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ABSTRACT

Devoted to providing industrial workers with a greater knowledge of precautionary measures undertaken and enforced by industries for the protection of workers, this safety education manual contains 14 lessons ranging from "The Problems of Accidents during Work" to "Trade Unions and Workers and Industrial Safety." Fire protection, safety equipment and hazards in certain tools and equipment are discussed, as well as worker attitudes, propaganda, education, and training. Accident statistics, preventive methods, and safety activities and responsibilities initiated and assumed by the industry are covered. Related questions are included at the end of each topics. (SN)

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INTERNATIONAL LABOUR OFFICE

ACCIDENT PREVENTION

A Workers' Education Manual

GENEVA

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PREFACE

In 1956 the I.L.O. inaugurated a programme of workers' education with the object of giving the worker a better understanding of the complexities of present-day social and industrial life and helping him to shoulder his responsibilities and safeguard his interests in the world of industry. The programme includes the organisation of courses and seminars, assistance to institutions responsible for workers' education, and the publication of the present series of manuals.

This manual deals with safety in industry, a subject of particularly direct interest to workers, for it concerns the preservation of life and limb.

It does not purport to deal comprehensively with the subject of occupational safety, the vastness and complexity of which are attested by the number of voluminous works written on each of its various aspects, such as safety in coal mining, in factories, in building and civil engineering, in agriculture, in forestry, in dock work, in the use of electricity, in the use of and maintenance of elevators or boilers, and other specialised subjects.

Nor does it pretend to cover every occupational field; it is, in fact, addressed almost exclusively to workers in manufacturing industries, and will give little specific guidance to the miner, the farm worker or the bricklayer.

Lastly, it is not a technical manual. It does not pretend to tell people how to prevent every kind of accident or guard every kind of equipment that could be met with in a factory. It only purports to explain why safety is important, by what methods it is promoted and what kinds of authorities, institutions and other organisations are responsible for promoting it.

The subject of occupational health is not touched upon here.

A list of I.L.O. publications is given at the end of the book.

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FIRST LESSON

THE PROBLEM OF ACCIDENTS DURING WORK

Every year, throughout the world, millions of industrial accidents occur. Some of them are fatal and some result in permanent disablement, complete or partial; the great majority cause only temporary disablement, which, however, may last for several months. Every accident causes suffering to the victim, a considerable proportion must cause much anguish to his family, and many—especially those resulting in death or permanent disablement—may have a catastrophic effect on family life. Moreover, all accidents waste time and money.

The world is paying heavily for accidents in terms of both human suffering and economic waste. The task of preventing industrial accidents is therefore a vital and urgent one.

A general idea of the magnitude of the problem can be gained by comparing figures of military casualties during the Second World War with those of casualties in industry during the same period. Over the duration of the war, monthly casualties in the armed forces of the United Kingdom (excluding merchant seamen) averaged 3,462 killed, 752 missing and 3,912 wounded—a total of 8,126. During the six years from 1939 to 1944, in manufacturing industry alone (including docks and shipyards), the monthly average was 107 deaths and 22,002 injuries. In the United States armed forces during the Second World War the average monthly losses were 6,084 killed, 763 missing and 15,161 injured, a total of 22,088; while the monthly average of industrial casualties during the years 1942-44 was 1,219 persons killed, 121 permanently and totally disabled, 7,051 permanently and partially disabled and 152,356 temporarily disabled—a total of 160,747.

It can thus be seen that in these two countries industrial injuries caused more casualties—leaving aside for the moment all questions of relative severity—than the operations of a major war.

Today some countries (Japan, the United States) regularly report over 2 million occupation accidents a year, and others (France, the Federal Republic of Germany, Italy) over a million. Many countries, including some of the largest or most highly industrialised, do not publish any figures; but it is fairly safe to assume that over 15 million occupational accidents occur throughout the world every year—a staggering number when considered in terms of the suffering, sorrow and waste they cause.

Much has been written about the economic cost of industrial accidents, but few attempts have been made to assess it accurately. An American author estimated a few years ago that each lost-time injury —i.e., an injury involving absence from work for a certain time—in industrial employment in the United States cost the employer approximately $1,800. According to the same author, the American Social Security Administration estimated that in a typical year it paid out compensation amounting to approximately $535 million, while the National Safety Council estimated its medical expenses at $130 million, making a total direct expenditure of $665 million. The number of lost-time injuries which gave rise to this expenditure was 1,950,000; thus the average direct cost of each was $340.[1] It is often asserted that the indirect costs of an accident (in lost output, lost wages or damage to property) average four times the direct costs (medical treatment and compensation). If this assertion is accepted, the indirect costs work out at $1,360 per injured person; moreover, to this sum should be added $128, representing the overhead expenditure of the compensation insurance schemes. The total cost of each lost-time accident thus comes to $1,828. The 4:1 ratio of indirect to direct costs is not applicable to all countries, but even if it is as low as 2:1 there can still be no questioning the fact that accidents are costly in all countries.

How Accidents Are Caused

All industrial accidents are—either directly or indirectly—attributable to human failings. Man is not a machine; his performance is not fully predictable and he sometimes makes mistakes. A mistake may be made by the architect who designed a factory, the contractor who built it, a machine designer, a manager, an engineer, a chemist, an electrician, a foreman, an operator, a maintenance man—in fact, by anyone who has anything to do with the design, construction, installation, management, supervision and use of the factory and anything in it.

Much thought has been given to the study of causes of accidents and many books have been written on the subject. There are many different ways of classifying accidents; nearly every country has a different one. One method is to classify them according to where the fault lies (e.g. with the management, a foreman, the victim or another worker). Another method used in several countries is to classify them according

[1] W. D. Keefer: "Accident Costs", in *Industrial Safety*, edited by R. P. Blake, second edition (New York, Prentice-Hall, 1953), pp. 22-29.

to the cause. In some cases this has been done on the basis of a resolution adopted by the First International Conference of Labour Statisticians, organised by the I.L.O. in 1923, which recommends classification of accidents by cause under the following main heads: machinery; transport equipment; explosions and fire; poisonous, hot, or corrosive substances; electricity; falls of persons; stepping on or striking against objects; falling objects; handling without machinery; hand tools; animals; and other causes. A third method used is classification according to the nature of the act which gave rise to the accident (e.g. operating equipment without proper authority, working at an unsafe speed, making safety devices inoperative, using defective or unsafe tools or equipment, or using tools or equipment in a dangerous manner, overloading, crowding, poor arrangement of equipment, unnecessary exposure to danger, the distracting of the attention of the injured person by another worker, or failure to use safety devices). Accidents may also be classified according to material causes, such as improperly guarded or defective equipment, improper illumination, improper ventilation and unsafe dress. Other classifications give information on the age, sex and occupational experience of the victim; the time and nature of the accident; or the part of the body injured.

All these classifications throw some light on the actual causes of industrial accidents, but they do little to indicate the circumstances in which they occur. For instance, it is generally admitted that an accident may be partly due to worry, grief, ill health, bad temper, frustration, exuberance, intoxication, or other physical and mental states, and that these states may be induced in varying degrees by circumstances inside the factory or outside it. Very often, too, an accident is the result of a combination of circumstances of a technological, physiological and psychological nature. Some of them will be considered in subsequent lessons.

However, it can be said that the most common causes of accidents are to be found, not in the most dangerous machines (such as circular saws, spindle moulding machines and power presses) or the most dangerous substances (such as explosives and volatile flammable liquids) but in quite ordinary actions like stumbling, falling, the faulty handling of goods or use of hand tools, and being struck by falling objects.

The truth of this statement can be illustrated statistically. According to the French industrial accident statistics for 1958 [1], for instance, handling of goods accounted for 34.5 per cent. of all accidents and 18.7 per cent. of all time lost; working surfaces (i.e. the floors or tables on

[1] Caisse nationale de sécurité sociale: *Statistiques technologiques d'accidents du travail (année 1958) : Remarques* (Paris, Chaix, 1960), p. 9.

which the work is performed) for 16.5 per cent. of accidents and 12.9 per cent. of time lost; machines for 11.5 per cent. of accidents and 17.1 per cent. of time lost; elevated workplaces for 8.4 per cent. of accidents and 18.9 per cent. of time lost; and hand tools for 7.3 per cent. of accidents and 3.5 per cent. of time lost. Thus these factors between them accounted for 78.2 per cent. of all the accidents that occurred and 71.1 per cent. of all the time lost as a result of accidents. The percentage distribution of industrial accidents in New Zealand in 1955[1] was as follows: handling of objects, 29.0 per cent.; machinery, 20.4 per cent.; hand tools, 16.1 per cent.; falls of persons, 10.9 per cent.; vehicles, 5.6 per cent.; stepping on or striking against objects, 4.6 per cent.; falling or otherwise moving objects, 3.6 per cent.; and other causes, 9.8 per cent. Lastly, in the United States, recent figures compiled on the basis of statistics of fatal compensable work injuries for six states gave the following distribution: manual handling of objects, 24.4 per cent.; falls on the same level, 9.5 per cent.; falls from one level to another, 8.5 per cent.; impact of falling or moving objects, 10.1 per cent.; machinery, 9.8 per cent.; motor vehicles, 5.6 per cent.; other vehicles 2.0 per cent.; stepping on or striking against objects, 6.6 per cent.; hand tools, 6.5 per cent.; electricity, heat and explosives, 3.1 per cent.; elevators, hoists and conveyors, 2.3 per cent.; engines and motors, 0.4 per cent.; and other causes, 8.6 per cent.[2]

How Accidents Are Prevented

The various means generally used at the present time to promote industrial safety may be classified as follows:

(1) *regulations*, i.e. mandatory prescriptions concerning such matters as general working conditions, the design, construction, maintenance, inspection, testing and operation of industrial equipment, the duties of employers and workers, training, medical supervision, first aid, and medical examinations;

(2) *standardisation*, i.e. the laying down of official, semi-official or unofficial standards concerning, for example, the safe construction of certain types of industrial equipment, safe and hygienic practices, or personal protective devices;

(3) *inspection*, i.e. the enforcement of mandatory regulations;

(4) *technical research*, including such matters as investigation of the properties and characteristics of harmful materials, the study of machine

[1] Department of Statistics: *Report on the Industrial Accidents Statistics of New Zealand for the Year 1955* (Wellington, 1957), p. 10.

[2] *Accident Facts* (Chicago, National Safety Council), 1959 edition, p. 31.

guards, the testing of respiratory masks, the investigation of methods of preventing gas and dust explosions, or the search for the most suitable materials and designs for hoisting ropes and other hoisting equipment;

(5) *medical research*, including, in particular, investigation of the physiological and pathological effects of environmental and technological factors, and the physical circumstances conducive to accidents;

(6) *psychological research*, i.e. investigation of the psychological patterns conducive to accidents;

(7) *statistical research* to ascertain what kinds of accidents occur, in what numbers, to what types of people, in what operations, and from what causes;

(8) *education*, involving the teaching of safety as a subject in engineering colleges, trade schools or apprenticeship courses;

(9) *training*, i.e. the practical instruction of workers, and especially new workers, in safety matters;

(10) *persuasion*, i.e. the employment of various methods of publicity and appeal to develop " safety-mindedness ";

(11) *insurance*, i.e. the provision of financial incentives to promote accident prevention, in the form, for instance, of reductions in premiums payable by factories where safety measures of a high standard are taken; and

(12) *safety measures within the individual undertaking*.

It may be said that in the last resort the value of the first 11 items will depend very largely on the effectiveness of the last. It is in undertakings that accidents occur, and the accident pattern in a given undertaking may be determined very largely by the degree of safety-mindedness shown by all those who work in it.

It will be clear from this list that accident prevention requires the co-operation of many kinds of people—legislators, government officials, technologists, physicians, psychologists, statisticians, teachers and, of course, the employers and workers themselves.

Accidents and Accident Prevention Today

The first great change for hundreds (perhaps for thousands) of years in the nature of industrial hazards came with the introduction of steam-powered industrial machinery. Later came electricity, the use of which gave rise to yet other types of accidents. The pattern of risk has also been changed by the replacement of coal by gas and oil; the internal-combustion engine, too, has its dangers. The continual spread of mechanisation and the ever-increasing variety of industrial chemicals in use have added yet more problems of protection. The most recent hazards to arrive on the scene are those deriving from ionising radiations and atomic power.

However, technological changes do not always result in a net increase in the degree of risk. The individual drive for machines is undoubtedly safer than the old line shafting; the modern electric motor for cranes is safer than the old steam engine; mechanical handling equipment prevents injuries due to over-exertion; and pneumatic conveyors prevent harmful dusts from entering the atmosphere.

In recent years it has come to be realised that technological advance cannot be held solely responsible for accidents. Accidents occur on the most carefully guarded machine, the non-slip floor, the completely inclosed switchgear, and with all sorts of equipment apparently provided with every conceivable safety device. Guards and covers may be removed, shoes may be unsuitable, safety devices may be put out of action, people may try out equipment that they are not supposed to touch. At any time a worker may feel unwell, be absent-minded, forget something, momentarily cease to concentrate on his work, or suffer from some other condition that may lead to an accident. It is not surprising, therefore, that increasing attention is being paid to accident risks inherent in human behaviour in the factory or other workplaces.

The war on accidents has developed from the tentative and sporadic measures of a century ago into a full-scale campaign in which almost every conceivable weapon, ranging from imposing codes of regulations down to cartoons, is being used. In this war great successes have been achieved, but final victory—the reduction of accident frequency and severity rates to the lowest figures attainable by human effort—is a long way off.

It is not possible to fix a definite goal for accident prevention, but there is a wide measure of agreement among factory inspectors and other safety experts that most accidents can be prevented. Companies with good safety organisation have actually proved that this is so in a large number of cases. If every undertaking in each industry were to reduce its accident rate to that attained by the few companies with the best safety records in the industry, then without much doubt the world accident total would only be a fraction of what it is now.

In the following pages an attempt is made to give a general idea of what accident prevention involves in the way of resources and effort, describing some of the tasks that have to be performed and the agencies established to perform them.

Questions

1. *Do you consider that the prevention of occupational accidents is a serious problem? Give reasons for your answer.*

2. *Why is it difficult to explain satisfactorily how accidents happen?*

3. *Describe some of the ways in which endeavours are being made to prevent accidents.*

4. *Discuss whether technological progress is likely to reduce the danger of accidents in industry or not.*

SECOND LESSON

THE ORIGINS OF ACCIDENT PREVENTION

Industrial accidents first began to occur in large numbers some 150 years ago as the revolution in industrial techniques began to make possible large-scale mechanised production with the factory as the production unit. Some of the conditions to which the Industrial Revolution gave rise, as it ran its triumphant but pitiless course, were so atrocious as to create a widespread feeling of horror and a demand for reforms.

The movement for reform was led by people who felt that they had a moral responsibility for the well-being of their fellows. Accident prevention work has from the very beginning owed much to these public-spirited men and women, whose sense of justice was outraged by the exploitation of the weak and whose sympathy was stirred by their sufferings. The aim of the reformers was to persuade or shame the government into protecting the factory workers (and above all the children), who often lived and worked under conditions which today would be considered shocking, from the danger of mutilation, disease and immorality by taking, among other things, measures to reduce the frequency of industrial accidents.

If one takes the country in which the Industrial Revolution began —Great Britain—as an example, one finds that these humanitarian efforts were first of all directed towards reducing the hours of work and protecting the health of children, who were by far the worst sufferers from these conditions, and that it was only at a comparatively late stage that any action was taken to prevent accidents in general.

In the eighteenth century, as a result of a remarkable series of inventions, of which the flying shuttle, the spinning jenny, the mule and the power loom were among the most important, the textile industry gradually developed from a cottage industry into a factory industry. There arose a great demand for cheap labour, and a convenient supply was found among the pauper children who were in the care of the public assistance authorities of the large towns. They worked " unknown, unprotected and forgotten ", as a writer described them in 1795, in insanitary conditions, for 14 or 15 hours a day. During the next 40 or 50 years, as a result of more or less continuous agitation, much was done to improve their lot.

Then attention was turned to the problem of safety. The increasing power, speed and crowding of machinery were making factories more and more dangerous. Engels, writing of conditions in 1844, remarked that there were so many cripples in Manchester that the inhabitants looked like an army which had just returned from a campaign. It is almost impossible today to realise the indignation with which some of the mill-owners received the suggestion that they should be held responsible for any accidents that occurred on their premises. But no matter how stubbornly they resisted, the tide of opinion was running against them; and, thanks to the combined and persistent efforts of philanthropists, inspectors, statesmen, members of parliament, journalists and others, some effective safety provisions were incorporated in the Factories Act of 1844.

Early Safety Legislation

The first tangible achievement of the reformers was actually the adoption in 1802 of an Act for the preservation of the health and morals of apprentices and others employed in mills and factories. The inspection of these mills and factories was entrusted to honorary visitors chosen from among the local magistrates and the clergy. An amending Act of 1833 created a government inspectorate, but it was not until 1844 that clauses relating to the fencing of machinery, the provision of other safeguards and the reporting of accidents were inserted in the Act.

In other countries the lot of the children was sometimes little better. In an account of conditions in the cotton, wool and silk industries in France, compiled in 1840 by the statistician Louis René Villermé, one reads of children of 6 and 8 years of age working in a standing position for 16 to 17 hours a day, badly fed, badly dressed, obliged to walk long distances to the workshop at 5 o'clock in the morning and returning home exhausted at night. In France, too, some zealous reformers, among whom several Alsatian textile manufacturers were conspicuous, strove to mitigate the sufferings of the mill children, and in their efforts originated the movement for the prevention of industrial accidents. Engel Dollfus, who in 1867 founded an association in Mulhouse for the prevention of factory accidents and for the exchange of experience in safety problems, was a man of high social principles, which he expressed in the following words:

> The employer owes more than wages to his workers. It is his duty to take care of their moral and physical condition, and this purely moral obligation.

which cannot be replaced by any kind of wages, should take precedence over considerations of private interest.[1]

The first piece of factory legislation in France was an Act, dated 22 March 1841, on the employment of children in industrial undertakings, factories and workshops using mechanical power or carrying on continuous processes, and in factories employing more than 20 workers. It also provided for a system of inspection; but safety legislation in the strict sense was not introduced until 1893.

In Prussia the first steps taken to establish a factory inspection system took the form of regulations issued on 9 March 1839 concerning the employment of young workers in factories. A circular of the Prussian Minister of the Interior, Finance and Education, dated 28 May 1845, recommended the appointment of medical inspectors of factories. State factory inspectors empowered to deal with matters affecting the safety as well as the health of young persons were appointed for the industrial centres of Düsseldorf, Aachen and Arnsberg in 1853. General protection of workers against industrial accidents and diseases was provided for under the industrial code *(Gewerbeordnung)* of the North German Federation issued in May 1869. A system of inspection covering industrial health and safety generally was introduced in 1872 in Prussia, and at about the same time in the industrial states of Saxony and Baden. An Imperial Act of 15 July 1878 made factory inspection compulsory in all the German states. The industrial accident insurance legislation, under which the system of mutual accident insurance associations was developed, dates from 1884.

In Belgium industrial safety and health legislation had a rather different origin; it derived from the legislation of the Napoleonic era, partly from inspection legislation and partly from legislation protecting the public against industrial dangers and nuisances. An Act concerning mines, smelting works and similar undertakings, promulgated on 21 April 1810, created a system of inspection, and although the inspectors had no statutory duties in connection with safety and health, they did attend to these matters in practice. Subsequently, pursuant to an Imperial Decree dated 15 October 1810, the Government issued regulations for the protection of the public from nuisances arising from dangerous, unhealthy or obnoxious undertakings, and used them to promote industrial safety and health by treating the workers as members of the public.

Other European countries, including Denmark and Switzerland, had factory legislation on the statute books by 1840, but it was not until much later—in Denmark in 1873, and in Switzerland (at the federal

[1] Quoted by P. CALONI in *Échec au risque* (Paris, Société d'éditions françaises et internationales, 1952), pp. 10-11.

level) after 1877—that effective systems of factory inspection to enforce safety and health standards were established.

In the United States, Massachusetts was the first state to pass an Act for the prevention of accidents in factories. This Act, dated 11 May 1877, provided for the guarding of belting, shafting and gearing, prohibited the cleaning of machinery in motion, and required elevators and hoistways to be protected and sufficient exits to be provided in case of fire. Massachusetts was also the first state to pass an Act requiring accidents to be reported; it was dated 1 June 1886. Similar Acts were passed by Ohio in 1888, Missouri in 1891, and Rhode Island in 1896.

In the United States, as in Europe, the first factory legislation made no provision for the establishment of special enforcement agencies, on the assumption that complaints would be made by the injured employees. It was, however, found that employees would not make complaints for fear of being discharged, and in the 1860s a beginning was made with the appointment of factory inspectors who could conduct prosecutions without calling upon employees to testify. Once again Massachusetts was the first in the field: there a state inspectorate was established in 1867. Wisconsin passed factory inspection legislation in 1885 and New York in 1886. After 1885, too, the principle of employers' liability in respect of employment injury began to appear in the legislation of the different states.

The growing importance and complexity of industry in western countries, where labour inspection services were responsible for the enforcement of safety laws, made it necessary to add to the staff of these services a number of specialists suitably qualified to cope with the new and increasingly complicated safety problems which were arising. With the assistance of medical, electrical, chemical and other specialists the labour inspector could become a technical consultant to whom employers and workers could turn, and in this capacity he could make a better contribution to safety promotion than when he was merely an official responsible for enforcing the law.

In some countries assistance in the promotion of safe working conditions has come from social insurance institutions. These institutions have to pay compensation in case of accidents and are interested in accident prevention as a means of limiting the cost of social insurance. Their activities in this field have included the issue of enforceable safety rules and the publication of safety pamphlets for different branches of industry. Such a system has been followed in Germany since 1884; it resulted in that country having two different state services (labour inspection and social insurance), both of them responsible to some extent for accident prevention—an arrangement that has given rise to some administrative problems.

In the United States, as the number of states to pass laws concerning employers' liability in respect of employment injury increased, the employers' liability was gradually taken over by insurance companies. The latter appointed inspectors to supervise safety measures in the insured undertakings, and in this way they entered the accident prevention field.

Exchanges of Experience

The idea of Engel Dollfus of exchanging experience on safety matters between different undertakings gave a powerful stimulus to the introduction of suitable precautions in industry. Earlier, individual undertakings had sometimes taken far-reaching safety measures, but these had rarely been applied in other factories.

The activities of Engel Dollfus resulted in the adoption of safety measures applicable in all the textile factories in Mulhouse.

In 1889 the accident prevention association in Mulhouse published an album containing all the safeguards known at that time to have given satisfaction in the factories where they were in use--another idea of Dollfus's. It was sent to the international exhibition in Paris, where it received much attention, for by that time in many countries safety was considered an important industrial problem. An improved and expanded second edition was published in 1895.[1] It is most interesting to observe that several of the safety devices described in this manual are still recommended in safety publications.

At about this time a number of international safety congresses were held (in Paris in 1889, in Berne in 1891, and in Milan in 1894), which had a not inconsiderable influence on the legislation of the period. The system of promoting safety by exchanges of experience and the publicising of suitable safeguards had been shown to be invaluable but not sufficient to arrive at substantial results. It was found, for example, that those who were responsible for the enforcement of safety measures in the factory itself were not sufficiently independent or had other work to do which prevented them from attending to safety matters; alternatively, there was no co-operation between management and workers, or the workers themselves were opposed to the new measures.

At the Berne Congress the employers' representatives suggested that these difficulties should be overcome by promulgating safety laws and

[1] Gesellschaft zur Verhütung von Fabrikunfällen: *Sammlung von Vorrichtungen und Apparaten zur Verhütung von Unfällen an Maschinen, 1895*, second edition (Mulhouse, 1895).

by setting up state inspection services for their enforcement; in this way safeguarding dangerous places would become a statutory obligation. Moreover, to make sure that the obligation should be a real one, state inspectors, not influenced by local conditions, should be appointed to see that the law was enforced. Three years later, at the Milan Congress, this proposal was put forward again; in addition, it was proposed that governments should promote the founding and functioning of safety associations, organised by private persons, to promote action aimed at improving the safety and protecting the health of the workers. State labour inspectors were to co-operate with these associations.

Safety Associations

Most of the voluntary safety organisations in existence are of even more recent origin than safety legislation. As far as is known, the oldest safety organisation in the world is the Mulhouse Accident Prevention Association, founded in 1867, to which reference has already been made. Other European countries gradually followed the French example. The Belgian Manufacturers' Association for the Prevention of Industrial Accidents was founded in 1890 and its Italian counterpart in 1894. The Swedish Workers' Protection Association dates from 1905. The British National Safety First Association (now the Royal Society for the Prevention of Accidents) did not come into existence until after the First World War. The National Safety Council of the United States was founded in 1913. The Cuban National Safety Council, apparently the first of its kind in Latin America, goes back only to 1936. The first safety association to be founded in Africa seems to have been the Cape Province Safety First Association, dating from 1936. In Asia the Japanese Industrial Welfare Society (founded in 1928) was the first to appear; the second was the Safety First Association of India, founded in 1931. The National Safety Council of Australia and the New South Wales Safety First Association both began activity in 1927.

Testing and Research Institutions

Two other types of institution rendered necessary by the progress of technology are those engaged in the testing of industrial materials and equipment and those concerned with research in fields such as technology, physiology and psychology. Mining is perhaps the industry for which most safety research has been done; gas explosions, dust explosions, fires, electrical equipment and haulage equipment are among the subjects to which an enormous amount of research has been devoted; but industry generally has benefited from research into chemicals, constructional materials, traction equipment, respirators, and many other things.

Examples of testing institutions are the Belgian Manufacturers' Association, the German State Material-Testing Institute, the Study and Research Centre of the French nationalised coal industry, the Silicosis Research Institute at Bochum (Federal Republic of Germany), the Italian National Institute for Accident Prevention, the Safety in Mines Research Establishment at Sheffield (United Kingdom) and the United States Bureau of Mines.[1]

Questions

1. *How did the Industrial Revolution give birth to the accident prevention movement?*

2. *Describe some of the earliest measures taken to prevent accidents.*

3. *In which parts of the world did accident prevention activities develop first?*

4. *State what you know of the development of accident prevention legislation and activity in your own country.*

[1] More detailed information on research and testing institutions will be found in I.L.O.: *Safety in Factories* (Geneva, 1949); *Safety in Coal Mines*, Studies and Reports, New Series, No. 33, Vol. I (Geneva, 1953); and *International Directory of Institutions Engaged in Study, Research and Other Activities in the Field of Occupational Safety and Health*. 2 vols. (Geneva, 1958) (mimeographed).

THIRD LESSON

ACCIDENT INVESTIGATIONS AND STATISTICS

Statistics of accidents have proved to be essential for planning accident-prevention activities and for assessing their effectiveness. It is from statistics that we learn how many accidents occur, what kinds of accidents they are, how serious they are, what classes of workers incur them, what machines and other equipment are involved in them, what sort of behaviour is associated with them, and at what times and places they occur most frequently. Statistics provide a bird's-eye view, as it were, of the situation, and without them it would be practically impossible to estimate needs or judge results.

In order that accurate statistics may be compiled it is, of course, necessary that all accidents be reported to the person, authority or institution responsible for compiling the statistics. Such reports must provide the kind of information needed for the particular statistical studies in view and in a form that lends itself to statistical treatment. The simplest information refers only to the total number of accidents. If frequency rates are to be compiled, the number of accidents must be studied in relation to the number of hours of exposure to the risk. For the compilation of severity rates the amount of time lost will be required in addition. For statistics showing the distribution of accidents by cause, type of accident, nature of injury, equipment involved, or age and sex of the victim, still more information is required, and the more complicated the statistics, the more complicated the report form required. It will often not be possible to fill in a report form until the accident has been thoroughly investigated—which will have to be done in any case if the causes of the accident are to be correctly indicated.

Causes of Accidents

Before suitable precautions against accidents can be taken, it is necessary to know exactly how and why they occur. This knowledge has to be obtained by careful investigation of each case.

In countries where social insurance schemes exist or where, for other reasons, accidents have to be reported, accident causes are often defined in such terms as "hand tools" or "falls of objects". These indications are of little use for accident-prevention purposes. Much more detailed information is needed, and as a rule this has to come from a special investigation. Such investigations usually bring to light a series of circumstances or factors, the combination or sequence of which made the accident possible. Each of these circumstances or factors is an essential part of the cause of the accident; but only the sequence of all of them resulted in an accident, and in the absence of any one of them the accident would not have occurred.

An example may make this clear. Suppose a man climbing down a ladder falls because it has a missing rung. Investigation of the accident may reveal the following circumstances:

(1) there was a ladder with a rung missing in the workroom;

(2) a worker took that ladder and used it for a small repair job; and

(3) after finishing the job he came down the ladder without remembering that there was a rung missing.

Each of these three factors was required to bring about a situation in which the accident could happen, but the accident only took place when all three were present in combination. If one of the circumstances could be eliminated, the accident could not recur. When deciding which factor should be considered as the cause of the accident, it is essential that the one chosen is one which can actually be prevented from recurring; this is the only way to achieve practical results in accident prevention.

To take the third factor (insufficient attention of the worker) in the first instance, it will be very difficult, if not impossible, to make sure that a worker thinks of his work continuously and never allows his attention to wander, even for a moment. Consequently this factor should not be considered as the cause of the accident.

The second factor (using a defective ladder) could perhaps be dealt with by giving instructions forbidding the use of defective ladders. Such instructions, however, will not be fully effective, for it will not always be possible to prevent a worker who wants a ladder just for a moment from taking the first one he sees instead of spending time looking for a suitable one.

The factor mentioned first (presence of a defective ladder in the workroom) remains to be considered. The accident could easily have been avoided if the management had given orders that every defective ladder should immediately be sent to the repair shop and seen to it that those orders were carried out. Consequently this is the point where the chain of circumstances could most easily be broken, and this is the factor that should be considered as the primary cause of the accident. In short, the primary cause may be defined as the most easily preventable circumstance in the absence of which the accident could not have occurred.

Investigation of Accidents

There are several methods of conducting an accident investigation which are neither too complicated nor too time-consuming. For minor accidents good results have been obtained by the following method. The victim goes to the first-aid room and, after treatment, is given an accident investigation form which he has to take to his foreman; the latter fills it in and sends it to the safety engineer who, according to circumstances, may decide to make a more detailed investigation himself (or to take some other action) or simply to file it for statistical purposes or for discussion in the safety committee. This method has the advantage of stressing the responsibility of the foreman for safety in his department.

An accident investigation should always be made on the spot. It will be greatly facilitated if the investigator finds the situation on the scene of the accident exactly as it was when the accident took place. Consequently, after an accident the site should be left undisturbed unless steps have to be taken to ensure the safety of persons or to prevent further damage.

Whether the site has been disturbed or not, it is desirable to try to reconstruct the sequence of events just before and during the accident, possibly with the assistance of the injured person, and with the co-operation of witnesses. The investigator should carefully inspect the site and then examine the witnesses. In many cases the cause of the accident will be discovered in this way, but in some cases—e.g., where breakages of metal parts are involved—it may be necessary to ask for the assistance of a research laboratory.

If a pat of a piece of apparatus such as a chain or a wire rope breaks, it is desirable to know the cause of the failure, and for this reason the material should be examined and tested to discover whether it was unsuitable, had been maltreated or was just worn out. The necessary information may be provided by a microscopic examination, by tests carried out on a sample of the material, or by chemical analysis.

Example. A chain used in a hoisting apparatus with a maximum safe working load of 500 kg broke when 700 kg was lifted. The chain was overloaded, but this circumstance in itself was not sufficient to explain why it broke. Tensile tests on two links showed that they broke when the load was about 2,500 to 2,600 kg. Links tested by hammering their narrow end until the long side became the short side did not show any defect. A microscopic examination, with magnifications of 200 and 1,000, showed ageing phenomena, i.e. changes in the properties of the material which had occurred with the passage of time. These ageing phenomena resulted in decreased resistance to shock such as occurs in working conditions, and this had caused the accident.

Where an accident is due to unforeseen chemical reactions, laboratory tests are also necessary in order to ascertain what exactly happened.

Example. A series of inexplicable fires and explosions occurred in a number of dextrin factories. An investigation was made into the chemical properties of the substances present in these factories. First, a general study was made of the influence of small quantities of different substances added to the dextrin on the explosibility of dextrin dust clouds. Next, the circumstances which influenced the composition of dust clouds and the possibility of a dust explosion were studied. These experiments showed that if the air contained some hundredths of a gram of dextrin dust per litre, explosions could be expected; different substances added to the air increased the danger.

It remained to determine the source of ignition. Further experiments were made, which showed that oxidation started at relatively low temperatures (170°C, sometimes even 155°C), and that sufficient heat was developed to raise the temperature to such an extent that spontaneous combustion became possible if heat losses were prevented and sufficient time allowed.

This combination of unfavourable circumstances seldom existed in the factories concerned but was not unknown, and the research work explained not only why the fires and explosions occurred but why fires often started on Sundays, more than 24 hours after the closing of the factories on Saturdays.

Accidents may be investigated for two purposes: to ascertain who is responsible for them, or to find out how similar accidents can be prevented. Determining the responsibility for accidents can be quite different from preventing them. Responsibility may be associated solely with liability for compensation or with prosecution for breaches of regulations, or some other punishment or blame, but in certain cases the determination of responsibility may be of assistance in preventing repetition of an accident.

Often accident investigation is concerned with both responsibility and prevention, and this may seriously hamper discovery of the cause. If the persons questioned feel that as a result of the investigation someone will be blamed, those whose consciences are not quite at ease may give incorrect or incomplete information. It may then be impossible to find the cause and consequently to devise means of prevention. In accident investigations it should always be borne in mind that prevention of accidents is much more important than the mere apportioning of blame.

Analysis and Classification of Accidents

The very many types of accidents which occur make it difficult to develop a method of classification and recording that gives information essential for prevention without being too complicated.

The I.L.O. Classification of Accident Causes

In 1923 the First International Conference of Labour Statisticians convened by the I.L.O. recommended that accidents should be classified by cause, as far as possible in accordance with the following list, but with such subdivisions as might be considered necessary:

(i) machinery:
  (a) prime movers;
  (b) transmission machinery;
  (c) lifting machinery;
  (d) working machinery;
(ii) transport:
  (a) railways;
  (b) ships;
  (c) vehicles;
(iii) explosions; fire;
(iv) poisonous, hot or corrosive substances;
(v) electricity;
(vi) falls of persons;
(vii) stepping on or striking against objects;
(viii) falling objects;
(ix) falls of ground;
(x) handling without machinery;
(xi) hand tools;
(xii) animals;
(xiii) miscellaneous.

In this plan, as in most others, each accident is treated as having a single cause. In determining causes, the criterion usually adopted is that of prevention, i.e. the accident is ascribed to that cause which can be eliminated most easily and directly. The possible causes of accidents, however, are manifold, and some of them, such as psychological factors, cannot yet be analysed statistically. Moreover, most accidents are due to a combination of factors—material, physiological, psychological, organisational, educational and other. Consequently, if the greatest possible benefit is to be derived from accident statistics, they must be comprehensive. Some countries do in fact publish a great variety of data bearing on accident causation.

The "American Recommended Practice for Compiling Industrial Accident Causes"

Probably the boldest attempt at evolving a statistical scheme providing information adequate for accident prevention purposes is represented by the *American Recommended Practice for Compiling Industrial Accident Causes* developed by the American Standards Association.[1] This provides for the classification of accident causes according to—

[1] American Standards Association: *American Recommended Practice for Compiling Industrial Accident Causes*, Publication Z16.2-1941, Parts I and II (New York, 1941).

(1) the agency and agency part concerned (e.g. machines, elevators, boilers);

(2) the unsafe mechanical or physical condition encountered (e.g. improperly guarded agencies, hazardous arrangement around the agency, improper illumination, improper ventilation, unsafe dress);

(3) the type of accident (e.g. striking against, struck by, caught in, fall on same level, slip, contact with extreme temperatures);

(4) the unsafe act committed (e.g. operating without authority, operating at unsafe speed, making safety devices inoperative); and

(5) the unsafe personal factor involved (e.g. improper attitude, lack of knowledge or skill, bodily defects).

(1) *Agency and Agency Part.*

(a) *Agency.* The " agency " is the object or substance which is most closely associated with the injury and which in general could have been properly guarded or adjusted. Agencies are subdivided into major groups such as the following:

00 Machines.
01 Pumps and prime movers.
02 Elevators.
03 Hoisting apparatus.
04 Conveyors.
05 Boilers and pressure vessels.
06 Vehicles.
07 Animals.
08 Mechanical power-transmission apparatus.
09 Electric apparatus.
10 Hand tools.
11 Chemicals.

Each major group is split up into secondary groups. For instance the group entitled " machines " contains, among others, the following:

0000 Agitators, mixers, tumblers, etc.
0004 Buffers, polishers, sanders, grinders.
0008 Casting, forging and welding machines.
0013 Crushing, pulverising machines, etc.
0017 Drilling, boring and turning machines.

(b) *Agency part.* The " agency part " is the particular part of the selected agency which is most closely associated with the injury and which in general was defective or not properly guarded.

For " pumps and prime movers ", for instance, the complete list of agency parts is the following:

0 Belts, pulleys, chains and sprockets, cables and sheaves or gears.
1 Moving parts, not elsewhere classified.
2 Ignition, heating or cooling system parts.

3 Frame, bed, etc.
4 Valves, etc.
5 Gaskets, packing, etc.
6 Safety devices.
7 Flywheel
8 --
9 Parts of pumps and prime movers not elsewhere classified.

(2) *Unsafe Mechanical or Physical Condition.*

The unsafe mechanical or physical condition is the specific reason why the selected agency was unsafe. Under this heading are classified matters such as—

0 Improperly guarded agencies.
1 Defects of agencies.
2 Hazardous arrangement, procedure, etc., in, on, or around the selected agency.
3 Improper illumination.
4 Improper ventilation.
5 Unsafe dress or apparel.

(3) *Type of Accident.*

" Type of accident " refers to the manner in which the injured person came into contact with or became exposed to the object or substance which caused the accident, or the movement of the injured person which resulted in the injury. The following are examples:

0 Striking against (refers generally to contacts with sharp or rough objects, resulting in cuts, slivers, punctures, etc., due to striking against, kneeling on or slipping on objects).
1 Struck by (falling, flying, sliding or otherwise moving objects).
2 Caught in, on, or between.
3 Fall on the same level.
4 Fall to different level.

(4) *Unsafe Act Committed.*

The unsafe act is that violation of a commonly accepted safe procedure which resulted in the selected accident type.

Unsafe acts include—

0 Operating without authority, failure to secure or warn.
1 Operating or working at unsafe speed.
2 Making safety devices inoperative.
3 Using unsafe equipment, hands instead of equipment, or equipment unsafely.
4 Unsafe loading, placing, mixing, combining.
5 Taking unsafe position or posture.

(5) *The Unsafe Personal Factor.*

The unsafe personal factor is the mental or bodily characteristic which permitted or occasioned the selected unsafe act.

This factor is divided into groups such as—

0 Improper attitude.
1 Lack of knowledge or skill.
2 Bodily defects.

Each group is subdivided in a detailed classification. For instance, under " improper attitude " we find—

00 Wilful disregard of instructions.
01 Violent temper.
02 Absent-mindedness.
03 Wilful intent to injure.
04 Nervous, excitable, etc.
05 Failure to understand instructions.

If this system of classifying an accident is used for the ladder accident mentioned earlier the following might be the findings:

(1) *(a)* Agency	19000	Miscellaneous agency.
	19501	Ladder.
(b) Agency part		Not applicable.
(2) Unsafe mechanical or physical condition	1	Defect of agency.
	17	Decayed, aged, worn, cracked, etc. (missing rung).
(3) Accident type	4	Fall to different level.
(4) Unsafe act	6	Working on dangerous equipment.
(5) Unsafe personal factor	0	Improper attitude.
	02	Absent-mindedness.

The code numbers allotted to the different factors facilitate the use of the report for statistical purposes. As already mentioned, in this case the essential circumstance is shown under item (2) and it is here that accident prevention work should start. If at the same time something can be done with regard to items (4) and (5), all the better ; but item (2) is where efforts to eliminate accidents of this type should be concentrated.

It will be noticed that when we come to the unsafe act (4) and the unsafe personal factor (5) we enter the realm of psychology. The *American Recommended Practice* is largely based on the assumption that it is usually the victim of the accident who commits the unsafe act and has the unsafe personal factor. However, a good deal of investigation is going on at the present time into improper attitudes, lack of knowledge and other unsafe personal characteristics of managers and foremen, as factors in accident causation. In their present form sections (4) and (5) give the impression that the psychological causes of accidents almost always reside in the worker, and they do not bring out such factors as poor supervision, poor personnel management and excessive speed of work.

Nevertheless, the *American Recommended Practice* remains probably the best classification of accident causes yet published. It is however, only a recommendation, and, with the exception of a few of the states of the United States, it is hardly used at all in official statistics. In fact, few countries publish classifications which go into anything like so much detail.

STATISTICS CONCERNING THE " HUMAN FACTOR " IN ACCIDENT CAUSATION

Statistics have also been compiled to give an idea of how accidents are distributed over the different hours of a working day and how many accidents happen on each day of the week. Such information is very interesting, for here the general environment remains constant and the " human factor " is much more likely to be the cause of variations. As a rule, more accidents have been found to occur near the end of the morning and near the end of the afternoon shift than at other times. Figure 1 gives an example of such statistics presented in graphic form.[1]

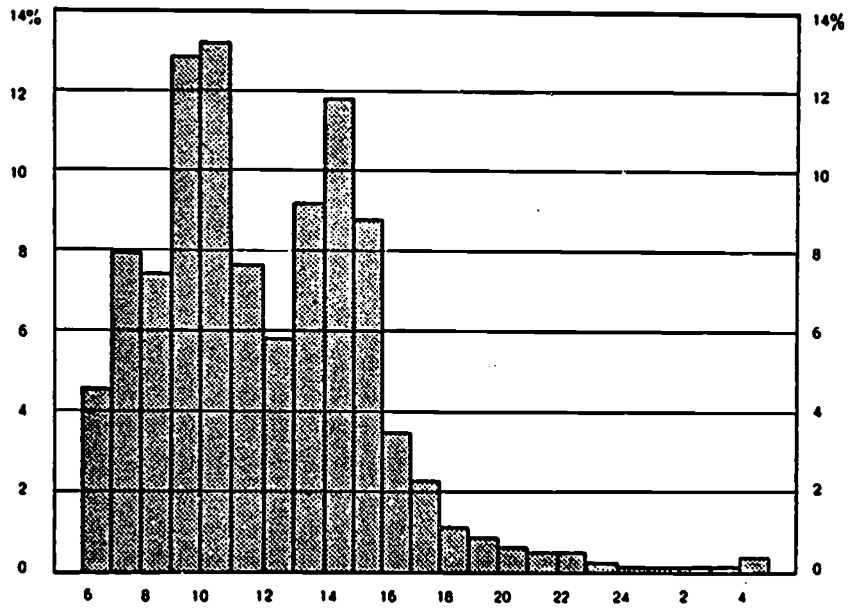


Fig. 1. Percentage distribution of accidents by time of the day.

The question whether more experienced workers have more or fewer accidents than less experienced ones can be discussed with the aid of

[1] Based on conditions in Sweden as reported by N. ZETTERMAN in " Industrial Accidents—A Burden on the National Economy ", in *Occupational Safety and Health* (Geneva, I.L.O.), Vol. I, No. 2, Apr.-June 1951, pp. 61-62.

statistics indicating how accidents are distributed among workers with different lengths of service, or statistics giving information on accidents in which skilled and unskilled workers working under similar circumstances are involved.

Statistics showing the relation between the number of accidents and the age of the workers illustrate another interesting aspect of the influence of the " human factor ". Figure 2 gives an example.[1]

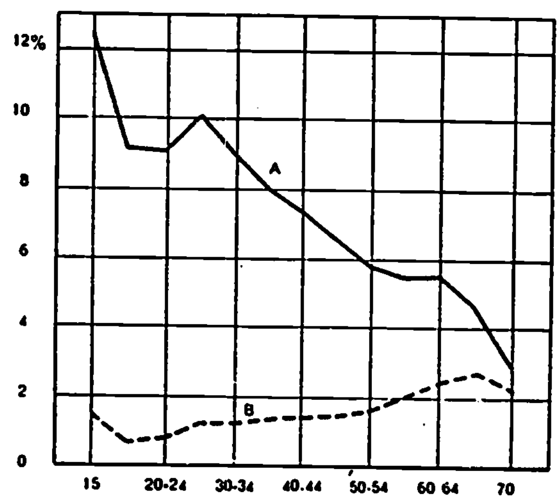


Fig. 2. Percentage distribution of accidents by age.
A : Temporary disablement cases.
B : Fatal and permanent disablement cases.

Statistics of this kind give interesting information on a number of different factors. However, it is difficult to interpret this information accurately, since it is not immediately apparent whether, for instance, the differences shown can be attributed solely to the factors mentioned (age, time of the day, or day of the week) or whether other factors are also involved. The difficulty would be partially overcome if the statistics covered sufficiently large numbers of persons, but there would still remain room for doubt on how to interpret them. A certain number of reasonably definite conclusions can, however, be drawn from the statistics shown. Figure 2, for instance, clearly shows the necessity for giving special attention to the protection of young persons. Figure 1 shows that accidents reach a peak towards the end of the morning and another in the

[1] Based on conditions in Sweden as reported by N. ZETTERMAN in "Industrial Accidents—A Burden on the National Economy", op. cit.

afternoon. These maxima also call for special attention, but it is not easy to discover their cause. Is it fatigue or is it something in the habits of the workers (who perhaps do not always work at the same speed)? Or are there still other causes? Here the statistics suggest that something should be done to improve matters. Special investigations seem to be required to discover why accidents are particularly frequent at these times of day and what should be done to reduce their number.

Are Accidents Due Mainly to Unsafe Equipment or to Unsafe Behaviour?

In safety literature two groups of accidents are often distinguished: those due to technological, mechanical or physical causes, and those due to unsafe behaviour by the worker. To the first group belong accidents caused, for example, by defective parts, unguarded machines, damaged electric cables and worn-out hoisting ropes. To the second group belong those resulting from absent-mindedness, negligence, foolhardiness, or ignorance of risk. The first group is often considered to comprise 15 per cent. of all accidents, the second 85 per cent., and the conclusion is accordingly drawn that attention should be concentrated on the latter group.

Further examination, however, will show that many accidents which are placed in the larger group—for instance, accidents resulting from poor organisation in the factory, for which the worker is not necessarily to blame—might equally well be placed in the smaller group.

An accident is very seldom due solely to unsafe behaviour. As already stated, accidents are usually caused by a group of circumstances; one of these may be unsafe behaviour, but in all probability unsafe physical conditions are present as well, and so it would be equally justifiable to classify the accident as due to unsafe mechanical or physical conditions.

In practice it will be possible to classify the great majority of accidents in such a way that an unsafe act by a worker is not given as the primary cause (i.e. the factor on which efforts to prevent a recurrence of the accident should be concentrated). The following example is an illustration of how this is done.

Example. A 15-year-old boy had the job of cleaning the gangways of a workroom and was told not to clean under the machines. When he saw oil on the floor under a rope-making machine he cleaned that part of the floor also, but as he did so the cotton waste used for cleaning became caught between two gear wheels just above the floor and protected by a hood on the top and sides. As he tried to pull out the cotton his hand was caught between the gears and badly mutilated.

If this accident is analysed in terms of the *American Recommended Practice*, the result is as follows:

(1)	*(a)* Agency	00	Machine.
		00587	Ropemaker.
	(b) Agency part	0	Gears.
(2)	Unsafe mechanical or physical condition	01	Inadequately guarded.
(3)	Accident type	2	Caught between gears.
(4)	Unsafe act	0	Operating without authority.
(5)	Unsafe factor	00	Wilful disregard of instructions.

For prevention purposes it is sufficient to concentrate on point (2) and to make it a general safety rule that gears shall be completely enclosed. It will be more difficult to correct factors (4) and (5).

It has already been pointed out that no useful purpose will be served by citing circumstances which cannot be prevented ; hence carelessness, negligence, absent-mindedness and the like should not be considered as main accident causes, although they may, as already pointed out, be contributory factors. There are so many different circumstances which disturb the mind of a worker but cannot be eliminated— a quarrel with a fellow worker, a difference of opinion as to wages with the foreman, poor health, difficulties at home, day-dreaming—that it is impossible to prevent moments of carelessness or absent-mindedness. We shall return to this point in the eighth lesson when discussing the psychological aspects of accident prevention.

Serious Accidents, Minor Accidents and Near-Accidents

Statistics show that one accident of the kind that is ordinarily compensable happens for every 29 accidents resulting in minor injuries and for every 300 accidents which do not cause injury (i.e. " near-accidents"). Some investigators give the ratio as 1: 20: 200. Whichever is the more accurate, the point is that for every major accident, many dangerous incidents occur which do not cause injuries. This knowledge can be used to great advantage in planning safety programmes ; for if sufficient attention is paid to the no-injury accidents, there is every likelihood that the number of accidents resulting in injuries, and especially serious injuries, will fall. In any case it will be necessary to pay special attention to minor accidents and near-accidents, because often the seriousness of an accident is not at all an indication of the frequency with which it will happen again, nor does the fact that an accident did not cause injury to anybody on one occasion constitute an assurance that under similar circumstances a serious accident will not occur in future. Consequently it would be very wrong if, out of the 330 accidents mentioned at the beginning of the paragraph, measures should be taken to prevent the recurrence of only one and the other 329 ignored. The most important task is that of finding ways of discovering and preventing the 300 near-accidents.

It is easy to arrange for lost-time accidents to be reported to the safety engineer or any other appropriate official, and most of the 29 minor injuries can be reported by the first-aid department ; but what is to be done about the 300 near-accidents ? Some undertakings consider it important that these should also be reported, for among them are cases of stumbling, slipping or falling which might have resulted in an injury, even a serious injury, but which just by chance did not. If these events could be discovered, it might be possible to take steps to prevent their recurrence, and the number of accidents in the minor-injury and lost-time groups could probably be reduced.

In undertakings where the importance of accidents of this type is realised, attempts have been made to solve the problem of how to learn from them. In one undertaking there are two or three selected workers in every department who are responsible for reporting all small defects and shortcomings in their area, such as a hole in the floor, a split-pin replaced by a nail, or a broken window cord, to the safety engineer; for each report a small reward is paid. The safety engineer orders the necessary remedial measures in co-operation with the maintenance department. In another undertaking the safety engineer obtains information on no-injury accidents at meetings with the foremen.

Compilation of Accident Statistics

Statistics may be compiled for a single undertaking, a region, an industry or all the industries in a country. Specialised statistics may be compiled for particular types of accidents (e.g. electrical accidents or ladder accidents), for particular classes of workers (e.g. young persons) or for other types of information. Statistics of the same kind for different years serve to show whether the number of accidents is increasing or decreasing, and hence how successful or unsuccessful accident-prevention work has been in the undertaking, region or industry concerned. Statistics prepared for different undertakings working under more or less the same conditions indicate whether a certain undertaking is better than average or whether it needs substantial improvement from the accident-prevention point of view.

It is clear, therefore, that accident statistics should be comparable not only from year to year but also from industry to industry, region to region and, so far as practicable, country to country. The principal limitation on the comparability of accident statistics lies in the dual purpose for which they are designed : use in accident prevention and use in accident compensation. For prevention purposes statistics of accidents should provide complete information on cause, frequency, industry and occupation, as well as on other factors that influence risk. Statistics for compensation, on the other hand, are used mainly for administrative purposes and must show the number of accidents of each degree of severity, the length of disability and the amounts paid in compensation; for these purposes various legal conditions to which the granting of compensation is subject are incorporated in the definition of an accident. Failure to appreciate the distinction between these two uses has proved a serious obstacle to the utilisation of accident statistics for purposes of prevention. Statistics to be used for accident-prevention purposes should not be designed primarily to meet the requirements of workmen's compensation authorities.

To give accident statistics the highest possible degree of comparability for prevention purposes the following principles must be applied :

(1) Accident statistics should be compiled on the basis of a uniform definition of industrial accidents, framed for the purposes of prevention in general and the measurement of the importance of the risk rates in particular. All accidents as thus defined should be reported and tabulated uniformly.

(2) Frequency and severity rates should be compiled on the basis of uniform methods ; there should be uniform definitions of accidents, uniform methods of estimating the time of exposure to risk, and uniform methods of statement of the risk rates.

(3) The classification of industries and occupations for the purposes of accident statistics should everywhere be uniform.

(4) The classification of causes and accidents should be uniform, and the principles used for determining the causes of accidents should be the same in all cases.

It is not absolutely essential that national statistics should be comparable in all details, but they should be comparable on essential points; in each country data additional to those called for in international comparisons can be compiled for specific purposes.

Some progress has been made towards the international standardisation of industrial accident statistics, and measures have been planned, particularly under the auspices of the International Labour Office, which has been interested in the problem ever since the First International Conference of Labour Statisticians considered it in 1923.[1] The various I.L.O. Conferences of Labour Statisticians have also adopted resolutions embodying recommendations on frequency and severity rates and the classification of accidents by industry and occupation, by cause and by other factors.

CALCULATION OF ACCIDENT RATES

To compare the number of accidents in one factory with that in another in the same branch of industry it is necessary to take into account the differences which may result from the differences in the numbers of workers employed in the two factories. This can be done by calculating the accident frequency rate, i.e. the number of injuries for each million man-hours of exposure.[2] This is expressed by the following formula, in which F represents the frequency rate:

$$F = \frac{\text{number of injuries} \times 1{,}000{,}000}{\text{total man-hours of exposure}}$$

Example. An undertaking with 500 workers, working 50 weeks of 48 hours each, had 60 accidents during one year. Owing to illnesses, accidents and other reasons the workers were absent during 5 per cent. of the aggregate working time. Thus the total number of man-hours ($500 \times 50 \times 48 = 1{,}200{,}000$) has to be reduced by 5 per cent. (60,000), giving the real number of man-hours of exposure as 1,140,000. This being so—

$$F = \frac{60 \times 1{,}000{,}000}{1{,}140{,}000} = 52.63$$

This frequency rate indicates that in a year about 53 accidents occurred per million man-hours worked.

So far only the number of accidents has been considered, and this is not a very exact measure of the effects of accidents. To obtain a better idea of the situation the severity rate must also be calculated. The Sixth International Conference of Labour Statisticians recommended that the severity rate should be taken as the time loss in days per thousand man-hours of exposure. The American Standards Association, on the other

[1] For an account of the proceedings of the Conference see I.L.O.: *International Conference of Labour Statisticians*, Studies and Reports, Series N, No. 4 (Geneva, 1924). See also idem: *Methods of Statistics of Industrial Accidents*, Studies and Reports, Series N, No. 3 (Geneva, 1923) and *Methods of Statistics of Industrial Injuries*, Studies and Reports, New Series, No. 7, Part 3 (Geneva, 1948).

[2] For further details see the resolution concerning industrial injury rates adopted by the Sixth International Conference of Labour Statisticians (Montreal, 1947) in I.L.O.: *The International Standardisation of Labour Statistics*, Studies and Reports, New Series, No. 53 (Geneva, 1959); and American Standards Association: *American Standard Method of Recording and Measuring Work Injury Experience*, Publication Z 16.1-1954 (R 1959) (New York, 1959).

hand, recommends that the rate be calculated per million man-hours of exposure. Consequently, the American rate is 1,000 times the rate recommended by the Conference of Labour Statisticians.

Example. If, in the example given for the calculation of the frequency rate, the number of days lost as a result of the 60 accidents was 1,200, the severity rate (S) would be as follows :

$$S = \frac{1,200 \times 1,000}{1,140,000} = 1.053$$

This means that in a year about one day was lost per 1,000 man-hours (under the American system, 1,053 days per million man-hours) or, on the basis of 2,400 hours of work per year, 2.4 days per worker.

The calculation of severity rates is more difficult where an accident gives rise to permanent disability or death. To cover such cases there is usually a national schedule specifying the number of days to be counted as lost (time charges) for statistical purposes for each type of disability. The American standard contains such a schedule, which assigns time charges for losses of limbs or impairment of functions. The maximum time charge is 6,000 days in case of death, and smaller amounts are charged for loss of or damage to the different parts of the body. The time charge for a fatal accident recommended by the Sixth International Conference of Labour Statisticians in 1947 is 7,500 days.

Example. If, in addition to the 60 lost-time accidents mentioned in the previous examples, one fatal accident had occurred, the frequency rate would have been—

$$F = \frac{61 \times 1,000,000}{1,140,000} = 53.5$$

The time loss in days in that case, using the recommendation of the Sixth International Conference of Labour Statisticians, would have been 8,700 (7,500+1,200) and the severity rate—

$$S = \frac{8,700 \times 1,000}{1,140,000} = 7.63$$

As might be expected, such a serious accident has a considerable effect on the severity rate, but does not greatly affect the frequency rate.

Accident frequency and severity rates give valuable information on the safety situation in a factory, both absolutely and by comparison with other factories working under similar conditions. It is therefore desirable that rates should be published regularly for different branches of industry, and this is done in many countries.

The following figures, which concern the United States in 1956, illustrate the differences between frequency and severity rates in different branches of industry:

Industry	Frequency rates				Severity rates
	Death and permanent total disablement	Permanent partial disablement	Temporary total disablement	All disabling injuries	
Mining, underground coal (1955)	0.64	1.45	20.98	23.07	5,770
Lumber	0.19	1.09	21.04	22.32	2,436
Construction	0.28	0.60	18.22	19.10	2,375
Communications	0.01	0.01	0.97	0.99	58
Tobacco	0.00	0.16	3.11	3.27	82

Source: *Accident Rates* (Chicago, National Safety Council), 1957 edition, p. 6.

The table shows that in coal mining underground there was approximately one accident per 43,000 man-hours, and that 250 days were lost per accident. Two-thirds of the total are accounted for by fatal and permanent-disability cases (lost time being reckoned at 6,000 days in each case); even so, the other accidents involved an average absence from work of 83 days. In the tobacco industry, at the other end of the scale, there was approximately one accident per 306,000 man-hours, with an average absence from work of 25 days.

These figures do not give the impression that prevention can now be considered fully effective. However, if we look at the accident rates of a given industry over a period of years, we can sometimes see that the efforts made have given good results. In 1947, for example, the American tobacco industry had a frequency rate of 6.55 and a severity rate of 240.[1] If these figures are compared with those for 1956 in the above table, it will be seen that in a period of ten years the number of accidents declined by 50 per cent., and the average period of absence from work per accident by about 12 days.

Presentation of Statistics

Accident statistics are not compiled solely for the purpose of research and study in the interests of accident prevention. Though this is the main reason, it is also important to give all persons concerned appropriate information on the accident situation, so as to warn them of the dangers to which they are exposed, keep their interest alive, and make them safety-

[1] *Accident Rates*, op. cit., p. 50.

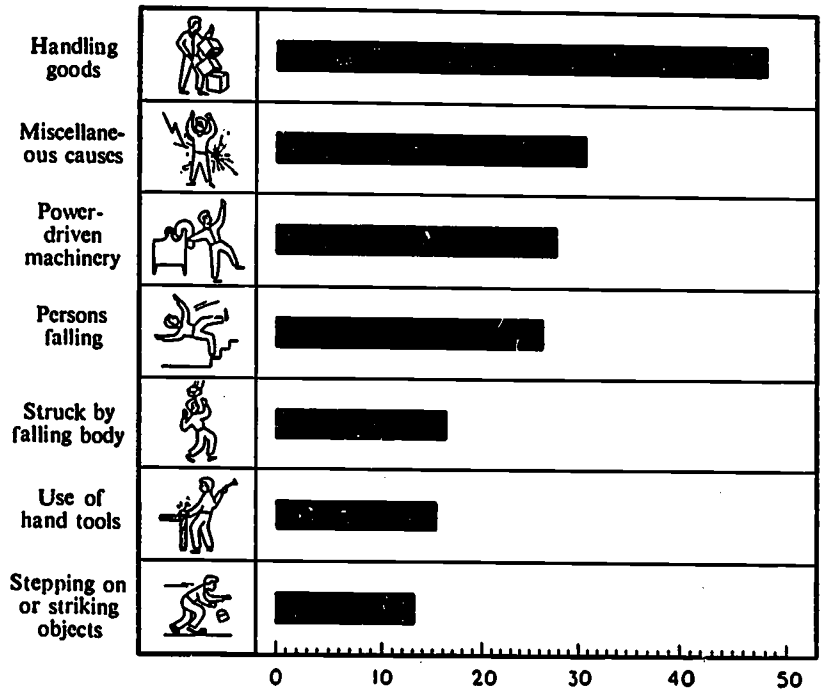


Fig. 3. Total number of accidents per year, by cause. (In thousands)

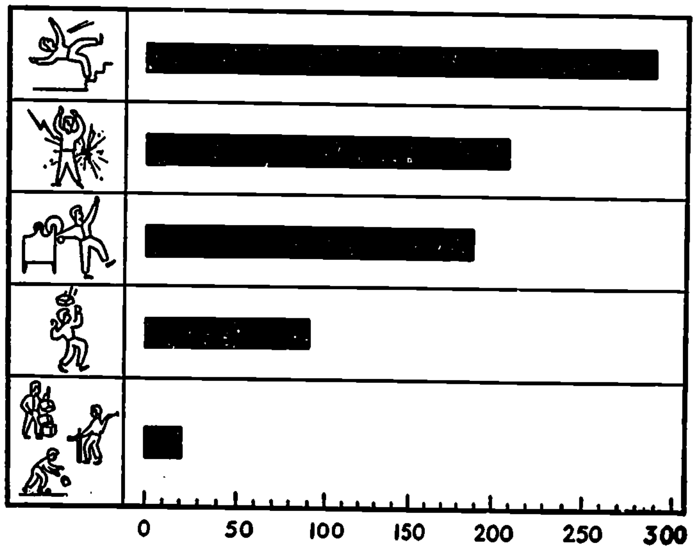


Fig. 4. Number of fatal accidents per year, by cause.

minded. Accordingly, it is sometimes desirable to present statistical data not only in figures but also in pictures. The latter often attract attention better than figures and are the only means of making statistics understandable to persons who cannot read or write. In countries where a large part of the population is illiterate, the publication of sketches and drawings giving facts about accidents and their effects—possibly by trade unions—might well prove an extremely effective instrument for instilling safety-mindedness into the workers. Examples of accident records in pictorial form are given in figures 3, 4 and 5.

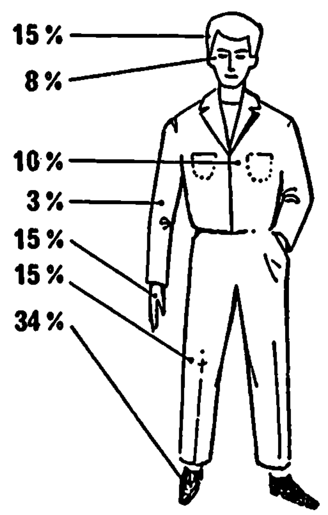


Fig. 5. Percentage distribution of injuries, by part of body affected.

Questions

1. *What kinds of occurrences can be considered to be causes of accidents?*

2. *What purposes are served by investigating accidents?*

3. *What do you think of the classification of accident causes recommended by the I.L.O.?*

4. *Do you think that the* American Recommended Practice for Compiling Industrial Accident Causes *is better than the I.L.O. classification? Give reasons for your answer.*

5. *Are so-called technical and human causes of accidents related? If so, in what ways?*

6. *What is the significance of near-accidents for accident-prevention purposes?*

7. *Mention some of the steps that must be taken to enable accident statistics to be compiled on a uniform basis.*

8. *What is meant by accident rates?*

9. *Describe the principal uses of the different kinds of accident statistics.*

FOURTH LESSON

SOME PRINCIPLES OF ACCIDENT PREVENTION

I: FIRE PROTECTION

Many factory fires start outside working hours. In such cases there is, of course, no risk of personal accident, but the resulting loss of employment makes such fires both an economic and a social calamity. Fires occurring during working hours, however, constitute a very real danger to workers.

Example. In 1956 an old four-storeyed factory building containing worsted spinning and twisting machines, in which 41 persons were working, was destroyed by fire; eight persons, all working above the ground floor, were killed and three injured. The fire started on the ground floor when the flame of a plumber's blowlamp ignited waste wool fibres on the ceiling joists and the fire spread rapidly from end to end of the floor. The factory was properly equipped with an outside fire escape, but the access to it was soon cut off by the flames; the remaining internal staircase was steep and narrow, and afforded an easy passage for the dense smoke rising from the ground floor—for, although it was lobbied off from the upper floors, it was open at ground level. Workers escaping down these stairs panicked at the sight of the smoke, ran back up the stairs and lost their lives—not by burning, but by asphyxia.

Much can and should be done to prevent disasters of this kind by those responsible for the building of factories; but the workers, too, have a very real responsibility for ensuring the effectiveness of fire-prevention measures.

Common Fire Hazards

For a fire to start, three elements must be present: oxygen, fuel and heat. Without the oxygen, nothing can burn; without fuel, there is nothing to burn; and, without heat, there can be no fire (figure 6).

Common fire hazards include smoking, flammable liquids, open lights and flames, poor housekeeping, badly maintained and hence overheated machines, electric wiring, static electricity, welding and soldering equipment. Some industries (e.g. chemicals, oil and paint manufacture) involve special fire risks.

[1] Ministry of Labour and National Insurance: *Annua Report of the Chief Inspector of Factories for the Year 1956* (London, H.M. Stationery Office, 1958), p. 64.

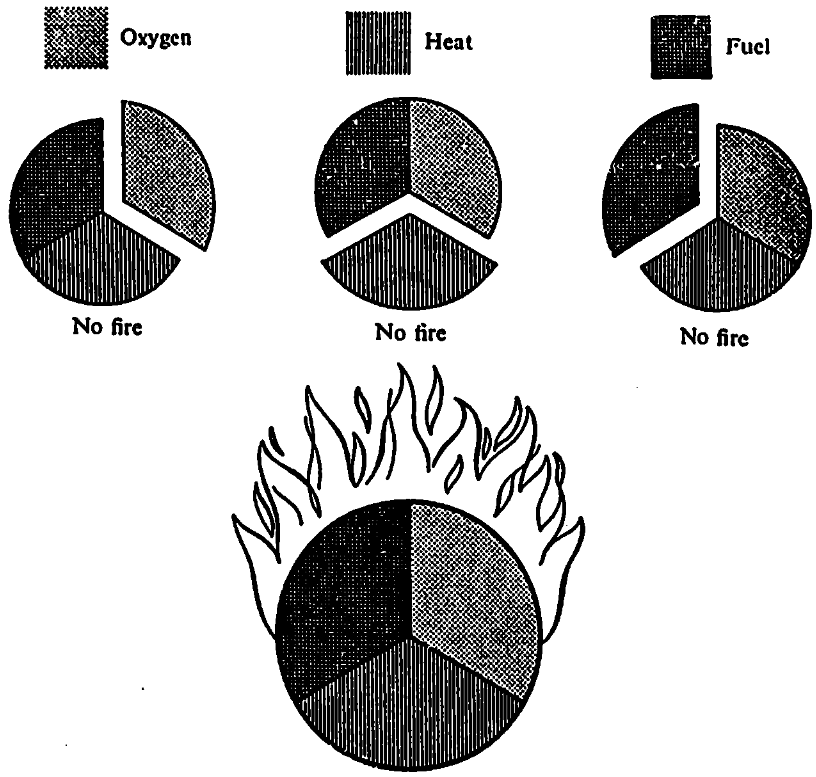


Fig. 6. How fires start. The presence of all the three elements represented by the sectors of the circle is necessary to produce a fire.

One very common fire precaution is the " no smoking " rule. In practice, however, it is not always observed, for some persons find it extremely difficult not to smoke during the four or five consecutive hours of a shift. In factories where no special fire risks exist, such as metal-working establishments, the solution sometimes adopted is to prohibit smoking only during the last working hour, with a view to ensuring that no unextinguished cigarette ends are left lying around unobserved after working hours, when they could start a fire. In factories where the fire risk is particularly great, such as textile plants, a special room is sometimes provided where workers are allowed to go during working hours for an occasional smoke. Smoking should, wherever possible, be permitted in canteens so that workers will feel less strongly the need to smoke while at work.

Flammable liquids can be safely stored in underground tanks. In factories, however, these liquids are not often used in such large quantities as to make this arrangement practicable. Very small quantities should never be stored in glass bottles, which have often caused fatal accidents, but always in metal containers.

Example. A typical example of the accidents which the use of glass bottles can cause is that of the worker who was filling a glass bottle with gasoline from a metal can, holding the container in one hand and the bottle in the other. Suddenly the glass bottle fell on the floor and smashed, and the contents splashed over the floor and the worker's clothes. The gasoline vapour was ignited by a stove which was near the worker and caused a fire. The worker's clothes also caught fire, and the man died the following day from his injuries.

Structural Features and Exits

The first line of defence against fire is in the construction of the building itself. Industrial buildings should be sufficiently fire-resistant, having regard to the fire risks inherent in the processes carried on inside. This is, of course, primarily a matter for architects and designers; but some aspects of the problem are matters in which the workers themselves can give invaluable assistance (for instance, points (4) and (5) in the list of recommendations below). Fire-resistant construction should ensure that structural parts do not readily burn and that fires cannot spread through the building either horizontally or vertically through walls, floors, doors, elevator shafts, stair wells, or ventilating ducts. Exits are most important, and should conform to the following general rules:

(1) No part of the building should be far from an exit leading to the outside, the distance depending on the degree of hazard.

(2) Each floor should have at least two exits, sufficiently wide, protected against flames and smoke and well separated from each other.

(3) Wooden stairs, spiral stairs, elevators and ladders should not count as exits.

(4) Exits should be signposted and well lit.

(5) Exits should always be kept unobstructed.

(6) Outside stairways and fire escapes should not discharge into interior courtyards or blind alleys.[1]

Fire-Extinguishing Equipment

Fire-extinguishing equipment may range from buckets of water or sand to complete sprinkler systems. The kind and amount of equipment

[1] See National Safety Council: *Accident Prevention Manual*, second edition (Chicago, 1951), Ch. 17, pp. 18 ff.

needed will depend on the size and construction of the building to be protected and the processes carried on in it. Sometimes it is sufficient to have portable fire extinguishers, or even a supply of dry sand or some barrels filled with water. Most factories in regions with piped water supplies will have hydrants and hoses.

As regards portable fire extinguishers, care should be taken that they do not constitute a danger in themselves. This is sometimes the case with appliances of unsuitable construction containing chemicals which may block the spray nozzle. When such an appliance has to be used, the chemicals inside are mixed, either by the breaking of a seal or just by turning the appliance upside down. The pressure inside the cylinder then increases, forcing out a jet or spray of extinguishing material; but, if the nozzle is blocked, the appliance will burst. Suitable construction and regular control should prevent these accidents. Another serious risk arises when extinguishers are filled with a toxic substance such as methyl bromide or carbon tetrachloride; there will be a risk of poisoning if the extinguisher leaks or is used in a confined space. Such extinguishers should therefore not be used indoors.

Fire hoses provided with nozzles should be available where practicable, and it is important that the connections should fit the equipment of public fire brigades so that the latter can operate in the factory.

Factories where the risk of fire is great, such as textile plants, should normally be equipped with sprinkler systems, in which water under pressure is carried in a network of pipes near the ceilings of the workrooms. The pipes have nozzles closed by metal strips. If a fire breaks out, the heat melts the nearest strip and water is sprayed into the room.

Fire Alarms

An alarm system should be available to warn everybody in case of fire. This can be done, if the alarm is not given automatically, by installing alarm bells, whistles or sirens in different parts of the factory, and push-buttons or handles in all workrooms to operate the alarm if necessary. Alarms must be audible everywhere in the factory, including workrooms, store houses, gangways, locker rooms, lavatories and washrooms.

Fire-Prevention Organisation

There is more to fire protection then fire-resistant construction and the provision of fire-extinguishing equipment. There are also matters such as the organisation and training of fire brigades, fire drills, and the inspection and maintenance of fire-fighting equipment, in which the workers themselves have an important part to play.

Firstly, every undertaking should have trained fire fighters on each shift; large undertakings may have complete brigades and, if the risk warrants it, a full-time fire-prevention officer. Fire fighters should be kept in training by regular drills.

Secondly, it is essential that undertakings be inspected at suitable intervals for fire risks and to see that all fire-fighting equipment is in good condition. Some undertakings employ full-time watchmen for this purpose.

Thirdly, it is desirable that regular fire drills be organised to make sure that all workers know how to use the fire-extinguishing equipment, where the nearest exit is, and how to leave in good order. Fire drills to ensure that exits are sufficient to enable the factory to be evacuated quickly and that the workers know how to leave the premises in an orderly manner should also be organised from time to time. However, it should not be overlooked that fire drills are expensive, as they suddenly stop production, and it may take some time before work can be resumed. They should therefore not be abused.

Lastly, it is also necessary to ensure close co-operation with the local fire brigade. In some factories the telephone number of the fire brigade is indicated near every telephone, so that anybody can call in the fire brigade if necessary. Some factories, however, arrange for workers to call the factory telephone exchange, which then calls the fire brigade. The practice whereby the factory telephone operator is authorised to call the fire brigade only if certain specified members of the factory personnel so request is undesirable; it has caused delays in cases of fire that have sometimes proved to be extremely costly.

Precautions against Explosions

In some factories precautions are necessary not only against fire risks but also against the risk of explosions, which can be very violent and destructive.

Explosions may be caused by substances such as commercial explosives or by concentrations of certain vapours, gases and dusts in the air. Trinitrotoluene, fulminate of mercury and lead azide are examples of commercial explosives. Dusts that may be explosive when mixed with air include organic dusts such as those of flour, sugar, starch and cork and some metallic dusts such as those of aluminium and magnesium. Among the vapours and gases that may cause an explosion when mixed with air are acetylene, butylene-n, carbon monoxide, ether, hydrogen sulphide and methanol. Not all mixtures of such gases and vapours with air are explosive; the mixture must contain the right proportion of the two ingredients. This proportion lies between what are known as the upper and lower explosive limits. For instance, any atmosphere containing at least 2.5 per cent. and at most 80 per cent. of acetylene is explosive.

Example. In a basement a worker was repairing an ammonia refrigerator. Suddenly a large quantity of the gas escaped from the apparatus and the air-ammonia mixture was ignited by an open gas flame. The resulting explosion completely destroyed the ground floor of the building.

Mixtures of gasoline vapour and air have caused many explosions, e.g. in car repair shops.

Example. During repair work on a car, gasoline was spilled on the floor. Gasoline vapour spread through the workroom and through a small office, where it was ignited by an open electric radiator used for heating the office. The whole building was burned down.

A dust explosion occurs when a suitable mixture of flammable dust and air is ignited by a heat source of sufficient intensity, for instance when a cloud of dust is ignited by a flame, a spark or a very hot object, such as a carbon-filament electric bulb. Dangerous concentrations of dust in the air may be present, for example, in workrooms, pneumatic conveyors, milling equipment and dust exhaust systems.

The sources of ignition may be open flames, poorly maintained power-transmission equipment, unsuitable electrical installations, static electricity, and even smoking.

Example. In a flour mill large quantities of dust had settled on beams, window sills and other parts of the building. When a small fire started one day, workers tried to extinguish the fire with a hose. However, the force of the water jet whipped up a cloud of dust which was ignited by the fire and caused a minor explosion, which shook all the dust settled on beams and other parts of the building loose. The result was a second explosion, this time sufficiently powerful to destroy the entire plant.

A whole series of precautions are necessary in the manufacture, handling, storage and use of commercial explosives. They will not be dealt with here.[1]

As regards explosive air-gas and air-vapour mixtures, the best line of defence is to prevent their formation or, if this is not practicable, to dilute them beyond the lower explosive limit by general ventilation, or remove them at the source by local exhaust ventilation.

[1] There are voluminous regulations and handbooks on this subject. See, for example, Institute of Makers of Explosives: *Safety in the Handling and Use of Explosives*, Pamphlet No. 17, revised edition (New York, 1951). Some provisions on the subject will also be found in Chapters III and X of I.L.O.: *Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry* (Geneva, 1950).

Where there is a risk of dust explosions inside apparatus, the oxygen content of the air may be reduced by removing some air and replacing it by an inert gas such as nitrogen or carbon dioxide.

Preventing dangerous dust concentrations in dust exhaust systems is in the first place a matter of proper design. Correct operation may reduce the risks still further; for instance it is advisable to keep the exhaust machinery running a few minutes after the machines it serves have stopped. In this way the ducting will be purged, and the danger that starting the exhaust fans may whirl up dangerous clouds in them is eliminated.

Questions

1. *Mention some common fire hazards and means of eliminating them.*
2. *What requirements should building exits satisfy?*
3. *What precautions are required with portable fire extinguishers?*
4. *How should fire protection be organised in a factory?*
5. *Name some explosive dusts.*

FIFTH LESSON

SOME PRINCIPLES OF ACCIDENT PREVENTION
II: MACHINE GUARDING

It is customary to divide machinery into a number of categories, namely prime movers, transmissions and working machines, all of which exhibit considerable variety. It is not therefore possible here to deal in detail with the guarding of machinery. Even the guarding of a single machine may be complicated if it has belts, gears and a number of different tools. This lesson will accordingly be confined to the general aspects of the problem of guards.

Machinery was largely responsible for the need for safety precautions and has always been a matter of major concern in accident-prevention work. In the early days of the Industrial Revolution it was machinery that caused the spectacular accidents in factories which so aroused public opinion; and some of the earliest measures to introduce safety legislation and inspection were designed to reduce the dangers inherent in machinery. Machinery is still important from the accident-prevention point of view: in highly industrialised countries it causes only a fairly small minority of industrial accidents (usually between 15 and 25 per cent.), but the severity rate of the accidents it does cause is generally high.

In the course of time, the practice of fitting guards to machines spread gradually; but the guards were often unsatisfactory for one reason or another—they were unreliable, they hampered the work, or they needed too much attention. Consequently the guards were often taken off and work went on with unprotected machines.

Usually, in fact, the designers of guards were mainly concerned with compliance with the law or removal of a risk and gave little thought to the influence of a guard on production or to the nuisance it might represent for the worker. Sometimes—as in the case of the fencing of dangerous parts of power-transmission equipment—this attitude did not matter much; but in other cases (e.g. with woodworking machinery and metal presses) the guards designed were a serious impediment to efficient production. The result was that they were removed by the workers, replaced whenever an inspector came by and removed again as soon as he had left the factory. Work was done on these machines without guards, and the machines remained as dangerous as previously. Sometimes machines would be delivered with the same guards, which would never be used, for as long as 20 or 30 years; thus the fact that a particular type of guard remained in use for so long did not necessarily mean that it had proved its worth.

In some countries machine guarding has been promoted by the setting up of committees to study means of protecting a particular type of machine. Such committees often consist of representatives of the labour inspectorate, the social insurance authority, machinery manufacturers and purchasers, and workers. In Great Britain, for instance, they have produced new ideas for the protection of machinery used in the textile and rubber industries and of metal presses. The committee system has been used in the Netherlands to study the protection of elevators, the transportation and storage of flammable liquids, and other matters. It has proved valuable, not only for dealing with difficult technical problems, but also in cases where adequate safety precautions were an important factor in the cost of the equipment, as is the case with elevators. In addition, this way of dealing with safety problems does much to ensure the co-operation of all concerned when recommendations have to be translated into practice.

In France the method of official certification is used. The competent authority lays down the general principles to which the protection of a particular type of machine must conform. Manufacturers of safety equipment have to submit their devices to a committee which, if they are up to standard, certifies that they conform to tl e general principles governing the protection of the machine concerned. Once a protective device has been so certified it can be sold and used.

Conditions to Be Satisfied by Guards

For purposes of convenience the requirements that a machine guard should satisfy are analysed here on the basis of the relevant provisions of the *Model Code of Safety Regulations for Industrial Establishments*, drawn up by a tripartite technical conference organised by the I.L.O. in Geneva in 1948 to serve as a guide for governments and industries to use as they thought fit in the drawing-up of their safety regulations and rules. Regulation 82 of this Model Code reads as follows:

1. Guards should be so designed, constructed and used that they will—

(*a*) provide positive protection;
(*b*) prevent all access to the danger zone during operations;
(*c*) cause the operator no discomfort or inconvenience;
(*d*) not interfere unnecessarily with production;
(*e*) operate automatically or with minimum effort;

(f) be suitable for the job and the machine;
(g) preferably constitute a built-in feature;
(h) provide for machine oiling, inspection, adjustment and repair;
(i) withstand long use with minimum maintenance;
(j) resist normal wear and shock;
(k) be durable, fire- and corrosion-resistant;
(l) not constitute a hazard by themselves (without splinters, sharp corners, rough edges, or other sources of accidents); and
(m) protect against unforeseen operational contingencies, not merely against normally expected hazards.

(a) *The guard should provide positive protection.* This means that, should the guard cease to operate for any reason, the machine will automatically stop or access to the danger zone be prevented. Such an arrangement is illustrated by figure 7.

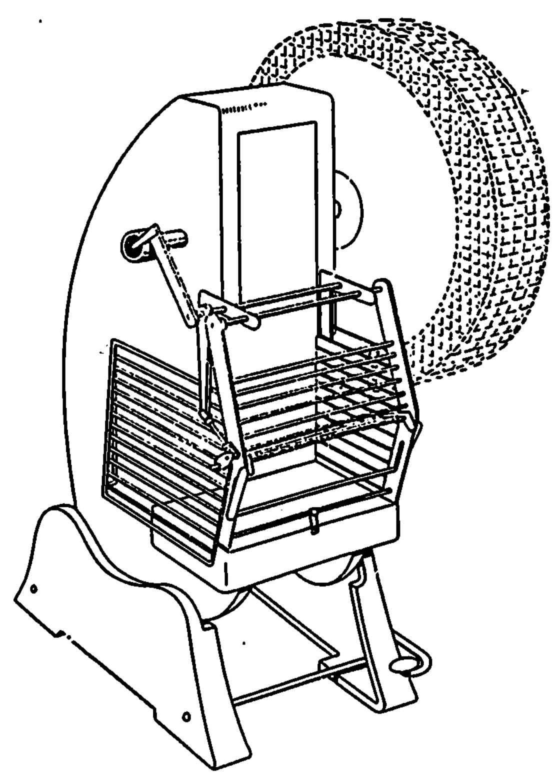


Fig. 7. Power press with guard providing positive protection. An interlocking mechanism prevents the die from coming down as long as the guard is not closed.

(b) *The guard should prevent all access to the danger zone during operations.* Consequently, it is not sufficient for the guard to give a warning signal when there is a risk of any part of the body entering the danger zone, for instance by means of an alarm bell or a light signal; it should actually block all access to the danger zone, as shown in figure 8.

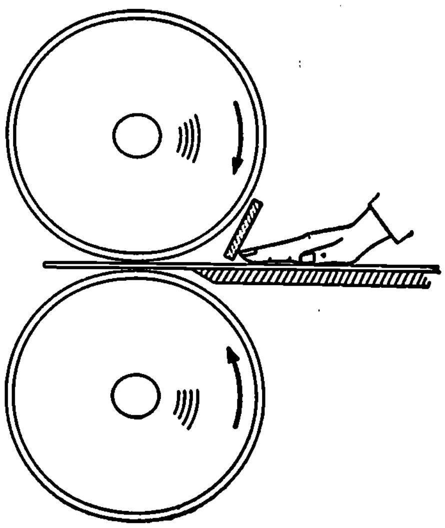


Fig. 8. Example of a guard effectively barring access to the danger zone. It is physically impossible for the operative's hands to be caught between the rollers.

(c) *The guard should cause the operator no discomfort or inconvenience.* As already mentioned, guards which cause discomfort or inconvenience are put aside by the worker, and their usefulness is lost. An arrangement combining safety with ease of operation is shown in figure 9.

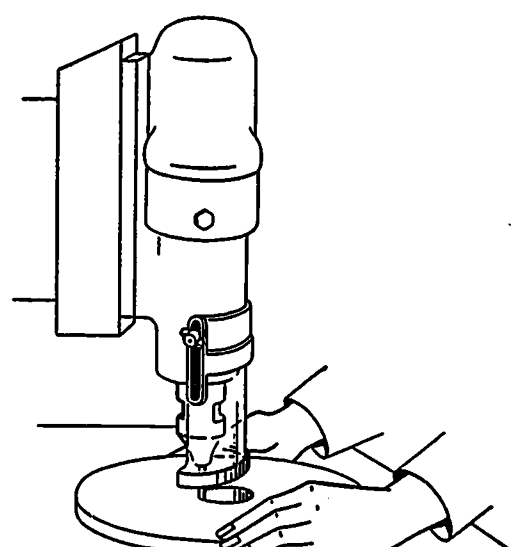


Fig. 9. Reamer guarded by plexiglass screen, which does not obstruct the worker's view of the job.

(d) *The guard should not interfere unnecessarily with production.* For this reason the use of guards such as two-hand systems on metal presses, or so-called " automatic " hoods for circular saws, should be avoided if other systems exist which give better protection and do not interfere with production. However, when it is impossible to find such a guard that does not interfere with production, safety should take precedence over considerations of production and imperfect protection should be preferred to an unprotected machine.

(e) *The guard should operate automatically or with minimum effort.* An example of an automatically operating guard is the hood for the cutter cylinder of a textile shearing machine. This hood is connected with the starting mechanism in such a way that the hood cannot be opened when the machine is running, and when the hood is open the machine cannot start.

One type of guard for wood-planing machines, which has been in use for many years, consists of a screen placed above the machine shaft pivoting on a vertical spindle placed at the side of the machine. The guard opens when the wood on the machine table touches it and closes when the wood has passed the machine shaft. Such guards are often styled " automatic guards ", but they cannot be said to work automatically. They are completely unsatisfactory because they also open when a hand accidentally touches the screen and thus fail to give protection at the moment when it is most needed. Such a guard does not operate automatically at the critical moment.

One special type of automatic guard is the electronic guard working with photo-electric cells. In this system parallel light rays are projected in front of the danger zone of a machine. Interruption of these rays stops the machine or prevents it from starting. Such systems have, as a rule, a high sensitivity, and the absence of movable parts in front of the worker is also an advantage, but special care has to be taken to make sure that the beam is sufficiently wide and placed in such a way that all access to the danger zone is prevented during operations.[1]

(f) *The guard should be suitable for the job and the machine.* Too often guards have been constructed which, while giving real protection, are not at all suitable for the job and are consequently not used.

Example. A sewing-machine factory designed a guard to prevent fingers being pierced by the descending needle. The danger zone was perfectly protected, but the guard made it very difficult to thread the needle, and normal control of the work was impossible because the operator could not see what happened under the needle. It eventually had to be replaced by another which, besides giving adequate protection, permitted the needle to be threaded and the work to be controlled easily.

(g) *The guard should preferably constitute a built-in feature.* From a constructional point of view, much better results are usually obtained

[1] See E. HELLEN: "The Application of Electronics in the Field of Industrial Safety", in *Industrial Safety Survey* (Geneva, I.L.O.), Vol. XXVI, No. 4, July-Aug. 1950, pp. 121-127.

when a guard is part of the machine design than when one has to be added to the machine later.

Example. The small hand or electrically operated meat mincer, used in factories and also in households, has a dangerous nipping point between the endless screw on the machine shaft and the casing near the feed opening. Guards to eliminate this hazard were often a nuisance to the worker, either during normal work or when cleaning the machine. A safe construction, fundamentally consisting of a sufficiently long and not too wide feed opening which makes it impossible to reach the dangerous nipping point with the fingers, while at the same time permitting normal work and cleaning without difficulty, has now been designed.

(h) *The guard should allow for machine oiling, inspection, adjustment and repair.* Where these requirements are not observed, it is necessary to remove the guard for each of these operations; in practice it is often not replaced, with the result that the machine is unguarded when next used. Such difficulties have been encountered, in particular, with guards for power-transmission equipment.

Example. A machine pulley near the floor with a belt running on an overhead pulley of the transmission shaft should be protected by a steel angle frame, at least 6 feet in height, with panels filled by perforated steel plates. For oiling and inspection the guard should be provided with a small door near the pulley with inclined hinges. Such a door closes by gravity when left in the open position. In this way access to the pulley is easy and, at the same time, protection of the dangerous parts is guaranteed more or less automatically.

Figures 10 and 11 represent two types of non-removable guards designed to permit oiling and other maintenance operations to be performed without difficulty.

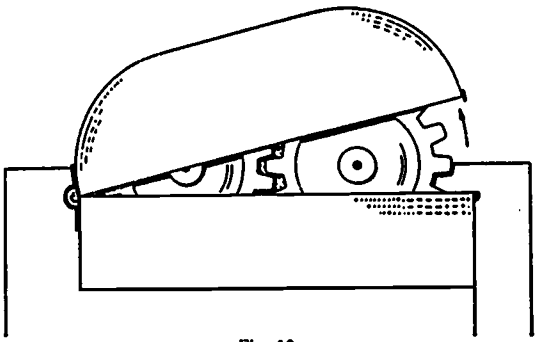


Fig. 10.

(i) and (j) *The guard should withstand long use and normal wear and shock with minimum maintenance.* It might seem unnecessary to mention this point particularly, since all guards should satisfy these requirements. However, many guards are constructed in a very flimsy way, perhaps because some home-made device is considered sufficient, perhaps because

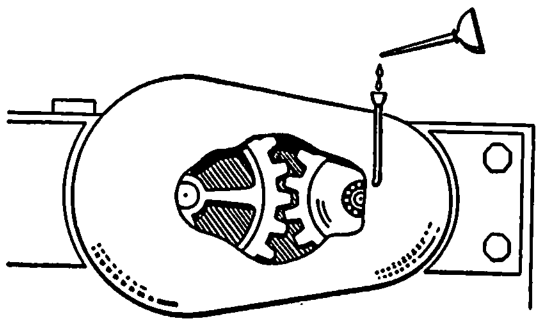


Fig. 11.

insufficient allowance is made for ordinary wear and tear. Movable screens on metal presses have often proved defective because the fact that such screens may be opened and closed 800 times a day was overlooked in their design. The design of a guard calls for as much precision as that of a machine, and satisfactory results cannot be expected without such precision.

(k) *The guard should be durable, and fire- and corrosion-resistant.* Here special attention has to be paid to the choice of the material used. If a guard is not durable it soon has to be replaced, and many examples show that in such cases replacement is not always made in time, with the result that the machine is used unguarded. Fire-resistant materials are always to be recommended, and corrosion-resistant materials are necessary if the guard comes into contact with chemicals or is used in very damp places.

(l) *The guard should not constitute a hazard by itself; in particular, it should be free of splinters, sharp corners, rough edges or other sources of accidents.* There should not be any danger of nipping between moving guards on moving machine parts and a machine part.

Example. A machine for shearing metal was provided with a screen lowered automatically on the table in front of the knives when the machine was started. Under normal conditions the screen prevented a hand from entering the danger zone under the knives before the latter descended. However, if a hand was in the danger zone at the moment the machine was started, it might happen that the descending screen pressed the hand on the table and, when it was trapped in that position, the descending knives would cut off the fingers. A better arrangement would be that, when the descending screen met some object, the knives would be blocked.

(m) *The guard should protect against unforeseen operational contingencies, not merely against normally expected hazards.* Often a machine is considered to be adequately guarded when under normal working conditions no special risk exists. Experience has taught that this is insufficient to prevent accidents.

The example of the two-hand system for metal presses, previously mentioned in another connection, should also be considered here. The system consists of two handles or two push buttons arranged in such a way that, in order to start the press, the worker has to push both down, and thus has to remove both hands from the danger zone of the press before the ram descends. However, apart from interfering with productive efficiency, as mentioned earlier, this system gives no protection to any other person besides the operator (e.g. to a foreman who has been called to verify the working of the press).

Not all these requirements for guards can always be satisfied, but as far as circumstances permit they should be. It will be clear that designing a guard calls for more research and experience than the average employer can be expected to provide. It is not surprising, therefore, that in some countries the State has taken a hand in the designing of guards and, by drawing on all the inventive resources of the country, provided industry with guards which are usually far superior to any home-made device.

Guards and Production Costs

A suitable guard may not only give adequate protection, but at the same time improve the quality and quantity of the work done on the machine; in other words, the guard will be not only a means of protection, but also a tool that facilitates work. This is one reason why a sufficient knowledge of the technical factors embodied in a particular machine is the essential basis for any attempt to make it safe, and that sometimes an efficient working method must be found before the designing of a guard can begin. This approach has proved to be particularly valuable for the protection of woodworking machinery, and it has also resulted in the designing of completely new systems for guarding machines such as metal presses and grinding wheels. The Swiss National Accident Insurance Institute was among the first to apply the principle that, firstly, an efficient way of operating the machine must be found and, secondly, the guard must facilitate operation as well as protect the operator.

Many employers (and, in particular, small employers) desire to keep the cost of guards as low as possible. They often forget that guards which give incomplete protection may fail to prevent an accident and thus may prove, in the end, much more expensive than an effective guard.

Built-in Guards

It is only comparatively recently that widespread support has developed for the principle of " built-in safety ", that is to say, the principle that the most effective way of protecting a machine is to make the guard an integral part of the machine. Generally speaking, it may be said that built-in guards are usually cheaper and more effective than guards added to the machine after it has been delivered to the user (although, as will be seen, it is not always practicable for manufacturers to do this as far as guards at the point of operation are concerned). Moreover, it is often much simpler for manufacturers to equip their machines with guards than for the individual user to do so. Many attempts have been made to make built-in safety for machines and other equipment a statutory obligation on manufacturers and distributors.[1] This obligation exists in varying forms in some countries, e.g. Austria, Denmark, France, Sweden, the Netherlands and the United Kingdom.

Though the requirement that machines should be guarded before they are delivered has advantages, it also has its drawbacks.

For instance the relevant statutory provisions may be so strict as to make the construction of new safety appliances impossible.

Example. Some safety legislation prescribes that wood-planing machines must be equipped with round cutter blocks. This limits the freedom of construction. However, as the necessity for cutter blocks of other shapes has never been felt, the standardised round block has not given rise to difficulties.

Another problem is that the use that will be made of a machine is not always known to the manufacturer, while the type of guard required depends on this use.

Example. A metal press used exclusively for making objects from metal strips, as is the case in the canning industry, should be guarded with a fixed enclosure of the ram to make the machine safe and ensure maximum production; when the machine is used for different types of work, an interlocked movable screen is necessary.

Finally, some guards are not fixed to the machine but to the floor, the wall or the ceiling near the machine.

Example. If in a woodworking factory very large workpieces have to be handled, it is necessary to keep the machine tables of circular saws and moulding machines free from any obstruction and to hang the hood or other guard from the ceiling, to fix it on the wall or to place it on the floor near the machine; delivery of the machine with a guard attached to it would be impracticable.

[1] See I.L.O.: *Model Code of Safety Regulations for Industrial Establishments*, op. cit., Regulation 6, para. 2: " The builders, manufacturers and vendors shall comply with the provisions of this Code concerning the protection of machines, apparatus or vessels, and the packing and working of flammable, explosive or toxic substances."

The guarding of machines by the manufacturer is generally practicable in the case of guards for transmissions or guards at the point of operation, where developments have been consolidated and standardised, as is the case with calenders in laundries. When no standard guard exists, it is impossible to do more than indicate that a certain hazard has to be eliminated.

In some cases it is sufficient for safety regulations to prescribe that the machine should be so designed that it is possible to fit a suitable guard, without giving specifications for the guard itself. This is the case with the riving knife of a circular saw, for the specifications of the knife required depend on those of the saw blade to be used; no difficulties will be met later in the matter of guarding if an adequate support for riving knives has been placed on the machine.

Questions

1. *Give some reasons why workmen may fail to use machine guards provided for them.*

2. *Mention some of the requirements that a machine guard should satisfy.*

3. *Describe the potential advantages and drawbacks of machine guarding.*

4. *What are the advantages of built-in guards?*

SIXTH LESSON

SOME PRINCIPLES OF ACCIDENT PREVENTION
III: OTHER PROTECTIVE MEASURES

PLANNING

Good planning is as essential in safety as it is in production. If a new factory is to be built or an existing factory reconstructed there are many things affecting both safety and production that should be taken into account in the planning stage, such as the site, facilities for handling and storing materials and equipment, floors, lighting, heating, ventilation, lifts, boilers, pressure vessels, electrical installations, machinery, maintenance and repair facilities, and fire precautions.

It is essential that safety considerations be borne in mind at the time of the actual planning and not as an afterthought when the factory has been built. Consequently there should be a safety engineer on the planning team from start to finish.

The submission of plans for new and reconstructed factories to the labour inspectorate (or other competent authority) for comments or approval is also a useful precaution; indeed, in some countries it is compulsory.

Good plans make for economy as well as safety. It is much cheaper to modify a plan than to alter a building.

Once a factory is in operation planning is still essential in a number of fields to ensure the highest possible standards of safety as well as efficiency. Processes have to be organised, plant has to be arranged for them, methods of work have to be decided upon; changes will occur from time to time in the kinds of processes carried on; there may be minor structural alterations; new equipment will have to be acquired. All these things need planning. Here again better results are obtained more cheaply by planning safety measures beforehand than by improvising them afterwards.

There are a number of principles the manager of a factory can generally follow in planning for safe and efficient production. Here are some examples:

(a) Keep the handling of materials and articles to the minimum.

(b) Provide safe walking surfaces on floors, stairs, platforms, gangways, etc.

(c) Provide adequate space for machinery and equipment.

(d) Provide safe access to every place to which workers have to go.

(e) Provide for the safety of maintenance and repair personnel, such as window cleaners and of men working on overhead equipment.

(f) Provide safe transport facilities.

(g) Provide adequate means of escape in case of fire.

(h) Allow for expansion.

(i) Isolate dangerous processes such as spray painting and processes with high fire or explosion risks.

(j) If possible, only buy machines with built-in safety devices.

The following are some examples of measures that can be taken to reduce accident risks in the production process:

(1) In the woodworking industry tenoning can be done more safely on a moulding machine than on a circular saw, and consequently a moulding machine should be made available for such work.

(2) In rubber-shoe factories benzene-rubber solutions are used to glue different parts together. As benzene vapours, which can cause serious blood diseases, may escape into the factory premises, benzene should be replaced by gasoline, which, although about as inflammable as benzene, is much less toxic.

(3) In garages and car repair shops machine parts are often cleaned with gasoline. The substitution of kerosene (paraffin) reduces fire risks considerably.

As already stated, the planning of repair and maintenance work is just as important from the safety viewpoint as the planning of layout and processes. The breakage of some machine part is often the cause, not only of an accident, but also of an interruption of work. Regular inspections, good maintenance and prompt repair will help considerably to improve the efficiency of work and reduce the number of accidents. Here are some examples:

(1) In the chemical industry inner baskets of hydro-extractors have sometimes burst owing to corrosion by substances which have dried in them. Regular inspection of the extractors and replacement of corroded baskets in time could have prevented such accidents.

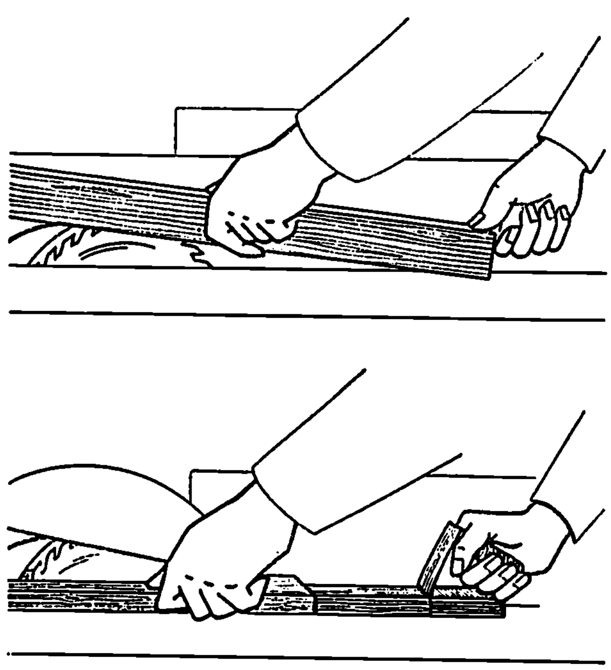
(2) Accidents caused by broken chains or wires are often due t lack of regular inspection.

(3) Many fatal accidents caused by electricity happen with electric hand tools which have been damaged in normal use and have not been regularly examined. As a result casings carry mains voltage, and when a worker touches them in unfavourable conditions he is killed.

Particular care should be taken with the organisation of tool rooms. These rooms should have inspection and repair facilities to ensure that no dangerous tools (such as mushroomed chisels and defective electrical tools) are given out to workers. This also applies to other items of equipment such as chains, wire ropes and ladders.

The use of safe working methods by the worker himself is another important practical aspect of accident prevention. It is extremely difficult to change a person's way of thinking. In addition, as already indicated, it is very difficult, if not impossible, to make sure that a person who has corrected a wrong attitude does not forget his good intention or become distracted by sorrow, illness or his interests outside the factory and fall back—permanently or temporarily—into his old habits.

The formation of safe working habits is a different matter; it involves the absorption of a safe working method until it has become second nature and is followed automatically. When this is so, one may expect that the same work method will be followed whether the worker is thinking about his work or not; this should guarantee safe working in all



Figs. 12 and 13. Safe methods of passing a workpiece through a circular saw.

circumstances, and in any case some accidents due to unsafe acts, improper attitudes, and the like will be prevented. The following are examples of safe working habits :

(1) In working on woodworking machines the way of placing the hands is very important. When sawing an interrupted covered cut on a circular saw, both hands should be placed behind the saw blade as indicated in figure 12. In the case of a kick-back the hands will not then pass the saw blade and cannot come into contact with the saw teeth.

(2) Working with closed hands in the manner shown in figure 13 will decrease the risk of touching the saw teeth under the hood.

The importance of teaching safe working habits to young persons is self-evident. Adult workers often have difficulty in changing working habits, and consequently once incorrect habits have been formed, it is difficult, but not impossible, to correct them. The system used for Training Within Industry [1] could be used here.

Good working habits also include taking proper care of machines and tools, keeping them in good condition and in particular keeping cutting tools well shaped and sharp.

Good Order and Good Housekeeping

A third group of safety measures consists of those related to good order and good housekeeping all over the plant. If there is a place for everything and if everything is in its place, a considerable number of accidents are likely to be avoided.

Good order means in the first place the removal of objects obstructing passageways so as to prevent collisions and stumbling and to facilitate escape in emergencies. Passageways should be clearly marked off (e.g. with white lines) and should not be used for storage of materials. Good order also means that materials must be properly stored and waste materials promptly removed. Cotton waste, for instance, should be placed in closed metal containers—a measure that promotes good order and limits fire hazards at the same time.

Dry, clean, ventilated store rooms with suitable racks, hooks, etc. should be provided for electric hand tools and other tools, chains, wire ropes, ladders, etc.; and when not in use these items should be kept in their proper places in the store room. One aspect of good housekeeping in this field is regular inspection and the discarding of defective equipment. Containers for inflammable liquids should be completely airtight to prevent any leakage.

The following are examples of improvements that good housekeeping can bring about:

(1) Suitable containers for spilled and leaking oil placed under the barrels containing lubricating oil in engine rooms will prevent the floor from becoming oily and therefore slippery.

[1] See p. 115.

Fig. 14. The kind of accident that occurs when floors are allowed to become oily.

(2) The removal of vapours in textile-dyeing rooms will not only contribute to better visibility and in this way to safety but also help to reduce the cost of repair and maintenance of the building.

(3) In car repair shops the risks of tripping over tools and engine parts would be lessened if workers were provided with small trolleys containing compartments and drawers to hold a complete set of tools and with spaces for small machine parts removed during repair work.

Good order and good housekeeping not only reduce accident risks by eliminating physical risks but also contribute to safety by their psychological effect. Where much thought is given to good order, and where good housekeeping is the universal practice, a worker will most probably behave more carefully than where disorder prevails and housekeeping is neglected.

It will be clear that good order and good housekeeping can be more easily achieved if workers are keen on it and obey all instructions designed to promote it, for instance by keeping gangways free from obstructions, using receptacles for waste materials and storing tools in their proper places. Once good habits are acquired, it is not too difficult to preserve them, for good housekeeping not only helps to prevent accidents but also facilitates work. It would be interesting to ascertain how much time is lost by looking for misplaced tools, or for seeking the right bolt, nut or washer, where such items are not kept in any particular place. The saying " safety pays " is true in every sense when applied to maintaining good order in workplaces.

Working Clothes

The *Model Code of Safety Regulations for Industrial Establishments* contains an extremely comprehensive summary of safety requirements regarding working clothes, which reads as follows:

Regulation 226. Working Clothes

1. When selecting working clothes, consideration should be given to the hazards to which the wearer may be exposed, and those types should be selected which will reduce the hazards to the minimum attainable in each case.

2. Working clothes should fit well; there should be no loose flaps or strings, and pockets, if any, should be few and as small as practicable.

3. Loose, tom or ragged garments, neckties and key chains or watch chains shall not be worn near moving parts of machines.

4. When the operations involve a danger of explosion or fire, it shall be prohibited, during working hours, to wear articles such as collars, eyeshades, cap visors and spectacle frames made of celluloid or other flammable materials.

5. Shirts with short sleeves should be worn in preference to shirts with rolled-up sleeves.

6. Sharp or pointed objects, explosive substances or flammable liquids shall not be carried in pockets.

7. Persons exposed to flammable, explosive or toxic dusts shall not wear clothing having pockets, cuffs or turn-ups that might collect such dusts.

Workers' clothes and footwear are often completely unsuitable for work in factories. Women in particular, but sometimes also men, work in old clothes and shoes which they consider to be no longer good enough for street wear. In some countries local custom obliges women to wear long veils, even when working near machines.

The wearing of clothes with loose attachments has caused many accidents.

Example.

An experienced worker started to clean a pit under a machine. To protect himself from liquid dripping down from the machine, he put a cloth on his head, fixed it under the chin and left the loose end hanging over his shoulder. Some minutes later he was found in the pit decapitated. The cloth had been caught by a revolving shaft, which was about 1.20 m. (4 feet) above the bottom of the pit.

Example.

In a dairy-products plant a painter was working standing on a ladder near a revolving transmission shaft. Suddenly his sleeve was caught by the shaft, with the result that his clothes were torn to pieces and he suffered several injuries.

If working clothes are exposed to heavy wear and tear, moisture or dirt, the employer should provide suitable types of clothing: in most countries the workers have to buy their own if this is not done.

The wearing of veils and other clothes with loose parts which are considered necessary because of national customs or religious opinion are a very difficult problem. The only way to eliminate undesirable risks in such cases may be to prohibit the employment of such persons in types of work in which clothes are very liable to be caught in moving machine parts.

Ordinary working clothes cannot protect the wearer against hot metal, acids, flying fragments and various other risks; here personal protective equipment is required.

The wearing of finger rings during working hours has often resulted in the loss of a finger when the ring has been caught in moving machinery.

Falls on the same level (i.e. tripping, slipping, etc.) are among the commonest of all accidents; many of them are doubtless due to the wearing of unsuitable footwear. The high heels of women's shoes are particularly dangerous on factory floors: they are liable to cause falls as a result of poor balance, catching in gratings or small irregularities and slipping. Falls may also be caused by loose laces and ragged soles or heels.[1]

Personal Protective Equipment

The best way of preventing accidents is admittedly the elimination of the hazard (for instance by guarding a machine or other piece of equipment); but if this is impossible it becomes necessary to protect the worker himself by providing him with a mask, goggles, safety shoes or some other personal means of protection.

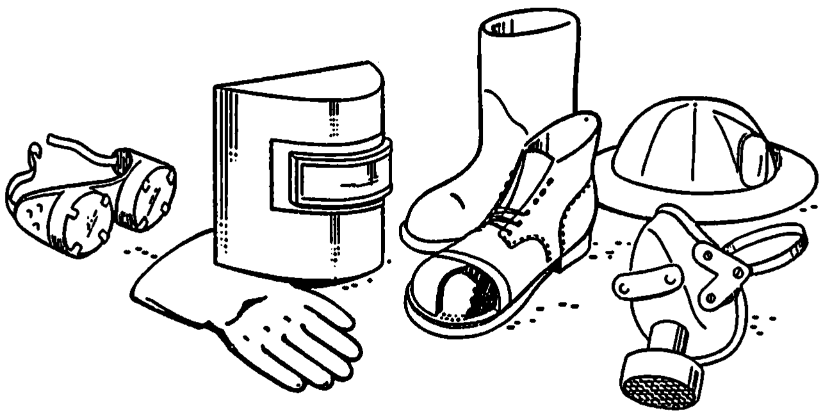


Fig. 15. Typical items of personal protective equipment.

The history of this equipment runs more or less parallel with that of guards: where the designs were unsuitable, masks, goggles, etc., were not used, as the workers preferred to work unprotected, thus exposing themselves to avoidable head, eye, foot and other injuries. Personal protective equipment is still very often considered a nuisance by the worker, and it is even more difficult to achieve good results with it than with guards. Design and construction are matters of great difficulty. As a rule, personal protective equipment is manufactured by pri-

[1] See "The Prevention of Falls", by R. P. Blake, in *Industrial Safety*, op. cit., p. 283.

vate firms, but in some cases research work has been done by labour inspection services, government research laboratories and insurance institutes. Standards for safety goggles, gloves, shoes, hats, etc. have been drawn up by national standards institutes.

Goggles.

One of the most difficult problems in accident prevention is the prevention of eye accidents, of which there are far too many. Persons not accustomed to using prescription spectacles usually reject safety goggles as being a nuisance and causing discomfort, but quite satisfactory safety goggles are now becoming available in increasing numbers. However, it is not enough to have good goggles; they must be worn, and much effort in the way of disciplinary action, education and persuasion may be required to induce workers to wear them. Workers who think that the risk of an eye accident is a very real one will wear safety goggles willingly, but those who think the risk very small will object.

This difficulty can be overcome in different ways. In some undertakings, places in which a real risk of eye accidents is considered to exist may be entered only if goggles are worn. Consequently in these places all workers wear goggles during the whole working time, and any man who does not will, at the very least, have an unpleasant feeling of " not belonging ".

Other factories make available a large number of different types of goggles, leaving every worker to make his own choice; correct use of the goggles is ensured by regular inspections. In such cases a worker is not obliged to wear goggles of types which the management considers suitable but he does not.

Some workers may not find suitable goggles because they have eye defects. It is therefore desirable that the management should arrange for the workers' eyes to be tested and for the provision of advice on the most suitable type of safety goggles having regard to the hazards inherent in the job, the eye distance, etc. If necessary, advice can be given on the fitting of prescription goggles at the same time.

There are various kinds of eye accident, and different types of goggles have been found necessary according to the work done. For instance, goggles for workers engaged in chipping, riveting, caulking, scaling, dry grinding or similar operations in which flying fragments could pierce the eye have to have mechanically strong lenses; while goggles for welders, furnacemen and other workers exposed to glare have to have suitable filter lenses.[1]

[1] *Model Code of Safety Regulations for Industrial Establishments*, R.228.

Safety Shoes.

Safety shoes should protect workers against accidents caused by heavy objects dropping on the feet, protruding nails trodden on, molten metal, acids, etc. Ordinary leather shoes in good condition give some protection against crushing and piercing, but to be really safe a man has to wear shoes with built-in steel toe-caps and with steel soles inside the leather ones. The latter precaution is particularly important for workers on building sites, where protruding nails may be common hazards.

Sometimes special kinds of footwear are necessary. For instance, electricians should wear non-conducting shoes (i.e. shoes with no metal nails), and workers in explosives factories should wear non-sparking shoes (also without metal nails).

Gloves.

Gloves should be distributed to workers with due consideration to the hazards as well as to the need to allow free movement for fingers and hands. The kind of glove required will vary according to the injury to be prevented (puncture, cut, heat burn, chemical burn, electric shock, radiation burn, etc.). It should be remembered that it is dangerous to wear gloves when working at drilling machines, power presses and other machines in which a glove might be caught.[1]

Hard Hats.

Workers liable to be struck by falling or flying objects or otherwise exposed to head injuries should wear hard hats or helmets, sufficiently strong and at the same time not too heavy. Plastic hard hats with cloth linings have proved to be very suitable.

Aprons.

Aprons of various materials may be very useful to protect workers against chemical or heat burns, wet or oil, but they should not be worn when working near machines.

Ear Protection.

Ears should, when necessary, be protected against sparks, splashes of molten metal or other flying particles. Protection against harmful noise is dealt with later in this lesson.[2]

Lung Protection.

Lung protection will be required whenever there are undue quantities of harmful elements or a deficiency of oxygen in the atmosphere. The

[1] *Model Code of Safety Regulations for Industrial Establishments*, R.233.

[2] See p. 66.

former may be gases, fumes, mists or dusts; the latter may occur in a badly ventilated place such as a tank or a bin. Harmful elements may be toxic, corrosive or irritating and, if in the form of dusts, may cause a pathological lung condition known as pneumoconiosis. The commonest of the pneumoconioses is silicosis, which is caused by silica dust. The subject of respiratory protection is more within the field of health than that of safety and will not be dealt with in any detail here. In some countries, however, cases of gassing are considered as accidents.

Other Protective Equipment.

Other examples of personal protective equipment are suits and hoods for workers exposed to corrosive substances, safety belts and lifelines for workers in confined spaces where they may be gassed, and leggings for workers manipulating molten metal.

During the last 25 years much progress has been made in many countries in the design of suitable personal protective equipment, and the number of goggles, shoes, helmets and other items used in different branches of industry has increased considerably. However, there are still countries where personal protective equipment is hardly known and where, consequently, workers are unnecessarily exposed to risks.

Colours, Notices, Signs, Labels

Colours.

Colours may be used for a variety of purposes in the interests of safety, as the following examples will show:

(1) General safety colour codes are used to identify danger spots, fire protection equipment, first-aid equipment, exits, traffic lanes and so on.

(2) Special colour codes are used to identify the contents of gas cylinders and piping.

(3) Suitable colour schemes can improve perception and visibility in workrooms, passageways, etc.

(4) Attractive colour schemes for walls, ceilings, equipment, etc., can have a good psychological effect.

An international safety colour code is being drawn up by a Committee of the International Organization for Standardization in collaboration with the I.L.O. Amber (orange-yellow) is used to indicate danger (for example to identify places normally covered by guards so that it is easy to see when the guard is missing); red for stop signals, emergency stop devices and fire-fighting equipment; and green for escape routes, first-aid stations, " go " traffic signals and safety installations generally.

Columns or other fixed objects near passageways, and in fact obstructions of all kinds, are often painted with inclined yellow and black lines, which contrast well with their surroundings; traffic lanes may be marked with white lines.

Notices and Signs.

Notices and signs can also serve a variety of purposes. They can convey instructions, warnings or general information. They are not a general substitute for protective measures and safety instructions but can very usefully supplement them.

" No Smoking " is one of the commonest examples of an instructional notice; it is a reminder of the danger of smoking in places with a fire risk. Another common use of notices is to prohibit the opening of locked valves and switches controlling equipment on which maintenance work is being done. Quite a number of notices and signs can be used to regulate transport in the factory.

" High Voltage ", " Level Crossing " and " Caution. Men at Work " are other examples of warning notices.

Informational notices serve to indicate the whereabouts of exits, first-aid posts, etc.

Resort to notices and signs should not be carried to excess, or they will most likely be ignored.

Labels.

Dangerous substances and the containers for such substances should be properly labelled. Many accidents occur because toxic, corrosive, flammable or other dangerous substances are kept in containers that do not show that the contents are dangerous, or—even worse—in containers destined for ordinary drinks. Very serious accidents have occurred when workers have drunk poisons kept in milk or beer bottles.

Example. A worker seeing a beer bottle near the place of a fellow worker who had gone away for some minutes took the bottle and, to play a joke on his mate, drank the contents. The bottle was in fact filled with mordant, and the worker had to be immediately taken to hospital, where he was treated for two weeks.

For the prevention of such accidents, labels such as indicated in figures 16 to 21 are often used.[1] The symbols were originally designed by a meeting of experts on dangerous substances convened by the I.L.O.

[1] See: " I.L.O. Meeting of Experts on Dangerous Substances, 1956 ", in *Occupational Safety and Health*, Vol. VII, No. 2, 1957.

FIGS. 16–21. SYMBOLS FOR LABELLING OF DANGEROUS SUBSTANCES

Fig. 16. Toxic substances.

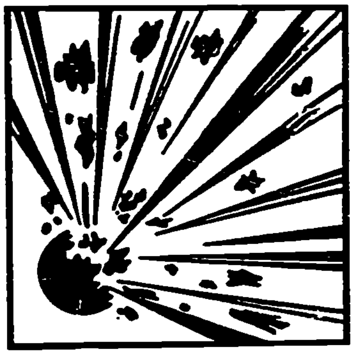


Fig. 17. Explosive substances.

Fig. 18. Flammable substances.

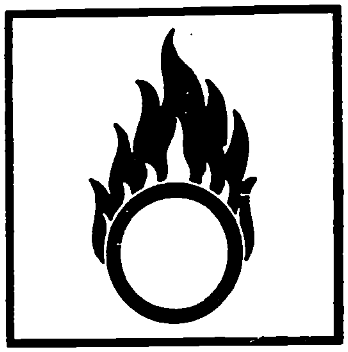


Fig. 19. Oxidising substances.

Fig. 20. Corrosive substances.

Fig. 21. Radioactive substances.[1]

[1] The skull and crossbones do not appear on labels intended for the transport of parcels containing radioactive sources other than large sources as defined in the International Atomic Energy Agency's *Regulations for the Safe Transport of Radioactive Materials.*

in 1956 to draw attention to the risks associated with dangerous substances; some of them have since been modified.

The use of symbols for this purpose has the advantage that the labels can be understood by illiterate persons. However, it is desirable to add to such a symbol a text indicating—

(a) the name of the substances;

(b) a description of the main risk or risks;

(c) a statement of the main precautions to be taken; and

(d) if necessary, indication of first-aid or other simple measures to be taken in the case of injury or emergency.

Figs. 22 and 23. Examples of labels used for dangerous substances.

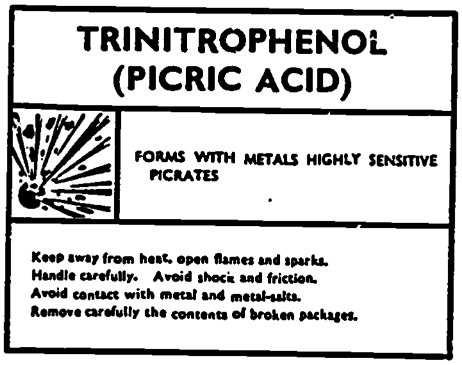


Fig. 22. Picric acid.

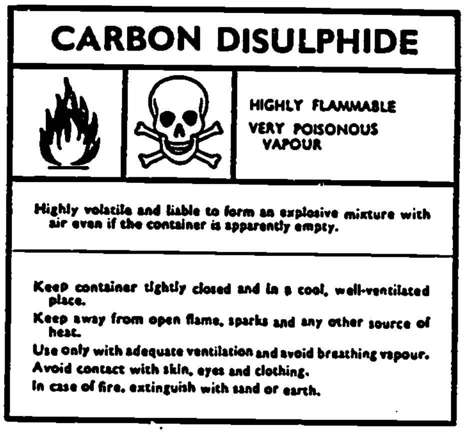


Fig. 23. Carbon disulphide.

LIGHTING

As a safety factor in the physical environment of the worker lighting is important. Several investigations into the relation between production and lighting have shown that adequate lighting, arranged to suit the type of work to be done, may result in a maximum of production and a minimum of inefficiency, and thereby, in all probability, help indirectly to reduce the number of accidents. To the extent that accidents result from fatigue, adequate lighting is a preventive measure; and for many years the relation between poor lighting and high accident rates has been demonstrated in quite a number of publications.

Factors in illumination that are contributory causes of accidents include direct glare, reflected glare from the work and dark shadows; sudden passing from bright surroundings into darkness or vice versa may also be dangerous. Sometimes, also, what appears to be carelessness may be the result of difficulty in seeing.

The following are two examples of accidents caused by abrupt transition from bright light to darkness.

Example. During the night materials were being stored with a crane. The place where they were stored was lighted with a shaded acetylene lamp of high intensity. The lampshade caused a strong contrast between the lighted area and the adjacent areas, which were in complete darkness. Suddenly the crane slewed and a man walking in the dark sector was hit by the load and seriously injured. It was impossible for the crane driver, whose eyes were accustomed to the light of the acetylene lamp, to adapt his vision fast enough to see what was going on outside the lighted area in time to avert the accident.

Example. A man descending a staircase missed his footing and fell in poor lighting which threw sharp shadows on the treads.

Adequate lighting is particularly important from the accident prevention viewpoint at places where a risk of stumbling or falling exists, e.g. near quaysides, railway lines, etc., and in gangways, on staircases and near exits which have to be used in emergencies.

When there are large numbers of persons in workrooms, it will be necessary for gangways, staircases and exits (and if necessary places near dangerous machines) to be kept lighted under all circumstances, even if normal lighting fails. In practice this is a difficult problem. Small electric generators exist which can feed a group of lamps in an emergency independently of the normal supply of electricity, but these are only available in a limited number of countries, where in any case they are not widely used. Another solution is to use candles or kerosene lamps at strategic points in gangways and on staircases, but this entails lighting up every evening, which is seldom regularly done. In addition these types of lights may give rise to fire hazards in certain types of factories. In some cases a solution has been found by painting lines and arrows on floors and walls with luminous paints so that the exits can be seen if normal light fails. Light signs indicating emergency exits and placed near the ceiling are not always suitable, as in the case of fire they may be hidden by smoke.

Ventilation and Temperature Control

Ventilation, whether general ventilation or local exhaust ventilation, falls mainly within the province of industrial hygiene, but is of some importance from the safety standpoint. The same is true of air conditioning. Exhaust ventilation, for example, is one means of removing explosive dusts, such as those of aluminium, magnesium, cork, starch and flour from the working atmosphere. Flammable vapours in the atmosphere can be diluted to safe limits by general ventilation or removed altogether by exhaust ventilation. Air conditioning can prevent excessive cold and excessive heat, both of which have been found to be conducive to accidents.

Ventilation systems, however, require careful designing—this applies particularly to exhaust ventilation systems, which, if badly designed, can be worse than no ventilation at all. Exhaust hoods or slots should be so located that no part of the fumes or dusts being removed can enter the worker's breathing zone (see figure 24).

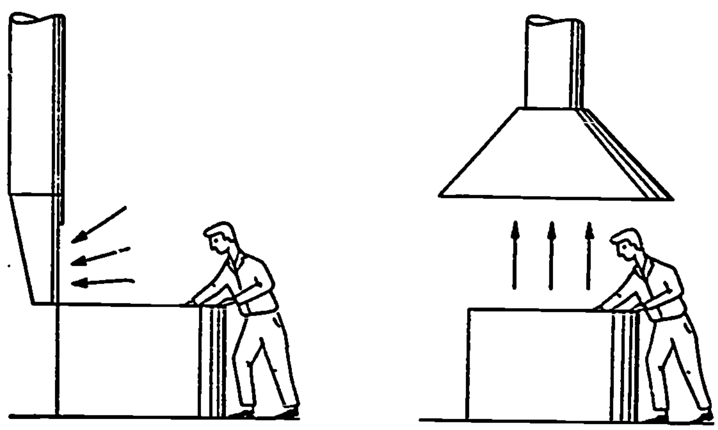


Fig. 24.

It is generally known that working on machines with cold hands may result in less accurate working and accidental contact with machine knives or cutters. High temperatures, in particular in combination with a high degree of humidity, cause unnecessary fatigue. It is often stated that the optimum safe temperature in the workroom is about 20°C. (68°F.) in temperate climates. It is, however, truer to say that the optimum safe temperature depends on a number of factors, including the relative humidity and the physical effort demanded by the work.[1]

Noise

There is no hard-and-fast definition of excessive noise, but there is a wide measure of agreement that any sound intensity above 90 decibels is objectionable to workers and that high-pitched sounds may be objectionable at lower intensities. Intensities above 90 decibels are commonly encountered in riveting operations, circular sawing, weaving sheds, boiler shops and aircraft-engine testing shops.

[1] See, for instance, H. M. VERNON: *Industrial Fatigue and Efficiency* (London, Routledge, 1921).

Excessive noise makes communication between workers very difficult, makes hearing of warning signals impossible, causes misunderstandings and may lead to permanent loss of hearing. For these reasons noise should not be overlooked when dealing with safety. In addition, noise can be extremely tiring, and in this respect it has the same ill-effects as other types of fatigue.

Safety precautions against noise take the form of specially designed machines to prevent noise, measures to absorb noise and vibrations and, where absorption is impracticable, limiting the number of persons exposed to excessive noise as far as possible. In the last resort ear plugs can be worn. Although working at a noisy machine may be unavoidable, it is often unnecessary to expose workers in charge of preparatory work to the same noise; this group can be placed in a separate workroom. For example thousands of looms are still constructed in such a way that weaving sheds are among the noisiest workrooms. So long as this situation cannot be changed, workers preparing weaving beams should not work in the weaving shed, but in an adjacent room properly separated and isolated from the noisy looms.

Questions

1. *Mention some ways in which planning can improve safety standards.*

2. *What is the value of good working habits?*

3. *Give some examples of good housekeeping.*

4. *What kinds of working clothes are dangerous—*
   - (a) *around machinery?*
   - (b) *near fires?*
   - (c) *in explosive atmospheres?*

5. *What sorts of injuries might be avoided by the wearing of—*
   - (a) *hard hats?*
   - (b) *safety boots?*
   - (c) *safety goggles?*
   - (d) *respirators?*

6. *Do you think all workers should wear safety goggles? Give reasons for your answer.*

7. *Mention some of the uses made of colours for accident prevention purposes.*

8. *How can labels help to prevent accidents?*

9. *Mention some of the requirements that good lighting should satisfy.*

10. *What bearing has ventilation on safety?*

11. *How can noise be dangerous?*

SEVENTH LESSON

SOME PRACTICAL APPLICATIONS OF ACCIDENT PREVENTION PRINCIPLES

It has become apparent from the preceding lessons that many volumes could be written about the safety measures desirable in the planning of the various parts of a factory building, the designing and installing of equipment that may be housed in it, and the handling and storage of the dangerous substances that it may use or manufacture. It is not possible in this book to explain in any detail the precautions that should be taken against all the risks that may arise in a factory in relation to the building itself, the equipment in it and the processes carried on. However, it is particularly important that every worker should know the main precautions to be taken with certain items of equipment in general use (such as hand tools, portable electrical apparatus, gears, silos, acetylene cylinders and ladders), and these are explained in this lesson. For purposes of convenience reference is made at times to the relevant provisions of the *Model Code of Safety Regulations for Industrial Establishments*, which was mentioned earlier.

HAND TOOLS

A large number of injuries are caused by hand tools. Most of them are not very serious, but long periods of absence from work may be necessary if the injury becomes infected. The main causes of these accidents are the use of unsuitable tools, the misuse of tools, poor maintenance and improper storage. Regulations 119 and 211 (the latter dealing with the more specific subject of tools for maintenance and repair work) of the *Model Code* contain general recommendations for the prevention of such accidents; these are quoted below with explanatory comments.

Regulation 119.

1. *Hand tools for factory use shall be of material of good quality and appropriate for the work for which they will be used.*

Many accidents caused by breakages of tools or parts of tools (such as handles) occur because the material is of poor quality. Tools in general should be made of best-quality steel, and handles for hammers, axes and similar tools of good-quality hickory, ash or maple. In many countries recommendations on the quality of materials for tools are laid down in national standards. As in practice it is often difficult to verify the quality of materials, tools should be purchased from specialised firms of high repute.

Tools unsuitable for the work to be done, such as hammers of incorrect shape or weight and wrenches which are too long or too short, should not be used. National standards in different countries deal with these points too. In the factory itself it is the responsibility of the tool buyer to see that the right tools are available and the responsibility of the worker to use them in the right way.

2. *Hand tools shall be used only for the specific purposes for which they were designed.*

The use of hand tools for purposes other than those for which they were designed (for instance using a knife as a screwdriver or a spanner as a hammer) is dangerous because the tool may break, splinter or slip and so cause an accident. Tools are often misused because the right one is not available when it is wanted. If a worker wants a wrench that is missing he will not want to interrupt his work to look for it; he will use one with an opening too large for the nut and put in filler plates. He may forget, not only that a wrench so used may slip off the nut, but also that it is too long for the nut and that if too much pressure is applied the bolt may snap—an accident which in certain circumstances might result in injury to the worker—or be otherwise damaged, with a resultant loss of time.

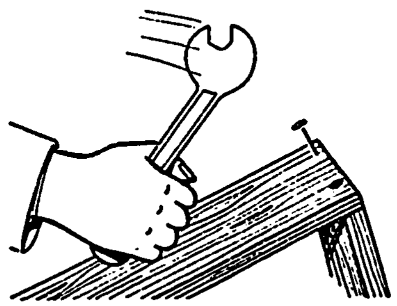


Fig. 25. Never do this! Use a hammer instead.

The remedy is careful planning of the composition of sets of tools for different workers—possibly in consultation with the workers themselves—and regular inspection to make sure that no tools are missing. Every worker who knows his job will certainly use the right tools if they are provided.

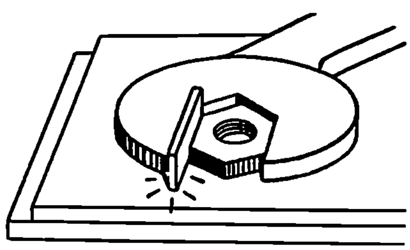


Fig. 26. This is *dangerous*! Find a wrench of the proper size.

3. *Wooden handles of hand tools shall be—*

(a) *best-quality straight-grained material;*

(b) *of suitable shape and size; and*

(c) *smooth, without splinters or sharp edges.*

A good-quality springy wood, such as hickory, ash or maple, should be used for handles. The length of the handle will obviously depend on the type of tool (hammer, axe) for which it is used. The handle should be shaped to fit the opening of the head of the hammer or axe. The joint between head and handle should be secured by a wedge, preferably of hard wood. Special care should be taken to fix the head of a hammer (see also figure 29) at right angles to the handle, otherwise the joint is dangerously weakened, and when the hammer is used the head may fly up and injure somebody.

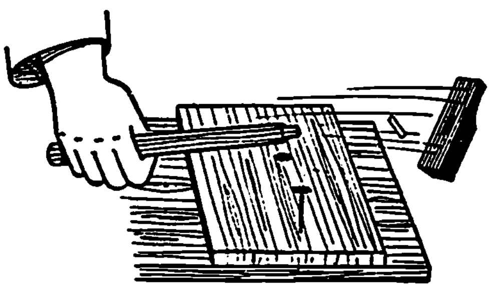


Fig. 27. What is liable to happen if the head of a hammer is not fixed to the shaft at right angles.

4. *Where there is any risk of an explosive atmosphere being ignited by sparks, any hand tools used therein shall be of a non-sparking type.*

Explosive atmospheres can be expected in places where inflammable liquids are manufactured, handled or stored, e.g. in places where gasoline is stored or calcium-carbide containers have to be opened. In such cases the tools used should be made of wood, hard rubber, copper, beryllium alloy or some other alloy which does not produce sparks when hit.

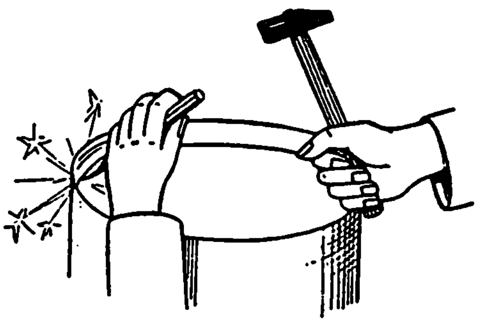


Fig. 28. If there are inflammable vapours about, do not use chisels (like this one) which produce sparks when hit.

5. *Hammers and sledges, cold chisels, cutters, punches and other similar shock tools should be made of carefully selected steel, hard enough to withstand blows without mushrooming extensively but not so hard as to chip or break.*

The hardness of steel shock tools influences safety to a large extent. Excessively soft steel will soon mushroom at the point of impact, and if the tool is not ground in time small particles will be loosened by a blow and fly off, endangering persons in the neighbourhood and in particular their eyes. Excessively hard steel, too, may splinter on impact; such splinters sometimes penetrate very deeply into the eye, and sight may be entirely lost. To eliminate these risks, steel used for shock tools must be neither too soft nor too hard; the limits are often laid down.

6. *Heads of shock tools should be dressed or ground to a suitable radius on the edge as soon as they begin to mushroom or crack.*

The risks of flying splinters can be reduced by rounding the edges of hammers, anvils, etc. (see figure 29).

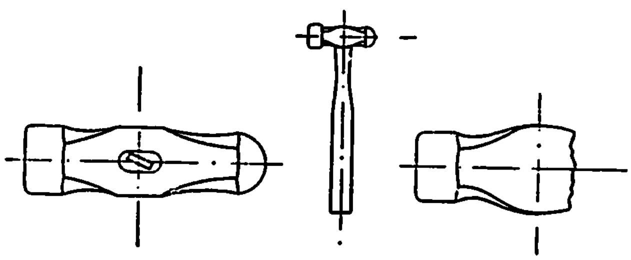


Fig. 29.

7. *Hand tools should be tempered, dressed and repaired only by properly qualified persons.*

As the properties of steel depend on the way in which it has been hardened and tempered, this work should be done only by competent persons who are fully aware of the consequences of changes in temperature or treatment. Repair work should also be done only by qualified persons, this to prevent damage to the tools or to the materials from which they are made.

8. *When not in use, sharp-edged or sharp-pointed hand tools shall be provided with protection for the edges or points.*

The protection of sharp edges and points of tools prevents injury by accidental contact and at the same time protects tools from damage by impact against stone floors or other objects. The protection may consist of leather sheaths or hoods.

9. *Hand tools shall not be allowed to lie on floors, passageways, stairways, or in other places where persons have to work or pass, or on elevations from which they may fall on persons below.*

This provision is necessary to prevent accidents caused by tripping over objects or by falling objects. However, full compliance can only be expected if suitable containers are available to hold tools not in use during the performance of work. Workers should be provided with suitable tool boxes, small trolleys or other convenient means of storing tools. A simple precaution to prevent tools falling from step ladders is the placing of a slot in the highest tread in which tools can be placed temporarily.

10. *Suitable and conveniently located cabinets, holders or shelves shall be provided at benches or machines for hand tools.*

Persons working at benches or machines should also be provided with proper facilities for storing tools. It is important that there should be sufficient space for every tool, and that the tools can be stored in such a way that every one can be found easily, and that checking does not cause any difficulty. The general rule for good housekeeping—" for overything a place and everything in its place "—should be strictly applied.

11. *Hand tools should be—*

(a) *issued through a tool room, in which they are stored safely on racks or shelves in cabinets or tool boxes ;*

(b) *inspected periodically by competent persons ; and*

(c) *replaced or repaired when found defective.*

The inspection of hand tools is facilitated if they are distributed by storekeepers in a tool room. However, it is sometimes more convenient to leave workers permanently in charge of some tools, and in other cases local custom prescribes that workers should have their own. Then it would be desirable to make a rule that all tools should be handed in periodically at the tool room for inspection and examination by competent persons to ensure that they are properly looked after and in good condition. Tool-room attendants should have strict instructions not to issue damaged or otherwise unsuitable tools.

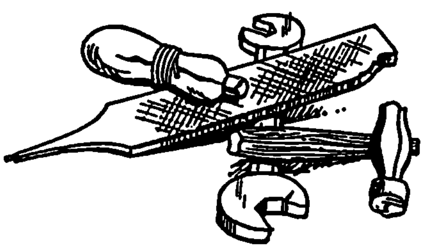
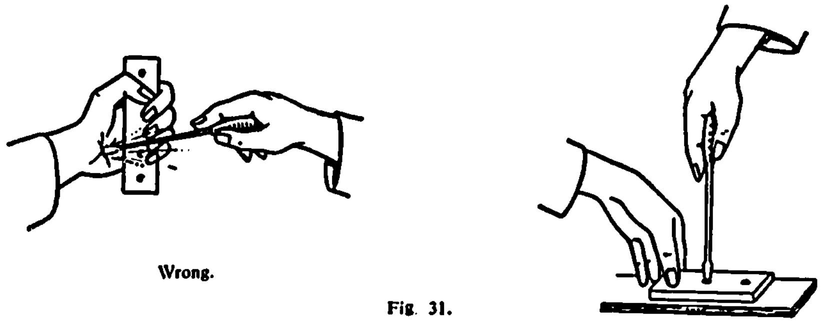


Fig. 30. These are *dangerous* and should be *scrapped.*

12. *Workers should be properly instructed and trained in the safe use of their hand tools.*

As improper use often results from insufficient skill, training has an indirect influence on safety standards. Regular inspection of work habits offers an opportunity to discover where additional training and instruction is necessary.

An example of an incorrect and a correct way of using a screwdriver is shown in figure 31.



Wrong.

Fig. 31.

Right.

Regulation 212.

. . . .

9. *A sufficient supply of tools of the various types required shall always be kept available for maintenance and repair men.*

A sufficient supply of tools is not only necessary for the reasons already mentioned under Regulation 119 (2), but also as a guarantee that maintenance and repair work will be done correctly, thus eliminating the risks due to defective repair work.

10. *Such tools shall be kept in safe condition and should be inspected at regular intervals by a competent person appointed by the management.*

The observations on Regulation 119 (11) apply here also.

11. (1) *Maintenance and repair personnel shall be provided with special tool bags or portable tool boxes of a size sufficient to hold all the hand tools needed for their work and so constructed that they can easily and safely be hoisted on to platforms and other elevated workplaces.*

(2) *Where necessary, special hand trucks shall be provided for the transport of heavy tools needed in repair and maintenance work.*

As maintenance and repair personnel may have to go anywhere in the factory, they should be provided with tool boxes or tool trolleys in which the tools can be placed and fixed in such a way that they are not disturbed even if the box or trolley is tilted. This can be done by using boards or rubber sheets with openings, closed by a cover, into which the different tools fit.

Boxes and trolleys should be so constructed that they can be transported without difficulty.

12. *In large establishments special fixed tool cabinets or tool boxes for maintenance and repair men should be provided in each department, particularly where special tools or tools too heavy to carry over considerable distances may be frequently needed for their work.*

Unnecessary transport operations should be avoided. As maintenance and repair work may be urgently needed to prevent serious damage to factory equipment or disruption of production, or to avert accidents, the tools necessary for this work should be immediately available at all times.

13. *All repair men should be provided with strong electric flashlights, which shall preferably be of the flame-proof type.*

On account of fire risks, repair men should not use matches or candles to see by in dark places. Flame-proof flashlights are necessary if highly inflammable substances are present (e.g. in textile factories and flour mills).

Portable Electrical Apparatus

Many accidents occur because the casings of portable electrical apparatus (such as power drills) are carrying mains voltage as a result of some defect inside the apparatus. Accidents have also been caused by defects in the socket, the plug or the flexible cable. When a person touches an electrically charged object there may be a serious, even a fatal, accident if the voltage is above a certain level or threshold.[1] As the mains voltage of electrical installations is higher than this threshold, special precautions must always be taken when using portable electrical apparatus.

One essential measure to prevent accidents of this kind is the earthing of casings. This can be done by having an extra wire, inside the cable, attached to a third pin in the plug which is connected to a good earth through the socket. This method is not, however, completely reliable because the electric cable of portable apparatus is often carried or dragged about and sometimes laid on floors, and it is liable to be trodden on or otherwise maltreated, with the result that sometimes a wire breaks. If the earth wire is the one affected, the break is often not immediately discovered; and if subsequently an internal fault develops in the appliance

[1] The generally accepted thresholds are: three-phase and earthed neutral alternating current, 42 volts; single-phase alternating current, 24 volts; direct current, 110 volts.

the casing may become live, and the ne.. time the appliance is used the worker may receive a severe shock. The broken earth wire may even touch one of the live wires and cause the casing to carry mains voltage. Safer, therefore, is the system according to which, in addition to the earth wire described above, one end of a loose wire is attached to the casing of the apparatus and the other to an earthed point. This type of earthing is more reliable, but its efficacy depends on the worker, since he is responsible for attaching the second earth wire before plugging in the apparatus.

Figure 32 shows an electrical hand drill with a socket outlet well earthed to a fixed earth conductor or to an earth pipe, e.g. the main water supply pipe (gas piping should never be used as an earth). The earthing system is connected to a special socket contact receiving a pin which in turn is connected to a special earth wire in the cable. Consequently, the latter contains three wires; two current-carrying and one for earthing the drill casing. The drill is provided with a switch, which is self-releasing. If for greater safety a second, visible earth conductor is used, this should be connected to the earth pipe before the plug of the drill is connected.

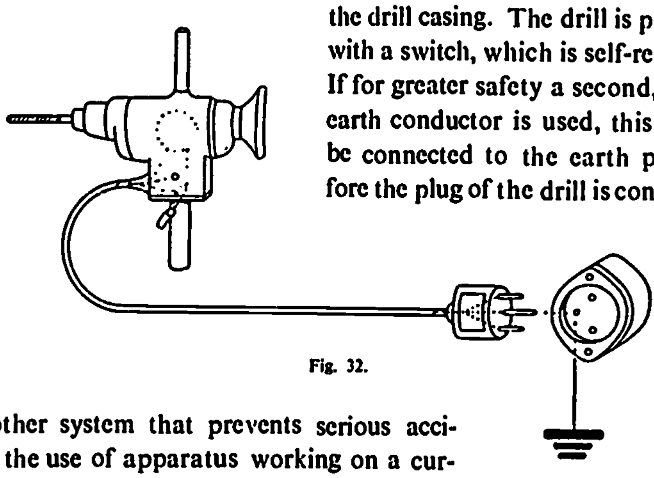


Fig. 32.

Another system that prevents serious accidents is the use of apparatus working on a current of 42 volts alternating current (AC) (a threshold voltage) or less and of transformers that reduce the mains voltage to the requisite level.

The precautions described are not necessary when the casing of the tool is made of insulating material and when protruding metal parts (shaft, etc.) are insulated from the motor, e.g. by a coupling made of insulating material. Nor are special precautions necessary if the apparatus has double insulation, i.e. it is so constructed that not only are the different parts normally insulated, but the casing is also lined with insulating material and protruding parts are constructed as described above.

Where tools working at very low voltages are not available, safety can be increased by using an isolating transformer rated at 220/110 or 110/110 volts (see figure 33). The tool is operated, not by current direct from the mains, but by current from a completely separate secondary circuit set up by the transformer, and in the event of current leaking into the casing the worker will not receive the full shock of the mains current. Since the secondary circuit is completely isolated from the earth the danger of touching a live casing is less.

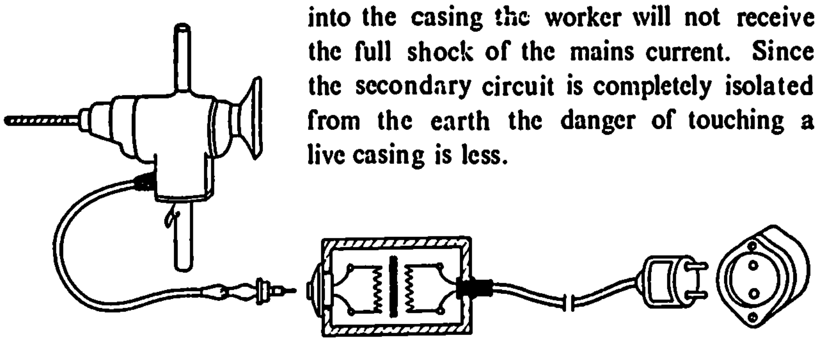


Fig. 33. An electrical power drill with an isolating transformer.

Earthing of the portable apparatus is unnecessary in this case. However, as safety is here based on the fact that the tool circuit is completely isolated from earth, care should be taken to ensure that the cable of the secondary circuit is in good condition. It is advisable to have this cable as short as possible; if necessary a long primary cable should be used, and the transformer should be placed as near as possible to the point of operation, although never at a place where the use of voltages higher than the threshold voltages mentioned earlier is particularly dangerous (e.g. in boilers, double bottoms of ships, etc.). The midpoint of the secondary winding of the transformer should not be earthed.

To ensure that the apparatus is not used without the transformer the plug at the end of the primary cable and the one used for connecting the apparatus to the secondary cable should be of completely different types. Moreover, there should be a separate transformer for every appliance.

Every transformer used for safety purposes should have the primary and secondary windings completely separated, so that even in the case of a defect the two cannot come into contact.

Experience has taught that proper maintenance of portable tools and daily inspection after working hours can reduce the number of accidents considerably.

Lastly, attention should be drawn to a dangerous aspect of portable electric apparatus which can easily be overlooked. Some equipment has been so designed and manufactured as to leave a small metal portion not earthed (e.g. a metal switch recessed into an insulated handle) and yet liable to become electrically charged, with consequent danger to the user. Workers using apparatus of this kind should be particularly circumspect.

GEARS [1]

Regulation 76 of the *Model Code* makes the following recommendations for the safeguarding of gears:

1. *Exposed power-driven gears shall be guarded in one of the following ways:*

(a) *with a complete enclosure;*

(b) *if the gear wheels are of the solid disc type, with a band guard covering the face of the gear and having flanges extending inward beyond the root of the teeth on the exposed side or sides.*

2. *Hand-operated gears shall be guarded in a manner similar to that prescribed for power-driven gears whenever they present a hazard.*

Generally speaking, the danger inherent in gears can only be eliminated by enclosing them completely. The guard should be constructed in such a way that oiling can be done without removing it (e.g. through small openings). An example was given earlier (figure 11).

If this is not practicable, or if the gear wheels have to be replaced from time to time, the guard should be so designed as to lock when the machine is running. This system is used for some textile machines, for instance. Where such an arrangement is impracticable, the guard should be so placed as to inconvenience the worker when open, so that if he wants to work comfortably he will have to close it.

An example of a guard for gears is shown in figure 10. As it is necessary to change the gears in accordance with the work to be done, the guard can pivot on the bolt. If in this case the gears had been completely enclosed it would have been necessary to take the guard off each time the gears had to be changed, and it is doubtful whether such a guard would always be replaced in practice.

A guard that only covers the area where two gear wheels meet is insufficient, either because it does not prevent a finger from penetrating between the gear wheels from a direction parallel to the shaft, or because there is a risk of nipping between the end of the guard and the teeth of the wheel, or, again, because the guard is so made that a small incidental deformation brings it too close to the teeth and creates a similar risk.

The risk of nipping between two gear wheels is not their only danger. Gears present the same risks as other protruding parts of a revolving shaft

[1] For the protection of mechanical power transmission equipment in general see I.L.O.: *Guide for Labour Inspectors*, Studies and Reports, New Series, No. 41 (Geneva, 1955).

(catching loose clothes or materials such as fibres, yarns, cords, etc.). Spoked gears may cause accidents when a hand or some object penetrates among the spokes.

The hazards of gears on machines turned by hand are often underestimated, as may be seen from the following example.

Example. In a small bakery a hand-driven machine was used for cutting dough in the shape of biscuits. As this machine was seldom used, was hand-driven, and was designed to be used by one person, and as only a father and his grown-up son worked in the bakery, guarding the gears of the machine was thought to be unnecessary.

One day the machine was being used by the father and son together, the father turning the handwheel and the son feeding the machine with dough. Suddenly the son's hand caught between the gears, and before he could shout to his father to stop turning the wheel he had lost the tips of two fingers.

Accidents like this show that it is essential to enclose gears completely, whether they are slow-running or fast-running and whether they are hand-driven or power-driven.

Large Containers (Silos, Bins) for Dry Bulk Materials [1]

Fatal accidents have occurred in hoppers and bins containing dry bulk materials when persons have entered them to try to start the material moving after it had stopped for one reason or another.

The following is typical of the kind of accident which may occur. Under certain circumstances the material stored in a bin or silo is liable to stop flowing out though the outlet funnel at the bottom is open. Sometimes this is due to the construction (the unsuitable shape of the bin and in particular of the bottom) or the unsuitability of the funnels for the material stored. In other cases stoppage is due to momentary causes such as settling of the material, damp and frost. When the flow stops, the material in most cases is blocked in the bin either in the form of a bridge (an enclosed cavity not visible from the top) or in the shape of a funnel or a chimney.

The first reaction of the worker who sees that the flow has stopped is to try to restart it by pushing a pole or some other implement up through the funnel opening. This may work for a time; but then there may be another stoppage. Next, the worker goes to the top of the bin and, standing on a platform, tries to start the material moving with a shovel or a bar. If his attempts fail, he takes a ladder, places it inside the silo, descends, walks over the material and tries again. Suddenly, as the mass starts to move, he may lose his footing and be engulfed before he has even had time to cry for help. At the mouth of the funnel under the silo his mates will notice nothing amiss until an arm or a leg appears at the opening; but by then it is probably too late to save his life.

Such accidents have happened in large silos as well as in small ones, and in silos containing sawdust or grain as well as in those containing

[1] See Ministry of Labour and National Service, Factory Department: *Accidents, How They Happen and How to Prevent Them*, Vol. II (New Series), Apr. 1952 (London, H.M. Stationery Office).

sand or gravel. Moreover, once a man is buried in the mass it is very difficult to pull him out. In one case seven men were unable to pull up a man who was buried in sand up to his thighs; after some terrible minutes the man disappeared under the sand and died before the silo could be emptied.

To prevent such accidents it is sometimes considered to be sufficient to provide workers entering bins with a belt attached to a lifeline and have another worker stationed outside to render assistance if necessary. These measures have proved to be necessary but insufficient if no special precautions have been taken.

Regulation 184, paragraphs 34 to 41, of the *Model Code* contains the following provisions on storage bins for dry bulk material:

34. *Dry bulk material should be stored in bins which will permit removal from the bottom.*

35. *Open-top hopper bins containing bulk material which is discharged at the bottom either by hand or by mechanical means shall be covered with gratings which will allow the use of pokers to break up bridging of the stored material, but which will prevent workers from falling into the bins.*

These gratings give easier access to the stored materials with pokers than gangways do, because it is possible to stand on them at any point above the material. However, in very large silos the gratings required would be impossibly large, and suitable, well-guarded gangways and platforms should be installed at the top of the silo.

36. *Where it is necessary for workers to enter bins for storing dry bulk material—*

(a) *each worker shall be provided with, and shall use, a lifebelt attached to a lifeline that is as short as practicable and securely fastened to a fixed object ; and*

(b) *another worker shall be stationed outside during the entire operation to render such assistance as is needed.*

Working rules should prescribe that only the person in charge of the work may decide whether it is necessary to enter a bin. To do away as far as possible with the need for entering bins the latter should at the time of construction be equipped with every possible safety feature; for instance they should have adequate funnels for emptying and gratings at the top. Where this is impracticable, openings should be made in the walls to enable blocked material to be freed with poles or by other means. Depending on circumstances and the kind of material stored in the bins, such precautions can be completed by equipping them with heating apparatus (against frost), vibrators, water jets, compressed-air jets, mechanical breakers, etc. In addition, for working on gratings or platforms, suitable rods, poles or other appliances should be readily available.

The lifebelt should preferably take the form of a harness of the kind shown in figure 34.

Harnesses and lifebelts should be examined regularly to make sure that they are in good condition. The requirement that the lifeline has to be " as short as practicable " is essential. As already indicated above, it is practically impossible to pull up a man engulfed in the mass, and consequently every precaution should be taken to see that the worker does not even get his legs buried in it.

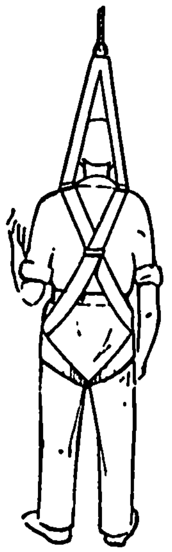


Fig. 34.

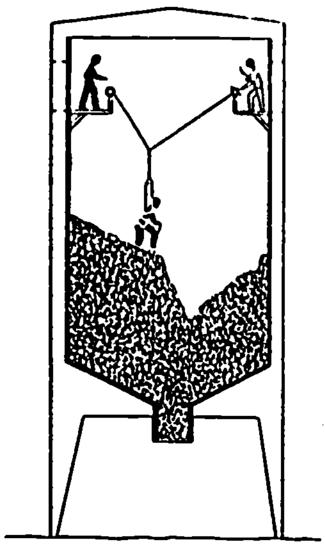


Fig. 35.

Figure 35 shows a method of seeing that there is no slack in the lifeline when the man has to work in the middle of the silo (note that two attendants are required). In other cases the lifeline should be kept as nearly vertical as possible. As the man changes his position the line should be let out or taken in. The worker stationed outside should continuously watch his mate inside and always be in such a position that he can pull him up. He should secure the lifeline by passing it two or three times round a substantial fixture, taking care that for the whole time the man fastened to the line remains in the bin this line is kept " as short as practicable ". The attendant should be perfectly familiar with the hazards inherent in this type of work. He should never change the point of anchorage for the lifeline while the worker in the silo is not in a safe position, that is, is not standing on a part of the structure or on a ladder securely fixed to it.

37. *Workers shall not be permitted to enter bins used for storing dry bulk material until all supply of material to the bin has been discontinued and precautions have been taken against accidental renewal.*

As a rule workers around a silo have no direct control of the filling equipment. Hence special precautions have to be taken against unexpected starting of the machinery; this can be done, for instance, by locking the switches. It is also desirable that during work in the silo the discharge funnel should remain closed.

38. *Bins used for storing dry bulk material shall be provided with stairways or permanent ladders, and platforms where necessary, for easy and safe access to all parts, with standard railings on both stairways and platforms.*

It is desirable to have fixed ladders inside bins; if portable ladders are used they must be adequately fixed to structural parts of the bin.

On the subject of standard railings, Regulation 13 of the *Model Code* (which deals with stairways) contains the following recommendations:

Railings.

10. *All stairways having four or more risers shall be equipped with stair railings on any open side.*

. . . .

14. *Stair railings shall be constructed in a permanent and substantial manner of wood, pipe, structural metal or other material of sufficient strength.*

15. *The height of stair railings, from the upper surface of the top rail to the surface of the tread in line with the face of the riser at the forward edge of the tread, shall be not less than 76 cm (30 in.); if the railing is used as a handrail, the height shall not be more than 86 cm (34 in.);*

Regulation 12 contains these provisions on standard railings for platforms:

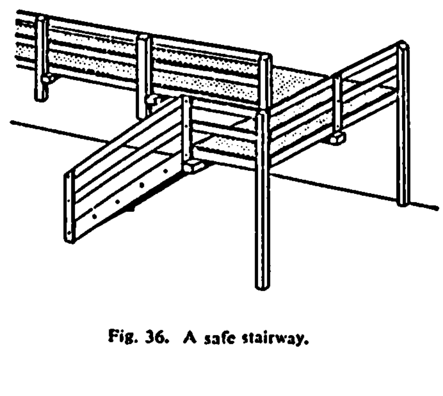


Fig. 36. A safe stairway.

12. *Standard railings shall be at least 90 cm (36 in.) from the upper surface of the top rail to floor level.*

13. *Standard railings shall have posts not more than 2 m (6 ft. 6 in.) apart and an intermediate rail half-way between the top rail and the floor.*

In conclusion, mention should be made of the final provisions of Regulation 184, which reads as follows:

39. *Bins used for storing combustible dry materials shall be of fire-resisting construction and provided with lids and an adequate ventilation system.*

40. *Where dry bulk material is piled and removed manually, undermining of piles shall not be permitted.*

41. *Special precautions shall be taken where the dry material stored is such as to lead to the formation and release of explosive or toxic mixtures.*

These last three provisions remind us that there are still other hazards in storage bins. For instance a danger of suffocation exists in silos where there is a shortage of oxygen, which can be expected where cereals are stored. If necessary the atmosphere in silos should be tested before persons enter the bin and fresh-air helmets should be worn.

Acetylene Cylinders

Acetylene cylinders are made of steel; they are filled with acetylene dissolved in acetone. They should be handled carefully to prevent damage, which might lead to bursting of the cylinder or leakage through the cylinder valve; they should also be protected against excessive heat, which would cause an increase of internal pressure and perhaps an explosion.

Acetylene cylinders should therefore not be banged, jolted violently, dropped or thrown about. When being loaded on or unloaded from a

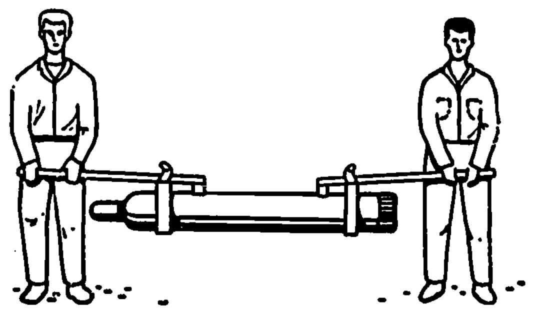


Fig. 37. A simple carrying device for acetylene cylinders.

truck, a cylinder should be lowered gently into place. In the workroom the cylinder should be prevented from falling by being fixed to the wall or a column by a collar or a chain in such a way that it can easily be removed in case of fire (see figure 38).

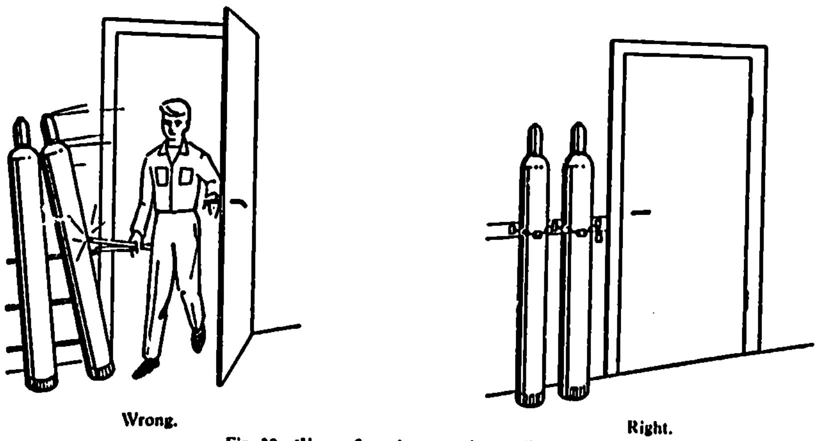


Fig. 38. Ways of storing acetylene cylinders.

During transportation the valve should be protected by a steel cap. When in use the cylinder should be kept in an upright or nearly upright position to prevent acetone escaping with the acetylene.

Acetylene cylinders are normally filled to a pressure of 15 kg/cm² at 15°C. (about 200 lb. per square inch at 60°F.); at this pressure dissolved acetylene can be stored without danger. The risk of an explosion increases sharply with the pressure in the cylinder, and consequently if the latter is substantially above this level (say, 17 kg/cm² at 15°C.—or 230 lb. per square inch at 60°F.—or higher) it is highly advisable to refuse to accept delivery and return the cylinder at once to the filling station.

For every degree Centigrade by which the temperature rises the pressure increases by about 0.4 kg/cm² (about 5½ lb./sq. in.). Therefore cylinders should not be exposed to the direct rays of the sun or to the heat of ovens, boilers, heating apparatus, etc. In case of fire, acetylene cylinders (and other gas cylinders) should, if possible, be removed from the premises to prevent an explosion. Heating an acetylene cylinder will result in an increase of pressure not only because acetylene is liberated from the acetone, but also because of decomposition (known as dissociation) of the acetylene; it is the latter that is particularly dangerous and most liable to cause an explosion.

When, after work has been finished, the worker hangs the acetylene and oxygen hoses and the torch on the acetylene cylinder without completely extinguishing the welding flame, a small flame will remain burning near the outside of the cylinder. If this goes on for some time dissociation of acetylene in the cylinder starts. For this reason there should be a special support, near the acetylene and oxygen cylinders of a welding set, to hold the pipes when the apparatus is not in use.

Another cause of overheating in a cylinder may be a flame near the connection between the pressure-reducing valve and the cylinder valve due to leaking acetylene which has been ignited by a spark or by static electricity. This is possible when the two parts have been imperfectly connected or when the washer used for this connection is damaged; welders should always be in possession of a good supply of new washers. Leakages of acetylene sometimes also occur near the stem of the cylinder valve; this, however, can be prevented by the use of valves of the membrane type.

If a flashback occurs in the acetylene hose the flame may reach the inside of the cylinder, passing through the reducing valve. Flashbacks may be caused by incorrect handling of the torch, or by a defect in the torch, such as a metal particle blocking the nozzle or a badly connected torch tip. To prevent flashbacks a flame-arrester should be placed between the hose and the valve; but it is equally important that the equipment be used properly and kept in good condition.

Another cause of acetylene dissociation is the presence of copper in the cylinder or its accessories; this element, when in contact with acetylene, forms an explosive compound. For this reason there should be no copper in any apparatus which comes into contact with acetylene. Unfortunately this rule is not always observed. Acetylene pressure gauges are sometimes fitted with copper Bourdon springs, or the springs may have been soldered with copper to the casing of the gauge. However, alloys containing less than 63 per cent. of copper are not dangerous in this respect.

Thus acetylene dissociation in an acetylene cylinder may begin either with or without external application of heat. In both cases a part of the cylinder will become hot. What is to be done then?

If there is a small flame near the cylinder valve, the former should first be extinguished and the valve closed. The cause of the incident should be investigated and defects repaired, and every five minutes for an hour the cylinder-head temperature should be checked to ascertain whether dissociation has started. If the flame is of some size the same procedure should be followed, but in this case it will be necessary to wear gloves to shut the valve.

If the flames are so fierce that the valve cannot be closed they should be extinguished with a fire extinguisher, preferably one filled with carbon dioxide. If such an extinguisher is not available a blanket or a wet cloth should be used. It is also possible—but not easy—to put out the flames with a water jet.

If a part of the acetylene cylinder is observed to be rapidly becoming h[illegible]r the cylinder valve must be closed and kept closed. If possible t[illegible] ylinder should be thrown into a canal or a river or be taken to a place where there is no special danger in case of explosion and cooled by a water jet; in either case it should be given four or five hours to cool. If it is impossible to take such measures an explosion must be expected and the area cordoned off.

In the case of spontaneous heating the cylinder valve must be closed and kept closed. The idea that opening the valve will prevent a dangerous increase in pressure is mistaken; it will accelerate the process of decomposition, and, furthermore, the aperture of the valve will become blocked by accumulations of soot.

The foregoing shows how essential it is to be able to close the cylinder at any moment. For this reason the key used for turning the valve spindle should always be on or near the cylinder.

Portable Ladders

Portable ladders are used to give access to scaffolds, platforms and other places in buildings under construction and places where people have to go for maintenance and repair work, and for many other purposes. Ladders are, for instance, an important part of the equipment of fire brigades. In many countries ladders are in such common use that it seems superfluous to draw attention to the purposes they serve. However, there are countries where the use of ladders is far from general and workers climb up scaffolding, using uprights, ledges and other parts of the construction; to reach a higher level for maintenance or repair work, workers sometimes use primitive and badly constructed apparatus that has hardly any resemblance to an ordinary ladder.

In countries where portable ladders are in general use they are manufactured in specialised factories and usually made of wood or aluminium alloy. On building sites home-made ladders are often used. The design of a ladder depends on the use that is to be made of it. Ladders to be used on building sites have to be more rigid than ladders for maintenance or repair; ladders for window cleaners have the rungs placed at larger intervals (about 35 cm) than is usual for ladders for general purposes (about 25 cm).

As it is desirable to keep the weight of portable ladders down to a minimum the construction is as light as possible; hence ladders should be handled carefully. Aluminium ladders have advantages over wooden ones, for they are extremely light. However, it is dangerous to use metal ladders in the neighbourhood of uninsulated electric wires, for all metals are good conductors of electricity.

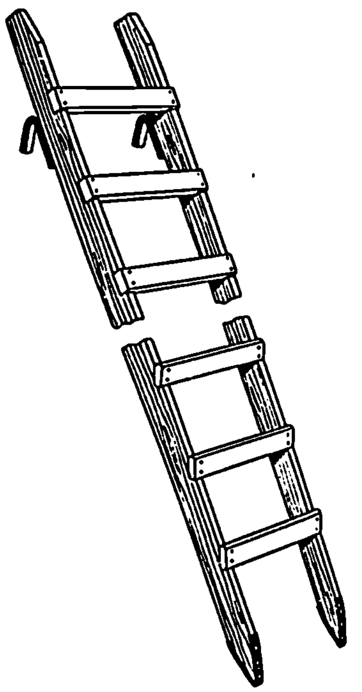


Fig. 39. Example of safe ladder construction. Note how the rungs are mortised into slots in the uprights.

In some countries the construction of ladders has been standardised and the different types tested. This practice has helped considerably to ensure safe construction.[1]

In 1937 the International Labour Conference adopted a Recommendation on safety provisions in the building industry. This Recommendation contains a model code of safety regulations which includes a number of provisions concerning ladders. For instance, Regulation 3 contains the following:

> 1. . . . *all ladders shall be of sound material and be of adequate strength having regard to the loads and strains to which they will be subjected.*

Ladders used on building sites are usually made of ordinary wood, and consequently should have dimensions suitable for the material used and the rough treatment to which they may be exposed. An example of a good home-made construction is shown in figure 39. The dimensions of this ladder, made of ordinary pine, should be—

(a) if the length of the ladder is not more than 3 m: uprights 5×7 cm; rungs 2×7 cm.

(b) if the length of the ladder is more than 3 m, but not more than 5 m: uprights 5×10 cm; rungs 2.5×7 cm.

The uprights are mortised in such a way that the load is suitably distributed between the rungs and the uprights.

The second provision reads:

[1] See, for instance, British Standards Institution: *Aluminium Ladders, Steps and Trestles*, British Standard 2037 (London, 1953).

2. *The wooden parts used for ... ladders shall be of good quality, shall have long fibres, shall be in good condition, and shall not be painted or treated in a manner likely to hide defects.*

Knots and other irregularities in the fibres may cause breakage if a relatively heavy load is placed on the ladder or if it is exposed to shocks. As weak spots (e.g. cracks) in uprights and rungs can be made invisible by painting, the painting of ladders is often forbidden. Varnishing is allowed, provided that the varnish is transparent and does not prevent inspection of the quality of the wood or its condition.

Regulation 22 of the same code contains the following provisions:

1. *Every ladder used as a means of communication shall rise at least 1 m above the highest point to be reached by any person using the ladder, or one of the uprights shall be continued to that height to serve as a hand-rail at the top.*

2. *Ladders shall not stand on loose bricks or other loose packing, but shall have a level and firm footing.*

A firm footing is one of the most important safety precautions to be taken with ladders. A particular warning should be given against the extremely dangerous practice of using a ladder which is too short and placing some object under it to make it reach higher; this has often led to accidents.

3. *Every ladder—*

(a) *shall be securely fixed so that it cannot move from its top or bottom points of rest; or*

(b) *if it cannot be secured at the top, shall be securely fastened at the base; or*

(c) *if fastening at the base is also impossible, shall have a man stationed at the foot to prevent slipping.*

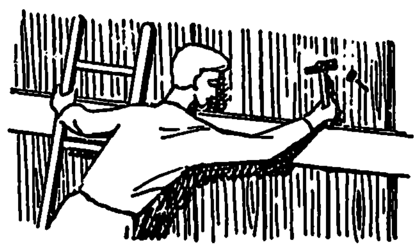


Fig. 40. Never do this! The ladder may slip sideways. Move it along.

Not only should the danger of the foot of the ladder slipping be kept in mind, but care should be taken to prevent the top of the ladder slipping sideways.

4. *The undue sagging of ladders shall be prevented.*

Long ladders (e.g. those used for giving access to scaffolds) should be fixed by braces to the scaffold construction at suitable intervals to prevent undue sagging.

5. *Ladders shall be equally and properly supported on each upright.*

When placing a ladder, care should be taken that each of the two uprights has a firm footing, so that the load on the ladder is equally shared by both.

6. *Where ladders connect different floors—*

(a) *the ladders shall be staggered ;* and

(b) *a protective landing with the smallest possible opening shall be provided at each floor.*

It is desirable not to use ladders which are too long, and sometimes two or three have to be used to connect different levels. If the ladders are staggered all of them can be used simultaneously without danger of overloading any one or of persons on the lower ladders being hurt by an object dropped by a person on a higher one.

7. *A ladder having a missing or defective rung shall not be used.*

The ladder accident described in Lesson 3 will be remembered.

8. *No ladder having any rung which depends for its support on nails, spikes or other similar fixing shall be used.*

Experience has shown that rungs held in place by nails or spikes alone are unreliable. Two correct ways of fixing rungs are shown in figure 39.

9. *Wooden ladders shall be constructed with—*

(a) *uprights of adequate strength made of wood free from visible defects and having the grain of the wood running lengthwise, and*

(b) *rungs made of wood free from visible defects and mortised into the uprights, to the exclusion of any rungs fixed only by nails.*

Wooden ladders made in specialised factories usually have the rungs fixed in mortises in the uprights and kept in place by glue and by wooden safety pins which go through the upright and enter a hole about 8 mm deep in the rung. Uprights should be made of wood of good quality (such as Oregon pine) and without blemishes. The two uprights of a long ladder are not parallel, but converge slightly towards the top. Rungs should be made of good-quality oak, hickory, ash or other wood with similar properties

10. *Roofers' and painters' ladders shall not be used by workmen in other trades.*

Roofers' and painters' ladders are often of a very light construction and are insufficiently rigid for general use.

The *Model Code of Safety Regulations for Industrial Establishments* contains a general provision to the effect that all ladders should comply with the provisions laid down in the 1937 safety code for the building industry; it then goes on to recommend certain additional precautions.

Regulation 211 contains the following provisions:

16. *An adequate supply of portable ladders of good construction and of such types and lengths as may be required should be kept in readiness for use in maintenance and repair work.*

Portable ladders for maintenance and repair should be of sound construction. This does not mean simply that ladders should be of suitable materials and sufficiently rigid, but also that the different rungs should be of the same construction and that the intervals between them should be uniform. To be able to place ladders in the right position (see paragraph 22 below) it is necessary to have ladders of different leugths.

17. *Ladders shall always be kept in good condition and shall be inspected at regular intervals by a competent person.*

As the condition of a ladder is an important safety factor, regular inspection is necessary, especially in the case of wooden ladders, which can easily become damaged and are more likely to have hidden defects than metal ladders.

18. *Portable ladders that have missing or damaged rungs or are otherwise defective shall not be issued or accepted for use.*

This paragraph covers much the same ground as paragraph 7 of Regulation 22 of the safety code for the building industry.[1]

19. *Defective ladders shall be promptly repaired or destroyed.*

If a defective ladder is present in a workplace, it is likely to be used when somebody wants a ladder just for a moment. For this reason defective ladders should be repaired immediately or removed.

20. *Portable ladders should be equipped with non-slip bases, when such bases will decrease the hazard of slipping.*

[1] See previous page.

When using wooden ladders on a concrete floor, there will usually be no risk of slipping. On the other hand, on glazed tiles, parquet floors and floors covered with linoleum there is such a danger, and special precautions have to be taken. On these floors non-slip rubber or lead bases should be used. Special attention should be given to the influence of wear on non-slip bases. Many types are quite satisfactory when they are new but become quite unsuitable after being in use for some time. Regular inspection is therefore necessary. Most non-slip bases are useless when the floor is wet or covered with oil.

Examples of non-slip bases are given in figure 41.

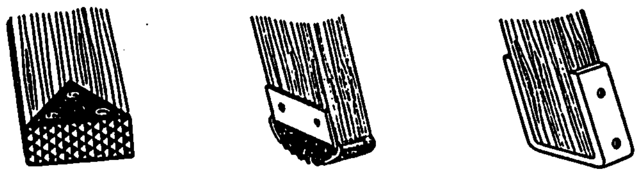


Fig. 41.

21. *The person in charge of repair work for which portable ladders or platforms are required shall see that the ladders and platforms are of the proper type for the work in question.*

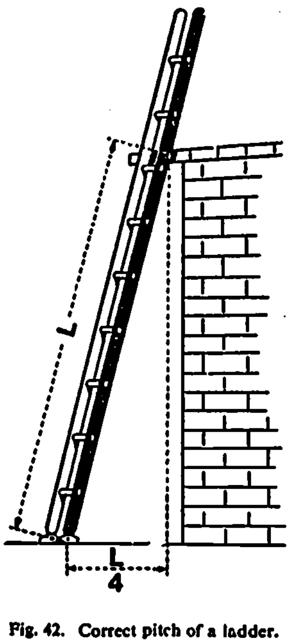


Fig. 42. Correct pitch of a ladder.

An adequate supply of portable ladders in itself is not sufficient. What is also necessary is to see that the right ladder is chosen for a particular job; for instance when the workplace has a low ceiling the ladder should not be so long that it cannot be placed correctly (see following paragraph).

22. *Portable ladders should be used at a pitch such that the horizontal distance from the top support to the foot of the ladder is one-quarter of the length of the ladder.*

See observations on paragraph 16 above.

23. *Crowding on ladders shall not be allowed.*

As portable ladders are made as light as possible to facilitate transportation, they are not suitable for use by more than one person at a time. The practice of having one person go up a ladder holding one part of a heavy object, followed by another person supporting the lower part of the object, is to be condemned; ladders are not made to stand such strains.

24. *Portable ladders shall not be placed in front of doors opening towards the ladder unless the door is blocked open, locked or guarded.*

If this is not done, there is a danger that if somebody opens the door the ladder may be brought down with the worker on it.

25. *Portable ladders shall not be spliced together.*

Splicing ladders may considerably increase the strain on the uprights of each and in this way may weaken them.

26. *Portable ladders shall not be used as a guy, brace or skid or for any other purpose for which they are not intended.*

It is dangerous to use ladders for purposes which may set up abnormal stresses in the uprights, since concealed defects may result which will one day cause an accident.

27. *Portable ladders shall be so stored that—*

(a) *they are easy of access ;*

(b) *they can be easily and safely withdrawn for use ;*

(c) *they are not exposed to the weather, excessive heat or excessive dampness :*

(d) *they are exposed to good ventilation ;* and

(e) *if horizontal, they are sufficiently well supported to avoid sagging and permanent set.*

When a worker wants a ladder he should not have any difficulty in getting one, otherwise he may well look for something else that is not so safe (e.g. a box or a pile of objects) on which he can stand, thus exposing himself to unnecessary risks.

The fibre structure of wooden ladders may be damaged by exposure to the weather, excessive heat or dampness, or by storage in a badly ventilated place. The weakening may not be immediately visible, with the result that a defective ladder which is liable to break at any time may be left in use.

Sagging may result in permanent deformation and weakening if ladders are not properly supported when in a horizontal position; of course, long ladders will be most liable to sag.

Questions

1. *Mention some of the precautions that should be taken with hand tools.*

2. *What can be done to promote the safe use of hand tools by maintenance and repair men?*

3. *Why can portable electric apparatus be dangerous?*

4. *What are the maximum voltages considered safe for portable electric apparatus?*

5. *Discuss whether power-driven gears should always be completely enclosed.*

6. *What dangers are presented by storage bins containing dry bulk materials?*

7. *In what circumstances may workmen be allowed to enter storage bins?*

8. *Describe some precautions to be taken when using acetylene cylinders.*

9. *What should be done when an acetylene cylinder is found to be on fire?*

10. *Mention some of the requirements that a good portable ladder should satisfy.*

11. *What care should be taken of portable ladders to keep them in safe condition?*

12. *Mention some precautions that should be taken by persons using ladders.*

EIGHTH LESSON

PSYCHOLOGICAL AND PHYSIOLOGICAL ASPECTS OF ACCIDENT PREVENTION

The last three lessons were concerned with technical aspects of accident prevention affecting the workplace and its equipment rather than with the attitude of the worker himself. But the latter factor is a vital one in accident causation and accident prevention and cannot be left out of account. In discussing this human factor it is usual to talk about physiology and psychology but, as a result of modern scientific discoveries, no one is sure where the one begins and the other leaves off. It might be more accurate to treat mind and body as a single whole and man as a psycho-physical being. The subject is infinitely complex, and space allows no more than a brief mention of a few of the countless elements in " the human factor " which operate to endanger or to protect the worker or his fellow men.

This lesson will therefore be concerned only with general matters and some frequently discussed problems such as industrial relations, accident proneness of individuals and fatigue. Some means of prevention that may be considered to be in the psychological domain—propaganda, education and training—will be discussed later.[1] To simplify matters the physiological and psychological elements will be treated separately.

Briefly, the task of the psychologist in the field of accident prevention is to discover in what circumstances and for what reasons persons, and more especially workers, behave in such a way as to endanger themselves or others.

Attitudes Towards Safety

There are many possible answers to the question: why does a worker do a job in an unsafe way when he could do it in a safe way ? The worker may consider the unsafe way easier, less troublesome or faster; he may think that the unsafe way is the best one; he may consider safety precautions unnecessary because he is convinced that he can look after himself

[1] See Lesson 9.

in all circumstances; he may feel that as a man of experience he can quite well determine his own way of working; or he may be ignorant or unaware of the safe method.

It may be assumed that as a rule a factory worker desires to earn wages as high as circumstances permit; if wages are higher when work goes faster, it is not difficult to understand that he may be led to neglect safety in order to increase output. It can also be understood that many people will not give up an easier way of working (i.e. one that yields the same results with less trouble) just because another way is safer. These considerations have already been mentioned when discussing technical aspects of accident prevention (Lesson 5). If the worker can work more comfortably without a guard (as is sometimes the case with certain old-fashioned guards on woodworking machines), or give a better finish to the job if it is removed, he may well object to working with it, especially if he is highly skilled and takes pride in his work.

Working in a factory with many other persons, under foremen, overseers and managers, the worker may feel that, while it is necessary to obey orders, he does not want to do so more than is necessary. He may want to be his own master in his place and his job and to take care of himself. He may object to interference in personal matters, even to orders given in his own interest. This attitude, which is often mere bravado, can, however, be dangerous and lead him to take risks just to prove his independence; it should have been counteracted while he was at school or learning his trade. The same can be said of ignorance of safe working methods. Many difficulties met in accident prevention are due to insufficient vocational training.

There is another point that should not be forgotten when considering the reasons why so many persons do not co-operate in ensuring maximum safety. A person needs a powerful imagination to realise what an accident really can mean to him; it is very difficult, if not impossible, to realise what losing a leg or one's eyesight means and to put oneself in the place of a man who has.

The general psychological patterns of individuals are not exactly the same in all parts of the world, and consequently the workers' attitude to safety problems differs somewhat from region to region. In countries in the early stages of industrialisation workers are often unaware of the possibilities of accident-prevention work and consider accidents more or less as they consider diseases, namely unavoidable, mysterious afflictions that have to be suffered like bad weather. Much can be done to alter this attitude by placing suitable emphasis on safety questions during vocational training.

Environment and Frequency of Accidents

The worker's environment constitutes an important psychological factor in safety. It has been observed in many undertakings that the frequency of accidents is influenced by the general atmosphere. When relations between employers and workers are bad, when workers are dissatisfied with wages, working hours or other labour conditions, the number of accidents tends to increase, while in periods when industrial relations are good the opposite seems to be the case. Welfare measures designed to make the worker's life more comfortable also make it safer.

Workers' behaviour usually reflects their material and psychological environment. Reasonable wages, good human relations inside the factory, good understanding between management and labour, correct decisions on questions of promotion and, at the same time, well-cared-for workplaces, sanitary facilities much better than " good enough for a worker ", welfare facilities—all these material and intangible factors influence a worker's behaviour and have been found to be conducive to greater safety. As the same factors have a considerable influence on labour turnover, they also increase safety indirectly by making for stability among the personnel.

Insecurity of employment is almost certainly a factor making for accidents. When workers fear dismissal, they may well be in an emotionally unbalanced state which will make them more liable to have accidents. In countries with social security legislation guaranteeing payment of at least a part of wages in case of absence from work caused by an accident, but not in cases of ordinary unemployment, it even happens that accidents are caused wilfully to provide an income during an impending period of unemployment. However, such cases are not within the scope of ordinary accident-prevention work.

Good order, good housekeeping, and adequately guarded machines are examples of environmental factors that not only contribute materially to safety but also have a considerable psychological effect. People in a dirty, untidy workroom, cluttered up with tools, materials and rubbish, tend to behave differently from when they are in a clean, attractive workroom where good housekeeping is the rule. This difference in behaviour will usually be reflected by a difference in accident frequency.

Respect for the worker's feeling and dignity helps to give him peace of mind, and this is a most important psychological safety factor. Consequently the worker's body is more likely to be immune from injury when the management is careful in its relations with him as a person.

It should not be overlooked that peace of mind does not depend only on the situation inside the factory. Living conditions outside the factory also have an influence; living in slum areas has undesirable moral and physical effects and thereby adversely influences the worker's attitude in the factory and tends to increase accident rates. Here again it is clear that safety is not something that can be separated from other aspects of life, but is linked with them all.

The worker's peace of mind may also be disturbed by family circumstances. Remedying these situations is a very delicate task. Of course it is most undesirable to do anything that might give the impression of interfering with a worker's private life. Something can, however, be done when there are social workers in the personnel department of the undertaking.

FATIGUE AND BOREDOM

Many authorities consider that fatigue increases the risk of accidents, and the greater the fatigue, the greater the risk; but the relation between fatigue and accidents is extremely complex, and it is not easy to draw simple conclusions on the subject.

Fatigue makes a worker less attentive, slower in action and neglectful of precautions. However, the ordinary fatigue of the working day is not clearly reflected in the accident rates for the different hours of the day. In addition, the influence of fatigue differs with different persons. A worker who is very interested in his job will give all his attention to it and does not feel fatigue, while a worker who is not interested at all in his job tends to become inattentive and careless at times when fatigue cannot play an important part in his behaviour.

Accidents are often related not so much to physical fatigue as to the worker's mental attitude. This attitude depends to a high degree on whether he likes his work or not, and here again the general environment counts. Everything which helps to augment his interest and satisfaction in his work—things such as responsibility for the work, appreciation of the management, and being kept informed of what goes on in the factory—will tend to decrease his liability to accidents.

Some persons are quite satisfied with monotonous work; they do it almost automatically and without thinking. Accidents sometimes happen to them when for one reason or another something goes wrong with their machines or their work-pieces while they continue the usual movements automatically. This has happened many times to workers on metal presses. If the press has a defect in the clutch mechanism, the ram may descend a little later than usual; the worker already has his hand under the die to remove the work-piece and is hurt by the descending ram. In most cases such accidents can be prevented by the installation of a suitable guard. Other persons are irritated by monotonous work; they try to find variations in the ever-recurring cycle of movements and in this way cause accidents. In such cases accidents occur because they are too intellectual for this type of work and not because they are " playing with the machine ", as the findings of the accident investigation sometimes state.

Experience and Inexperience

On the subject of the influence of the length of service and the experience of the worker on accident rates it is equally difficult to draw clear conclusions, for the different factors influencing accidents influence one another and cannot be isolated. For instance the majority of inexperienced workers are adolescent and the majority of experienced workers are adult: it may be difficult to distinguish between the influence of age and that of experience.

The attention of workers who are not yet familiar with the factory environment will be distracted by the many new impressions they receive, and this in combination with their lack of experience of the job may provide an explanation of the relative frequency of accidents among newcomers. Much depends on the vocational training they receive before entering industry, and on the way they are introduced to their jobs and supervised. These problems are discussed further in Lessons 9 and 11.

Experienced workers are not handicapped by unfamiliarity with their surroundings; but their very familiarity with the risks of the job often makes them less careful, and this is an adverse factor. A characteristic example is the high number of electrical accidents occurring to electricians. Moreover, if no serious accidents occur in any particular type of work for a considerable time, the workers become less careful, for they tend more and more to assume that the danger is not so serious as they had been told. Safety measures will then be neglected till a new accident again shows the importance of safety precautions.

Accident Proneness

Statistics show that there are workers who have no accidents, and others who have several, in a given period. This suggests that certain workers are more liable to accidents than others; they are usually described as " accident prone ".

The question of accident proneness has a statistical basis; if in a group of 100 workers 100 accidents occur during a certain period, it is most improbable that every worker will have had one accident, even if the circumstances of all the workers are the same in every respect.

To understand this fact let us consider the simplest case of all: a group of two workers (A and B) in which two accidents occur. If A has the first accident, it does not inevitably follow that B will have the second; in fact, both A and B still have equal chances of being the one involved. Conversely, if B has the first accident, the second accident may happen either to A or to B. We have then four possibilities: that A has both accidents; that A has the first and B the second; that B has the first and A the second; and that B has both. It will be seen that in two of the four possible courses of events one worker will have both accidents and in the other two each of them will have one. The probability that each worker will have one accident is in this case 50 per cent. (i.e. two chances out of four); in other words, the chances are even.

When the numbers of workers and accidents involved is higher, this percentage will be lower. In the case of four workers having together four accidents, the probability that every worker will have one accident is only 9 per cent. (i.e. the chances or odds are about 11 to 1 against), but the probability that one worker will have two accidents, two workers each one accident and one worker none at all is 56 per cent.; in other words, the chances are slightly better than even. Consequently, if in such a group during a given period one of these workers has had two accidents and another none, this fact by itself is not a reason to blame the one or to give a bonus to the one who had none; neither does it indicate that the one who had two accidents was working in a more dangerous manner than the one who did not have any.

Similar calculations can be made for more complicated cases, e.g. for cases with a large number of workers and a smaller number of accidents. For instance, if five accidents happen in a group of ten workers, the odds are about 14 to 1 against one worker having two accidents (a probability of 7½ per cent.); consequently there is no special reason for blaming a worker who has two accidents, even though other workers in completely similar circumstances have none. (The odds on any one worker's not having any accidents at all are considerably better than even (about 5 to 3) precisely because one member of the group may have more than one.) The probability that one worker will have three accidents is 0.8 per cent., or about one chance in 125; such a worker should, from the statistical point of view, be suspected of suffering from accident proneness.

The conclusion to be drawn from these considerations is that when workers have more accidents than others working under the same conditions it is possible—but not certain—that there is a specific reason for the difference.

For the same mathematical reasons as those mentioned above it must be expected that one group of workers will not have the same number of accidents as another group working under similar conditions. However, investigations into the distribution of accidents in a group of workers have led to the conclusion that the differences in the numbers of accidents sustained by different workers cannot be explained entirely in terms of probability or chance. Some researches in this field have shown not only that a large proportion of the accidents occurring in a given period happen to a relatively small number of workers, but also that this same small group of workers also have more than their share of accidents during a subsequent control period. Some workers always have a large number of accidents, others are always found in the group with the least accidents, and still others move from one group to another. It is far from easy to find a satisfactory explanation for this situation. There are always many circumstances simultaneously influencing working conditions, and the workers and their circumstances change with time in several ways. This makes it extremely difficult to determine the influence of each circumstance separately.

Moreover, it is not sure that in statistics the same meaning is always given to the word "accident". If two persons meet with a different number of "accidents", it is quite possible that the difference is due to the fact that one of them considers an event as an accident while the other does not. It is also possible that statistical differences result from the fact that one worker has a slight accident which is included in the statistics while the other has a near-accident which is not. The number of accidents incurred by a given person can also be affected by unsafe acts of another person or by defective machine parts, which are matters completely independent of the mental processes of the injured worker.

As the attitude of a worker depends to a great extent on the conditions in which he lives inside and outside the factory, and as these conditions change in the course of time, a worker cannot be considered to retain complete psychological stability for ever, and a man who is accident prone during a certain period may well not be during a subsequent period.

Changing age and experience also influence the situation, and, all in all, it is very difficult to know whether workers considered to be doing similar work simultaneously are really exposed to identical hazards.

Investigations into accident proneness have shown that it has something to do with being distracted for one reason or another, with being "nervous" or "calm", with taking risks to show independence, with bravado and with "knowing all about it". Accident proneness may also arise when emotional persons do jobs requiring rhythmic coordination or monotonous work.

The complicated problem of accident proneness is not limited to the foregoing considerations. Some persons can easily give their attention to many things; others concentrate on one and experience difficulties when they have to divide their attention. These differences in attention to the environment have a bearing on accidents that depends on the type of work that has to be done. A crane driver, for instance, has not only to see how to pick up and transport a load, but also to watch the movements of persons in the machine hall where he is working. If his mental constitution does not permit him to pay attention more or less simultaneously to a number of different things there will be a kind of accident proneness that may result in accidents, not to himself, but to other persons.

Accidents can be caused by the influence of an earlier accident. If once an accident has happened and the worker finds himself in a similar situation to that before the accident, or has to continue work on the same type of machine, he may develop feelings of uncertainty, fear, resentment, etc., which may be conducive to another accident.

Another source of accidents resulting from the psychological attitude of the worker is the desire to show off knowledge, courage or skill. He wants to feel important, to attract attention, to be admired. Excessive haste (that is, working too fast for one's mental and physical capacity), may also result in accidents. The opposite is no better: the worker who is not sure of his skill or of himself may be accident-prone because he cannot act in time.

There are, of course, degrees of accident proneness; while one bad psychological factor—say vanity—may not be particularly dangerous, the combination of several—say vanity, carelessness and nervousness—in one person probably will be. Some people, aware of their defects, can do much, others little—depending on their personalities—to correct and to control them, and consequently capacity for correction must be taken into account.

If it were possible to find out what factors in the mentality of a person have a direct bearing on the chances of his having an accident, and if those factors could be measured by some kind of psychological examination or test, there would be ways of assessing accident proneness in workers before they are given a job. However, this would not be the final solution of the problem, for the end in view is not exclusion of a person from industrial work but employing him in a place where he does not encounter a particular risk. Hence the problem is ultimately a technical one: that of safeguarding the workers' environment in such a way that accident-prone persons have open to them the largest possible number of jobs not involving them in serious risks.

Physiological Conditions

Some accidents are attributable to the worker's physical condition. Many persons have eye defects without knowing it; others suffer from a certain degree of deafness; still others suffer from illnesses (e.g. epilepsy) which expose them and other persons to abnormal risks. Such cases should be given special attention by factory physicians, and, if it is impossible to eliminate the handicaps, suitable work should be selected for those suffering from them if circumstances permit. The problem is not how to exclude such persons from work but how to employ them usefully notwithstanding their physical defects or infirmities. If a physician is not available, the management should try to find a solution, and in any case should remember that accidents may be caused by physical defects.

Closely related to the accidents caused by defects or infirmities are those due to intoxications. Examples of such accidents are cases of errors of judgment caused by carbon-monoxide inhalation (as may occur with crane drivers in foundries) and accidents caused by persons intoxicated by alcohol, trichlorethylene, etc.

Questions

1. *Give some reasons why workers may do dangerous things.*

2. *Discuss whether workers who are satisfied with their conditions of employment are less liable to accidents than workers who are dissatisfied with them.*

3. *Can fatigue lead to accidents? If so, how?*

4. *Are experienced workers more careless than inexperienced ones?*

5. *What do you know about accident proneness?*

6. *Is there a relation between health and accident proneness?*

NINTH LESSON

PROPAGANDA, EDUCATION, TRAINING

The last lesson dealt with some aspects of accident prevention that relate more particularly to the workers' physical and mental characteristics and explained the special measures which might need to be taken to deal with workers with unhelpful attitudes or unsuitable physical conditions. This lesson is concerned with some measures which are aimed directly at the worker himself and are applicable to all workers, irrespective of their physical or mental make-up, namely measures of an educational character.

There are three main types of educational measures: propaganda, education and training. We shall begin with propaganda, which is the most superficial of the three, then discuss safety education, which is more systematic and thorough, and conclude with training, which is the most highly specialised and practical type of measure and should ensure that a man is really well able to do his job safely.

Propaganda is a matter of using stickers and posters, organising film shows, talks, competitions with rewards, safety weeks, and so on. These will be described in turn.

Safety education may begin in the elementary school and be continued in higher schools, trade schools and technical colleges. It can also be given in special courses and classes and in other ways.

Practical training can also be given through various channels: in trade and technical schools, in apprentices' courses and on the job.

While, generally speaking, propaganda seeks to persuade, education seeks to provide information, and training seeks to provide skill, there is really no sharp distinction between them, and all have some educational value.

PROPAGANDA

Posters.

There are all sorts of safety posters and each may help to promote safety in a different way. Some are humorous, some gruesome, some give general advice, some demonstrate a particular hazard in a particular operation, and so on. Posters may be used to deprecate common bad habits, show the general advantages of safe working, or give detailed information, advice or instructions on particular points. Some try to influence the worker by appealing to his pride, self-love, affection, curiosity or humour.

One type of poster (known as the positive poster) shows the advantages of caution; another type (known as the negative poster) illustrates the consequences of carelessness. Those in favour of positive posters think that showing a good example will result in its being followed. A positive poster may be of value, for example, at a time when workers are worrying about something—perhaps family troubles—and their attention wanders from their work. At such times they need encouragement, and it is therefore inadvisable to use negative posters which may cause fear or, as it is sometimes called, safety neurosis. The users of negative posters, on the other hand, think that workers do not realise the hazards to which they are exposed, and consequently should be shown the risks in a realistic way; and that to achieve results deeper impressions must be made than can be made by positive posters.

Figure 43 shows an example of a negative poster, published by the Egyptian Ministry of Commerce and Industry, while figure 44 illustrates the positive approach.

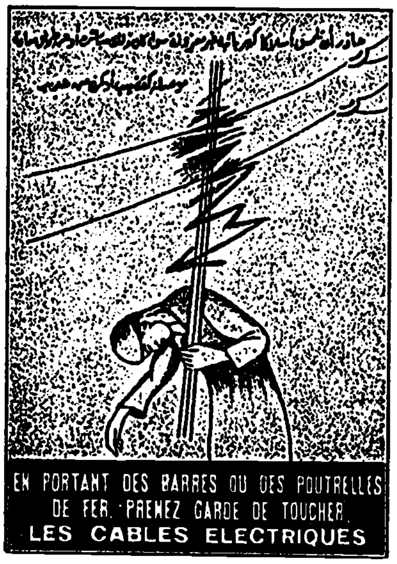


Fig. 43. When carrying iron bars or rods, beware of overhead power lines.

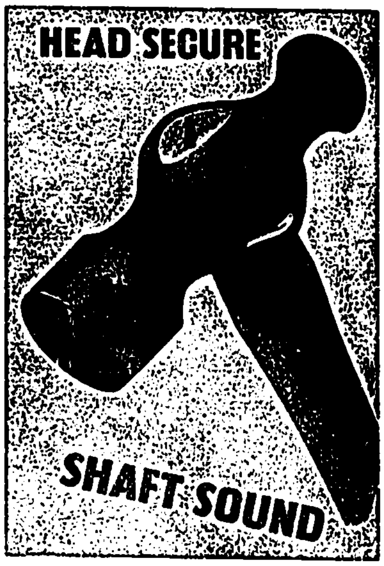


Fig. 44. Condition in which hammers should be maintained.

Both groups agree that safety posters should be chosen with due consideration to the mentality of the workers concerned, and that this mentality differs from industry to industry and from country to country.

Experience has shown that it is very difficult to design safety posters which have more than a momentary effect on workers. Several proposals have been made to meet this difficulty. One is that the artist who designs a poster should make sure that the details are right, a technician should verify that it is technically correct, and a psychologist should advise on whether the desired impression will be made.

Fig. 45. A "drawn" poster.

Some people recommend posters showing photographs, others prefer drawings. Photographs show real events and in particular provide a means of illustrating situations in the undertaking concerned. Drawings have the advantage of showing just the one thing that needs special attention and omitting all non-essential details. Figure 45 is an example of a good and simple drawing published in England.

Safety posters should be displayed in places where workers usually spend some time when not working, such as the factory entrance and locker rooms. As regards canteens, some people think that they should be places for rest and recreation providing a complete contrast to the factory itself, and that posters reminding workers of the workshop and the job should not be displayed there.

Bulletin boards for posters should be agreeable to the eye and properly maintained. They should be attractively painted, glass-fronted and well lighted. To stimulate the interest of the workers in the boards, notices and objects relating to safety in general or to a recent accident should be displayed on the same board. Such objects may be, for instance, safety shoes or goggles damaged during the performance of normal work. Only a small number of different posters should be displayed simultaneously, and they should be changed periodically, possibly at intervals of one or two weeks; even daily renewal has been proposed.

Safety posters can only be an accessory means of improving safety; they cannot replace good housekeeping, correct planning, good working habits and suitable guards, but they should stimulate workers to think more about safety. They have the advantage that they can be used anywhere, both in large undertakings and in small workshops, at little cost.

Posters can be useful for instructional purposes. If, for instance, a special type of guard is not adjusted correctly—as is often the case with the riving knife of a circular saw—or if an unsafe working method is followed (e.g. if loads are slung on the hook of a crane in the wrong way), the situation should be remedied by giving suitable instructions; but at the same time posters can be used as a reminder to indicate the correct way of dealing with these matters.

Figures 46 and 47 are examples of a poster giving an instruction.

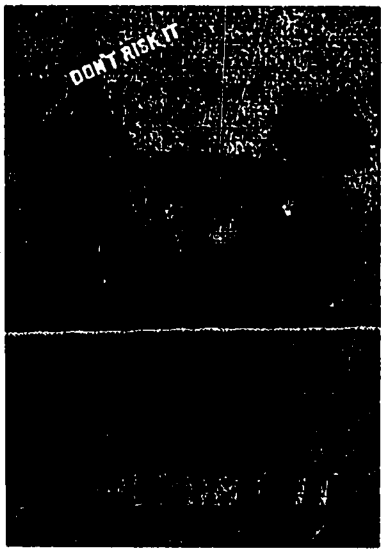


Fig. 46. Never take a chance with worn ladders.

Fig. 47. The assistant should wear protective clothing too.

Safety posters can also be used to illustrate a general rule. If, for instance, in a factory injuries often result in infections, and investigation shows that this is due to neglect of small injuries and failure to ask for first-aid treatment, the management may decide to display posters for one week in the different departments of the undertaking indicating the importance of first aid. To these should be added a notice with the name of the man in charge of first-aid treatment or the place where the injured worker should go.

However, safety posters should not be used for situations the remedying of which is the exclusive responsibility of the management. A poster warning against unsafe power presses should not be used, since the management is responsible for their protection and for installing guards and keeping these in good working order. In this connection figure 47 should be considered. The poster does not show whether the welder's assistant has been given adequate protective equipment for the eyes. Posters of this kind only have real value if they are designed to urge workers to use protective equipment that is actually available.

Safety posters should never be used to warn against hazards with the intention of enabling management to deny responsibility for accidents if the warning is not observed.

Films and Slides.

A poster gives just one impression of a hazard. A film can tell the whole story of an accident, showing the environment, how the dangerous situation arose, how the accident happened, what the consequences were, and how it could have been prevented. As many persons like going to the cinema, accident prevention programme organisers have tried to exploit the possibilities of films to make persons safety-minded. Here problems arise similar to those already mentioned in connection with safety posters, and the same means of solving them have been tried. Humour is often introduced into a film, as is the case with posters, to overcome objections to receiving orders and advice.

The situation in a factory should be shown accurately to prevent the film giving the impression that it is not based on normal working conditions. The feelings of the workers and their customs and circumstances should be carefully reflected.

As films have to show the situation to which the worker is accustomed and to consider his way of thinking, the same film is not necessarily suitable for different countries. For instance a film may show a factory with workers who start work in an unsafe way. Before a worker can complete his wrong working sequence and endanger himself or others, a girl arrives in the picture, holding back his hand or in some other way preventing an accident from happening and indicating how the work should be done safely. In countries where women are to a considerable degree emancipated, workers will watch the film with some amusement. In countries where the emancipation of women has hardly begun, however, workers will consider that if even a woman knows the job better than the workers in the picture the latter must be abysmally stupid.

Films made for specific instructional purposes are more valuable than those in the nature of general propaganda, and are particularly useful for explaining new safety devices or new working methods. Films can give oral explanations, show laboratory tests, analyse technical processes, explain difficult and complicated matters in a methodical way and reproduce a rapid sequence of events in slow motion. Nevertheless, demonstrations will often make a more vivid impression, and at the same time furnish opportunities for the audience to ask questions and discuss particular points.

Slides have some advantages over films: they can be projected for as long as desirable, more detailed explanations can be given, and questions can be asked. However, slides have the same limitations as posters.

Sometimes there is advantage in combining films and slides. A film giving a general impression of the subject may be followed by slides bringing out the main points of the film, which can then be discussed in detail.

It may be that television will also eventually be used for industrial safety education, for it enables actual scenes in a factory to be shown in the lecture room and so makes it possible to discuss questions with the audience without disturbing work in the factory.

Talks, Lectures and Conferences.

With talks, lectures and conferences much depends on the speaker's understanding of the audience. If he knows how to hold the attention of those who listen to him, he may have some influence on them. What is most essential is that the audience should feel that he is sincere. For instance, little can be expected from a speech by the manager of an undertaking at a safety meeting if it has been written by the safety engineer and if the manager shows that he is not very familiar with its contents or seems to be in a hurry to finish because he has something else to do.

As is the case with safety posters, films and other means of safety propaganda, talks and lectures and conferences can only contribute in a modest way to safety, but they do offer an opportunity for direct contact between speaker and audience, which is a great advantage.

Studies have been made of the value of talks and lectures, and the results have not been encouraging. Hence increasing use is being made of discussion groups, in which subjects are discussed either by all present or by a panel of persons who bring out the different aspects of the subject for the benefit of the audience.

Competitions.

Many people obtain great pleasure from sporting competitions; the idea of safety competitions is obviously one which must have considerable appeal to organisers of safety programmes.

Competitions are usually organised between factories working under similar conditions or between different departments of the same factory. Some mental reservations have to be made about them: as with individuals, there is a possibility of differences in accident rates that are not related to the behaviour of the persons concerned. Moreover, different departments of an undertaking present different risks, and for this reason interdepartmental competitions are sometimes based, not on the actual number of accidents taking place, but on the increase or decrease in that number in a prescribed period. The department showing the best results is usually awarded a prize (for instance a cup), which remains in that department until the end of the next competition period, when it goes to the new winner. The success of a competition does not depend on who is the winner, but on the improvement achieved in accident rates in the factory as a whole.

Safety competitions are frequent in some countries, but practically unknown in others. In countries where they are common they are considered to have made a useful contribution to safety; but they will lose much of their value if competitors cheat by not reporting injuries.

Exhibitions.

Exhibitions are a means of acquainting workers in a very realistic way with hazards and means of eliminating them.

One frequently encountered type of safety exhibition is the permanent ones found in safety museums. Their drawbacks are that it is impossible to keep them up to date for financial reasons; that only a small number of those persons who have anything to do with industrial safety—and, above all, very few workers—visit them; and the difficulty of proving that working systems demonstrated in a museum will prove effective under normal working conditions in factories and workshops.

One method of publicising an exhibition is to invite employers and workers to come and visit it; but a much more effective one is to take the exhibition where they can see it. Examples of this approach are itinerant and factory exhibitions. These usually deal with a very limited number of subjects, and are organised either by safety associations, acting on behalf of local industry or a single undertaking, or by an undertaking for itself. The best results can be expected when such an exhibition is combined with other safety activities having a limited objective. For instance, the management of a factory in which large numbers of eye accidents occur may decide to organise an exhibition of appliances for eye protection as the beginning of a campaign against accidents causing injury to eyes. In another case it may be of interest to organise an exhibition of scaffolding parts, showing how they should be assembled and used.

Attention can also be focused on safety questions by an exhibition of objects dealing with recent accidents in the factory, such as a broken grinding wheel, the flying pieces of which were caught by the hood, or a hard hat damaged by a falling object (in this case the object should also be shown). Such an exhibition shows the practical value of safety precautions. It is most important that the means of protection exhibited should actually be available to the workers. A very unfortunate impression will be produced if this is not done; for the workers will—with some justification—wonder why they are not available and may well feel that they have a legitimate grievance.

Safety Literature.

The types of safety propaganda so far described can also be used for illiterate workers. Documents, unless they consist entirely of pictures, are only of value for workers who can read.

The subject-matter of safety literature is practically inexhaustible, and the stream of safety publications is unending. In many countries safety magazines appear regularly, containing illustrated articles describing new safeguards, the results of investigations and research in the field of industrial safety, new ways of preventing accidents, etc. There are other periodicals designed not so much to pass on new knowledge as to disseminate knowledge of existing techniques to a wider public. It is important that editors of periodicals should be aware of their responsibility: in particular they should make sure that what is recommended is really based on experience and practice. All too often articles are published which describe safety measures used only in one single case, or even not in actual use at all but merely proposed. Such articles may do more harm than good. The reader, of course, before taking any steps to make practical use of the ideas contained in an article, must use his judgment to determine whether they are applicable in his own particular context and whether the experience quoted is sufficient to imply that their introduction would have a reasonable chance of being successful.

Some space is usually reserved in works magazines for safety subjects. The articles on safety are sometimes intended to be read not only by the worker himself, but also by the members of his family. Some people think that in this way an influence will be exerted on the worker by the family. The same idea—bringing safety into the worker's home—underlies radio talks and television shows on safety and the distribution of safety calendars.

Other vehicles for safety propaganda include pamphlets and leaflets, safety stamps, illustrations and slogans on pay envelopes, etc. So far as this material brings new ideas to the workers' notice it has a certain value. If, however, such propaganda only reminds workers of what is already common knowledge (with the intention perhaps of dispelling indifference), it is difficult to measure its value.

It must not be thought that documentation on safety is confined to magazines, pamphlets, leaflets, etc.. designed primarily for the workers and their families. There is a very large and steadily increasing quantity of safety literature, consisting of reports of labour inspectorates and research institutions, general safety manuals, manuals on particular subjects such as electricity, boilers and fire protection and all kinds of technical booklets, pamphlets, data sheets, and the like. This more scientific and technical material is useful to inspectors, managers, safety engineers, safety associations, and indeed to everyone bearing some responsibility for the promotion of occupational safety.

Safety Drives.

From time to time the need is felt to launch an intensive safety drive. One way of doing this is the organisation of a safety day or a safety week, perhaps on a national scale, perhaps in a city, perhaps in just one undertaking. When the campaign is organised for industrial undertakings generally the programme is usually a general one; but when it is organised just in one undertaking it may be focused on one particular subject. It may well make use of a combination of some of the different items of safety propaganda discussed earlier in this lesson.

National or regional safety days and weeks are usually patronised by the public authorities (such as the Ministry of Labour or the Governor of a state or province) and are given much publicity by the press, the radio, the cinemas, etc. The campaigns may include exhibitions, film shows, demonstrations, competitions, discussions, and so on.

In some cases the nucleus of a factory programme may be a single theme such as safety shoes, lifebelts or other safety equipment. The programme of a typical safety day might include an exhibition of the appliances, talks and film shows to impress on the staff the importance of the measures to be taken, competitions and the distribution of crossword puzzles which in some way or another mention the theme, and in conclusion a programme of entertainment for the workers and their families; in a final meeting the co-operation of everybody to prevent accidents of the type to which the theme of the safety day related is requested. On the next day the new safety equipment will be distributed.

FORMAL EDUCATION

In recent years there has been a growing realisation in a number of countries of the advantages of giving some industrial safety education in schools and colleges so as to ensure that entrants into industry have at least an idea of the dangers awaiting them and the means by which they can help to obviate them.

In the United States the Second World War gave a great impetus to the development of safety education. In 1941 the Department of Labor sponsored 96-hour safety courses under the Engineering, Science and Management War Training Program administered by the United States Office of Education; more than 70,000 persons completed them. A more advanced course was given to 7,000 persons in armament factories who had completed the first course. In 1942 the American Society of Safety Engineers' Committee on Co-operation with Engineering Colleges recommended that colleges and universities should provide integrated safety instruction as a part of each course regularly taught in the curriculum and specialised safety courses for undergraduates, especially those taking technical courses. Towards the end of the war the National Safety Council provided funds for the University of California, the Georgia School of Technology, the Illinois Institute of Technology and New York University to enable them to integrate safety engineering into their curricula. Similar measures were taken at the University of Maryland. The President's Conference on Industrial Safety has also made recommendations concerning the development of safety education. One is that teachers. authors and publishers should be encouraged to include appropriate safety references in textbooks; laboratory manuals and other instructional materials. Another is that engineering colleges should enable students to specialise as safety engineers.

An example of a university non-technical safety course is that provided by the Center for Safety Education at New York University. It comprises 16 subjects, of which the following nine are compulsory:

- SC—1 Accident Prevention: Its Background, Objectives and Relationships.
- SC—2 The Philosophy and Basic Principles of Accident Prevention.
- SC—3 Industrial Hazards, Mechanical and Personal; Control Methods.
- SC—4 Safety Directors and Safety Engineers: Their Qualifications, Duties and Responsibilities.
- SC—5 Safety Organisation: Values and Limitations.
- SC—6 Management and Supervision in Accident Prevention.
- SC—7 Industrial Hygiene and Occupational Diseases.
- SC—8 Fire Prevention and Protection Inspection.
- SC—16 Psychology of Accident Prevention.

The subjects of non-compulsory courses include motor vehicle safety, the prevention of accidents at sea and principles of safety inspection.

At the present time a large number of schools, colleges and universities in the United States run courses of various kinds on safety in engineering.[1]

Special attention has been paid here to the United States, where educational establishments providing safety courses exist in the greatest numbers; but similar facilities do exist in other countries, among which particular mention may be made of Canada, Italy and the Nordic Countries.

TRAINING

Training of Workers.

The importance of proper training in safety is attested by the fact that a high proportion of all the accidents which happen occur to people who are new to their jobs and have not yet developed safe working habits. The reasons for this are many, as was seen in Lesson 8. Often accidents occur because the worker was not aware that there was a risk; in other cases he perhaps knew that there was danger but did not know how to avoid it or felt that he need not do so. In some cases he did bother about the danger but did not wish to appear afraid. These are the kinds of accident which proper training seeks to eliminate. Training for safe working is no different from training for efficient working; in fact, the safety aspect should be, and often is, stressed equally with quality and speed by job instructors, foremen and vocational training instructors when they teach a job.

Safety training should reach as far as the factory gate. Many accidents occur outside the workplace: bicycle wheels and feet become trapped in rails, workers going to or from their work are knocked down by trucks, etc. The induction training[2] given by many undertakings to all new employees covers matters such as the organisation of transport within the factory area, the traffic rules applied and the precautions which the employees must take when going to their workplaces or when leaving for home.

The first part of the induction scheme is often instruction in general safety rules. Newcomers are taught by safety instructors, charge-hands or foremen about things such as the transport lanes inside the factory, the general housekeeping rules, the regulations regarding the use of

[1] The information in this section is taken from New York University, Center for Safety Education: *Training for Industrial Accident Prevention* (published in co-operation with the American Museum of Safety, New York, 1952).

[2] See Lesson 11.

transport equipment, safe working with electrical equipment, and the precautions to be taken when heavy loads are being transported through the shop. In particular, youngsters or other persons who have no previous experience of factory work may be told how they can help to keep the factory safe: picking up loose parts thrown around, putting sand or ash on spots of oil, disposing of oily cotton waste (so that spontaneous combustion cannot take place) and other things all workers must do, whether it is part of their job or not, to make their contribution to the general safety of the plant.

The next stage in training may be instruction for the first job. In modern plants job instructors, charge-hands and foremen are taught to analyse the job before they give instruction to newcomers, and particularly to identify the various difficulties and hazards which the trainee should learn to deal with.[1] The newcomers are taught safe methods of work, and the risks are explained to them to make them understand that deviation from safe methods may result in an accident. Moreover, the job instructor or supervisor should keep an eye on the newcomers throughout the training period, or until they have acquired the necessary routine, to make sure that they do not depart from the methods of working that they have been taught. A particularly dangerous time comes when the trainee begins to think he knows the job and to slacken his attention. He begins to take risks, looks up from his job while his hands continue working, and needs extra supervision and tactful explanations: in fact he needs "follow-up" on his training. Training for a specific job might have to be supplemented by some instruction on common jobs such as lifting heavy loads, using transport equipment, loading and stacking.

A more comprehensive course in safety may be given to new employees who are likely to remain in the factory after an initial period of employment. Instruction about such things as the care of belts, motors and electric wiring and the identification of weaknesses in such equipment, the capacity of the ropes and chains used in lifting, and other matters which it might be useful for an employee to know about may be given to supplement general instruction in lifting and transport operations.

Long-term trainees, in fact, are normally given more comprehensive instruction in regard to the safety aspects of work generally, and particularly of jobs which come within their trade. The syllabuses of many vocational training schools and apprenticeship courses include thorough instruction on safety and health risks, hygiene, care of clothing and the maintenance and care of machines, tools, equipment and materials

[1] See Lesson 11.

associated with the trade concerned. Supervisors in training schools and shops and senior workers taking care of apprentices are normally instructed to place particular stress in their instruction on the need to keep tools in perfect condition and order, and most of the textbooks used in the longer training courses emphasise this point as well. Trainees and apprentices are, for instance, instructed in the techniques of sharpening tools, of grinding the heads of chisels and drills which have mushroomed under hammer blows, and taught the importance of using safety equipment such as goggles or screens shielding grinding wheels, etc.

Training of Job Instructors, Job Setters and Supervisors.

Particular emphasis is placed today in most industrial undertakings on the training of supervisory or educational staff in the requirements of job safety, in the application of safe practices to work, and particularly in the teaching of safe practices to newcomers. A great number of courses have been designed for this purpose. A recent example is the job safety course for supervisors devised by the United Kingdom Ministry of Labour and subsequently incorporated in the general training scheme for supervisors known as T.W.I. (Training Within Industry). The general purpose of this course is to make the participants aware of the importance of the part they play in safety work in the factory and to teach them how to identify risks and to plan, and instruct in, safe methods for the job. Most of the other courses have the same general purpose and content, and may in addition contain specific instruction in regard to safe methods of work in a particular industry or occupation.

Some undertakings organise safety discussion groups for their supervisors where the responsibilities of instructors and charge-hands, supervisors and other staff in charge of the work of others are underlined, and where case studies are made of accidents which have occurred in the plant. It is normally one of the tasks of the safety inspectors and the safety engineer to instruct the responsible supervisory staff, and particularly the foremen and assistant foremen, in the action to be taken, when an accident has occurred, to ensure proper assessment of the cause and of the means by which a repetition might be avoided in the future.

Finally, the instruction given to senior shop personnel often includes a course in first aid, methods of putting out small fires, and matters such as the precautions to take—and the alarm bell to ring—when something untoward happens.

Training of Departmental Heads, Engineers, etc.

The training of middle management personnel today normally includes instruction in regard to occupational safety and health in the industry concerned and also in regard to the functions and responsibility of persons in these grades in such matters. Great progress has been made in many undertakings through training designers of tools and equipment to pay all due regard to the safety aspects of the work in which the tools and equipment are to be used. Similarly, safety is considered in the design of machine tools; the technique of designing proper guards for machines is today an important aspect of the training of machine constructors.

The training of safety inspectors and safety engineers (see Lesson 11) is, of course, the most thoroughgoing safety training given to any industrial staff. These persons must be able to study operations from the safety angle, identify risks and design safe working methods or equipment enabling the machines and tools to be safely handled. They must have a sound knowledge of the laws and regulations and the safety rules applying to the industry concerned and the methods of investigation and reporting required by insurance companies, factory inspectorates and other outside agencies with which the undertaking has relations. Many factory inspectorates, voluntary associations for the prevention of accidents and employers' central organisations organise special courses for such safety officials to help prepare them for their highly specialised work.

Training of Workers' Representatives.

Finally, a few words should be said about the training courses organised by many trade unions for the purpose of educating workers' representatives on safety committees and shop safety representatives of workers in plants.[1] These courses normally give instruction in the laws, regulations and rules applying to the industry concerned, the general policy of the trade union in regard to safety work, joint consultation on safety questions with management, and other matters which might be of use to a workers' representative in a plant.

Questions

1. *Describe some means by which safety propaganda is disseminated.*
2. *How can safety posters contribute to accident prevention?*
3. *Compare the educational value of posters, films and slides.*

[1] This subject is dealt with at greater length in Lesson 14.

4. *How can schools and colleges help to promote occupational safety?*

5. *Discuss whether, and if so why, safety training should be given to—*

   (a) *workers on very dangerous jobs;*

   (b) *all workers without exception;*

   (c) *foremen and other supervisors;*

   (d) *managerial staff.*

TENTH LESSON

SPECIAL CATEGORIES OF WORKERS

So far we have been concerned with aspects of safety and accident prevention that involve all workers; but there are certain categories of workers which need special consideration because, for one reason of another, they are exposed to special risks. In many countries some or these groups—children, young persons and women—are the subject of special legislation; but there do not appear to be any special safety regulations for the handicapped or the elderly worker. Nevertheless. the latter groups have formed the subject of a certain amount of study, Another special category of workers, but of a rather different kind, comprises those required to possess an official certificate of competency.

Children and Young Persons

Young workers need special care for both physiological and psychological reasons. They usually lack the physical strength of the adult, they are apt to act impetuously and they are wanting in experience; in short, they are both physically and mentally immature.

There is no sharp distinction between a child and a young person: the one category merges imperceptibly into the other. Two international labour Conventions adopted in 1937, concerning the minimum age for admission to industrial and non-industrial employment respectively, prohibit the employment of children under the age of 15 years in industrial and non-industrial work but provide that different minimum ages may be fixed in certain circumstances.

Most countries now have laws which fix a minimum age for admission to employment and thus exclude children from all industrial work. As noted, the relevant international labour Convention fixes this age at 15. In individual countries it ranges from 14 to 16 years, or even higher, in the industrially developed countries to 12 or 13 years or even less in the countries in which industrialisation is just beginning. In the latter countries minimum-age laws are often inadequate or not enforced owing to lack of schools, family poverty, lack of properly equipped inspection services or other reasons. In such countries children as young as 5 years of age may be allowed to work in industrial undertakings, exposed to all the risks of industrial work, and fatal accidents among them are all too frequent. The prohibition of the employment of children under a given minimum age fixed realistically in the light of national circumstances is a vital necessity for the protection of their health and safety.

Young persons under 18 or 20 years of age also need special attention from the safety standpoint. In many countries the law requires them to undergo medical examinations to ascertain their fitness for work before they are admitted to employment and to remain under medical supervision until they reach a certain age, which varies between 18 and 21 years according to the country. The subject is dealt with in two international labour Conventions adopted in 1946, one for industrial and one for non-industrial employment.

In several countries the law places restrictions on the work of young persons in order to prevent their employment in dangerous conditions. This phrase covers work that directly exposes workers to danger (e.g. work that has to be done at considerable heights on buildings under construction); work that brings the worker into contact with very toxic substances, such as white lead or cyanides; work classified as "heavy", such as stoking steam boilers; work that lays on the worker great responsibility towards fellow workers, such as the operating of certain machines; work for which adequate protection does not yet exist, such as certain types of work on metal presses; and work that demands a particularly high degree of concentration, such as work on electrical installations. Restrictions are also frequently placed on the employment of young persons in some types of work which are clearly harmful to their health.

A good many of the laws and regulations specifying the dangerous, heavy or unhealthy jobs prohibited to young persons include exceptions designed to enable a young person to obtain suitable training for such work. Most of them provide, too, for the lists of prohibited jobs to be revised from time to time in the light of technological progress which may reduce the danger of accidents occurring to young persons.

Young persons may be protected by the managements of undertakings as well as by statutory prohibitions. Many occupations can be followed by young persons provided that safe working conditions are maintained. Safe working conditions imply correct working habits, and great care should be taken to teach them during the period of apprenticeship.[1]

Safety can never be considered as an accessory to a working method, but should be incorporated in the method itself. This rule must be

[1] See p. 114.

followed not only in technical schools, but also in training courses for newcomers inside the factory, and whenever the apprentice has to learn his work by helping an experienced worker. If we consider the prohibition of child labour as the first step towards greater safety, the second is to provide young persons with adequate safety training facilities, if possible in the form of technical schools with teachers well versed in accident prevention. This is not only important from the point of view of the work that young persons will have to do in factories later; it is equally important for maintaining safe working conditions in the schools themselves, where relatively large numbers of serious accidents still occur. The following are examples of what can happen if these precepts are neglected:

Example. An apprentice blacksmith was hammering an iron bar on an anvil, and a steel splinter from the hammer flew into his eye; the eye was lost and the boy had to change his job. Better maintenance of hand tools and the wearing of suitable safety goggles would have prevented the accident.

Example. A 15-year-old apprentice in the woodworking shop of a technical school was working on a circular saw which was not adequately protected. The boy's left hand came into contact with the sawblade, and three fingers were severed.

Finally, when young persons leave school or finish their training courses and enter the factory to start ordinary work, it all too often happens that the safe working methods they have been taught are " looked down on " by the older workers; this attitude often intimidates the new arrivals, and in order to " be like the others " they abandon their safe working methods and follow the general practice. Much safety educational work has been wasted because of such attitudes. The teaching of safe working practices is not sufficient; conditions in the factory must be such as to encourage their use, and steps must be taken to ensure that their use continues until they become second nature.

One cause of accidents involving young workers is lack of a sense of responsibility for themselves and others. Very serious, even fatal, accidents have occurred to young persons during breaks. Hoisting appliances, transport equipment and other potentially dangerous installations are an extremely attractive source of amusement for young people during rest hours. The following [1] are examples of the kind of accidents this attitude can cause:

Example. During the dinner hour at a printing works two boys began to play with a sack hoist the lifting chain of which was fitted with double hooks supporting a hessian hammock. One boy operated the control rope while

[1] United Kingdom, Ministry of Labour and National Service: *Annual Report of the Chief Inspector of Factories for the Year 1952* (London, H.M. Stationery Office, 1953).

the other sat in the hammock and rode up and down. During one of these rides the motion of the hoist was reversed abruptly and the boy in the hammock was ejected violently.

Example. Two boys employed on night shift in a steel rolling mill decided to amuse themselves by playing with two narrow-gauge battery-operated locomotives. While they were putting them back in the shed, one boy fell in front of the locomotive he was driving and was killed.

It would be wrong for management to deny responsibility for these accidents on the ground that horseplay should not occur and that the accidents happened to persons unauthorised to handle the equipment concerned. The management must realise that such accidents often do happen; that measures for their prevention have to be taken, and that here too it is more important to prevent accidents occurring than to assign the blame once they have occurred. This is particularly true in cases where it is easy to cut off power or lock control handles. As usual, good order and good supervision can do much to prevent such accidents.

Women

Generally speaking, the safety rules applying to men are equally valid for women workers. In some cases, however, special additional measures have to be taken to protect women from certain occupational risks because of their maternity functions.

An indirect accident risk arises if women employed in factories are permitted to take their children to work with them; for children may play in the proximity of running machines or come into contact with dangerous substances. This is the case in some cotton-spinning mills where women work on winding machines, at the same time taking care of their little children, some of whom play on the floor between the machines during the whole working time; and in plant for sorting uncleaned wool in which women in charge of sorting are accompanied by babies and assisted by somewhat older children. The children are exposed to a very real risk of anthrax.

In all such cases a crèche would not only provide a place where care could be taken of the children, but would also be a means of preserving them from accidents.

Women sometimes need special safety education and clothing to minimise the risk of accidents. Loose clothing or hair may be caught in moving machine parts. For instance, a woman working on a sewing machine in a shirt-making factory bent her head under the machine table to pick up a pair of scissors from the floor and her hair came into contact with the transmission shaft. A large part of the hair and scalp were lost. Special measures may be necessary to prevent such accidents.

It would be interesting to know whether women have relatively more or fewer accidents than men doing similar work. However, there are not enough statistics available covering a sufficiently large number of men and women working under similar conditions.

Elderly Workers

It is well known that some physical capacities, such as sight, hearing-agility and reaction speed, decline steadily after the age of 30 or there, abouts. On the other hand, older workers may be more careful, reliable and conscientious than younger ones. The problems of accident prevention among older workers may therefore differ in some respects from those affecting workers in general.

The precise effects of aging on accident causation have not been studied extensively, but it has been found that some types of accident (such as falls of persons) tend to occur more frequently among elderly than among young and middle-aged workers.[1] There is also some evidence that the average severity of accidents increases with age. For instance, in Sweden, while persons over 60 years of age accounted for about one-fifth of all disablement cases, they accounted for nearly one-third of the cases with disablement of over 50 per cent. At present, however, the reliable data available are too scanty to permit of any firm conclusions.

Handicapped Workers

There are at present very considerable numbers of blind, crippled and otherwise handicapped workers—many of them owing their disabilities to war wounds—in industry. Provided that they are given work suited to their capabilities there is no need to take any special safety precautions in respect of them.

Certificated Personnel

The safe operation of some installations, such as steam boilers, steam engines, electrical plant, cranes and locomotives, depends to a considerable extent on the competency of the personnel responsible for operating them. In some countries such installations can only be operated by holders of official certificates of competency. Some of the regulations covering the qualifications, examination, certification and employment of such workers are very comprehensive. For instance the regulations concerning " operating engineers " of steam, compressor or refrigeration

[1] Riksförsäkringsanstalten: *Olycksfall i arbete år 1954* (Stockholm, 1957).

equipment in force in Ontario (Canada) deal with such matters as shift work, sickness and holidays, and absences exceeding 15 minutes, and have different provisions for the operation of machinery with different levels of horsepower.

Questions

1. *What special measures, if any, should be taken to protect children and young persons against accidents and why?*

2. *Are there any accident risks peculiar to women?*

3. *Why should some categories of workers be required to possess certificates of competency?*

ELEVENTH LESSON

SAFETY ACTIVITIES IN THE UNDERTAKING

Laws, regulations, inspection, recommendations, advice, research, exhibitions, congresses and all the rest will none of them serve any useful purpose in the last resort if nothing is done to promote safety in the factory itself. We have described the different forms of activity carried on outside the factory to promote safety and now come to the organisation of safety activities in the factory itself.

It cannot be repeated too often that the manager himself must take the lead in promoting safety activities. Everybody in the undertaking should know that the employer is interested not only in production, in the quality and quantity of the products, in preventing waste of material, in proper maintenance of machines and tools, but also in safety. This lesson deals with the responsibility of management, the delegation of this responsibility to the supervisory staff, the status and activities of safety committees and safety engineers, and related matters.

Among the more technical safety measures discussed in Lessons 4, 5 and 6 were good planning by management, the use of safe working methods by the workers, good order and good housekeeping, and the guarding of dangerous machines. Management has to organise processes efficiently, combining a maximum of production with a minimum of cost, and treating safety not as an extra but as part of the process itself. Correct working habits should be inculcated by adequate vocational training [1], which must where necessary be followed up in the factory itself. Good order and good housekeeping are essential for production as well as for safety, and so are guards. As regards the psychological aspects of safety it was observed that a working condition conducive to the worker's peace of mind would greatly help to promote safety.[2] In the undertaking, management has to decide what should be done about all these problems and give the necessary orders. The man usually responsible for carrying these out is the foreman. who consequently has a vital part to play in all safety matters.

[1] See p. 113.

[2] See Lesson 8.

In large undertakings guidance in safety matters may be given by a safety engineer, and the co-operation of all concerned organised and encouraged through a safety committee. As a rule the personnel department will be responsible for recruiting new employees and for vocational training inside the undertaking. In small undertakings the principles of promoting safety are the same as those in large ones, but the organisation of safety work is of course much simpler.

One problem which frequently arises is that of whether an undertaking should have both a safety engineer and a safety committee. As the safety engineer is a safety expert, while the safety committee's primary duty is to establish effective co-operation between employer and workers in the field of safety, there is room for both. However, in smaller undertakings there is not enough work to provide full-time employment for a safety engineer, but there is scope for a safety committee. In the smallest undertakings the need for a safety committee is less apparent, since personal contact between management, supervisory staff and workers is much easier to establish and personnel relations are more intimate. The *Model Code of Safety Regulations for Industrial Establishments* recommends the appointment of a safety committee in each department in which at least 25 workers are regularly employed. In a very small undertaking, instead of a full-scale safety committee there should be one or more workers' safety delegates with roughly the same duties as members of a safety committee.

The Role of Management

The slogan "safety begins at the top" clearly states the essential condition for successful safety work in an undertaking. Foremen, safety engineers and other staff members can never achieve substantial results if the management does not take the lead in promoting and maintaining high safety standards. The influence of management must be manifest in all that has to do with the working environment and the handling of the people in the undertaking.

Environmental factors which have proved their worth as means of reducing the number of accidents include cleanliness, efficient production, high-quality equipment, machines with individual motors, excellent lighting, carefully chosen colours for ceilings, walls and machines, an adequate air-conditioning system, and suitable seats. The management's concern for safety must also be attested by such things as properly guarded machines, the adequate protection of danger spots, the provision of suitable tools and their proper maintenance, ample provision of good personal protective equipment, regular maintenance and repair services, and good housekeeping. Where such things are lacking the workers will never believe that management really bothers about safety, and in all probability they will not bother either.

The management should leave no doubts in the minds of the employees that it is particularly concerned about accidents. If, for instance, after a serious accident the manager not only looks at the accident report, but also obtains first-hand information from the victim, the foreman or the department manager, he will, besides giving the personnel the impression that he takes safety seriously, also emphasise the responsibility of the foreman and the department manager for what happens in their department. If the accident is serious, the concern of the management might be made manifest in some appropriate way at the hospital or the worker's home.

In many countries employers usually have a strong feeling of responsibility for safety and are willing to consider every serious proposal for improving it. Employers who do not will draw on themselves the attention of the labour inspection services and may even be subjected to pressure by trade unions. However, in countries which are technically less developed many employers need education in safety-mindedness; for they are reluctant to believe that much can be done to reduce the number of deaths and injuries caused by industrial accidents. There are ways of instilling more positive attitudes into employers; some of them are described in Lessons 12 and 13, which describe the role of governments, safety associations, trade unions and other bodies in the promotion of occupational safety.

The Role of the Foreman

The enforcement of safety measures depends to a great extent on the foreman, for the workers are in his charge and their behaviour will be powerfully influenced by his. If the foreman wants to devote all his time to production or feels that he has more important things to do than promote safety, his department is likely to have a bad accident record. However, having regard to the cost of accidents, it might be thought that the foreman who can think only of costs would want to prevent accidents anyhow. Moreover, he would probably not think that he had more important things than safety to think about unless he was encouraged to do so by a management insufficiently safety-minded. A foreman may also be overworked and have to neglect some jobs; then safety standards may suffer seriously.

Example. A metal press had to be overhauled and repaired. After some parts of the press had been replaced the usual guard could no longer be used, and some alterations were needed to enable it to be fitted on. As the foreman knew that some articles were urgently required, he ordered them to be made on the press without waiting for the guard to be fitted " so as not to lose time ". The worker started work and had an accident resulting in mutilation of his right hand. As the firm carried its own risks, it had to pay about $5,000 direct costs and lost an unknown amount in indirect costs. Thus failure to wait a day or two for the guard resulted in a considerable financial loss and, what is far worse, caused permanent disablement of a worker.

The foreman should be convinced that accidents are preventable, just as he is convinced that wastage of material is preventable and that working methods can be improved. He should know what safety demands in different situations; where necessary he should be able to obtain guidance from the safety engineer or, if there is none, from some representative of the management. He has to give continuous attention to the hazards of the equipment and processes in his department. For instance, he has to see that guards are correctly mounted and used, that machines and tools are properly maintained and repaired, that correct working methods are followed and that no unsafe practices are tolerated.

For the workers the foreman represents the management. He has to see that the intentions and orders of the management are carried out by exerting his personal authority and influence. If the foreman does not take safety seriously, those under him will not either. On the other hand, if he is convinced of the importance of safety, if he shows that safety has to be considered all the time, and if he himself does everything that reasonably can be done to prevent accidents, workers will follow his example.

The Role of the Safety Engineer [1]

While the foreman is the man responsible for the enforcement of safety measures, the safety engineer (or the factory safety inspector or other factory safety official performing similar duties) is the general adviser on safety. As he is only an adviser the success of his work must depend a good deal on his character, but he will always need the support of the management. He discusses safety problems with the supervisory staff and often with the foreman, making recommendations but leaving responsibility for their implementation—and the actual decision whether to implement them or not—with the line of command.

The duties of the safety engineer are, in short, to eliminate hazards and will usually include the following:

(a) formulating and supervising the execution of the company's general accident-prevention policy;

[1] See also *Model Code of Safety Regulations for Industrial Establishments*, op. cit., Regulation 244, paragraphs 26-28.

(b) reporting to and advising management on all safety matters;

(c) giving guidance to supervisory staff;

(d) investigating accidents;

(e) keeping accident records and statistics;

(f) supervising safety training;

(g) examining plant, equipment, processes and working methods;

(h) serving on the safety committee if there is one;

(i) drawing up safety instructions, guides and other safety literature;

(j) directing safety activities such as competitions, exhibitions, and propaganda campaigns;

(k) inspecting fire-protection equipment and facilities and directing fire-protection activities such as drills;

(l) in general, doing everything he can to bring the factory into a safe condition and keep it so, and to eliminate unsafe working practices.

The matters on which the safety engineer will report to and advise management under *(b)* will include—

(1) the planning of new buildings or the alteration of existing ones;

(2) the acquisition of new machines and other equipment;

(3) the condition of existing equipment;

(4) arrangements for the testing, maintenance and repair of equipment;

(5) safety devices of all kinds;

(6) personal protective equipment;

(7) fire protection.

The safety engineer has a special status when work has to be done that calls for extraordinary precautions, e.g. welding tanks used for highly flammable liquids. In such cases he is no longer just an adviser: work should not start until he has given his permission. As a rule he has to provide the department in charge of the work with a written permit indicating the precautions to be taken; and while the work is going on he will supervise it very closely.

When during a plant inspection the safety engineer discovers an imminent and serious danger he usually has the authority to order a stoppage of work until the necessary precautions have been taken to permit it to be continued safely.

There have been differences of opinion as to the position that the safety engineer should occupy in the factory hierarchy, but there is a wide measure of agreement that he should have a high rank and report directly to the top management.

Small undertakings that cannot afford a full-time safety engineer may combine to share the services of one.

Example. During the construction of a power station by a group of co-operating firms, each one took care of a part of the construction (steelwork, brickwork, boilers and engines, electrical installations, etc.). These firms joined together to appoint one safety engineer for the whole site. In this case the co-operating firms were not small ones, but each was represented by a relatively small number of workers. The need for one safety engineer to look after all the workers on the site was demonstrated by the fact that one of the firms protected dangerous places only as long as its own workers had to work near them, so that when the workers from other firms took over they found the places completely unprotected. Moreover, difficulties arose as to who had to provide guards. When a safety engineer was appointed, problems of this kind were settled, safety was improved and everybody was satisfied.

Example. A number of small road-construction firms convinced that a separate safety engineer for every firm was too expensive, but also that observing safety precautions could only be an advantage for everybody concerned, decided to co-operate on safety matters. Here too the arrangement adopted satisfied the firms concerned.

Sometimes an arrangement of this kind may be difficult to bring about. A safety engineer has to deal with many aspects of the undertaking, and many owners of small firms are reluctant to introduce anyone into their undertaking who also works for other firms. In such cases an alternative to sharing a safety engineer might be for each undertaking to combine the duties of a safety engineer with other duties, e.g. those of chief of the maintenance and repair department. In very small undertakings all safety activities could be entrusted to a foreman.

SAFETY COMMITTEES [1]

Safety committees are established to promote safety by co-operation between employer and workers; in some countries the law makes their establishment compulsory while in others they are voluntary in character. The management should use the safety committee to explain the safety policy of the undertaking, for through the committee members it can reach all workers; conversely, the latter should turn to the committee to put their views and suggestions on safety matters to the management. The safety committee should help to give workers confidence in the safety policy of the management and help to make the management appreciate the safety experience of the workers. In brief, the safety committee should contribute to mutual understanding and good team work between management and labour to improve safety.

[1] See: *Model Code of Safety Regulations for Industrial Establishments*, op. cit., Regulation 244, paragraphs 17-25.

Safety committees should preferably consist of representatives of both the employer and the workers. The employer's representatives should always include the staff members who have direct responsibility for safety, such as the manager or a deputy, the safety engineer, foremen, and the factory doctor if there is one.

As many persons as possible should serve on these committees, because membership is very likely to stimulate interest in safety. Worker members could, therefore, be appointed for a limited period (e.g. one year), so as to allow all the workers to serve on the committee in turn. In most cases the workers' members will be elected by them, but sometimes they will be nominated by the employer. In undertakings with a number of departments there may be a safety committee for each department and a central committee for the whole undertaking.

To increase the number of workers participating in committee meetings, in some undertakings one or two workers who are not members but work in a department that is directly concerned with an item on the agenda may be invited to attend a particular meeting to give their opinions or make proposals. The same persons may be invited for two consecutive meetings; in the first they can make proposals, and at the second they are informed of the action taken on their proposals.

In some undertakings safety committees have been working successfully for many years and have built up good relations between employer and workers and useful co-operation in safety matters. In others committees have been less successful: after a reasonably good start the members have found themselves at a loss for subjects to discuss and have lost interest. Investigations into circumstances that have had a favourable influence on the work of safety committees or been responsible for their failure have shown the following considerations to be of particular importance:

(1) The items on the agenda of every meeting must be carefully prepared, so that, if necessary, the chairman can give the members clear guidance on every point that may come up. The discussion must never be allowed to become confused. In some factories the first item on the agenda of every meeting is communications from the management which convey information of general interest, concerning, for instance, new developments and plans. The general atmosphere of committee meetings has sometimes been improved by giving members an opportunity of discussing subjects of particular interest to them, even if those subjects are not strictly within the field of safety. Everything possible should be done to keep the committee interested in its work.

(2) Failure has often been due to overlooking the fact that promoting safety is a matter not only of goodwill but also of competence. This does

not mean that every member of a safety committee has to be a safety expert, but it does mean that enough members should know enough about safety to make the committee competent to perform its task.

(3) Worker members should always feel free to express their opinions and should not have cause to fear that if they make criticisms their superiors will make life difficult for them. An employer or senior managerial official will seldom object to constructive criticism; but sometimes a foreman resents what he feels to be personal criticism in discussions on safety in his department, and it may require the joint efforts of the management and the committee to smooth matters out and so allay the fear of reprisals in the workers' minds.

(4) A safety committee must feel that it is backed by the employer. This can be ensured by having a member of the management as its chairman, providing suitable facilities such as a comfortable, well-furnished room for meetings, allowing the members time off to attend them, furnishing secretarial assistance, permitting members to visit any place in the factory when there is good reason to do so in the interests of safety, and perhaps in other ways.

(5) The committee should meet regularly, for instance once a month. One item on the agenda of every meeting should be discussion of any accidents that have occurred in the undertaking since the last meeting. The discussions should be directed to determining the cause of each accident and working out measures to prevent its recurrence.

(6) Committee members, accompanied by the safety engineer or another competent person, should make periodical inspections of the undertaking. In this way they will see conditions for themselves and have opportunities of discussing them with the safety engineer; it is important that the members should understand why the different safety precautions are taken and be able to judge their practical value. Inspections of parts of the undertaking may also reveal how safety measures are carried out, and members will be particularly interested to see the effect given to their recommendations.

(7) The committee should be consulted on all proposals for new safety measures so that as far as possible those finally adopted have the support of both the employer and the workers.

(8) If a proposal made by the committee is rejected by the management, the committee should be informed of the reasons.

(9) All needful information, such as statistics, should be given to the committee members, not only to keep them informed of the general situation and the accident trend but also to provide them with a sound basis for discussing improvements.

Members of safety committees have the general duty of promoting the co-operation of all workers in the endeavour to improve safety standards. They should try to secure obedience to safety instructions and to counteract indifference and passive resistance. The dislike that many persons have of taking orders may be avoided when these are explained by fellow-workers who are not in authority but are respected or liked.

Committee members should try to replace the attitude of " I can take care of myself " with one of " I am a fool to take unnecessary risks ". They are more likely to be successful the more workers are given a voice in the formulating of safety regulations. The co-operation of the committee is particularly valuable when the time comes to inform workers of safety regulations, instructions and the like—a task more difficult than it seems. It is not sufficient to give workers a booklet of safety instructions; the contents must be explained to them, if necessary several times, to ensure that they are understood. On the other hand, safety committee members are in a position to inform the management of the practical value of instructions given and of improvements in them likely to make them more effective.

In some undertakings the chairman of the safety committee is authorised to invite a worker who has had an accident to explain how it happened so that if it was partly due to a mistake or fault on his part the latter can be pointed out to him. Whether such an arrangement can be recommended or not depends entirely on the personality of the chairman. If he deals with such cases tactfully, an advantage will be gained in that the criticisms of the worker's behaviour will come, not from the foreman, who is responsible for safety and is in addition his direct superior, but from a more neutral person who is concerned solely with accident prevention.

Lastly, a member of a safety committee should not forget that one of his main duties is to report hazardous conditions to the safety engineer mmediately and not to wait till the next meeting to do so.

Job Safety Analysis

Just as productivity can benefit from work study (job analysis), so can safety benefit from job safety analysis. What is more, the two are intimately bound together; the work-study man cannot ignore safety and the safety man cannot ignore productivity considerations.

Job safety analysis, whether effected as part of work study or not, can do much to eliminate the hazards of a job. The analysis isolates every single operation in a job, examines the hazards of each and indicates what should be done about them. It involves the examination of work permits, drawings and tools, the qualifications required of the worker doing the job and the instructions and training that he needs.[1]

One way in which work study can simplify the task of job safety analysis is by eliminating unnecessary operations and simplifying complicated ones. It is well known, for instance, that large numbers of factory accidents occur during the handling of materials. If work study can reduce the number of operations in which materials have to be handled it will *ipso facto* remove potential causes of accidents.[2]

Safety Instructions

Another safety measure used in factories is the issue of safety instructions for handling materials, operating machines or other kinds of work. Such instructions cannot replace protective devices, but may be useful in supplementing them or where their installation is not practicable. Instructions should be issued, for instance, on the way in which hoisting chains and wire ropes are to be used, stored and examined, and on the maintenance of machines and other equipment.

Preparing instructions is not difficult; the real problem is their enforcement. The best way to ensure that rules are obeyed is perhaps to give those who have to obey them a part in their drafting. This can be done through the safety committee, or, if there is no safety committee, by some other form of consultation, perhaps through the intermediary of the trade union. It must not be thought that the issue of rules and instructions dispenses with the need for constant supervision. Indeed, supervision is the only means of ensuring that rules are obeyed. In any case it is not enough merely to issue instructions; steps must be taken to ensure that they are understood.

Instructions are useless unless they are complied with. If in practice they are ignored and there is no apparent means of enforcing them, they should be changed or withdrawn. A rule which is not observed does no good; on the contrary, the impression is given that it is unnecessary to obey any rule, and in this way the value of all rules is impaired. Consider, for instance, the following passage in the foreman's manual of a large undertaking:

> The use of safety shoes is recommended in many jobs, but the responsibility for their use is left with the employee.

At first sight it might seem that safety would be much better served i the passage read:

[1] For further details see M. A. Gimbel: "Job Safety Analysis", in *Industrial Safety*, op. cit., Ch. 10.

[2] I.L.O.: *Introduction to Work Study* (Geneva, 1957), p. 69.

Metal toe guards or safety boots or shoes shall be worn in operations such as piling pig iron and logs, or where heavy materials are being handled.[1]

However, if the management is of the opinion that for the time being it is impossible to enforce this regulation, it is much better only to recommend the use of safety shoes with the intention of replacing this passage by a more mandatory provision as soon as circumstances permit enforcement of a rule. Such a question might be put on the agenda of a safety day or of a safety committee meeting, and an endeavour might be made to secure the voluntary co-operation of the workers.

It is of particular importance that instructions which are systematically ignored should not be used by management as a means of escaping responsibility for accidents resulting from failure to obey them. From the accident prevention viewpoint it may even be necessary to prohibit the use of an appliance if failure to obey safety instructions may result in imminent danger.

Example. In a number of countries there is a rule[2] that the design of acetylene generators should be such that the decomposition of carbide does not take place in a gasholder under a movable gas bell. This rule is laid down because generators in which this occurs have to be cleaned after a prescribed quantity of carbide has been used. In the past, however, this rule was not fully observed; cleaning was often done only when much more carbide had been used than was specified in the instructions. The result was that on the water in these generators there floated a kind of lime foam in which small carbide particles were held. These particles were not in sufficient contact with the water and became very hot. When finally the gas bell was lifted to clean the generator, the acetylene in it mixed with the surrounding air and the mixture was ignited by glowing carbide particles. An explosion followed, the gas bell was blown off and the man in charge of cleaning was killed or very seriously injured. To prevent such accidents other types of acetylene generator had to be used, for in practice it was impossible to see that the cleaning instructions were obeyed, especially in small undertakings.

DISCIPLINE

On several occasions the responsibility of the employer has been mentioned. He is largely responsible for the workers' environment and the way in which work is carried on. However, it has also been mentioned that sometimes safety rules are not observed and safety appliances are not used by the workers. If this occurs because the rules are not suited to the circumstances, there is no special reason to criticise the workers' behaviour. It is another matter, however, if a worker does not use guards because he thinks them to be unnecessary. Here the problem is

[1] *Model Code of Safety Regulations for Industrial Establishments*, op. cit., Regulation 234, paragraph 6.

[2] Ibid., Regulation 191, paragraph 20.

one of enforcing normal factory discipline; if the attitude of the worker endangers himself or his mates, disciplinary measures will have to be taken. It may even be necessary to dismiss the worker; but this cannot be considered the most satisfactory way of settling the matter.

Sometimes the law makes the use of guards and other safety equipment an obligation and states that workers who do not fulfil this obligation are guilty of an offence. The legal responsibility of workers for safety is, as a rule, limited to cases specified in the law, and the general responsibilities of the employer are not affected.

Introduction of New Workers

Special care should be taken over introducing a new worker to the undertaking. He should be acquainted with the new environment and told what is expected of him. He should also have the hazards to which he may be exposed explained to him and be shown how he can avoid them by correct working methods and by obeying safety rules.

One of the reasons why statistics show a relatively high number of accidents among newly engaged workers is doubtless failure to initiate the latter properly. All too often a new worker when arriving for the first time at the factory is sent immediately to the department where he is to work and has to wait there till the foreman has time to show him his place and his work. He is told a few things and then is left to his own devices.

The impression a new worker receives from the factory in general and from his own environment in particular is very important. Whether he will be interested in the factory and his fellow workers or only in his wages, and whether he will feel that he is a full member of a new society or only an outsider, will depend to a great extent on the impressions he gains during the first few days.

The new worker should be shown generally how the factory is run and given an opportunity to ask questions. He should be given information on subjects of special interest to him such as wages, working hours, the canteen, the first-aid service and welfare facilities. The department in which he is to work will be described in greater detail: there will be full explanations of the working methods that he has to follow and the hazards to which he may be exposed. Safety instructions should be given and explained clearly and fully, and all care should be taken to ensure that the worker really understands them.

The importance of obtaining immediate first-aid treatment after an accident should also be stressed, so that the worker has no excuse for not reporting minor injuries to the first-aid service. Something should be said of the importance of good order and good housekeeping. It is most important that the newcomer be introduced to his foreman and the workers in his neighbourhood.

The methods used to introduce new personnel will differ from undertaking to undertaking. The introduction may take place during a talk in the personnel department or in the safety engineer's office, or even in the factory department concerned, and may be conducted by a member of the personnel department, the foreman or an experienced worker. In some cases the introduction includes an explanation of the technology of the undertaking, and a plan or model is shown to make things clear. In other cases illustrations are provided by a film strip or a film.

Though it may be necessary for formal reasons to provide a new worker with a copy of the factory regulations and instructions, it cannot be expected that he will fully understand them, or even that he will read them carefully. During his introduction such regulations and instructions should be explained as far as they are of immediate concern to him. After the explanation the correct way of working should be shown and the worker should be allowed to try it himself to make sure that he has understood it. Subsequently regular checks should be made to ensure that his work is done in the prescribed way and that no departures from safe working habits have occurred.

The main purpose of the introduction is to make a personal contact with the newcomer and to show a personal interest in him. If the man in charge of the introduction considers the procedure as only a boring routine, it will do more harm than good. The worker should be made to feel that, if he encounters an unexpected difficulty in the course of his work, there is somebody to whom he may go for information and advice; this will help him to feel at home in the factory and also to feel something like job-satisfaction, which is necessary for the peace of mind that reduces the risk of accidents.

Some firms arrange for another meeting with the newcomer about two or three months after his arrival to have a talk about his experiences, his needs and his desires. On this occasion difficulties which have arisen can be considered and unsatisfactory conditions corrected. In such ways labour turnover, which is also important from the safety point of view, may be reduced.

Questions

1. *To what extent does safety in a factory depend on the management ?*
2. *Why is the foreman often called " the key man in safety " ?*

3. *What are the duties of a safety engineer ?*

4. *What reasons are there for believing that safety committees are useful ?*

5. *Why are some safety committees failures ?*

6. *How should new workers be introduced into the factory ?*

TWELFTH LESSON

INDUSTRIAL SAFETY ACTIVITIES OF GOVERNMENTS, PUBLIC AUTHORITIES AND PRIVATE ASSOCIATIONS

The Prevention of Industrial Accidents Recommendation (No. 31), adopted by the International Labour Conference in 1929 contains a comprehensive statement of the principles that should govern the safety activities of governments, public authorities, industrial associations, insurance institutions, other bodies and employers and workers.

The functions assigned to governments and other public authorities are substantially as follows:

(a) the collection and utilisation of information on the causes and circumstances of accidents;

(b) the study, by means of statistics of accidents in each industry as a whole, of the special dangers that exist in the several industries, the " laws " determining the incidence of accidents and the effects of measures taken to avoid them;

(c) the carrying out of methodical investigations, where appropriate with the assistance of institutions or committees set up by individual branches of industry;

(d) investigation of physical, physiological and psychological factors in accidents;

(e) encouraging scientific research into the best methods of vocational guidance and selection and their practical application;

(f) establishing central departments to collect and collate statistics relating to industrial accidents;

(g) developing and encouraging co-operation between all parties interested in the prevention of industrial accidents, and particularly between employers and workers;

(h) arranging for periodical conferences between the state inspection service or other competent bodies and representative organisations of employers and workers in every industry or branch of industry to review the accident situation and discuss proposals for improving it;

(i) encouraging the adoption of safety measures such as the establishment of works safety organisations, co-operation between manage-

ment and workers in individual works, co-operation between employers' and workers' organisations in an industry, co-operation between these organisations and the State and with other appropriate bodies;

(j) awakening and maintaining the interest of the workers in the prevention of accidents and ensuring their co-operation by means of lectures, publications, films, visits to industrial establishments and other appropriate means;

(k) establishing or promoting the establishment of permanent safety exhibitions;

(l) ensuring, by indirect means, that employers do all in their power to improve the education of their workers in regard to the prevention of accidents and that workers' organisations should co-operate in this work;

(m) arranging for handbooks on accident causation and prevention in particular industries or branches of industry or particular processes to be prepared by the state inspection service or other competent authorities;

(n) arranging for the inclusion, in the curricula of elementary schools, of lessons designed to inculcate habits of carefulness and, in the curricula of continuation and vocational schools, of lessons in accident prevention and first aid;

(o) prescribing by law the measures required to ensure an adequate standard of safety;

(p) examining plans for the construction or substantial alteration of industrial establishments;

(q) consulting representative organisations of employers and workers before issuing administrative orders or regulations for the prevention of accidents;

(r) providing for the collaboration of the workers in securing the observance of safety regulations;

(s) endeavouring to secure that accident insurance institutions or companies take into account, in assessing the premium for an undertaking, the measures taken in it for the protection of the workers;

(t) inducing accident insurance institutions and companies to co-operate in the work of accident prevention.

This is a fairly comprehensive programme of activity for the State, but it is not all the State should do. It will be noticed that little is said about the extremely important subject of the organisation and functions of the state inspection service. These are dealt with in a Recommendation (No. 20) concerning the general principles for the organisation of systems of inspection to secure the enforcement of laws and regulations for the protection of workers, adopted by the International Labour Conference in 1923, and in the Labour Inspection Convention (No. 81) and Recommendation (No. 81), adopted by the Conference in 1947. We shall return to these subjects later in this lesson.

The functions attributed to governments and public authorities in these international instruments will be seen to fall into various classes: safety laws and regulations, enforcement investigation, education, research and testing, promotional activities and so on. These different branches of activity are described below.

Safety Laws and Regulations

The Accident Prevention Recommendation, 1929, states that any effective system of accident prevention should rest on a basis of statutory requirements. This statement is amply justified by experience.

There are many kinds of safety laws and regulations. In countries with parliamentary systems of government there is a clear distinction between a law and a regulation. A law is passed by parliament; a regulation is issued by a minister, although it may have to be submitted to parliament before it can become effective. Passing a law through parliament is usually a very laborious process, and consequently there is a tendency in many countries to draft safety laws in such a way that they do not frequently have to be resubmitted to the legislature for amendment in the light of subsequent developments. This is done by confining such laws to general principles and including a list of subjects on which the competent minister has the power to issue more detailed regulations. For instance the United Kingdom Factories Act of 1937 contains a provision which reads as follows:

> 60 (1). Where the Secretary of State is satisfied that any manufacture, machinery, plant, process or description of manual labour used in factories is of such a nature as to cause risk of bodily injury to persons employed in connection therewith, or any class of those persons, he may, subject to the provisions of this Act, make such special regulations as appear to him to be reasonably practicable to meet the necessity of the case.

The Factories, Machinery and Building Works Act of 1941 of the Union of South Africa is more specific; it mentions over 20 subjects on which the Governor-General may make regulations. Some examples are—

(a) the measures taken to secure cleanliness, safety and preservation of health in or about factories;

(b) the clothing, safety devices and protective articles to be provided by employers in certain circumstances;

(c) the first-aid equipment to be provided by occupiers of factories;

(d) the steps to be taken by the owners of buildings used or intended for use as factories, or places where machinery is used in connection with the structure of such buildings, or otherwise in order to prevent or extinguish fires, and to ensure the safety, in the event of fire, of persons in such buildings;

(e) the conditions governing the erection, installation, working and use of any machinery, and the duties, responsibilities and qualifications of the user or person in charge of or erecting such machinery.

Many regulations have been issued under the United Kingdom Factories Act. Among the subjects with which they deal are lighting, chemical works, the manufacture of aerated waters, the blasting of castings, eye protection, the manufacture and decoration of pottery, cotton spinning, woodworking machinery, the lifting of heavy weights, spray painting, electricity, lifting machines, operations at unfenced machinery, milling machines, grinding of metals, plant railways, acetylene, the manufacture or celluloid, the grinding of magnesium, luminising, and the training of young persons to operate dangerous machines. This short list is enough to show how complicated safety legislation is becoming. Indeed the factory safety regulations of quite a number of countries would make up substantial volumes (say 500 pages of a book like this one).

Although the amount of safety legislation is increasing rapidly, laws and regulations by themselves can never be enough to achieve the highest attainable standard of safety. They can only embody provisions that—*(a)* are enforceable without too much difficulty; and *(b)* can be applied by all those responsible for applying them. This means that they have to be as simple as possible and not too difficult for those undertakings with the very lowest standards of safety in the country to apply. Consequently, as a rule, laws and regulations lay down a bare minimum standard of safety. Moreover, they do not usually provide guidance as to how this standard is to be achieved.

Laws and regulations often have to combine technical with legal phraseology, and as a result they are sometimes not easy for the layman to understand. A useful practice followed in some countries is to issue booklets explaining the provisions of safety laws in simple language.

Here are one or two examples of legislative provisions, illustrating some of their limitations.

In the Netherlands the following regulation is in force:

Wooden ladders should not be painted, but coated with clear varnish.

This rule indicates exactly what has to be done, but does not explain that it should be done to prevent defects in the wood being concealed by paint.

Mexican legislation contains the following:

If it is necessary to nail anything, use should always be made of a hammer and not of any object, because if the tool is not suitable it is likely that the blow will glance off the head of the nail and fall on the worker's fingers.

Here a safety rule is formulated and the need for such a rule is explained as well.

A New York State regulation reads—

Each extractor hereafter installed and existing installations, where practicable, shall be equipped with an interlocking or other approved device that will prevent the cover being opened while the basket is in motion and also prevent the operation of the basket while the cover is open.

In this case the purpose of the guard is indicated, but no information is given as to how this purpose can be achieved or against what hazard the precaution is necessary.

Safety regulations often use general terms which require an explanation to make their intention clear. For instance they may lay down that " measures should be taken " without indicating what measures; that " suitable " guards should be used without mentioning what in that particular case " suitable " means; that precautions have to be taken " in good time " without fixing a period ; that measures are not necessary when machine parts are " safe by position " without prescribing in what circumstances the position can be considered to be safe. In practice the changes which are continually taking place in many sections of industry make it impossible to avoid such vague general expressions. To mention all the details of guards in a regulation would result in a very unwieldy document, and even if it were possible to compile it the regulation might well prove a serious impediment to new ideas on safety and new developments in safety engineering.

To meet the difficulties created by wording regulations in general terms, in some countries the legislation names an authority (e.g. an official of the labour inspection service) which is empowered to prescribe in a special case what the employer has to do to comply with a particular regulation. In other countries there is an authority responsible for approving guards. In yet others the decision whether a safety precaution is in accordance with the law is a matter for the courts, which usually decide after hearing the evidence of safety experts. In any case some authority is needed that is in a position to give a valid interpretation of safety regulations.

In industrially advanced countries safety regulations have been gradually built up over a long period. In these countries much experience has been acquired with regard to the practical value of safety regulations as well as with regard to the manner of enforcing them. In some industrially less developed countries, where the necessity for safety legislation dates from only a few years back, the situation is very different; the regulations there are sometimes based on those of the I.L.O. *Model Code of Safety Regulations for Industrial Establishments*, which in turn are based on the experience of the industrialised countries. The difference between the two groups of countries, is, however, that in the industrially less developed ones there are often very few persons (if any) who have experience of safety regulations or are familiar with their history, and this circumstance has proved to be an almost insurmountable obstacle to the enforcement of the regulations.

A solution to this problem has been sought by sending a number of persons with a suitable technical background from these countries to study safety questions in others with more experience, or by sending experienced advisers to the industrially less developed countries to adapt the regulations to local conditions and to make available experience acquired elsewhere. To a certain extent, too, the lack of knowledge and experience can be remedied by means of manuals.

Besides safety laws, laws dealing with accident insurance also contribute to safety. In many countries employers have been made liable by law to pay compensation in cases of accidents; in some the law obliges employers to reimburse insurance costs if an accident is due to insufficient protection, while in others the insurance institute increases or decreases premiums according to the safety precautions taken in an undertaking. In all these cases the employer has a direct financial interest in ensuring safe working conditions, and to this extent the law promotes safety.

Accident insurance legislation has much more influence on safety when it authorises insurance institutions to issue safety regulations and to supervise their enforcement. In this way the administration of accident compensation and prevention are combined in one institution. This is useful, since the accident-prevention department of the insurance institution is immediately informed of accidents. One advantage of having safety work done by social insurance institutes is the ease with which funds can be provided for research, educational and other work. It is a sound policy to invest money in this way, for it will yield a high return in the form of a reduction in the number of compensable accidents.

Enforcement of Laws and Regulations

Not very long after the first safety legislation was passed governments realised from the evidence that it would be ineffective unless some means could be found of enforcing it. After some experimenting with different enforcement agencies the great majority of countries eventually established state labour inspectorates, factory inspectorates or similar enforcement agencies. In some countries, however, this function is wholly or partly entrusted to other bodies, such as trade unions or associations of boiler owners.

Reference has already been made to the general principles for the organisation of labour inspectorates set out in a Recommendation adopted by the International Labour Conference in 1923.[1] On the specific subject of safety the Recommendation includes the following provisions:

> *(a)*...one of the essential duties of inspectors should be to investigate accidents...with a view to ascertaining by what measures they can be prevented;
>
> *(b)* that inspectors should inform and advise employers respecting the best standards of health and safety;
>
> *(c)* that inspectors should encourage the collaboration of employers, managing staff and workers for the promotion of personal caution, safety methods, and the perfecting of safety equipment;
>
> *(d)* that inspectors should endeavour to promote the improvement and perfecting of measures of health and safety....

The provisions concerning the organisation of inspectorates include a recommendation that in view of the difficult scientific and technical questions which arise under the conditions of modern industry, experts having competent medical, engineering, electrical or other scientific training and experience should be employed by the State.

The Recommendation further states that inspectors should possess a high standard of technical training and experience, be persons of good general education, and by their character and abilities be capable of acquiring the confidence of all parties. One important point made is that inspectors should be given such a status and standard of remuneration as to secure their freedom from any improper external influences.

As regards standards of inspection, it is suggested that, as far as possible, every establishment should undergo a general inspection at least once a year, and that unsatisfactory or particularly dangerous or unhealthy establishments should be inspected much more frequently. The Recommendation stresses the importance of co-operation between the inspectorate, employers and workers.

Labour inspection services[2] usually have to supervise the enforcement of all labour protection laws, such as those dealing with safety, health, working hours, rest periods, the protection of female and child labour and minimum wages. In addition they have to advise employers and workers

[1] The main general provisions of this Recommendation were subsequently embodied in a Convention (the Labour Inspection Convention, 1947 (No. 81)).

[2] See also I.L.O.: *Guide for Labour Inspectors*, Studies and Reports, New Series, No. 41 (Geneva, 1955) and the Labour Inspection Convention, 1947 (No. 81).

on social questions and keep the government informed of social conditions in the country.

Normally the inspection service has a headquarters staff with experts in different fields and administrative personnel. To facilitate the performance of the inspectorate's duties the country is divided into districts, each one under a district superintendent assisted by district inspectors and administrative personnel.

The district inspectors make the factory inspections, including safety inspections, under the general guidance of the district superintendent. They should be sufficiently familiar with the safety laws and regulations to be in a position to explain them and to advise on the best ways of complying with them. If they themselves require information on technical questions they may ask the district superintendent, who, if necessary, may refer the matter to the central authority. With the assistance of its specialists in medicine, chemistry, electricity, engineering, etc., the latter will be in a position to assist the labour inspectors and to provide them with any information they require.

Even inspectors with good technical knowledge are not in a position to deal with all the safety problems which arise in industry. Separate inspection services have been organised in most countries for boilers and mines, and in some countries also for elevators, ports, agriculture, electricity and other matters.

The specialisation necessary to make accident prevention work effective in the face of the ever-increasing complexities of technology threatens to overload labour inspectorates. The desire to avoid this and at the same time take advantage of private facilities has sometimes led governments to make private associations (e.g. associations of manufacturers of boilers, acetylene installations and elevators) responsible for safety inspection in their particular field.

In some countries the low levels of salaries offered to inspectors constitute a serious impediment to efficient inspection, since it is impossible to recruit qualified personnel in sufficient numbers. Inspectors may be appointed who lack technical knowledge and do not themselves understand the safety regulations they are supposed to enforce. Such inspectors can scarcely be expected to be good advisers.

It is also undesirable that inspectors be dependent on travelling facilities provided by employers or receive their fees from them; such a situation makes it difficult for them to perform their duties with the necessary independence.

It is most important that inspectors should be technically competent and command the respect of the people with whom they have to deal. An inspector with insufficient technical knowledge, or not well acquainted with factory conditions, who recommends impracticable or unsuitable safety measures is a nuisance to employers and workers alike and does little to prevent accidents. This sort of situation is liable to arise in countries where industry is in an early stage of development.

In cases of imminent danger labour inspectors are sometimes authorised to order that work should be stopped. As this is a very radical measure, the power to stop work should be used with the utmost caution. For this reason in some countries stoppage of work can only be ordered by a court on the application of a labour inspector. In other countries an order may be given by the labour inspector but has to be confirmed by a court within a prescribed period.

Example. An imminent danger exists when a welding torch is used for repairing a gasoline tank truck without measures being taken to prevent an explosion of the mixture of gasoline vapour and air inside the tank. Work should be interrupted immediately to eliminate the gasoline vapour or to fill the tank with an inert gas, such as nitrogen or carbon dioxide.

Example. The hoisting of materials above a place where men are working creates an imminent danger of injury from falling objects. As long as the men have to be at that place no hoisting should be performed.

Educational and Advisory Work by State Services

Safety programmes, courses and demonstrations have also been developed by state services, in particular for the smaller undertakings in some branches of industry. For instance, the Bureau of Labor Standards of the United States Department of Labor has prepared flow charts showing the sequence of plant operations with the principal hazards. A six-month safety programme has been devised and assistance is given in carrying it out. At the end of the period the results are assessed by calculating accident rates and by comparing the figures with the situation before the programme began. A follow-up programme exists to continue the safety activities.[1]

Figure 48 shows an inspection sheet for a bale breaker in the cotton industry used in the safety programme.

The figure indicates the points to which special attention should be paid in the interest of safety. These are:

(1) *Operator.* Stands to one side when cutting bale ties, not in front of tie being cut. Wears gloves and goggles when handling bale ties. Uses tie cutter to cut bale ties.

(2) Motor frames grounded.

(3) Sufficient light without glare.

[1] See "Special Industry Safety Programmes", in *Occupational Safety and Health*, Vol. IV, No. 1, Jan.-Mar. 1954, p. 28.

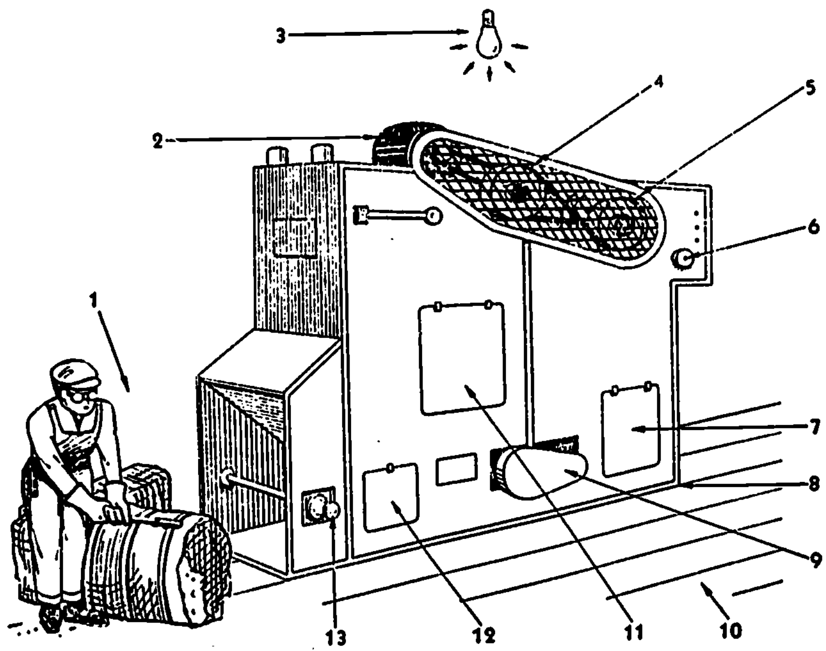


Fig. 48.

(4) If overhead line shaft drive, mechanical belt shifters provided.

(5) Belts and pulleys fully enclosed.

(6) *Operator.* Stops machine before oiling or cleaning.

(7) Inspection panel. Operator does not open while machine is in operation.

(8) Machine firmly anchored.

(9) Guard covering exposed gears.

(10) Floors free of oil, ties, tie buckles or obstructions, etc.

(11) Spiked apron or beater covered. Operator does not open while machine is in operation.

(12) *Operator.* Rake provided and used for cleaning out motes.

(13) Protruding shaft ends or revolving shafting guarded.

A very important contribution to accident prevention is made by the reports, periodicals, leaflets, posters, etc. published by labour inspection services and insurance institutes. These publications contain excellent material for the student of industrial safety.

Research and Testing

The vast development of technology has led labour inspectorates and other state services to set up laboratories for the analysis of dangerous chemical substances, for testing materials and equipment [1] and for research on dangerous working methods. Inspection services have acquired much experience in this field, and they have done valuable research work.

Example. When overhead recessing machines were introduced in the woodworking industry they were completely unguarded or provided with clumsy guards at the point of operation. Serious accidents happened to workers who occasionally came into accidental contact with the tool, perhaps because of an unsuitable working method, perhaps as a result of workpieces being kicked back or thrown out by the machine. With a view to remedying this situation the Swiss National Accident Insurance Institute (S.U.V.A.) undertook research by studying the different types of work done on these machines and developed a guard with the assistance of operators and heads of undertakings. Subsequently some manufacturers fitted their new machines with these guards, thus testifying to the value of the work performed by the Institute.[2]

The testing of materials from the safety standpoint is often done by inspection services in co-operation with specialised laboratories, for the inspection service itself may not be equipped for the purpose. Tests are important as a means of discovering the cause of an accident in which a broken chain, wire rope, rod or other piece plays a part. They enable conclusions to be drawn as to whether the cause of the accident was the use of the wrong material, overloading or treating in a wrong way (e.g. incorrect heat treatment of steel). In some cases the co-operation of the boiler inspection service is requested for the investigations; in others the inspectorate may turn to a mining research laboratory, a laboratory of a technical university or a specialised private laboratory.

Machine guarding is a field that has benefited greatly from the work of testing laboratories. Testing has prevented the introduction of unsuitable guards and has yielded valuable information on the structural details of these and other appliances. Good results have also been achieved through the testing of grinding wheels, chains, wire ropes, structural parts of scaffolds, ladders, safety shoes, etc.

Some private laboratories for testing materials and examining constructions and apparatus make important contributions to industrial safety, particularly when the latter is a regular feature of their activities. As an example mention may be made of the tests and examinations made in the laboratories of the Association of Belgian Manufacturers (*Association des Industriels de Belgique*). Here investigations are made on boilers, hoisting appliances, centrifugal driers, welding installations, electrical installations, chains, wire ropes, safety belts, ladders, etc. They have the necessary equipment for testing materials in different ways and for chemical and metallographic analysis.

[1] See pp. 13-14.

[2] See " The Safe Operation of Overhead Recessing Machines for Woodworking ", in *Occupational Safety and Health*, Vol. IV, No. 2, Apr.-June 1954, pp. 63-68.

Practical Work by State Services

A very interesting practical contribution to safety has been made by the Swiss National Accident Insurance Institute (S.U.V.A.) in the field of accident prevention in the woodworking industry. After designing guards first for circular saws and moulding machines and later for planers and overhead recessing machines [1], the Institute not only made them available to industry by organising their manufacture and distribution, but also placed at the disposal of the undertakings concerned highly qualified instructors to demonstrate how the guards should be used under the most varied conditions. In this way the workers learned not only how to perform dangerous operations safely but also how to improve the quality and quantity of production. This gesture has proved to be extremely useful in limiting the number and in particular the severity of woodworking-machine accidents. The example has so far only been followed by the Netherlands, and has not found favour in other countries.

Another service to industry provided only in the Netherlands and Switzerland consists of assistance in the mounting of certain guards. In both countries guards for power presses have been developed which require very accurate mounting to be efficient. To ensure that they are not rendered ineffectual by faulty mounting, officials of the insurance institute or labour inspection service attend to give advice when they are fitted.

Co-operation between Inspectorates and Employers and Workers

It has already been seen that while labour inspectors have to enforce laws and regulations they should be more than merely a kind of technical police force; they should also be able to give advice on safety and health matters. As accident prevention is of interest not only to the workers but also to the undertaking, and indeed to the country as a whole, it can be readily understood that many safety problems can best be solved by co-operation between inspectors, employers and workers. Much more can be achieved by co-operation than by the bare enforcement of the law, for, as we have said, the law embodies only minimum precautions.

Accordingly, labour inspectors can contribute to safe working conditions by giving advice based on their technical knowledge and experience as well as by simply knowing the regulations. Inspections of factories and investigations of accidents afford useful opportunities for discussions of safety matters with the management, supervisors and workers, from which all can benefit. However, having regard to the

[1] See opposite page.

number of inspectors in comparison with the number of establishments, it is obvious that a particular factory will not be visited by an inspector very frequently. Safety in factories cannot be ensured by labour inspectors alone.

State-Owned Industries and Government Contracts

Another means by which governments can promote safety lies in the existence of state-owned or state-controlled industries. In these industries the standard of safety could be brought up to a level that would make them models for private industry.

Again, government contracts with private firms for the construction of roads and buildings, the delivery of machines, etc., provide governments with opportunities for stipulating the safety measures that have to be taken in carrying out the contract.

Safety Museums and Exhibitions [1]

Safety museums may be said to have originated in the international safety congresses held at the end of the nineteenth century. A new way of propagating knowledge of safeguards was proposed at the Milan Congress (1894), although it had been mentioned still earlier at a hygiene congress held in Vienna (1887). The proposal was to establish " social museums " where the public could see models and obtain information on social insurance and in particular on accident prevention.

The original purpose of safety museums was to show the best and most modern means of protecting workers against the risks of their work (for instance specimens of effective guards for different machines, of personal safety equipment and of other means of preventing accidents and disease). In practice this purpose could never be completely achieved, and the earliest safety museums were partial failures, for there was not money enough to keep them fully equipped and up to date.

There were other difficulties. Only a relatively small number of persons visited the museums, and among them only a few could be considered as being directly interested in safety problems. Moreover, demonstrations of guards in a museum did not convince some people that they were also suitable under factory conditions.

Some museums have continued along conventional lines and are not very important today. Others have been reorganised and developed into institutions which now take an active part in the safety movement. One important development was the abandonment of the practice of inviting employers and workers to visit safety museums and the organisation

[1] See also p. 109.

of exhibitions in factories instead. Itinerant exhibitions of this kind have been organised and placed at the disposal of industry. It has thus become possible to provide an undertaking with what it needs at a particular moment for its safety programme. Similarly films, film strips and slides are no longer used solely for demonstrations in museums but are available to factories. Safety museums sometimes open lending libraries and information centres as well.

Lastly, members of the staff of some safety museums are now sometimes loaned to undertakings, and especially to the smaller ones. They may go to a factory and stay there for a month or longer to organise safety activities, to make inspections and to advise generally on accident prevention. This has proved to be an excellent method in cases where a safety engineer on the staff of the undertaking would be too costly or could not be fully employed. Guards may also be borrowed from the museums so that their practical value can be demonstrated to employers and workers.

Safety Associations

So far in this lesson we have been mainly concerned with the safety activities of organs of the State—the legislature, ministries, technical institutes and so on. In many countries these agencies do not handle all safety work, and much may be done by private bodies of various kinds—safety associations, standards institutions, employers' associations, trade unions, universities, private laboratories and others. However, it should not be forgotten that the functions exercised by voluntary bodies in some countries are exercised by state agencies in others.

There are different kinds of safety associations. Some cater for all or most industries and for the whole country; examples are the National Safety Council of Australia, the Royal Society for the Prevention of Accidents in the United Kingdom, and the National Safety Council in the United States. Others, such as the Normandy Industrial Safety Association in France, the Alberta Safety Council in Canada, and the Antwerp Provincial Safety Institute in Belgium, have a similar industry coverage but are regional bodies. Others again deal exclusively with a particular industry or a particular subject; examples are the Construction Safety Association of Ontario (Canada) and the Trade Association for Accident Prevention in Building and Civil Engineering in France.

Then there are industrial associations that are not wholly safety associations but have safety departments or otherwise engage in a wide range of safety activities. Examples are the Association of British Chemical Manufacturers, the Associated General Contractors of America, and the Japan Coal Association.

Some large insurance companies, such as the Employers Mutual Liability Insurance Company of Wisconsin (U.S.A.), also have safety departments.

Other examples of various kinds of association that engage in one way or another in safety activities are the Ahmedabad Textile Industry's Research Association in India, the American Society of Safety Engineers, the Algerian Association of Owners of Steam and Electric Plant, the British Colour Council, the Italian Centre for Safety Officers, the Safety Engineering Society, Melbourne, the German Federation of Electrical Engineers, and the Association of German Inspection Engineers.

The activities of these associations are as varied as their forms. It will scarcely be possible here to describe all the safety activities of all the types of safety association; but the types of work that they carry on include the following:

(1) Organisation of national safety congresses.

(2) Organisation of safety exhibitions.

(3) Training of safety officers and other persons responsible for safety.

(4) Operation of libraries.

(5) Operation of information service.

(6) Organisation of special safety campaigns.

(7) Practical assistance to small firms.

(8) Compilation of safety codes and rules.

(9) Publication of technical literature.

(10) Publication of periodicals.

(11) Publication of leaflets, posters and other propaganda material.

(12) Organisation of publicity through the press, radio, television, etc.

(13) Compilation of accident statistics.

(14) Plant inspections.

(15) Testing of materials, substances, atmospheres, etc.

(16) Technological (physical and chemical) research.

(17) The granting of awards to holders of safety records, winners of safety competitions, performers of meritorious services, etc.

(18) Collaboration with state agencies such as the labour inspectorate.

(19) Collaboration with institutions working in the safety field or related fields, such as standards, health, personnel management, scientific research, educational and welfare institutions.

STANDARDISATION

In assessing the contribution to safety made by private associations, a special place should be given to standards associations. Although these associations do not work exclusively in the interests of safety, they contribute substantially to it. Some results of standardisation have already been mentioned in connection with accident rates.[1] The formulation of general rules for the calculation of these rates has made it possible to compare the accident situation in different factories in the same country.

Standards associations were at first mainly concerned with reducing the unnecessary and inconvenient variety of common technical objects such as rivets, bolts and nuts; but their fields of activity soon expanded, and standardisation was applied to material and construction specifications, testing materials, design calculations, etc.

Nowadays many kinds of standards are published that have a bearing on safety. Some are actually called safety standards and are only concerned with safety; others are technical standards, codes of practice, etc. that deal to some extent with safety or have implications in the safety field.

The following are examples of various subjects of safety interests dealt with in national standards:

Industrial equipment. Ladders, abrasive wheels, pressure piping, boilers, elevators.

Personal protective equipment. Goggles, respirators, gloves, hats, boots, aprons.

Colours, signs, signals, symbols. Identification of piping systems, identification of gas cylinders, safety colours, signalling devices for printing presses, hand signals for hoisting appliances.

Safe practices. Safety procedures for quarries, industrial uses of X-rays, precautions against fire, installation and maintenance of flameproof and intrinsically safe electrical equipment.

Accident records. Recording and measuring work injury experience, compiling industrial injury rates.

Standards are valuable largely because they are the result of the coordinated efforts of all the parties concerned (manufacturers, users, scientists, etc.). Since safety standards enjoy universal approval, they have on several occasions been incorporated in official regulations.

[1] See Lesson 3.

For instance there are regulations which require the material used for crane hooks and slings to conform to the national standard, prohibit the use of respirators other than those conforming to the national standard. or allow only the use of standard electrical appliances.

One great advantage of standardisation is that it protects manufacturers of approved standard products against complaints by the user or the inspection service; moreover, users know precisely what they are buying and can thus avoid having to make expensive changes or adjustments in equipment.

As international contacts steadily multiply, and the advantages of international standards in international trade become more apparent, greater efforts are being made in the direction of international standardisation through the International Organisation for Standardisation (I.S.O.) at Geneva. However, progress is slow, and so far almost the only substantial results achieved have been confined to the electrical engineering industry. The two I.S.O. agencies working in this field are the International Commission on Rules for the Approval of Electrical Equipment (C.E.E.) and the International Electrotechnical Commission (I.E.C.). The C.E.E., to which about 15 European countries belong, has already succeeded in framing a considerable number of recommendations concerning the safety of electrical apparatus and materials; while the I.E.C., which is world-wide, has drawn up a large number of safety standards.

Standardisation can become an important safeguard to ensure that only safe appliances and machines are sent to technically underdeveloped countries. In some countries two types of machines are manufactured: one well guarded and destined for countries with advanced safety requirements, and one without guards for the others. This practice should be abandoned, but it will continue until world-wide safety standards exist.

Questions

1. *Mention some of the things that governments can do to promote occupational safety.*

2. *Mention some of the ways in which laws and regulations are—* (a) *effective ; and* (b) *ineffective in promoting safety.*

3. *What measures do governments take to get safety laws and regulations obeyed?*

4. *What requirements should a state labour inspection service satisfy ?*

5. *Why is co-operation between the labour inspection service, employers and workers essential?*

6. *Name some uses of safety exhibitions.*

7. *What kinds of work can voluntary safety associations do?*

8. *In what ways can standardisation contribute to safety?*

THIRTEENTH LESSON

INTERNATIONAL SAFETY ACTIVITIES

International action for accident prevention did not develop on any considerable scale until nearly a century after national action had begun. It is following the lines of national development, but in many respects it is still very incomplete.

BEGINNINGS

A modest beginning of international co-operation in accident prevention may perhaps be seen in one of the congresses to which we have referred several times, namely the International Industrial Accident Congress, held in Paris on the occasion of the Universal Exhibition of the year 1889. It was organised by a committee of 30 persons with some concern with or interest in accident prevention and compensation, designated by a French Ministerial Order of 26 December 1888. The Congress, which was concerned both with prevention and with compensation, was divided into three sections, the first dealing with technical questions, the second with statistics and administration, and the third with economic questions and legislation.

The delegates recommended the establishment of a permanent international body to compile the experience gained in the different countries and suggested the best procedure to be followed in the future. As a result a permanent international committee was set up in 1890; one of its specific tasks was to endeavour to find a basis for the compilation of international accident statistics. By 1891 it had a secretariat and 600 corresponding associates in different countries and aimed to become an International Industrial Accident Office.

A second international industrial accident congress was held in Berne in September 1891; several papers on accident prevention were read. Other conferences of the same kind were held in Milan in 1894, Brussels in 1897 and Paris in 1900; at the latter 18 countries were represented.

Another step forward in the international organisation of accident prevention may be seen in the foundation of the International Association for the Legal Protection of Workers in 1898. Under the auspices of this Association an International Labour Office was established at

Basle, which in 1902 began the publication of an international bulletin of labour legislation; numerous safety regulations were published in this periodical. The Association itself also took an interest in industrial safety and accident statistics.

By the time of the Paris Peace Conference of 1919, industrial safety had assumed such importance that the authors of the Treaty of Versailles specifically mentioned in the preamble to its labour clauses the protection of the worker against injury arising out of his employment as one of the measures to improve conditions of labour for which there was an urgent need.

The International Labour Organisation

The First World War was the end of an epoch, especially in western Europe, which had enjoyed over 40 years of uninterrupted peace. As the war dragged on, the feeling gained ground that such horror and cruelty should never occur again, and that the restoration of peace should usher in a new era in which people should live in decent conditions and enjoy a measure of what was subsequently to be known as social justice. The working classes of many countries looked forward to better living conditions after the war, and governments promised that their wishes would be granted. At an international workers' conference held in Leeds in 1916 various demands were formulated, including the following:

> The different countries should bind themselves to develop their legislation on occupational hygiene and safety. They should try to unify their legislation for every branch of industry. In particular they should organise permanent co-operation for common action against industrial poisons, defective or dangerous manufacturing processes and occupational diseases.

At an international trade union conference held in Berne in 1918 proposals for an industrial labour charter incorporating these demands were adopted together with a demand for the reduction of working hours in dangerous industries. Other workers' congresses made similar demands.

The Treaty of Versailles put an end to the First World War as far as western Europe was concerned. Part XIII of that Treaty established the International Labour Organisation. One reason for its foundation, given in the Preamble to Part XIII, was that it was urgently necessary to improve conditions of labour and in particular the " protection of the worker against sickness, disease and injury arising out of his employment ". A further argument put forward was that " the failure of any nation to adopt humane conditions of labour is an obstacle in the way of other nations which desire to improve conditions in their own countries ".[1]

The Treaty also considered it to be of special and urgent importance that " each State should make provision for a system of inspection . . . in order to ensure the enforcement of the laws and regulations for the protection of the employed ".

When the I.L.O. was founded in 1919 it had 42 States Members. By 31 December 1969 the number had risen to 121.

In 1919 the industrialised countries already had safety laws and regulations with labour inspectorates to watch over their enforcement. In factories employers were obliged by these laws and regulations to take certain precautions against accidents; in practice, however, safety standards left much to be desired. There may have been several reasons for this state of affairs: safety regulations were then not nearly so highly developed as they are now, nor labour inspectorates so well organised; many safety devices were impracticable because the technology of the processes in which they were to be used had been insufficiently studied; and more generally, public concern for safety was slight.

Structure and Functions of the I.L.O.

The permanent machinery of the International Labour Organisation for the performance of its functions consists essentially of the International Labour Office, its Governing Body and the International Labour Conference. For special purposes such as the discussion of international standards special conferences of worker, employer and government representatives, known as tripartite technical conferences, may be held, and ad hoc committees of experts may be appointed by the Governing Body to examine technical problems.

The main functions of the International Labour Office in the field of occupational safety are—

(a) the preparation and revision of international standards (Conventions, Recommendations, codes, etc.);

(b) the compilation of technical studies;

(c) direct assistance to governments by furnishing experts, providing fellowships, supplying equipment, drafting regulations, supplying information, etc.;

(d) assistance to national safety organisations, research centres, employers' associations, trade unions, etc., in different countries;

[1] Preamble to Part XIII of the Treaty.

(e) the running of an international information centre on occupational safety and health problems.

The Governing Body, which is a tripartite body composed of government, employer and worker members, has various functions which include fixing the agenda of the International Labour Conference and exercising general control over the activities of the Office and the advisory committees attached to it.

The International Labour Conference, which meets annually, is composed of national delegations made up of representatives of governments and of the most representative organisations of employers and workers in the country concerned. One of its functions is to discuss and adopt Conventions and Recommendations, many of which, as will be seen later, deal with matters of occupational safety and health. The Conference may also adopt resolutions calling for national or international action in this field. The member countries are required to submit Conventions adopted by the Conference to their competent authorities with a view to ratification. Recommendations are not subject to ratification and are not binding in the same way as Conventions, but governments are bound to consider them and decide whether their provisions are acceptable or not.

The Safety Activities of the I.L.O.

In the early years of the I.L.O.'s work relatively little importance was attached to industrial safety. The First Session of the International Labour Conference, held at Washington in 1919, dealt, among other things, with the related field of industrial hygiene by adopting Recommendations on the prevention of anthrax, the protection of women and children against lead poisoning, and the prohibition of the use of white phosphorus in the manufacture of matches; but during these years no items dealing directly with safety were placed on the agenda. However, an important contribution was made indirectly in the form of a draft Convention fixing the minimum age for admission of children to industrial employment. The I.L.O. first entered the safety field in 1923, when the First International Conference of Labour Statisticians made recommendations on accident rates and the classification of industrial accidents. The first safety handbook published by the Office was a report on statistics of accidents due to coupling and uncoupling operations on railways which appeared in 1924. Publication of a journal called *Industrial Safety Survey* [1] was started in 1925. In the same year

[1] The title was changed to *Occupational Safety and Health* in 1951. Publication was discontinued after the foundation of the International Information Centre on Occupational Safety and Health Problems (C.I.S.) in 1959.

a Correspondence Committee on Accident Prevention, composed of experts from several countries, was set up to advise the Office on measures to be taken in that field. The first safety Convention (that concerning the protection of dockers against accidents) was adopted by the International Labour Conference in 1929 and revised in 1932. Recommendations on safety (concerning accident prevention, in general and among dockers, and responsibility for the protection of power-driven machinery) were adopted by the Conference for the first time in 1929. A new departure was made in 1937, when a temporary committee of experts was appointed to help the Office draft safety provisions for coal mines; hitherto the Office had relied on members of the Correspondence Committee for help of this kind. Industrial Committees began to meet in 1945. Another new step was taken in 1948, when safety provisions for industrial establishments were incorporated in the *Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry*. This code was not related to any Convention or Recommendation and had no binding force whatsoever; it was intended solely to serve as a model for drafters of regulations on the subject. Technical assistance was expanded and reorganised in 1951 when the United Nations scheme came into operation.

The first of a new series of documents called *Codes of Practice* was drawn up in 1956. They are somewhat more informal than the *Model Code*. The first code of practice dealt with the safety and health of dockworkers. In 1958 it was decided to publish yet another series of documents called manuals (i.e. practical handbooks).

This brief survey gives a general idea of both the development and the variety of some of the I.L.O.'s main safety activities. In so far as our subject is concerned, the work of the I.L.O. is dealt with in greater detail in the appropriate lessons of this manual.

In addition, the following international labour Conventions and Recommendations are of special interest[1]:

Marking of Weight (Packages Transported by Vessels) Convention, 1929 (No. 27).

Protection against Accidents (Dockers) Convention (Revised), 1932 (No. 32).

Safety Provisions (Building) Convention, 1937 (No. 62).

Labour Inspection Convention, 1947 (No. 81).

[1] The text of the instruments adopted up to 1966 can be found in I.L.O.: *Conventions and Recommendations—1919-1966* (Geneva, 1966).

Radiation Protection Convention, 1960 (No. 115).

Guarding of Machinery Convention, 1963 (No. 119).

Hygiene (Commerce and Offices) Convention, 1964 (No. 120).

Maximum Weight Convention, 1967 (No. 127).

Prevention of Industrial Accidents Recommendation, 1929 (No. 31).

Power-Driven Machinery Recommendation, 1929 (No. 32).

Protection against Accidents (Dockers) Reciprocity Recommendation, 1929 (No. 33).

Protection against Accidents (Dockers) Consultation of Organisations Recommendation, 1929 (No. 34).

Safety Provisions (Building) Recommendation, 1937 (No. 53) with its appended Model Code.

Inspection (Building) Recommendation, 1937 (No. 54).

Co-operation in Accident Prevention (Building) Recommendation, 1937 (No. 55).

Vocational Education (Building) Recommendation, 1937 (No. 56).

Protection of Workers' Health Recommendation, 1953 (No. 97).

Occupational Health Services Recommendation, 1959 (No. 112).

Radiation Protection Recommendation, 1960 (No. 114).

Guarding of Machinery Recommendation, 1963 (No. 118).

Hygiene (Commerce and Offices) Recommendation, 1964 (No. 120).

Maximum Weight Recommendation, 1967 (No. 128).

International Technical Co-operation

Technical co-operation programmes, such as those sponsored during recent years by the United Nations, the organisations belonging to the United Nations family including the International Labour Organisation and many individual countries throughout the world, have been playing a prominent part in promoting occupational safety and health in developing countries. Essentially, these activities are designed to apply the rich and varied experiences of the more industrialised countries to those that are in the process of industrialisation, with due regard to local factors and circumstances. Through its Occupational Safety and Health Branch, the I.L.O. devotes considerable efforts to the search for solutions to old problems and to meeting new challenges brought about by changing technology.

A wide variety of activities, many of which have a direct bearing on the promotion and strengthening of the world network of the occupational safety and health movement, are carried out.

Associated in this work are employers' and workers' organisations, official, semi-public and private organisations and societies, all of which can and do make a significant contribution to the battle against accidents and diseases associated with employment. In this way it is possible to carry services, techniques and procedures straight to the shop-floor level where they can be built into normal processes and operations as part and parcel of production activities. Information and training in workers' protection matters are increasingly being integrated into the Organisation's numerous other projects in the field. The best opportunity to become acquainted with and to practise accident prevention is during apprenticeship and vocational training activities.

Particular attention is given to safety and health questions in projects designed to develop management and supervisory cadres and projects concerned with small-scale industries which present particularly difficult problems in this field.

Under the I.L.O.'s regular budget or under the United Nations Development Programme, experts have been sent to over 50 countries in all parts of the world to supply advice on the organisation of occupational safety and health services, factory inspection and mines safety. The general procedure is for an expert, or a team of experts, to make a survey of industrial conditions, legislation and administrative facilities and thereafter to recommend suitable action in each field.

The I.L.O. is also currently devoting considerable resources from the United Nations Development Programme (Special Fund) to meeting requests for assistance in setting up institutes to help to adapt work to man and man to his work. These institutes cover a wide variety of scientific and technical fields (e.g. nutrition, pollution control in the working environment, psychology, physiology and sociology, the broad field of ergonomics) which contribute to relieving mental and physical stresses and making work less arduous, more productive and more rewarding. Their main function is to formulate appropriate measures, taking into account the particular conditions of the country, to give direct assistance to industry in applying such measures in specific situations, to give all those responsible for occupational safety and health an opportunity for further training and to carry out research into occupational safety and health problems.

Thus, considerable assistance was provided by the I.L.O. to the Government of India in equipping and organising a Central and three Regional Labour Institutes in the country designed to serve as centres for the study of all socio-economic problems. Subsequently, two similar projects have been launched in Turkey and the United Arab Republic while a number of others are being planned for several other countries.

In order to ensure that the national projects set up with I.L.O. assistance function smoothly, regional projects under which experts are assigned to several countries in a region have also been launched as a component of international technical co-operation. The experts supervise the implementation of national projects and assist in ironing out difficulties as they arise. Three such projects have been undertaken in recent years, one in the Middle East, one in Asia and one in Central America. It is planned to extend this work considerably in the years ahead.

Particular attention is given not only to providing supporting materials for education and training but also to ensuring up-to-date information and investigation as operational research for better planning and implementation of technical co-operation activities. This line of action calls for the organisation of numerous symposia, seminars and meetings, the proceedings and conclusions of which become valuable instruments in training courses in general or on specific safety and health subjects. The range of such courses extends from protection against ionising radiations and dust prevention to factory inspection techniques and the safe use of equipment and chemicals in agriculture.

In brief, technical co-operation, to be effective, must have recourse to the many techniques available in accident prevention and related work and must continue to develop new approaches and methods to keep abreast of rapid industrialisation and the introduction of new production processes and operations.

Questions

1. *Give reasons why international action should be taken to promote occupational safety.*

2. *Mention some of the activities developed by the I.L.O. in the occupational safety field.*

FOURTEENTH LESSON

TRADE UNIONS AND WORKERS AND INDUSTRIAL SAFETY

TRADE UNIONS

Workers' unions have a very direct interest in promoting safety, for in nearly all cases it is workers who are killed and injured in accidents.

There are many ways in which unions can contribute to safety, and in fact some of them have taken direct action to ensure high standards of safety.

One important measure which unions can take is to have safety provisions included in collective agreements. This has been done, for instance, by several unions in the United States. Most of the agreements involved contain only general provisions concerning safety and health, although in particularly hazardous occupations, and where the safety of the general public is involved, they may include detailed rules and requirements. Generally, any differences between the union and the employers regarding safety and welfare may be referred to the regular grievance or other joint machinery for adjustment. Under some agreements such matters are referred to a special safety committee, which may be a joint management-union committee or one composed solely of union members. Others require the employer to maintain first-aid facilities in the plant and injured employees to report accidents. Since the employer is usually required to report all accidents under workmen's compensation legislation, most agreements do not contain clauses on the subject.

Co-operation between unions and employers in the United States takes a number of forms. Some unions provide for equal representation with the management on safety committees, the union representatives being appointed or elected directly. Others submit a given number of names of members to the management, which makes the final selection of a predetermined number (e.g. three names from a list of ten). In some cases the union nominees have to be approved by their foremen.

Sweden is a country in which co-operation between the unions and the other main parties interested in safety—the Government and the employers—is highly organised. The unions take the view that safety cannot be ensured by legislation alone, and that the latter must be supplemented by co-operation between employers, foremen and workers at all levels from national to local.

The existing arrangements for co-operation are based on a set of agreements concluded between the Confederation of Trade Unions and the Swedish Employers' Federation. They provide for the creation of a general joint body and of specialised joint bodies to deal with labour protection, vocational training, works councils and other matters. For the 15 years or so during which these arrangements have been in force they have worked well. Any difficulties which have arisen have been purely practical ones relating to questions such as the best ways of promoting safety (through textbooks, instructions, correspondence courses, films, study groups and so on).

Under the Swedish Labour Protection Act workers in places where more than five workers are employed have the right to appoint a safety delegate. There are now some 30,000 safety delegates in Swedish industrial undertakings; they are not only nominated, but also where necessary trained, by the unions.

An agreement on safety services in undertakings has also been worked out between the unions and the employers' federation.

The Confederation of Trade Unions and the Swedish Employers' Federation also co-operate in the running of a voluntary safety association—the Workers' Protection Association—which publishes a periodical, organises exhibitions and performs other functions.

In Sweden the unions are represented on the Labour Protection Board (the supreme authority for labour inspection) and also on the advisory councils attached to the 11 labour inspection districts into which the country is divided.

An arrangement which has existed for many years in the United Kingdom is of particular interest. In some industries standing joint committees, the membership of which includes trade union representatives, have been set up to discuss and make recommendations on safety matters. Sometimes agreements are concluded between the labour inspectorate, employers and workers in sectors where no such committees exist. Examples of joint standing committees are those for drop forging, power presses and paper mills. Tripartite agreements have been concluded for drop forging, the tinplate factories, paper mills, textile machinery manufacturing and other sectors of industry.

In some countries trade unions actually assist the labour inspection services. Sometimes this is achieved by including in the inspection service officials, appointed for a specific period by the workers, who help with the enforcement of regulations dealing with working conditions.

In other cases inspecting officials are recruited among trade union leaders.

In Norway a special system, of particular interest for countries where distances between population centres are great and population sparse, is followed with regard to workers' representation on the labour inspectorate. Norwegian law provides that in addition to the Directorate of Labour Inspection there shall be local inspectorates in every municipality in the country. The committees are appointed by the local councils. Of the members, at least one must be a woman and one a worker, and one must have technical qualifications. A qualified medical practitioner should also be appointed to the committee. In addition to the State Inspectorate of Labour there is also a Labour Inspection Council consisting of two employers' and two workers' representatives and a chairman with legal training. The Council is the appeal authority in respect of certain decisions taken by the Directorate of Labour Inspection.

In addition to co-operating with the authorities, safety institutions and employers, some unions engage in safety activities on their own account. The Metal Polishers, Buffers, Platers and Helpers International Union, for instance, has shown an active interest in industrial safety and health in the United States and Canada for very many years. It generally collaborates with state and regional authorities and voluntary organisations engaging in safety activities, has taken an interest in safety education, and carries on safety propaganda work among its members. It is of historical interest to note that the first resolution submitted to the American Federation of Labor in 1892 was one from the Metal Polishers Union calling for efficient factory inspection laws and mechanical exhaust ventilation. There is an increasing tendency in different countries for unions to set up safety committees of their own or to employ safety specialists.

The Swedish unions have laid great stress on safety education and have been very active in organising lectures, research, study groups, correspondence courses and special safety campaigns.

It is all to the good that trade unions should strive to secure better wages, working hours, holidays, social security benefits and other means of improving the living conditions of their members, but it might be said too that the first duty of trade unions is to do what they can to keep their members alive and intact. Good living conditions are of no use to a dead man; a widow's pension cannot replace a dead husband; and no amount of compensation will restore sight to a blind man.

In conclusion, mention should be made of one sort of union activity in this field which is not conducive to safety. Cases have occurred in which trade unions have demanded additional payment for their members (known as danger money) for work considered to be particularly dangerous. Safety is not promoted in this way, for the work, and the risks, remain the same whatever the rate of payment. Danger money has proved to be an altogether pernicious institution, for all too often unions have attempted to get work classified as dangerous rather than have the danger removed where it exists.

The Worker's Attitude

In the preceding lessons the different aspects of industrial safety have been dealt with. The economic and financial consequences of accidents have been described, and it has been seen that, though economic considerations are important, they are not the essential reason for safety activities, which is the moral obligation to protect the workers from physical danger. From this point of view the various kinds of preventive measures and the responsibilities of the various parties concerned have been examined. We may now well ask what the worker himself thinks about all this, and what he does and must do in the interest of his own safety and that of his fellow worker. This question is difficult to answer, because there are fundamental differences in the living conditions of the workers, their attitudes to their work and their ways of thinking in different parts of the world.

It may be assumed that workers want decent working conditions. In many countries they have shown a dislike of working conditions regulated solely by the employer's patronage or favours. They want conditions conforming to their conceptions of rightness, justice and equity. Where such is the case they may well feel that such conditions have usually been won as the outcome of long social struggles involving strikes and lockouts, prosecutions and persecutions. In these struggles long years of common action have brought forth feelings of solidarity, and a deep distrust of the employers, in the workers.

Today in some countries the workers have extensive rights which are generally accepted by the employers, and this distrust has given way more or less to feelings of mutual responsibility. In others trade unions hardly exist, and workers are not organised except perhaps in very small associations, embracing, for instance, a single factory. In technically advanced countries we find trade unions guided by persons with an expert knowledge of labour problems and employing technical advisers; but in underdeveloped countries there is nothing of the kind.

Some differences in the attitude of the workers may be traced to religious influences. It makes a great difference, for instance, whether a religion stresses mutual responsibility or teaches a fatalistic acceptance of things as they are.

Many a worker goes to the factory only to earn money for himself and his family; he has no special interest in his job, and he may work in the factory for years without any bond forming between his inner self and his work. He has little love for his employer or trust in him, and he is not likely to take kindly to advice and exhortations on safety or anything else.

A worker's attitude to industrial safety in fact may depend on a whole array of factors, ranging from the social and religious background to his own circumstances and character. It must be said that usually workers themselves are not the driving force in accident prevention activities. Even in technically advanced countries, where workers are relatively well off, tremendous efforts are required to make workers safety-minded. This seems to show that workers are seldom spontaneously interested in safety, even though their lives may be at stake. No doubt individual workers have made excellent contributions to safety as members of a safety committee or in some other capacity, but on the whole improvements in safety cannot be said to have originated among the workers. This can perhaps be partly explained by the fact that almost everywhere the law makes the employer responsible for establishing and maintaining safe working conditions; but the explanation is in all probability to be sought rather in the fact that workers are more interested in questions of wages, hours of work, holidays, compensation, the closed shop, etc.. than in questions of safety. There is also the fact that workers are accustomed to their working environment and its risks. Underestimation of these risks and a false feeling of immunity from them tend to make workers relatively indifferent towards safety matters.

In technically underdeveloped countries workers are often ignorant of the risks to which they are exposed. Many are peasants recruited from the villages and remain only for a short period in industry. They are often illiterate. It is therefore not surprising that they show little interest in accident prevention.

If it is true that workers generally have a very limited interest in accident prevention, one may ask whether the situation is likely to improve. Seeing that for many many years all the efforts made to arouse and intensify their interest have had only a very limited success, it cannot be expected that the situation will improve rapidly; but there can be little doubt that in the long run safety education in its various forms will pay good dividends. In any case it would be unthinkable to abandon the struggle.

The solidarity constantly shown by workers in times of trouble should manifest itself in the field by safety. Every worker has a duty and a responsibility to protect his fellow workers from accidents. A man's attitude must not be "Am I my brother's keeper?"; he must not stand aside when he sees a fellow worker taking serious risks, for this would be a grave breach of duty.

It was stated earlier that the accident frequency rate among young workers is relatively high. This is due sometimes to insufficient knowledge of risks, but more often to unnecessary actions motivated by a desire to do more than is absolutely necessary, to satisfy curiosity, or to indulge in horseplay. Here the older and more experienced workers have a definite responsibility to give guidance and supervision. The number of accidents in which young persons are involved might well be reduced considerably if this responsibility were more generally exercised.

One well-known cause of accidents to young workers is pressure from their elders to step up output. Here the older worker bears a grave responsibility, for he is not merely refraining from eliminating a risk but is actually creating one.

Some idea of the kinds of things that workers can do to promote safety can be obtained from the *Model Code of Safety Regulations for Industrial Establishments*, to which we have referred so often. Regulation 5 (Obligations of Employees) contains the following provisions:

1. Every employee shall co-operate with the employer in carrying out the provisions of this Code.

2. Every employee shall forthwith report to the employer or the foreman any defect that he may discover in the industrial establishment or the appliances used therein.

3. Every employee shall make proper use of all safeguards, safety devices and other appliances furnished in accordance with this Code for his protection or the protection of others, and shall obey all safety instructions made or approved by the competent authority pertaining to his work.

4. No employee shall interfere with, remove, displace, damage or destroy any safety devices or other appliances furnished for his protection or the protection of others, or interfere with any method or process adopted with a view to minimising occupational hazards.

5. All employees shall comply, in regard to their conduct, with the requirements of this Code.

Some of the practical, everyday tasks covered by these five short paragraphs are keeping gangways clear, cleaning up spilled oil, replacing guards that have to be removed for any purpose, keeping flammable waste in closed metal containers, and refraining from smoking in prohibited areas and from misusing machines or tools.

Some of the above duties are positive, some are negative; but they have one thing in common: they do not require much initiative. The workers, however, have plenty of opportunities of displaying initiative in the cause of safety if they want to; they can become safety delegates, they can take an active part in the work of safety committees, they can stimulate trade union action. A great deal will have been achieved when all workers make a passive contribution to safety by obeying safety rules and applying safety principles; but the safety movement will not be a complete success until every worker puts his heart and soul into the task of preventing accidents.

Questions

In group or private study, individual research on one's own or one's union's situation is an excellent method by which workers can explore the field of accident prevention further. To stimulate further study the questions which follow have been designed to cover a wider field than the matter contained in this lesson. They may provide a basis for the review of specific ideas brought out in previous lessons; they may also suggest certain subjects for group discussion. They are not intended to provide a framework for an exhaustive survey of the whole subject; but they will—with adaptations and complements—help the reader to discover for himself the practical implications of the knowledge acquired from the present course and also—possibly—to formulate the elements of a constructive union policy in respect of safety.

The Safety Situation.

1. *If your union had to formulate or review its policy with respect to safety matters in a factory, what would be the technical information and statistical data it should first obtain to determine that policy and justify subsequent claims or action?* (Some useful lines of investigation will be found in particular in Lessons 3, 9 and 11.)

The Worker's Attitude.

2. *Are the workers in your factory interested in promoting safety measures? How do you recognise this interest? What do they do in the interest of safety?*

3. *What factors (for instance, special dangers of the trade and frequency of accidents, education and propaganda programmes by the union, by the employer, by the labour inspection services) give rise to this attitude? In the last two cases, did the union co-operate? and if so, how?* (See in particular Lesson 8.)

4. *If there is lack of interest for an active safety attitude, what are its causes? (Examples: ignorance of risks, underestimation of risks, lack of*

solidarity between workers.) What remedies are there to this situation? In particular, what can the union do?

The Trade Unions.

5. *What safety provisions appear in the collective agreement covering your factory?*

6. *Are there first-aid facilities in the plant?*

7. *Are injured employees requested or required to report accidents?*

8. *What is the procedure for dealing with differences between the union and the employer on safety questions?*

9. *Is there a plant safety committee? Is it a union committee or a joint body? In the latter case, how are the worker members appointed? Do they receive specialised training for this job from the union, or otherwise?*

10. *In what ways (e.g. literature, campaigns, exhibitions, films) is safety promoted? How does the union co-operate in this educational effort?*

11. *Is there a joint or tripartite safety body at the industrial or national level?*

PUBLICATIONS OF THE I.L.O.

Model Codes

Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry. 1949.[1] xxxv + 523 pp.

Premises of industrial establishments; fire prevention and protection; machine guarding; electrical equipment; hand tools and portable power-driven tools; boilers and pressure vessels; furnaces, kilns and ovens; handling and transportation of materials; dangerous and obnoxious substances; dangerous radiations; maintenance and repairs; health protection; personal protective equipment; medical services; safety organisation.

Model Code of Safety Regulations in Underground Work in Coal Mines. 1950. ix + 102 pp.

Means of access and egress; plans; explosives and shotfiring; supports; haulage of materials; travel and transportation of workers on roads and inclines; winding of men and material; ventilation; precautions against firedamp and coal dust; miners' lamps; precautions against inrushes of water; prevention and extinction of mine fires; shaft sinking or deepening; electricity; machinery and plant; qualifications and duties of managing officials, supervisory officials and miners; notification, investigation and recording of accidents and dangerous occurrences; first aid and rescue; general inspections by managers and supervisory officials; safety organisation.

Codes of Practice

Prevention of Accidents Due to Fires Underground in Coal Mines. 1959. v + 48 pp.

Prevention of Accidents Due to Electricity Underground in Coal Mines. 1959. v + 54 pp.

Safety and Health in Dock Work. 1958. vi + 125 pp.

Safety and Health in Agricultural Work. 1965. viii + 132 pp.

Safety and Health in Forestry Work. 1969. xi + 165 pp.

Guides and Manuals

Guide for Labour Inspectors. 1955. iv + 107 pp.

Accident Prevention—A Workers' Education Manual. 1961. viii + 182 pp.

Manual of Industrial Radiation Protection :

Part 1: *Convention and Recommendation.*[2] 1963. 24 pp.

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[1] In 1956 the I.L.O. revised the regulations on the textile industry and welding operations, and in 1959 those concerning ionising radiations (see below, under "Guides and Manuals").

[2] Contains the text of the Radiation Protection Convention and Recommendation, 1960 (No. 115 and No. 114).

Part II: *Model Code of Safety Regulations (Ionising Radiations).*[1] IV+54 pp.

Part III: *General Guide on Protection against Ionising Radiations.* 1963. VIII+95 pp. Illustrated.

Part IV: *Guide on Protection against Ionising Radiations in Industrial Radiography and Fluoroscopy.* 1964. VIII+62 pp. Illustrated.

Part V: *Guide on Protection against Ionising Radiations in the Application of Luminous Compounds.* 1964. VIII+48 pp. Illustrated.

Part VI: *Radiation Protection in the Mining and Milling of Radioactive Ores.*[2] 1968. VI+108 pp.

Guide to the Prevention and Suppression of Dust in Mining, Tunnelling and Quarrying. 1965. XVIII+421 pp. Illustrated.

Guide to Safety and Health in Forestry Work. 1968. XII+223 pp. Illustrated.

The Role of Medical Inspection of Labour. 1968. 111 pp.

Occupational Safety and Health Series[3]

1. *Occupational Health Problems in Agriculture.* 1963. 223 pp.
2. *The Medical Inspection of Labour.* 1963. 104 pp.
3. *Adaptation of Work to Man and Occupational Health Problems in Countries Undergoing Industrial Development.* 1964. 19 pp.
4. *Man at Work. Studies on the Application of Physiology to Working Conditions in a Sub-tropical Country.* 1964. 49 pp.
5. *Maximum Permissible Weight to Be Carried by One Worker.* 1964. 112 pp.
6. *Respiratory Function Tests in Pneumoconioses.* 1966. 173 pp.
7. *Organisation of Occupational Health Services in Developing Countries.* 1967. 180 pp.
8. *Course on Dust Prevention in Industry.* 1964. 161 pp.
9. *Dust Sampling in Mines.* 1967. 88 pp.
10. *Kinetic Methods of Manual Handling in Industry.* 1967. 38 pp.
11. *Course on Radiation Protection in Industry.* 1965. VIII+256 pp.
12. *Benzene: Uses, Toxic Effects, Substitutes.* 1968. 302 pp.
13. *Official Services for Occupational Safety and Health.* 1968. 323 pp.
14. *Ergonomics in Machine Design.* (In preparation.)
15. *Safety Training for Underground Mineworkers.* 1968. 109 pp.
16. *International Directory of Occupational Safety and Health Institutions.* 1969. 520 pp.
17. *International Catalogue of Occupational Safety and Health Films.* 1969. 557 pp.
18. *Electrical Safety: Portable Tools and Mobile Appliances.* (In preparation.)

[1] Revised text of Section 2 of Chapter XI of the *Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry*, mentioned at the beginning of this list.

[2] Published jointly with the International Atomic Energy Agency in Vienna.

[3] Information on distribution may be obtained direct from the Occupational Safety and Health Branch of the I.L.O.

19. *International Directory of Occupational Safety and Health Courses.* 1970. 128 pp.

SET OF STANDARD FILMS ILLUSTRATING THE INTERNATIONAL CLASSIFICATION OF RADIOGRAPHS OF PNEUMOCONIOSES. 1958

Following a meeting of experts on the international classification of radiographs of pneumoconioses in 1958 a working party appointed by the meeting selected a set of radiographs to illustrate the various classes of the international classification. Negatives of standard size made from these radiographs to serve as model negatives for the assessment and radiological classification of cases of pneumoconioses.

PUBLICATIONS OF THE INTERNATIONAL OCCUPATIONAL SAFETY AND HEALTH INFORMATION CENTRE (C.I.S.) [1]

C.I.S. Cards

Cards giving abstracts of articles, books, regulations, legislation and films on various subjects connected with safety, health and industrial medicine. Issued periodically at a rate of 2,000 abstracts a year.

Occupational Safety and Health Abstracts

Publications intended particularly for small and medium-sized establishments.

C.I.S. Information Sheets [2]

1. *Safety Devices for Belt and Other Conveyors.* 19 pp. Illustrated.
2. *The Prevention of Accidents Due to Sliding, Vertical-Lift and Up-and-Over Doors.*
3. *Manual Lifting and Carrying.* 17 pp. Illustrated.
4. *Acceptable Levels of Industrial Noise.* 4 pp. Illustrated.
5. *Challenges in Industrial Hygiene.*
6. *Entering Tanks and Other Enclosed Spaces.* 13 pp. Illustrated.
7. *Circular Saws.* 50 pp. Illustrated.
8. *Flexible Swing Doors and Air Curtains.* 21 pp. Illustrated.
9. *Respiratory Protective Equipment.* 33 pp. Illustrated.
10. *Ergonomics of Machine Guarding.* 18 pp. Illustrated.
11. *Artificial Lighting in Factory and Office.* 61 pp. Illustrated.
12. *Ladders.* 80 pp. Illustrated.
13. *Management and Industrial Safety Achievement.* 10 pp.
14. *Automation and Occupational Health.* 18 pp.
15. *Human Factors and Safety.* 84 pp.
16. *Safety in the Construction of Reinforced Concrete Floors.* 26 pp. Illustrated.
17. *Noise in Industry.* 56 pp. Illustrated.

[1] Information on distribution may be obtained directly from C.I.S., at the International Labour Office.

[2] Nos. 1-17 are out of print.

18. *Asbestos Cement Roofs.* 13 pp. Illustrated.
19. *Fifty Years of International Collaboration in Occupational Safety and Health.* 69 pp.

C.I.S. Bibliographies

1. *Electrical Accidents.* Out of print.
2. *Cancer of the Urinary Tract Caused by Aromatic Nitro and Amino Compounds.* 9 pp.
3. *Prevention of Occupational Accidents and Diseases in Agriculture.* 15 pp.
4. *Automation and Prevention.* 13 pp.
5. *Methods of Promoting Safe Behaviour.* 12 pp.
6. *Occupational Hazards of Asbestos.* 39 pp.
7. *The Cost of Occupational Accidents and Diseases. The Economics of Safety and Health.* 12 pp.
8. *Hazards of Laser Beams.* 16 pp.
9. *Occupational Hazards in the Construction Industry.* 25 pp.

C.I.S. Symposia

Proceedings of the International Symposium on Electrical Accidents (Paris 1962). 270 pp. Illustrated.

Other Workers' Education Manuals

Wages

An introduction, explaining how wage rates are fixed, the relationship between wages and other benefits, and some of the problems of wage theory and policy.

Co-operation

A course of fourteen lessons on the origins and economic and social basis of the co-operative movement; the distinctive features and working rules of co-operatives; their administrative and financial organisation; problems of structure and management; co-operative federations, and problems of relations with the State and co-operative education.

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