to time, or it can be arranged for them to leave the bench at intervals—for example, to get fresh material—it will tend to lessen their fatigue and thus lower their accident liability.

6. Fitness for Work

A worker who is not well fitted to do his particular job is more liable to sustain accidents than one who is. If the work is unduly strenuous for the worker, on account of his age or general physique, he will be working under strain that will cause excessive fatigue and so be a contributory cause of accidents.

Apart from physical unfitness for work, a worker may be mentally ill-adapted to his task. It has been shown that if workers of high mental ability are employed on tasks of a repetitive kind, involving little thought, they soon become bored. In a bored state the level of output becomes very variable, for the work instead of being based on natural rhythm is dependent on conscious effort. This state of mind quickly engenders fatigue, which will contribute to

a high accident rate. If workers with poor mental ability are engaged on work above their capacity, they quickly become disheartened and give up effort. At such times they are liable to do something foolish which may lead to accidents.

This question of fitness is connected with that of adequate selection, which cannot be discussed here ; it is nevertheless true that any method of selection which prevents the grossest misfits will be a contribution to accident prevention.

7. Speed of Work

Speed of production is a fruitful cause of accidents. Speed is necessary in modern industry, particularly in war-time, and it must be reckoned with as one of the factors in accident causation.

The capacity for rapid movement is at its highest in the middle twenties. There is a fairly steep rise in this capacity during the years of growth, and efficiency does not noticeably begin to fall off until the late thirties. After that, capacity for rapid movement declines year by year. This decrease in capacity to move quickly does not mean that the worker's real capacity for work falls off at the age of 40. It is only his general capacity for rapid movement that begins to deteriorate at this age. The worker who has been employed for a long time on a particular process will have learnt economical muscular habits, so that his efficiency will remain for correspondingly longer.

The worker who takes up a new occupation after the age of 40 is, however, in a different position. He has to learn a new set of muscular habits at a time when his physical efficiency has begun to deteriorate, and his age will make the acquisition of new mental habits more difficult. The reliability and mental stability of such workers are often great assets in occupations where these factors are of prime importance. It is, however, desirable that elderly workers should not be employed in new occupations where very rapid movement is essential. When the employment of elderly workers on processes requiring great speed is inevitable, they should be given an adequate training period.

8. Organisation

An efficient routing scheme is essential if a high accident rate is to be avoided. Many industrial accidents occur, not at the bench, but in the passage ways of the factory. If goods become congested or have to be brought round awkward corners, unnecessary accidents are sure to occur.

It is also necessary to take into consideration the height of the working bench. Since workers differ in height, benches have to be arranged to suit the average height, but workers of short stature should be provided with raised stands or seats, so that they can work comfortably at the bench, with the various articles within easy reach. The provision of such amenities not only lessens the likelihood of accidents, but it also lessens fatigue by avoiding unnecessary stretching for articles.

9. Attitude of Management

The previous sections have dealt with causes of accidents, all of which are external to the worker and to a considerable degree controllable. But attention to these alone will not in itself be adequate to prevent accidents. The belief that accidents are really fortuitous has led to an attitude of mind that tends to accept them. In too many industrial plants the weekly toll of accidents is written off as inevitable. That a high accident rate, even under war conditions, can be avoided is shown by the records of a firm quoted by H.M. Chief Inspector of Factories in his Report for 1940. The accident rate of this firm had been falling for some years before the war and, in spite of the taking on of new workers during the war, this fall continued.

Many factories have Safety Committees, but, like other Committees, they are sometimes effective and sometimes not. Merely to appoint a Committee to deal with accidents is no guarantee that the number of accidents will be reduced. If Safety Committees meet rarely or confine themselves to conducting inquiries after serious accidents have occurred, little good will come from them. If, however, a Safety Committee takes a positive attitude towards the question of accidents and seriously tries to prevent them, it can considerably reduce their number.

Sometimes Safety Committees have little authority and must content themselves with making recommendations, which may or may not be seriously considered. If a management adopts the attitude that accident prevention is a humanitarian effort connected with production but not forming an essential part of it, then its Safety Committee is not likely to be able to do much to reduce accidents.

10. Attitude of Work-people

Carelessness is a failure to exercise adequate thought, and this is often a defect of the keen and proficient worker who thinks safety regulations all right for others, but in his own mind acts on the human principle of " it can't happen to me ". Even the most proficient worker is not immune from accidents, and a temporary lack of thought that may be due to slight physical ill-health or mental pre-occupation, may lead to an accident with disastrous consequences. Certain practices are dangerous and although the proficient worker is more likely to do these things with impunity than the less proficient, yet by so doing he increases his liability to accidents.

Moreover, the best workers have an obligation to the less able : the latter, quite rightly, tend to imitate the former, but if, in consequence, they are led to adopt dangerous practices, the results may be serious. There is therefore need for positive accident propaganda, and the skilful worker should include in his attitude to his work the idea that part of his skill is shown by incurring no accidents. A contrary spirit of bravado may easily lead to neglect of the requisite care.

The Royal Society for the Prevention of Accidents are doing useful work in this respect. Their posters are of a high standard, and by employing good artists with different styles they attract attention. The appeal is for the most part definitely positive, and much ingenuity is shown by varying its motive. Posters are based on such themes as self protection, the protection of others, future security, permanence of employment, pride of work and intelligent outlook. By varying the theme in this way allowance is made for different individual attitudes.

The importance of changing posters at intervals is so obvious as to need only brief mention. We quickly assimilate items in our surroundings into a general whole, so that they cease to attract any special attention. The change of a small item like a poster in our usual surroundings quickly does so, because the new poster stands out from the habitual background. The changing of posters takes time and is liable to be neglected in the stress of war, but it is an essential part of accident prevention and should not be abandoned.

The gruesome should as far as possible be avoided, since it is unwise to engender a feeling of fear. Dread of having an accident is just the attitude of mind likely to involve one. A healthy attitude towards work which we know to be dangerous but are not afraid of, is a better frame of mind than one of timidity.

Even a slight departure from normal health may involve diminution of muscular control and power of attention, though it may not be sufficiently serious to cause sickness absence. A little extra care under such conditions will do much to limit the chances of accident. Care is not synonymous with fear.

PART II—ACCIDENT PRONENESS

When all the causes mentioned in Part I have been considered, there remains a factor in accident causation that has dimly been recognised in practical life but has been ignored until recently. Everyday experience, or the examination of any accident records, makes it clear that, under like conditions of exposure and environment, some people have more accidents than others. This difference in accident rate among individuals might be attributed to various causes—including chance and also the effect of a first accident on the subject's liability to others—but scientific analysis has shown the special importance of the factor known as " accident proneness ".

1, Statistical Evidence

(*a*) *Distribution of accidents.* Statistical research workers were the first systematically to study the unequal distribution of accidents among people exposed to equal risks. They analysed the accident records of groups of industrial workers to see if they could suggest a hypothesis to account for the way in which the accidents were distributed among the individuals in the groups. Three hypotheses were examined.

The *first* was that accidents are distributed by chance among individuals exposed to equal risk (Simple Chance Distribution).

The *second* was that having an accident alters one's chance of having another in a given period of exposure ; it might increase one's chance of having another accident or lessen it (Biassed Distribution)—for instance, the victim might be made more careful (" the burnt child dreads the fire ") or more nervous (" if you break one thing you will break three within a short time ").

The *third* hypothesis was that individuals are initially unequal in their liability to sustain accidents under equal conditions of risk (Distribution of Unequal Liabilities)—which corresponds to the popular idea that there are people " whose fingers are all thumbs ".

Since these statistical researches were originally published, the methods employed have been applied to a large number of industrial and transport groups, and the results have repeatedly shown that the majority of the accidents were due to relatively few individuals.

It was not possible by statistical methods alone, however, to discover the reason for this.

(*b*) *The relation between major and minor accidents.*—The accidents studied have been, for the most part, minor accidents such as cuts and bruises. Serious accidents are not sufficiently frequent in any single department during an observational period of reasonable length to provide adequate data for testing the hypothesis of unequal liability. Another stage in the investigation, therefore, was to see if those who had an undue number of minor accidents also had an undue number of major accidents. The accident records of some 14,000 workers, comprising several different trades, were analysed, and it was found that, in most of the trades, those who had an undue number of minor accidents also had an undue number of major accidents. This implies that those specially liable had more accidents, both minor and major, than others with a lower degree of liability.

This adds to the practical value of our knowledge about the distribution of accidents, for although the distributions examined mostly refer to minor accidents, any conclusions arrived at will apply also to major accidents. The gravity of an accident depends largely on chance circumstances—for example, the part of the body injured—so that naturally any peculiarities in the distribution would be common to both major and minor accidents. Efforts made to prevent people specially susceptible to accidents from incurring danger will tend to protect them not only from minor accidents but also from major ones.

(*c*) *Accidents and sickness.*—The relation between sickness and accidents has been measured by two methods. One way is to compare the number of accidents and the number of illnesses reported by each individual in a working group. The other way is to compare the number of accidents and the amount of lost time through sickness, for each individual.

The former method shows that those who often report sick have, on the whole, a higher accident rate than others. Since this conclusion was arrived at by comparing the number of times each individual reported sick or reported an accident, the tendency for those who have an undue number of accidents also to have an undue number of sicknesses may be partly due to the fact that certain people tend to report both their sicknesses and accidents more often than others. No relation, however, has been found between the length of time lost through sickness and accident rate, probably because, when sickness rates are expressed in terms of lost time, they are a measure of the gravity of sickness and not of its incidence.

Measuring sickness rate by the number of times sickness is reported may give a better indication of general ill-health than measuring it by the length of time lost. The illnesses that are most often reported are colds, headaches, and digestive troubles, and to be constantly subject to these small ailments may be an indication of a generally poor state of health. In so far as this is so, it can readily be understood that the exertion of industrial life may put upon such people an undue strain and induce a state of nervousness which may be a predisposing cause of accidents; such a hypothesis would explain, in part, at least why those who are most often ill tend, on the whole, most often to have accidents.

Whatever the explanation, it is clear from the records examined that the number of illnesses is related to accident rate and that the length of time lost by sickness is not.

(*d*) *Age and experience.*—It has already been shown that the young and the inexperienced are more liable to have accidents than the mature and the experienced; but, if the accidents of groups of equal age and experience are analysed it is found that the majority of the accidents are limited to a relatively few of the subjects.

2. Accident Liability and Accident Proneness

Liability to accident is largely determined by the degree of risk to which a person is exposed. A person living the greater part of his life in a built-up area, or engaged in some particularly dangerous occupation, is more liable to have accidents than one living in a thinly populated area or employed in a relatively safe occupation. Differing environmental conditions alter accident liability, quite apart from any personal characteristics predisposing towards accidents. Such conditions have already been discussed.

Although general accident liability differs from one group of workers to another, according to the nature of their occupations and working conditions, we may enquire whether accident liability differs also for the individuals within a single working group. Analysis of the accident records of any group of workers shows clearly that some have more accidents than others. The most obvious assumption is that these workers are exposed to greater risks than other members of their group. There are, however, many groups in industry in which all the members are doing the same work and exposed to equal risk, and in these groups too it is found that some individuals sustain more accidents than others. This being so, some explanation other than the nature of the work must be sought. Psychological investigations have shown that those with an unduly high accident rate can be partly differentiated on the basis of *measurable individual reactions*. These individual differences are represented by the phrase "accident proneness". Hitherto only one factor in accident proneness has been identified and measured; others may come to be

measured, some may never be. From the fact that the tests are imperfect, however, it does not follow that they are invalid or useless—merely that only part of the task of measuring accident proneness has yet been done.

Accident proneness is a narrower term than accident liability, for it refers only to the personal factors tending towards a high accident rate. Circumstances may cause these factors to play only a small part in accident incidence, or may be such as to make them play a large part; but in any case they are included in the wider term of accident liability, which embraces all factors, personal or other, that determine the incidence of accidents.

Accident *proneness*, then, may be regarded as a set of personal qualities, some of which have been measured, rendering certain individuals more liable than others to sustain accidents.

3. Stability of Accident Proneness

Since some people are more liable to have accidents than others who are comparable with regard to age, experience and so on, it is advisable to know whether this is a stable factor. Are these people likely to have accidents of some one special kind, or accidents in general? Are they likely to have accidents at one time rather than another? Study of a number of industrial groups, and also of several groups of transport drivers, has shown that there is a general tendency for those who have an undue number of accidents in one period to have an undue number in all subsequent periods, *i.e.*, those who had an undue number of accidents in their first year of employment tended to have more accidents than their fellow workers each hour of the day, each day of the week, each month of the year, and each subsequent year.

Variations in density of traffic caused by what are known as the "rush hours" affect both those who are specially prone to accidents and those who are not. Although experience tends to lower accident rate in all drivers, those specially prone to accidents have at all times more accidents than those with an equal amount of experience, but with a lower degree of proneness.

The evidence from all sources goes to show that accident proneness is a relatively stable factor, manifesting itself in all periods of exposure and in different kinds of accidents. There are, of course, always other factors in determining accident rate, and these account for the absence of a closer relation between the number of accidents sustained by an individual in two different periods. In spite of this, the relation is sufficiently close to prove that some set of factors is constantly tending to make certain people more likely to have accidents than others. If some of these factors can be discovered and their operation guarded against, the beneficial effect on accident rate should be permanent and not merely of a transitory nature.

4. Can Accident Proneness be Measured?

Granted that certain people are more prone to accidents than their fellows, because of some personal characteristics, can these characteristics be measured? It would clearly be an advantage if this could be done, since entrants into industry with some particular characteristic or lack of it could be diverted to occupations where their peculiarity would not be dangerous. For nearly twenty years investigators have been experimenting to find some test, or group of tests, which would serve as a means of predicting this unduly liable minority. Experience shows that in a given department the probable number ranges from about 10 to 25 per cent. of the group.

In order that experiments to demonstrate this should be soundly based, a large number of subjects must be studied, whose age and experience are reasonably equal, and adequate records must be available of all their accidents for a number of years. They should be examined by means of a series of tests, after which they would be graded according to their test performance and according to the number of their accidents. If it could be shown that

all those who scored below a certain level in the tests had all the accidents and that those above this level had none, then it would be a justifiable assumption that the tests—if used at an early stage—would be useful for selection purposes. In testing human beings one never gets anything so clear cut, but the results are promising.

In the first experiment 600 subjects were tested and it was found that tests called " aesthetokinetic ", involving rapid and accurate hand and eye co-ordination, did differentiate people in this way. Those who were below the average in the tests had a subsequent accident rate 48 per cent. higher than those who were above it, and the accident rate of the worst 25 per cent. in the tests was 51 per cent. greater than that of the remaining 75 per cent.

At a later stage 1,800 subjects were tested, not only by the tests already mentioned, but also by linguistic intelligence, mechanical aptitude and perseveration tests. These, however, were not so closely associated with accident proneness, and need more research. The results showed that the accident rate of the worst 25 per cent. in the " aesthetokinetic " tests was approximately twice as great as that of the best. The tests used are described in detail in Reports Nos. 38, 55, 74 and 84 of the Industrial Health Research Board.

Of the various tests, the " aesthetokinetic " group showed the most consistent relationship with accident rate. The groups used for the research included transport workers, air pilots, railwaymen, and men employed in engineering occupations. The " aesthetokinetic " tests measure the capacity to respond accurately, within a controlled time interval, to various sensory stimuli. They can be given by persons who have had little previous training in psychology, provided that certain precautions are taken to ensure proper control. If these tests are used indiscriminately, without regard to controlled conditions concerning practice, methods of scoring and instructions to the subjects, only fallacious results will be forthcoming. If, however, these conditions are strictly adhered to, there is nothing to prevent the practical use of the tests for selecting, for dangerous occupations, persons with a specially low degree of accident proneness. If reliable results are to be obtained, it is necessary to use a group of " aesthetokinetic " tests and not to depend on one only.

Results show, however, that these tests are valid for prediction among skilled workers only. Hitherto it has not been possible to show a relation between these or any other tests and accident rate in unskilled occupations. The failure to predict accident proneness among unskilled workers is a matter for further research, but in the meantime there is no scientific justification for applying these tests in any other occupations than the skilled ones in which they have been found to have predictive value.

It is known that, in the skilled occupations in which these tests are applicable, those who do well in them have not only a lower accident rate but also a higher rate of proficiency than those who do badly. In unskilled trades no relation has been found between the tests and proficiency. Since the " aesthetokinetic " tests measure certain factors involved both in proficiency and in accident proneness in the skilled trades, it may be that accident proneness in an occupation is inversely related to proficiency in that occupation. The direct evidence on this question is still rather contradictory, but this may be on account of the difficulty of assessing it. Proficiency in certain occupations may be judged mainly on the basis of quantity of production. If in the process of manufacture there is some particular danger point, this will be passed more often by the more productive workers than by those who are producing less. In this way the accident liability of the more productive workers is increased, since, on account of their greater productivity, they are more often exposed to the particular danger point of the process on which they are engaged. The more proficient worker may be less accident prone but, if his liability is increased by other causes, this advantage may be partly lost and he may have an undue number of accidents.

The fact that it has not been possible by direct methods to reach any definite conclusions about general industrial proficiency and accident rate may be due to errors of this kind, which are difficult to avoid. It is nevertheless clear, from experimental data, that whatever is involved in the performance of the " aesthetokinetic " tests is also involved in accident proneness and industrial proficiency in the skilled occupations demanding manipulative ability. This means that if the tests were practically applied they would tend to select people having a low accident rate associated with a high rate of proficiency.

The reason why these tests have not been found to have any connection with either accident proneness or proficiency, in unskilled occupations, may be because unskilled occupations are less dependent on accurate and rapid co-ordination and more on a willingness to perform a repetitive process without finding it irksome. If this is so, then tests designed to measure factors not closely connected with the occupation cannot be expected to give positive results.

5. Practical Use of our Knowledge of Accident Proneness

In the previous section it has been shown that while accident liability is the sum total of all the factors determining accident incidence, accident proneness refers solely to the individual factors affecting it. It is true that the majority of accidents in any department is sustained by a small minority of the members, and to remove this small minority from a dangerous occupation would be the most effective way of reducing accidents. Unfortunately, we have no means of predicting with certainty all the individuals who will compose this minority. All we know is that by certain methods it is possible to select a group of people who will have a lower accident rate than those selected in the usual way, but in such a selected group there will still be a small minority who sustain the majority of the accidents. In so far as the selection has been successful there will be a smaller proportion of accident prone persons in the group and therefore the mean accident rate will be lower ; but in no case, given sufficient exposure, will any group be wholly free from accidents, and in every case there will be a small minority who will sustain an undue number of accidents in relation to the mean of the group.

It is necessary to emphasise this, in order to avoid the confusion that sometimes arises when different methods of accident prevention are discussed. There can be no antithesis between methods of accident prevention based on lessening accident liability and those based on lowering accident proneness. The two are complementary and neither can be substituted for the other.

In Part I of this report reference has been made to legislation concerning dangerous practices, the constant efforts of the Royal Society for the Prevention of Accidents, the part played in accident prevention by adequate lighting and ventilation, the proper layout of machines, hours of work and rest pauses, and the proper training of young people. Appropriate efforts along all these lines tend to reduce accident liability, and by so doing they reduce the accident rate both of those who are specially accident prone and also of others with a lower degree of accident proneness. In fact, they reduce the mean accident rate of a group whilst still leaving a significant difference between the accident rate of the specially prone and that of others.

The important part played in accident prevention by the various methods of lowering liability must be borne in mind if the contribution to be made by lowering the number of accident prone persons in a working group is to be seen in its right perspective. The question as to which method is likely to be the more successful depends on circumstances. If one imagined an occupation carried on without any safety precautions, then the introduction of proper precautions would be more likely to reduce accidents than would selection on the basis of accident proneness. If, on the other hand, one imagined an occupation where every safety precaution had been devised and conscientiously carried out by the management and the workers, then it would be possible to reduce accidents only by selection on the basis of accident proneness. Between these two

imaginary extremes all existing occupations will be found, and probably most occupations could have their accident rate reduced by both methods, so that we may leave unanswered the question of which is the more important.

We have seen that there are two ways of partially predicting the accident prone. One is by finding the number of accidents sustained by each individual in a working group during a previous period of exposure ; the other is by using certain special tests.

The prediction of accident proneness on the basis of the number of accidents sustained in a previous period of exposure rests on the stability of accident proneness. We know that those who sustain an undue number of accidents in one period of exposure will tend to sustain more than their fair share in all subsequent periods ; that those who sustain an undue number of one kind of accident will sustain an undue number of all other kinds, and that those who sustain an undue number of minor accidents will also sustain an undue number of major ones. We also know that differences in exposure to risk of the whole group will modify the mean accident rate of the group, but that they will leave unaffected the difference between the accident rate of those who may be regarded as accident prone, on account of the undue number of accidents they have sustained, and that of others who have been relatively free from accidents.

If, as a result of accident analysis along these lines, it is found that certain young people in a department sustain many more accidents than others of equal age and experience who are doing the same work, it is safe to regard them as accident prone, for the likelihood is that they will continue to sustain an undue number of accidents. It may be possible, especially in the early stages of industrial life, to divert a young worker from one department to another where accident risks are less, without any loss of prestige or pay.

In choosing a new department for an accident prone worker two considerations must be borne in mind—the mean accident rate of the new department and the severity of the accidents likely to be sustained. The mean accident rate of a department is a measure of the general liability of all workers—prone and non-prone—to sustain accidents. On the other hand, a department with a high accident rate may have a low severity rate, so that although a large number of minor accidents is sustained there are few serious ones ; there are many departments in industry where the likelihood of sustaining a large number of cuts and bruises is great, but where the chance of more serious accidents is small. In such a department an accident prone person may sustain many small injuries, but unless some less dangerous department can be found there may be little harm in his remaining where he is.

On the other hand, in a department in which the accidents are by nature serious the actual frequency rate may be low. Press work is a typical example of this. Most presses are effectively guarded so that the risk of accidents is greatly reduced ; but, nevertheless, accidents with presses do occur, and their occurrence almost always involves serious injury. To allow a young person, who may be regarded as accident prone on account of the number of accidents of a minor nature which he has sustained, to work in a department where the result of an accident is likely to be serious, is to court disaster.

The prediction of accident proneness on the basis of previous accident records has the disadvantage that a worker must have had a certain number of accidents before he can be regarded as prone to them. If it is probable that the accidents he is likely to sustain in his initial period of exposure will be only trivial, no great harm may be done, but if he runs the risk of major accidents at this stage, the decision that he is accident prone may be made too late to save him or his fellow workers from grave injury.

Another disadvantage is that prediction on the basis of previous accident records does not detect the accident prone so well as prediction by the "aesthetokinetic" tests. At first sight this may seem strange, for the "aesthetokinetic" tests measure only one set of factors in accident proneness, so that prediction by them must fail to find those who are accident prone on

account of possessing qualities which have not yet been measured, whereas prediction of accident proneness on the basis of accident records is free from this limitation because it is concerned not with measured or unmeasured causes of accident proneness but only with the evidence that a person has in fact sustained an undue number of accidents. The limiting factor in the prediction of accident proneness on the basis of accident records is due to the sampling errors which must enter into the records of any particular period. The longer the period over which the records are examined, the closer will be their predictive value ; but the period cannot in practice be greatly extended, for during the whole of it the person is sustaining many accidents, which it is the object of the method to prevent. The most accurate method of determining the degree of a person's accident proneness, for example, would be to examine the accident records of his whole working life. This, however, would be of little value to industry, for we should then know that the person was accident prone, only after the time at which any practical use could be made of our knowledge. Nevertheless, the examination of any shorter period than this is based on the stability factor and must suffer from sampling errors.

In the initial period of a juvenile's factory life the accident rate is usually high, so that errors due to sampling are to some extent overcome ; for this reason we can get a surer measure of accident proneness in a short time from young people than from older workers.

The use of psychological tests for the prediction of accident proneness has the advantage of indicating the likelihood of an individual's sustaining an undue number of accidents before he is exposed to industrial risks. This method makes it possible to guide those who are specially prone into the less dangerous occupations, and if extensively carried out it might well have the effect of lowering the general accident rate.

The severity of the selection must depend on the danger involved in the occupation and on the supply of otherwise suitable candidates. It must, however, be borne in mind that the higher the standard of sensori-motor co-ordination demanded the lower will be the likelihood of accidents being sustained by those who do well in the tests. The full value of selective tests for accident proneness in lowering accident rate will show itself only when all the members of a department have been selected in this way.

The most effective way of using our knowledge concerning accident proneness is to combine both methods of detecting it. This can be done by first selecting by means of the psychological tests, and then, at the end of an initial period, removing from a dangerous occupation those with an unduly high accident rate. This combined procedure has been shown, in both transport and industrial accidents, to reduce the subsequent accident rate to an appreciable extent : it is certainly the most effective way of ultimately producing a group of workers with a low accident rate.

The war has greatly aggravated the conditions conducive to a high accident rate, both on the roads and in the factories. The black-out makes motoring at night a considerable strain on the driver, and the large number of new drivers who have been rapidly trained for the defence services have added to the danger of the road both by day and by night. In industry a large number of people have undertaken work to which they are not accustomed, and women and young people have been put on to work normally done by men. Long hours have to be worked and the speed of production has risen. All these factors tend to increase accident liability. They are inevitable in war-time and are a part of the strain on the civil population. Since we cannot remove this strain to any great extent, it is important to see that it does not entail too high an accident rate. Naturally the proper preventive measures concerning guards and dangerous practices should be strictly adhered to, but in spite of these the accident liability may remain high on account of the general strain. In such circumstances the chief way to reduce it is by means of our knowledge of the factors affecting an individual's response to his surroundings.

There is no question of not employing those who are accident prone. They are perfectly normal people and can be usefully engaged in most occupations. It is only if they are employed in an occupation with a high accident liability that they are a danger to themselves and to others, and may thus become an ultimate charge on the State.

The relation between the tests and accidents has been deduced from highly selected groups of industrial workers. It is known that there is less variation in ability in such groups than in less selected groups. Where there is much variation in ability the relation between tests and accidents tends to be closer. Though this has been known for many years, the use of selection tests for the Army in war-time has revealed that it is far more important than at first appeared.

Selection tests of which the predictive value for certain occupations has been proved have been widely applied in the Army. This is undoubtedly due to the unselected nature of the groups of Army recruits. Intakes to the present Army consist of all the men of a particular age who are medically fit and not specially reserved, so that they are a relatively unselected population, showing considerable variation in ability from individual to individual. The same is true of the new entrants into industry, who manifest a wider range of ability than the usual peace-time entrants. We may therefore expect that if tests for accident proneness are applied they will predict those likely to sustain accidents with more accuracy than they have in peace-time groups.

6. Accident Records

If proper use is to be made of our knowledge of accident causation, it is most important that adequate accident records should be kept. In many factories accident records give merely the total number of accidents attended to, or only those of sufficient gravity to entail lost time. Such records tell us the gross number of accidents, but provide no basis for examining their incidence or cause.

The most satisfactory way of keeping accident and sickness records is by the card index system. The task of extracting any useful information about accidents merely entered in a book is so laborious that it is rarely undertaken.

A sample of a card that will give all that is necessary in the way of accident records is given on page 19. Each worker, whether he has sustained an accident or not, should have a card made out for him. It is not sufficient merely to make out cards for those who have accidents, for this tells us nothing of the people who are free from them although exposed to the same risk. A card should be made out for each worker when he is first employed, or when the system is first started, and the card should be removed from the record cabinet when the worker leaves. Records of minor ailments, treated in the ambulance room, may with advantage be kept on the back of the same card.

With the card index system it is so easy to extract the relevant information about accidents that this can be done by a junior clerk in a very short time. If, for instance, we want to compare the accident rates in two departments, all that is necessary is to sort out the cards into two packs, according to the departments. Then the total number of accidents recorded in each pack should be added, and divided by the total number of people employed in each department. This gives us the real accident rate. Merely to know that accidents in a department are numerous, without knowing their incidence in relation to the number employed, may give a false impression, but when the rate of each department has been ascertained we know at once which are the most dangerous departments. By re-sorting the cards of this department according to the age of the workers, the length of employment, or the particular occupation in which they were engaged when injured, we should be able to identify the chief factors in accident incidence. This information will be a guide as to the most hopeful methods for lowering the accident rate.

In such an examination a few individuals will be found to have an accident rate far higher than those of others doing the same kind of work. These are the people who are specially prone to accidents, and they will repay special study. It may be found that the work is too exacting for them, that their means of getting to work involves too much fatigue, that they are of a nervous disposition, that they are not in good health, or that they are worried about their relations with others. It is often possible to do something to relieve them of this extra strain. If not, it may be possible to put them in some other department where their liability to accidents will not be so great. In any case, one can be certain that if nothing is done to help them they will continue to have a high accident rate. It is also certain that if the accident rate is not examined in the way outlined, such people will rarely be discovered and many preventable accidents will be caused.

The main advantage of the card index system is that the management can be provided with reliable information, instead of information which is based on guesswork or which needs further detail to make it useful. The ease of getting such information makes it reasonable to ask for it at regular intervals; the management is thus in the satisfactory position of knowing the precise accident rate at any given time, instead of merely being confronted with the gross number of accidents over a past period, at a time when little can be done about the matter.

The effects of new practices or methods of routing on accident incidence can be immediately examined, and if two departments doing the same kind of work have significantly different accident rates, their organisation and methods of management may usefully be compared.

It is important that all accidents, however trivial, should be entered. If only those involving lost time are entered they will be few in number, and it will thus be much less easy to draw useful conclusions about accident incidence within a short period. We know that those who have an undue number of minor accidents have an undue number of serious accidents, so that we may be certain that people who are always having minor accidents will in time have a major one. If we are enabled to detect such people before they have a serious accident, it will amply repay the extra trouble of keeping records of all accidents, instead of only those of a serious nature. Apart from the humanitarian aspect of accident prevention, a reduction in the amount of working time lost through accidents would have a beneficial effect on production.

Summary

In Part I the general factors affecting accident rates have been discussed. These are the hours of work, heating and ventilation, lighting, experience, age, fitness for work, speed of work, organisation, attitude of management, and attitude of work-people.

Part II considers the special personal qualities which make some individuals more liable to accidents than others in the same circumstances. The possibility of using tests to select the accident prone is discussed in detail; although such tests are not yet wholly adequate, their value has been demonstrated. The most practical measure would be to use tests, supplemented by the record of all accidents experienced during an initial period, for every occupation where there is a special risk.

The importance of detailed and adequate accident records is stressed.

Systematic investigations have shown how the frequency of accidents may be reduced by the proper use of knowledge already available.

Reduction of the amount of time lost through accidents would have a beneficial effect on production.

SAMPLE CARD FOR KEEPING ACCIDENT RECORDS

NAME	Clock No.	Sex	Civil State	Department	Occupation

Date of Birth	Date of Entry	Date of Leaving	

Accidents of all kinds, trivial and serious :— C = Compensated U = Uncompensated

No.	Date	Day	Time	Nature of Injury	Cause	Occupation at the Time of Injury	C or U	No. of Days lost

12/46 (77841) (80505) Wt. 2548 7/47 Hw. S.O. Code No. 46–3–3