Conditions of work and safety in shipbuilding and ship repairing

Third item on the agenda

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INTRODUCTION

The Industrial Committees of the International Labour Organisation have all at one time or another concerned themselves with the subject of safety and health. In some cases they have dealt with the problem as a whole as it affects their own particular field, while in others they have confined themselves to examining only certain aspects.

The Metal Trades Committee has been no exception to this rule. At its First Session, in 1946, it adopted a series of four resolutions on the following subjects: the international standardisation of statistics of accidents and occupational diseases, international standardisation of warning signs, special safety services and safety committees, and education and propaganda in matters of industrial safety and health; a fifth called for a factual survey by the I.L.O. of measures taken in different countries for the prevention of accidents and the protection of health in the metal trades. At its Third Session in 1949, it adopted a resolution expressing its concern about the dangers inherent in sandblasting. When, subsequently, at its Fourth, Fifth and Sixth Sessions, the Committee reviewed its past activities, it decided to keep two of the resolutions just mentioned - the resolution on special safety services and safety committees, and the one on education in safety and health in industry - in the category of conclusions which governments, employers' and workers' organisations should bear in mind, i.e. governments should later supply additional information on these subjects or the subjects would come up again for examination at a later date.

The interest which the Committee takes in these subjects is also seen in a resolution which it adopted at its last (Sixth) Session, in 1957, in which it asked the I.L.O. to make a study of the health, safety and welfare of shipbuilding and ship repairing workers. In addition, reverting to a suggestion which had been made


at the previous session, the Employers' group suggested that the agenda of the Seventh Session should include the following item: "Study of the methods which have proved effective in connection with safety promotion and accident prevention and means of implementing the same". It will be recalled that while the draft resolution put forward by the Employers' group was not opposed, it was not adopted either, for lack of a quorum when voting took place. But this setback was not due to indifference on the part of the other groups, as is shown by the part they took in the discussion at the plenary sitting of a chapter of the General Report dealing with safety and health. The Workers' group merely wished to declare in a draft resolution, which suffered the same fate as the resolution of the Employers' group, its preference at that time for other subjects. The continuity of the interest shown by the Metal Trades Committee in safety problems is thus beyond question.

Another subject with which the Committee has dealt at various times, although it has not hitherto formed a separate item on the agenda, is shipbuilding and repairing. At its Fourth Session, in 1952, the Committee called for a "preliminary study" by the Office of certain features of this industry. This study in fact formed a chapter of the General Report for the Fifth Session in 1954. It dealt partly with employment problems having regard to the relevant economic factors and partly with wages and social conditions. The question was revived

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1I.L.O. Metal Trades Committee, Sixth Session, 1957, Report I (c), General Report - Recent Events and Developments in the Metal Trades (Geneva I.L.O., 1957), Chapter I.
For details of the discussion at the plenary sitting, see I.L.O. Metal Trades Committee, Summary Record of the Sixth Session, (Geneva, I.L.O., 1958), and Industry and Labour, Volume XVII, No. 12, 15 December 1957, p. 455.


3I.L.O., Metal Trades Committee, Fifth Session, 1954, Report 1 (a) and (b), General Report - Effect Given to the Conclusions of the Previous Sessions (Geneva, I.L.O., 1954), Chapters II and III.
in the General Report\(^1\) prepared for the Sixth Session in 1957; this was in accordance with a request made by the Committee in 1954 in its Memorandum concerning the regularisation of production and employment at a high level in the metal trades.\(^2\) In both cases the matter was dealt with by the Committee in its general discussion.\(^3\) Again, the Sixth Session, the Committee, as mentioned in the previous paragraph, asked for a study to be made of the health, safety and welfare of workers employed in shipbuilding and repairing.

Accordingly, at its 147th Session (November 1960), the Governing Body of the I.L.O., in fixing the agenda for the Seventh Session of the Metal Trades Committee, decided to merge these two subjects, to which the Committee attached such evident importance. On the one hand, it proposed that the Committee should consider the question of safety, which it had not hitherto dealt with as such, and, on the other, it limited the scope of the subject to an industry which, within the metal trades as a whole, has a number of distinctive features, namely shipbuilding and repairing. Thus, this item of the agenda would be concerned with conditions of work and safety in this one industry.

At this stage, a difference of opinion arose within the Governing Body. Some members considered that the term "conditions of work" referred to all the factors covered by a contract of employment, including, for example, remuneration, hours of work, time off and holidays with pay. Others, on the other hand, argued that in this particular case it should only cover the environmental or physical conditions (defined in the widest sense) in which the work is performed. Conditions of work in

\(^1\)I.L.O., Metal Trades Committee, Sixth Session, 1957, Report 1 (c), General Report - Recent Events and Development in the Metal Trades, op. cit., Chapter V.


\(^3\)The General Report prepared for the present Session also contains a chapter on recent developments in this industry (see I.L.O., Metal Trades Committee, Seventh Session Report I, Chapter VII).
shipyards, they claimed, were usually the same as in other metal trades, and the discussion would be more helpful if it were focussed on the problem of safety, conditions of work being dealt with only in so far as they had a direct influence on safety. Agreement was reached at the 148th Session of the Governing Body (March 1961). It was decided that the discussion should centre on safety problems without being confined to their technical aspects; it should not deal with conditions of work in general, but only with those conditions directly related to safety, i.e. environmental conditions, or those which may have an influence on safety, i.e. long hours of work or certain systems of payment. The following wording was finally adopted for this item: "Working conditions and safety in shipbuilding and ship repairing", it being understood that the Metal Trades Committee would be informed of the interpretation placed by the Governing Body on this wording.¹

This is the framework within which the Metal Trades Committee will have to examine this question, and the report before it has, of course, been drafted with this in mind. It does not, therefore, contain any detailed comparative analysis of the safety regulations in force in various countries, or any full description of safety devices now in use, or particulars of the minimum standards laid down, for example, for scaffolding. It merely sets out to give as clear an idea as possible of the hazards confronting workers in shipbuilding and repairing because of the particular conditions in which they operate, and to describe the way in which protection is organised in accordance with either general or specific regulations on the subject.

Chapter I describes the physical environment in which the operations involved in shipbuilding and repairing are carried out, and shows how this environment itself is changing under the impact of technical progress. Chapter II gives an account of the special dangers inherent in these operations and the reasons for them. Chapter III describes the measures by which public authorities and employers' and workers' organisations, as well as individual employers and workers, endeavour to reduce these hazards.

¹ See documents G.B. 147/15/31 and G.B. 148/17/35.
In the final chapter, an attempt is made to take stock and to single out the problems which appear to merit special attention. The Report ends with a list of points which might be found useful by the Committee as a basis for its discussion.

It goes without saying that in examining the third item on its agenda, the Committee will need to bear in mind the principles laid down by the International Labour Conference for accident prevention in industrial establishments. These principles are laid down in the Prevention of Industrial Accidents Recommendation adopted by the International Labour Conference in 1929 and in the Protection of Health of Workers Recommendation adopted in 1953. The Committee will also recall that, in 1949, the I.L.O. published a Model Code of Safety Regulations for Industrial Establishments, which applies to shipyards as well as to establishments in other industries. Both these documents apply to industry as a whole. Others, which are more limited in scope but are applicable mutatis mutandis to shipbuilding and repair, will be mentioned in this Report. (A list of them will be found in the Appendix).

* * *

In order to supplement and bring up to date the material available, the I.L.O. sent a few officials to visit a number of countries where the shipbuilding and repairing industry plays a large part in the national economic life. These officials toured shipyards and had talks with managements, labour inspectors and representatives of the employers' and workers' organisations. Information was also sought from countries which were not visited, and most of them sent in statements. The thanks of the Office are due to the public authorities, employers' and workers' organisations and shipyard managements which have helped it in its task.

CHAPTER I

TECHNICAL DEVELOPMENTS AND CHANGES IN THE WORKING ENVIRONMENT IN SHIPBUILDING AND REPAIRING

The problems before the Committee may fall into better perspective if some account is first given of the operations involved in shipbuilding and repairing. This will help to show that the shipbuilding industry is a world apart and will also bring out the main changes which have occurred in recent years in ship design and construction. The daily life of the workers - which is what concerns us here - is governed by the operating methods and it is important to keep them in mind in order to appreciate the hazards to which workers are exposed and to gauge the measures taken for their protection.

Some Distinctive Features of the Shipbuilding Industry

Because it moves through water, a ship is largely freed from some of the limitations which bear heavily on other vehicles, especially as regards weight and displacement. The result is that the dimensions of ships have grown as far as is technically and economically practicable - being limited on the one hand by the power of the propulsive equipment available and the risk that an excessively long hull might break its back, and on the other hand by the capacity of canals, harbours and repair facilities and the level of operating costs. Now that designers have overcome most of the technical obstacles, economic considerations tend to be the main factor, and whereas, before the Second World War, the only vessels in the highest range of tonnage were a few liners and warships, this size of ship is now used for goods as well, especially for liquids.
Tanker dimensions have increased steadily. Before the last war the commonest type was the "three twelves": 12,000 tons dead weight, 12 knots and a fuel consumption of 12 tons a day. After the war the 28,000 ton tanker became common, but ships steadily increased in size until by 1958 the Japanese shipyards were launching tankers of more than 100,000 tons; at the present time two 130,000-ton vessels are under construction.¹ This type of vessel is in fact the "giant of the seas" of modern times. The "Universe Apollo" of 104,520 tons dead weight is 285 metres long, 41 metres wide, 20.5 metres deep from deck to keel, and draws 14.6 metres of water; it can carry a cargo of 160,000 cubic metres of oil; its 25,000 h.p. turbine and five-blade propeller with a diameter of 7.5 metres give it a speed when loaded of 15.5 knots.² According to the shipowner, these vessels cut transport costs by 30 per cent, as compared with 45,000 ton tankers.³ These giants are still, however, exceptions.

Even when the vessels being built are not of these dimensions, the sheer scale of operation of a shipyard is impressive. The labour force gives the same impression. While in some of the smaller shipyards, especially those which concentrate on repairs, only a few hundred workers may be employed, most concerns employ several thousand. The shipbuilding industry has always employed large numbers of workers. Despite the remarkable progress of mechanisation there are many human skills which cannot be replaced. The installation of the engines, the assembly of the hull and the fitting out all involve a good deal of manual work. Moreover, ships are not normally produced in series, at least in the sense in which the term is usually understood. Each is a separate project, and it is treated somewhat as if it were a prototype, with few, if any, copies. The need to keep running costs as low as possible leads to specialisation, thus, in addition to passenger liners there are bulk

¹ It is reported that a 150,000 tons tanker is being planned in Japan to the order of an American shipowner; (L'Usine nouvelle, Paris, 16 November 1961).
² Ibid. 19 February 1959.
carriers, refrigerator ships, fruit ships, oil tankers, methane tankers, wine and vegetable oil tankers, ferry boats, whalers, etc. The shipowner's specifications are governed by the type of goods to be carried and the routes to be served, and it is up to the shipbuilder to solve the problems of all kinds that may be involved.

Attempts at standardisation by the shipbuilder, therefore, cannot be carried very far. This, after the huge scale of operations mentioned earlier, is the second distinctive feature of the industry. The construction methods and the whole layout of the shipyard are inevitably strongly influenced by both factors.

However, despite the variety of uses to which ships are put, each still consists essentially of a hull and its propulsive machinery and the whole work of the shipyard revolves round these two components. Let us therefore take a look at the departments which build the machinery and the hull.1

Machinery

Not all shipyards manufacture the machinery - engines, boilers, turbines and shafts - which they instal in their ships. Some rely on subcontractors, which may be other shipyards possessing machinery workshops with a capacity greatly in excess of their needs. Few yards make their own propellers. Most of them, however, have a foundry which varies in size according to whether they make their own machinery or not. There is no need here to devote further time to the foundry because the conditions of work are not peculiar to shipbuilding; (the hazards involved in foundry work will, however, be touched on in the following chapter).

It is not within the scope of this report to review the developments in marine engineering over the last few decades. It is, however, of some interest to note the main stages of development. The steam engine and its transmission gear have been perfected to such an extent

1See J.R. Parkinson: The Economics of Shipbuilding in the United Kingdom, Chapters 9 and 10 (Cambridge University Press, 1960).
that ships of identical horsepower consumed six times less coal in 1934 than in 1854. The introduction of the diesel engine with an efficiency of 35 - 40 per cent. against the 20 - 25 per cent. more usual for steam engines as well as the use of fuel occupying less space and easier to handle, have considerably reduced running costs. The steam engine has, therefore, been gradually replaced by the diesel engine, at least in so far as small and medium-sized vessels are concerned; and as a power of 20,000 h.p. can now be obtained from a diesel engine—a development making it possible for even the supertankers to be powered by diesel engines—such motors have started to be used, in recent years, for large ships also.

Research and trials in the post-war period have been conducted mainly in respect of three types of propulsion engines. The first is the free-piston engine, which uses a wide range of fuel; it has a high rate of efficiency and is flexible in its space requirements. The second is the gas turbine, which cannot reach maximum efficiency until certain technical difficulties can be overcome; but, power being equal, it is from two to four times lighter than a diesel engine. The third is the nuclear reactor, concerning which some words are called for since the adoption of this form of propulsion would involve large-scale safety problems, not only for the crews, but also for the workers engaged in the construction, installation, maintenance and repair of the engine, owing to the fact that radioactivity continues even when the reactor is shut down. The advantages of nuclear propulsion are well known— the vessel is self-sufficient as regards oxygen and the life of its fuel supply is almost indefinite. Two advantages which are particularly valuable in the case of submarines. The second advantage is mainly useful for surface warships, such as the aircraft carrier "Enterprise" launched in October 1961, and for merchant vessels which have to be in service for very long spells such as the ice-breaker "Lenin" which, with its three reactors developing a total of 40,000 h.p., travels at a speed of 20 knots on the open sea and at 2.25 knots through ice 2.40 metres thick, and can operate for a whole year without refuelling. But, for the time being at least, the prospects of using atomic energy to drive merchant ships are still very limited. The output of the reactor is far lower than that of diesel engines and its initial cost is very much higher. It follows that the performance of the
cargo liner "Savannah" will mainly have the value of a technical trial.

Research is now being carried out in an attempt to overcome the economic and technical obstacles involved. In addition to the achievements of the United States and the U.S.S.R., mention should also be made of projects being carried out in Canada, Japan, and a number of European countries, such as France, Italy, the Netherlands, Denmark, Norway, Sweden, the United Kingdom and the Federal Republic of Germany. Euratom is also taking part in some of these projects and so is the European Centre for Nuclear Energy. Whatever the outcome of this research, there is every reason to believe that traditional engines will long continue to compete with atomic reactors.

The Committee's attention will therefore be mainly focussed on conditions of work and safety in the manufacture and building of traditional engines. Strictly speaking, the workers engaged in these operations encounter conditions which do not differ greatly from those prevailing in large workshops. One of the characteristics of this type of work is undoubtedly the importance of materials handling operations, as can be seen from the following data: a 48,000 ton Japanese tanker at present under construction will be equipped with a 9-cylinder engine generating 16,500 h.p., which will measure 18.55 metres in height and 4 metres in width at the base and will weigh 668 tons. This serves to show the part played by lifting machinery in this sector of the industry.

In the machine sector, it is the development of this machinery which has exercised the most considerable influence on conditions of work, which for the most part have not changed in the last decades. It is, in fact, in the hull-building sector that technical developments have brought about the most striking change in both the appearance of the shipyards and the working environment.

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1The Shipping World, 13 December 1961, p. 471.
The Hull

As we have seen, the shipbuilder must adapt himself to the changes in ship design. He must be prepared to install the type of engine which appears to be the most satisfactory and the most economic, and to build and repair increasingly large vessels, as required by the shipowner.

Similarly, he must constantly ask himself whether the materials he employs are always best suited to his needs. Steel is, of course, far from being superseded as far as the main body of the ship is concerned, but aluminium alloys have replaced it for certain purposes because of their low specific weight and their elasticity. On the other hand, their high price limits the scope for their use—roughly speaking, a ton of aluminium alloy can do the work of two tons of steel, but costs as much as ten tons. Aluminium is increasingly used for superstructures, especially in liners, since its use in the upper part of a ship helps to lower the centre of gravity. Its use in conjunction with steel naturally creates a number of technical problems because the coefficient of expansion of the two metals is not the same. Techniques for joining them have however been devised. Above all—and for our purpose this is the most important point—some of these special techniques, such as inert gas welding, entail a number of safety problems for the workers.

Welding and Prefabrication

However, the effect of the introduction of aluminium on conditions of work in shipyards cannot be compared with the effect of the replacement of riveting by welding. This substitution has been described as having consequences as far-reaching as the replacement of wood by steel.

The first all-welded ship, a coastal vessel, was built in 1917, but before the 1930's it had few imitators. Shipowners were dubious about a technique which in their view could not guarantee the same sturdiness as the well-tried method of riveting. But technical improvements, the example of the world's navies which made increasingly wide use of the new method in order to save weight, coupled with the large-scale construction of all-welded Liberty ships during the last war, helped to ensure the success of welded assembly—a

1See Chapter II
success which has been reinforced since the ending of hostilities by a series of technical advances and, crowned, in the heavy tonnage group, by the bringing into service of the United States. The danger that a ship might break its back has been substantially reduced; nevertheless most ships are still built with a few horizontal and vertical lines of rivets designed to stop any cracks which might develop in the hull.

Thus welding has finally triumphed over riveting. It owes its success to its economic advantages, since a welded ship costs less to build and operate than a riveted ship. It requires a smaller quantity of steel, because plates when riveted necessarily overlap, whereas they can be butt welded; nor is the weight of the rivets themselves by any means negligible — it is estimated that the saving in steel is of the order of 12 per cent. Being lighter and having a more streamlined hull, a welded ship of equal tonnage can either travel faster or carry a bigger cargo, or achieve the same performance with less powerful engines, which therefore cost and consume less.

In addition, welded assembly has speeded up construction, partly because welding itself is faster than riveting, and partly because this technique has led to the introduction of new methods, which, as will be seen later, have considerably shortened some stages of construction. It may be said that resort to welding has literally revolutionised shipbuilding methods and with them the conditions in which many workers perform their jobs.

The general introduction of welding, coupled with various other factors, such as the need to reduce as far as possible the drawbacks of working in the open air and the convenience of operating at ground level, has led to another change which has had equally far-reaching effects on the workers' conditions, viz., workshop assembly or prefabrication. Some types of welding, especially of aluminium, require an envelope of inert gas to prevent oxidation and must therefore be sheltered against draughts, and can be carried out more easily under cover (to some extent this is true of all types of welding). Construction under cover is also desirable in the interests of precision, because the welded sections must be fitted together with the utmost accuracy, and for this a workshop is clearly more suitable.

Large deck section, whole bulkheads, sections of the double bottom, hull and fore- and after-peak, each weighing several dozen tons, are assembled in this way under cover, the maximum weight being dictated of course, by the capacity of the lifting equipment. A German shipbuilder has, however, asked whether it would not be advisable to limit the size of
of these prefabricated sections. The reason is that they must be welded in three dimensions, i.e., they must be turned over twice and, the heavier they are, the more subject they are to distortion, which is difficult and expensive to correct. But the advantages of prefabrication are not questioned by anybody and the method has rapidly become general.

As a result, assembly operations on the slipways have been considerably speeded up. For example, when the liner France was being built, ten men installed the last section of the prow weighing 31 tons in 17 minutes.

Consequently, the length of time a vessel is on the slipway and the total time of construction have been appreciably reduced. For example, a British shipyard recently launched an 18,500-ton dead-weight ore carrier 46 days after the keel was laid. The management of a Polish shipyard which is being reconstructed estimates that the time on the slipway will only account for between 16 to 20 per cent. of the total time taken to construct the hull, as against between 45 and 50 per cent. at the present time. Simultaneously, the amount of work done in the open or the number of workers engaged in assembly operations on the slipway has also fallen. In a Danish shipyard, the amount of work done in the open has fallen from 50 to 16 per cent.

Changes in Construction Techniques

The practice of prefabrication under cover not only affects the working conditions of the men actually assembling the hull; it has also led to changes affecting all the workers who are concerned in any way with the hull. All operations - the preparation of the plates as well as the construction itself - are tending to be increasingly closely integrated and to resemble assembly line operations.

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1. The Shipping World, 29 March 1961, p. 299
2. Industries et Techniques, (Paris), 1 May 1960, p. 9
3. L'Usine Nouvelle, 21 September 1961
4. The Shipping World, 8 November 1961, p. 358
When unloaded from goods wagons or barges, the plates and sections are stocked in the order in which they will be required in a yard equipped with all the necessary transport and lifting devices. From this yard the plates are picked up by a crane (the most modern being electro-magnetic) and transported either by the crane itself or on a flat car or truck, or on a roller conveyor which takes them to the plate shop where they are smoothed and scaled. For many years this scaling was done by means of sand blasting, but this practice has lately lost a good deal of ground, although it still appears to be the best method for certain operations. For the treatment of plates, it has tended to be superseded by shotblasting, i.e., each plate passes through a shed in which streams of shot remove the rust which has accumulated since it left the steel works.

The shotblasting shed leads directly to the plate shop. In many modern shipyards the traditional practice of laying out plates and shapes by means of full scale templates and scrieve boards which have been prepared in the mould loft is giving way to other methods. Using optical tracing, a full scale photograph of the drawing, which is on a scale of, for example 1:10, is now projected on to the plate. The tracers make their marks by following the line of light. Better still, another technique completely eliminates the tracing; a photo-electric cell "copies" the drawing and as it follows the outline, it controls the movements of an oxy-acetylene cutting machine, the blowpipes of which cut the plate in accordance with the design, without any tracing being necessary. In a Swedish shipyard, there are four centrally-controlled oxy-acetylene cutting machines, each of which has two blowpipes; these machines simultaneously cut eight plates about 15 metres long and 2 metres wide. Only four men are needed to carry out the operation. However, optical tracing still appears to be the most practical and economic method for certain purposes.


2 Over 100 shipyards have now adopted the system of optical tracing or optically-controlled automatic cutting and about 50 per cent. of shipbuilding (dead weight) is now carried out using one or other of these methods. (Fairplay, 8 March 1962, p. 37.)
At the same time plates and rib sections are being shaped. Cold shaping is becoming increasingly common and is carried out by means of powerful presses which require only a minimum of labour. One Swedish shipyard recently placed an order for a 340 ton hydraulic bending machine capable of dealing with plates 45 mm thick and 14.50 metres long.

The next stage sees the beginning of prefabrication, which was referred to earlier. Some sections of the hull, especially the curved parts, require fairly complicated operations, both on each plate and in assembly. In the case of other sections, such as the flat sides of the hull and the bulkheads, the plates are assembled without any preparatory operations apart from smoothing and shotblasting. Here, too, the machine now plays a major part. In a Danish shipyard, the plates are butt welded by an automatic welding machine which operates without any noise, smoke or glare. The resulting section which may be composed, for example, of six plates measuring 18m by 9n. overall, is then transported, lying flat, by a roller conveyor to a point 20 or 30 metres further along to make room for the next plate. At this stage it receives its reinforcing girders. An automatic welding machine of another type, but causing equally little smoke, noise or glare, now comes into action. It straddles the girder and welds it to the plates on both sides simultaneously. The completed section then resumes its progress to the end of the workshop, where a crane picks it up and places it on the open space at the head of the slipway. There it is stored with other prefabricated sections made by neighbouring departments of the plate shop while awaiting final assembly.

The last stage of building the hull now begins. Here too, a number of major changes have occurred in recent years. Not so long ago, all ships were built on inclined slipways from which, once work had reached a certain stage, they were "launched", i.e., they slid down into the water by force of gravity. This method has a number of drawbacks, not the least of which are the hazards involved in the actual launching - it is not necessary to go back very far to find an example of a ship capsizing. Above all, there is the fact that in the case of ships of any length, the slope of the slipway (between 1 in 25 and 1 in 17) seriously complicates the assembly of the highest section - the bow. For example, in the case of an oil tanker 200 metres long, the difference
in height is between 8 and 12 metres. This difficulty becomes acute if the slipway is itself raised above the level of the shipyard.

Accordingly, shipbuilders are increasingly coming to prefer construction in dry dock, which has a number of distinct advantages. In the first place, it abolishes the need for launching since, once work has progressed to the necessary stage, the dock is simply flooded and the vessel towed out to the fitting-out basin. This advantage is particularly important for shipyards on the banks of narrow rivers. Secondly, the vessel under construction lies horizontally, and the assembly of the bow does not entail any more difficult lifting operations than the assembly of the stern. Lastly, vessels are built at a lower level than that of the shipyard, which greatly facilitates lifting operations.

Recently constructed dry docks are naturally equipped to meet all modern shipbuilding needs, e.g., with high-capacity pumps, compressors, oxygen, acetylene and electricity supplies and, of course, suitable lifting gear.

Changes in Equipment

This last point brings us to the changes in the equipment of shipyards brought about by modern techniques and methods. The replacement of riveting by welding as the main method of assembly has made it possible to use far fewer drilling machines. Mechanical methods of cutting plate are losing ground to oxy-acetylene cutters which, in a single operation, can not only cut the plate but also bevel the edges in readiness to hold the V-shaped weld metal. Mention was made earlier of shotblasting machines, optical tracers, automatic welding machines and conveyors. 1 Reference has also been made a number of times to the increasing importance of lifting equipment, and the time has now come to deal with this point in more detail.

It would hardly be an exaggeration to say that the degree of modernisation of a shipyard can be gauged by the number and power of its lifting devices. They are everywhere. They pick up plates and girders from the storage yard, they are used in the assembly of the engines, they change the position of sections during prefabrication, they deposit them at the head of the slipway and, finally, put them in place on the hull. It is during these final stages

1See Lloyd's List, 1 November 1961, for a description headed "Japanese Use of Conveyor Belt System" of the way in which the materials are worked on while still on the conveyors.
that they come into their own. It is only because of their steadily increasing capacity that prefabrication has been able to develop to the extent it has and their part in transforming the shipbuilding industry must not be underestimated.

The capacity of the derricks, which at the beginning of this century operated on both sides of a slipway, did not exceed 5 tons, whereas now powerful cranes are used which can lift several dozen tons. Even the shape of some of them no longer resembles the silhouette of the birds after which they are named. They tend nowadays to be travelling gantry cranes like the two recently brought into service in a Danish shipyard, each of which has two hooks with a capacity of 150 tons, so that the crane can lift 300 tons. When coupled - they are in line and travel up and down the same track - they are subject to a single control and are capable of carrying 600 tons. They can straddle the whole dry dock and the yard where the prefabricated sections are stored and can travel from the gates at the sea-end to the inside of the prefabrication shop, which is 60 metres high. In this way they can serve the whole of the construction area. They now make it possible to assemble a hull in a small number of sections (between 10 and 35, depending on the tonnage) and the length of time on the slip has been cut to four or five weeks. Modernisation of the Polish shipyard referred to earlier involves the installation of a travelling gantry crane with two hooks, each of which is capable of lifting 250 tons. These performances are of course among the more spectacular achievements of the crane designers, but it is plain that any shipyard which is being modernised must pay special attention to equipment of this kind, whether powerful cranes to handle sections of the hull or travelling gantry cranes to move materials in the engineering and plate shops.

Reorganisation of Shipyards

The introduction of up-to-date techniques has inevitably led to far-reaching changes in the layout of shipyards. Out-of-date workshops are replaced by new high, spacious buildings. Whenever the site allows, an effort is made to achieve the ideal layout, which enables production to flow in a straight line from the plate storage yard to the slipway. Reconstruction is difficult because it is liable to paralyse the shipyard for some time. The alternative is to build on a "green field" site, and sometimes land can be won from the sea or the river. But most shipyards are unable to do so and are forced to proceed by stages. They are
often helped by being able to scrap some of their slipways - as was seen earlier, prefabrication speeds up the pace of assembly and lessens the time spent by each ship on the slipway, so that, for the same volume of production, the number of slipways required is considerably reduced. The tendency raised slipways has been hastened by the increasing preference for building ships in dry dock.

The most drastic solution is to build a shipyard on a completely new site. A Swedish firm is doing this at the present time because it was hemmed in by docks and various harbour facilities and could not be enlarged sufficiently to build the biggest oil tankers. It was therefore decided to construct a huge new shipyard 15 km away on an open site where an up-to-date layout could be adopted to meet the needs and exploit the possibilities of modern techniques.

The new shipyard covers an area of 250 acres. The workshops are laid out in a straight line, with the result that the plate storage yard is one kilometre away from the gates of the two dry docks. The plate shop is entirely mechanised. From it, the plates travel by conveyor belt through various workshops to the prefabrication shop. All the workshops are laid out in such a way that their raw materials come to them by the shortest route. The hull sections, weighing up to 200 tons, are assembled in a shop which communicates directly with the two dry docks, each of which is 300 metres long, 46 metres wide and 10.6 metres deep. The stern of the vessel is assembled first and is then hauled along the slipway by a roller conveyor, while assembly continues in the prefabrication shop and so on, until the fore-peak is finally set in place. As the ship progresses along the slipway, it receives its engines and other equipment. The dock is then flooded and the ship towed out, whereupon the assembly of the next begins. The dry docks can each take either a 140,000-ton dead weight vessel, or two of 20,000 tons, side by side; they are served by two 100-ton cranes and two others with a capacity of 35 tons.

Almost all the welding under this system is carried out under cover - a great advantage in view of the harsh Swedish winter.

Annual output will range from 180,000 to 300,000 tons dead weight, depending on the size of the vessels built. The time needed to build a 40,000-ton tanker, for example, will only be 20 weeks from start to finish.
Standardisation and Planning

It is obvious that the greater the degree of standardisation under this system, the greater the efficiency of production. This is equally true of shipyards which, without being organised and mechanised to the same extent as this, confine themselves to modernising, for example, their plate shops or simply to installing an automatic oxy-acetylene cutter. The greater the number of standard-sized vessels produced, the more worthwhile it is to make these changes. Accordingly, shipyards try to obtain orders for batches of ships. Inevitably, the batches are small, but it is obvious that an order for six identical oil tankers, or six 40,000-ton bulk carriers will lead to more intensive use of the equipment, shorter construction times and, as a result, lower costs. But it must be emphasised once more that the shipowner has the last word.

It also goes without saying that intensive mechanisation and rapid construction of the hull during the last stage, i.e., the assembly of prefabricated sections on the slipway, entail very detailed planning. As shipbuilding comes to resemble assembly-line production (making all due allowances), it becomes essential that each component should join the general flow at the right time and place. The day has gone by when the plans left a number of points to be settled "on the job" as construction progressed; the practice was to use full-scale drawings or patterns, or else measurements were taken on the vessel itself before deciding certain shapes and sizes. Nowadays, production is settled in advance, down to the last detail. For the enormous number of calculations involved, increasing use is now being made of electronic computers.

Variations in Degrees of Modernisation

The foregoing pages may give the impression that the modernisation of shipyards in recent times has been drastic and widespread. This impression must be qualified, because progress has not been equally rapid or extensive everywhere.

For example, prefabrication, towards which all shipyards are steadily progressing, is not always introduced overnight. Shipbuilders are adopting the method because of its many
advantages, but initially they may have to carry it out in the open near the slipway. The construction of prefabrication shops will only come later.

Some shipyards have to content themselves with renewing their equipment gradually, without changing the actual layout of their workshops. Apart from financial considerations, the decisive factor is the amount of space available. If there is no open space on which to build a new workshop to replace an old one while the latter, and ultimately the whole shipyard is reconstructed, many shipbuilders limit themselves to piecemeal modernisation, as otherwise their yards would be out of action for longer than their order books will allow.

Moreover, all shipyards do not build large vessels. Many smaller concerns build small ships, such as fishing boats, pleasure steamers, tugs and barges for use in harbours and inland waterways, etc. Some countries, which have no coastline, but which make use of a major waterway, only have shipyards of this kind. These, of course, are also being modernised but their output is not big enough to justify changes in methods and equipment as sweeping as those carried out in the big shipyards; nor does international competition appear to make itself felt to the same extent. The result is that the physical working conditions in these small concerns are only changing very slowly. Reference will be made later to the safety problems involved; in the main, they are the same as in the bigger shipyards, but the scale is different.

Influence of Technical Changes on Working Conditions

Irrespective of the degree of modernisation achieved by a shipyard, any changes must inevitably make themselves felt on working conditions.

The mechanisation of some operations has led to a reduction in the number of men needed. For example, in a British shipyard, one foreman and 20 workers, including two crane drivers, working a single-shift, 42-hour week, can prepare 10,000 tons of plate per year, or between 80 and 85 per cent. of the steel plate used by the shipyard. In a German shipyard, where planning and organisation have reached

a very high pitch, the rise in the productivity of the labour force, despite the fact that 40 per cent. of the workers are unskilled, has been such that the number of man-hours per ton has been reduced to 50.1 In Japan, the construction of a cargo vessel of 7,000 gross registered tons, which required a million man-hours in 1949, only needed 690,000 in 1954 and 450,000 in 1959.2

The physical exertions which workers are called upon to make have been greatly eased as a result of intensive mechanisation, not to mention automation, and the virtual elimination of manual handling. In Sweden, between 1939 and 1953, the average amount of power available to each shipyard worker increased from 3.9 to 7 H.P.3

As was stated earlier, the general introduction of welding has completely changed the working environment. The noise level has been lowered, although it is still high. The operation of the lifting machinery, especially the travelling cranes, the handling, shaping and scaling of the plates, the grinding of the joints, welding itself in certain confined spaces such as the double bottoms, which act as enormous sounding boards, and above all the chipping and caulking of the double bottoms - all these and many other jobs are extremely noisy. But they cannot be compared with the deafening hammering which is still occasionally heard today, produced by pneumatic rivetters, but formerly used to be continuous. The process of submerged arc welding eliminates the noisy task of caulking and chiselling the weld beads.4

In addition, welding is less arduous than riveting - one has only to think of the weight of a pneumatic hammer, the vibrations it causes and the burns produced by red-hot rivets. The difference is so great that some German shipyards employ

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1 Lloyd's List, 28 September 1960
2 News from Japan, Japanese Consulate General, Geneva 15 May 1961
women as welders in the prefabrication shops.¹ It is only fair to add that intensive use of welding also involves hazards, which will be referred to in the next chapter.

There has been a marked improvement in working conditions because of the reduction in the amount of work performed in the open air. This is important in most of the world's shipyards because bad weather, rain, snow, gales and bitter cold greatly hamper the work (when they do not hold it up altogether) and may endanger the workers' health or safety. Exposure to a blazing sun also has its drawbacks because, on the one hand, the expansion of the steel plates makes it more difficult to adjust them, and on the other hand, in excessive heat workers are apt to take off their safety equipment — in a temperature of 60°C, helmet, gloves or goggles become extremely uncomfortable. The problem is so acute, in some parts of the world, that working hours are adjusted during the hot season to avoid these drawbacks.

Another advantage of modernisation is that new buildings, which in their appearance, airiness, ventilation, heating, artificial lighting, flooring, etc., contrast sharply with the buildings they replace, are undoubtedly pleasanter and safer to work in.

But it should not be hastily concluded that the modern shipyard worker is now relieved of physical exertion and everywhere enjoys comfortable conditions, which his predecessors would never have dreamt of. As we have seen, the tempo of modernisation varies from one shipyard to another.

The biggest changes have naturally taken place in the largest shipyards, i.e., those with the most workers. It can therefore be asserted that most shipbuilding workers have been affected by the introduction of modern techniques, at least two of which — welding throughout and prefabrication — have been adopted by almost all builders of sea-going vessels. However, even when they are operating machines of modern design, many shipyard workers still spend their days in premises dating from the last century. In many cases, the path along which the materials move is suited to a time when material movements were on a far smaller scale and far slower than they are now. Most of the ships launched today still slide down a sloping way, instead of being floated while in dock, and it would be

¹ Communication from the Verband Deutscher Schiffswerften e.V.
possible to quote many other features of this kind which belong to the shipyard of yesterday, rather than to the shipyard of tomorrow.

Moreover, however much indoor work may replace work in the open, certain major operations must still be carried out in the open air, either on the slipway or in the fitting-out berth. This not only means that many workers are still exposed to bad weather, but also (especially in the case of shipyards in northern regions) that they have to work long hours during the winter by artificial light; it is of course far more difficult to provide effective lighting out of doors than inside a workshop.

Lastly, a great deal of manual work is still necessary in many operations. The opportunities for using an automatic welding machine are limited, and the welding torch and the electrode holder are still being used in many cases despite their smoke and dangerous glare. Unlike the machine, a man can weld components of all shapes and in all positions, no matter how uncomfortable (in the double bottom, or shaft tunnel) or dangerous (the welding of the hull on the slipway). At such times he drags after him the cables, wires and hoses which keep him supplied with electric power, compressed air, oxygen, acetylene, etc., and which, unless special devices are employed (and they are not known or installed everywhere) clutter up the floor, hamper movement and are liable to cause falls. This cluttered floor has for a long time been a characteristic feature of shipyards; in addition to all the wires and piping just mentioned, there are rivets, bolts, tools, girders, etc. Despite the great efforts made by most shipyards, ideal housekeeping is difficult to achieve.

**Fitting Out**

This account of the working environment, as it has been affected in varying degrees by the introduction of new processes and equipment, would be incomplete if no mention were made of the conditions in which ships are fitted out.

Some time before it is launched, the ship is handed over to the painters. They scrape the plates which, since they left the workshops, have become covered with a thin coat of rust, and then apply a number of coats of paint. The
danger involved and the precautions the men have to take can readily be imagined when it is realised that the hull of a large tanker may be anything from 16 to 20 metres high.

The ship receives its engines sometimes before launching and sometimes after, the time depending on various factors such as the weight of the hull with the engines and the depth of the water at the bottom of the slipway. The section of the hull where they are installed then becomes a hive of activity. Men in many different trades work elbow to elbow at a number of levels. Mechanics, electricians, welders, etc., assemble the engines, connect up the piping, install ladders, gangways, handrails, insulating material, and perform a number of other operations. These cramped working conditions are certainly uncomfortable and may represent a serious danger. The worst moment is when the temporary scaffolding and the ladders are taken away to be replaced by the permanent gangways and ladders, because the other jobs continue while this operation is taking place.

The same cramped conditions and discomfort recur when the ship is at the fitting-out berth. This is particularly true of vessels with a complicated internal layout, such as liners. Some 1,500 men worked simultaneously for more than a year on the France. The skilled workers normally engaged in shipbuilding are joined by men from all the other trades needed to turn the ship into an immense floating home - painters, joiners, electricians, plumbers, cabinet makers, upholsterers, decorators, etc. It is of course true that conditions of work in this case are not peculiar to shipbuilding.

One of the main difficulties as regards safety during this stage of construction is that many of the workers engaged in fitting the ship out are employed not by the shipyard itself but by sub-contractors. This makes it more difficult to co-ordinate the different trades and to maintain the necessary labour discipline. A shipyard safety inspector cannot take direct action against a worker whom he catches breaking the rules if he is employed by another concern, and usually the most he can do is to report the man to his employer. This point will be reverted to later, since it is also important in the case of ship repairing.
Ship Repairing

While shipbuilding techniques have undergone far-reaching changes over the past few decades, methods of repairing ships appear to have remained almost unaffected. Of course, some ships may be so seriously damaged as a result of a collision, an explosion, fire, etc., that the whole of the bow or stern or an entire middle section may have to be replaced. In such cases the procedure is exactly the same as when a vessel is lengthened by inserting an additional section. The whole operation is more akin to shipbuilding than to ship repairing and the new part is put together using modern techniques and is treated as an independent component. In some cases the construction of the new section and the final assembly actually take place in different shipyards which may in fact be some distance from each other. For example, a Danish shipyard has built halves of oil tankers which were then towed across the Atlantic to be joined to the other halves waiting for them in the United States.

But these are not every-day operations and we are concerned here with normal repair work. Each repair job is a special case and this inevitably rules out the kind of integrated techniques which are being used on an increasing scale in shipbuilding itself.

To some extent repair work is carried on in a dry or floating dock or at a berth if the lower part of the hull or the propeller have not been damaged. Such cases involve minor repairs which can be carried out on the spot; alternatively the damaged parts are dismantled and repaired in the workshops, or else replaced, and the repaired or new part is then re-installed. Other types of repair jobs are carried out in the workshops. There is no need to dwell on this latter aspect because conditions of work in repair workshops do not differ greatly from those in other heavy engineering factories.

Dismantling is a difficult operation. The volume and weight of the parts or sections which have to be removed are often substantial. A propeller weighs up to 20 tons and the tail of a propeller shaft up to 10 tons, while it

1 Similarly L'Usine Nouvelle, of 12 October 1961 states that a Norwegian shipyard has decided to concentrate on building middle sections for super-tankers, which will then be towed to another shipyard belonging to the same firm to be joined to the other sections.
may be necessary to move such bulky parts of the ship as sections of the deck or superstructure or a whole funnel. Alternatively, the position in which the work has to be carried out involves certain special hazards, e.g. the removal of the propeller tail-key.

Work on the hull, whether it involves welding, riveting or painting is normally done against the vertical or overhanging side of the ship above concrete or water. In other words, the work is dangerous by its very nature. In addition, the ground in a dry dock remains wet and slippery for some time after the water has been pumped out. Modern docks have been designed to facilitate repair operations as much as possible; for instance, in a recently opened Belgian dock, the walls are vertical without any steps, and there is a tunnel around the sides of the dock containing acetylene, compressed air and oxygen pipes and electrical wiring; outlets have been built into the dock wall at regular intervals.¹

Generally speaking, the work here is performed in the same conditions as in dry docks which have been designed for shipbuilding. But examples of this kind in ship repairing are still the exception, and the traditional docks with their steps, chutes for materials and ladders with sagging rungs are much commoner.

Repair work inside a ship often means that large numbers of workers have to perform their jobs simultaneously in confined spaces and are liable to get in each other's way. Moreover, they often have to work in conditions of extreme discomfort, e.g. the lighting is often poor, they are unable to stand upright and sometimes have even to crawl through narrow passages such as the double bottom and the shaft tunnel. Some of the jobs are extremely dirty, such as the dismantling of parts of the engine covered in grease or the removal of oil sludge.

The nature of the cargo may also be a source of danger and this point will be dealt with in the following chapter.

The risks inherent in ship repair work are aggravated by economic considerations. A ship in dry dock ties up an enormous amount of capital. It is essential to reduce this loss to a minimum, and the shipowner will normally give the

¹For a description of a similar Scottish installation which is even more recent, see Fairplay, 26 October 1961, p. 41.
work, provided the price quoted is the same, to a firm which he has found to be expeditious. The result is that ship repairers, in order to stay in business, must strain every nerve to carry out the work as fast as possible. They try to modernise their equipment, but where the law allows, they also set special working schedules. The urgency of the repairs may therefore lead to very long working days and also to night work, all of which is a source of sometimes undue fatigue; managements are likewise compelled in many cases to carry out a good deal of the work by artificial light. This same urgency may also mean that certain safety precautions are neglected, e.g. the bare minimum of scaffolding may be run up because scaffolding which meets the normal standards would take too long to erect. Lastly, managements are sometimes forced to take on temporary workers who are less experienced and less conscious of the importance of safety precautions and equipment and therefore more vulnerable.

One distinctive feature of certain ship-repairing centres should be mentioned at this point, viz., the special status of the workers themselves. An example of this can be found in Belgium. In Antwerp, where almost all Belgian ship repairing takes place, there is a limited pool of registered workers whose numbers (about 4,000 at the present time) are fixed once a quarter by the National Joint Council for the Ship Repairing Industry, in the light of the industry's needs. These workers, who are issued with pink cards, are given priority when any work is available. The others, who have green cards, form part of an additional pool on which the employers draw in case of need. The holder of a pink card who reports in the morning at the hiring hall and is not taken on is paid a special allowance for each day's unemployment. The holder of a green card is also paid an allowance but at a lower rate. This obligation on workers to accept any jobs offered to them under pain of forfeiting their entitlement to an unemployment allowance, combined with the irregularity of the work, causes a heavy labour turnover in the industry.

A similar scheme exists in Genoa, which is the main Italian ship repairing centre, and where the ship-repairing labour force is subject, not to the firms which employ them, but to the Port Authority, which administers all industrial and commercial activities within the port. Unless a vessel has come specially to Genoa for a particular repair job or stays in port for not less than a month (in which case the ship repairer can carry out the work on board using his own workers) a firm must obtain the necessary labour from the port authority.

The effect on job safety of this instability of employment, and the workers' independence of the firms employing them, can
readily be imagined. An employer has little control over a painter whom he sees recklessly dangling beside a ship's hull without a safety belt or a life jacket, if the painter is due to move on to another firm a few hours later.

Another problem is that it is sometimes difficult to decide which routine maintenance jobs should be done by the ship's crew and which should be done by repair workers. Sometimes the seamen have to do jobs such as painting the hull, involving risks with which they are unfamiliar and for which they do not always know how to take the necessary precautions. Nor is it uncommon for the crew to carry out maintenance work while the shipyard workers are doing repairs. Sometimes also there are dockers simultaneously loading or unloading the ship.

In order to avoid tying up the ship at considerable expense, shipowners sometimes have certain repairs carried out while the ship is at sea, and for this it takes on repair workers employed by the shipping company or by a shipyard. It is not always easy, however, to do this work while the ship is under way; moreover the safety regulations in force on land are not always applicable to work of this kind, with the result that the necessary precautions are not always taken.

* * *

This is the environment in which ship building and repairing takes place - an environment which is changing fast in the case of shipbuilding but far more slowly in the case of ship repairing. Keeping in mind this physical setting we can now turn to some types of accidents which occur in the industry - their frequency, seriousness and causes. This is the subject of Chapter II.
CHAPTER II

OCCUPATIONAL RISKS IN SHIPYARDS

I. The Degree of Occupational Risk in Shipbuilding and Ship repairing

From the time when the keel is laid until the departure of the ship for trials at sea, the various phases of construction take place under widely varying conditions, and the degree of risk varies with each operation; naturally enough, painting the outside of the hull 50 feet above the ground involves greater danger than operating a welding machine. Therefore, in order to have as clear a picture as possible a careful distinction must be made between the various sectors of shipyards, between the different occupations and even between the different operations involved. Nevertheless, it is worthwhile considering ship building and repairing as a whole in order to establish whether it is a particularly dangerous activity.

To judge by its reputation, the conclusion would seem to be affirmative. This view is supported by such authorities as the Minister of Labour of the United Kingdom, who mentioned the high risk of accidents in this industry, when he opened a Conference on Safety in the Shipbuilding and Ship repairing Industry at Newcastle-Upon-Tyne on 16 October 1961, and quoted figures which confirmed his remarks: In this branch, in 1960, 9,371 accidents, 35 of them fatal, were reported, which represented 1/20th of all accidents occurring throughout the whole of industry, and the frequency rate amounted to 42 accidents for every 1,000 people employed, which was twice the rate for manufacturing industry as a whole.

The trade unions are convinced that the industry is particularly dangerous. The conclusions of the Conference of Shipyard workers held at Hamburg in March 1960 by the International Metalworkers' Federation state that "in the shipbuilding industry, workers are more exposed to sickness and accidents than is the average case for all industries"1.

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During the debates, a German trade unionist said that the accident rate was 30 per cent. higher than the average in industry in his country.¹ The Italian Federation of Metalworkers, affiliated to the Italian General Confederation of Labour, pointing out that, in Italy, the available figures cover the whole of the industrial field, claims, on the basis of partial data relating to certain shipyards, that the percentage of accidents there is higher than for the average of industrial undertakings and that the frequency and severity of accidents are on the increase.²

Certain other opinions are less categorical. For instance, the Labour Inspectorate of Genoa counts shipbuilding and repairing among industries with an average accident rate, the occupational risk being compensated by the high level of skill of workers. The Italian National Accident Prevention Institute (E.N.P.I.: Ente nazionale per la prevenzione degli infortuni) considers that the frequency of accidents is very high, but that the average severity is fairly slight. These differences of opinion are obviously due to the absence of precise statistics.

In order to assess the degree of risk inherent in shipbuilding and repairing in each country as exactly as possible, the most suitable course would obviously be to compare accident statistics for the various industries on the international level. There are two major obstacles, however.

The first is the absence, in most countries, of any national accident statistics for shipyards. For the most part, the figures are lost in the statistics relating to the metal trades as a whole, or even to the manufacturing industries at large.

The second difficulty comes from the fact that what statistics are available are not really comparable, since they are not established on the basis of a uniform definition of what is an employment accident. Most of the time they are compiled for compensation purposes, and since many insurance schemes...

¹International Metalworkers' Federation, Minutes of the Conference of Shipyard Workers, Geneva, 1960, p. 41.

²Communication by the Italian Federation of Metalworkers, 7 October 1961.
provide for a waiting period - and even that is variable - only accidents resulting in incapacity for work of a certain duration are included. Moreover, some statistics refer to all accidents occurring in shipyards even if those affected are employed, for instance, by a building firm that is transforming the installations, whereas other figures deal solely with workers engaged in shipbuilding and repairing.

Nor is the measurement of the degree of risk governed by uniform rules. In the terms of the resolution concerning industrial injury rates adopted by the Sixth International Conference of Labour Statisticians (Montreal, August 1947)\(^1\), "the frequency rate should, if possible, be calculated by dividing the number of injuries (multiplied by 1,000,000) by the number of hours of working time of all persons covered." Some countries, such as Belgium, the United States, Japan and Poland, have adopted this method, whereas in France and the United Kingdom the number of injuries is related to 100,000 hours of working time rather than 1,000,000. In other countries, such as the Netherlands, it is the working day rather than the hour which is used as the unit of time. Even when the method practised in two countries is identical, the absence of any concordance between the various definitions of injury precludes comparison, and in any case statistics sometimes cover all the shipyards and, in other instances, merely a sample. Moreover, some yards are concerned exclusively with shipbuilding, whereas others also engage in ship repairing or even in quite different activities, such as heavy engineering or construction of railway equipment.

Severity rates, according to the above-mentioned resolution, should be "calculated by dividing the number of working days lost (multiplied by 1,000) by the number of hours of working time of all persons covered ... the loss from fatal injuries and those resulting in permanent total disability should be taken as equal to the loss of 7,500 working days". In France, Belgium and Japan, the number of days lost is related to 1,000 working hours, in the United States to 1,000,000 hours and in the Netherlands to 300 working days. One fatal case is regarded as equal to 7,500 days lost in Japan and the Netherlands.

but only 6,000 days in the United States and France. The annual reports of the Chief Inspector of Factories in the United Kingdom assess the average severity of accidents by relating the number of fatal cases to the number of accidents.\(^1\)

Therefore, there would be no point in comparing frequency and severity rates at the international level. On the other hand, the available national statistics may be considered in isolation. Subject to the precautions which must be observed owing to differences in methods from one industry to another, it therefore seems that in each particular country comparison between the figures for various branches of activity would make it possible to give a reply, even if only for purposes of illustration, to the question asked above, namely whether shipbuilding and repairing constitute a dangerous sector of activity.

In compiling the following charts and tables, the aim has been to bring together a certain amount of statistical data concerning different branches of activity for the United States, France, Japan and the United Kingdom. The choice of countries and industrial sectors has depended on the existence of sufficient statistical material for the particular country or sector, and in some cases on the significance of the particular branch in the national economy.

In the United States, the frequency rate of accidents in shipbuilding and repairing in 1960 is among the lowest.\(^2\) The rate of 4.33 is below the rate for all activities, which stands at 6.04. Compared to the rate for certain other branches of metallurgy and engineering, in connection with which particular attention will be paid to those concerning other countries, the rate exceeds that of the automobile industry (2.20) and the steel industry (3.14). It is very close to the figure for machinery (4.51). Going back to 1950 (See Chart 1), it will be noted that, during the past decade, the frequency rate in shipbuilding and repairing remained at a level between the above-mentioned branches and

---


considerably below the frequency rate for industrial activity in general.

Consideration of severity rates leads to slightly different conclusions. The severity rate for shipbuilding and repairing (1,496) is among the most severe for 1960, and far above the over-all figure of 729. It also exceeds the rates for the other branches of metalworking and engineering: automobile (261), machinery (365) and steel (742). The number of days lost per case is the highest of all: 346, as against 260 for coal mining, 236 for steel and 121 for all activities.

Chart 2 shows, however, that with regard to the severity of accidents in shipbuilding and repairing, the figures for 1960 were exceptionally high as compared with previous years. Although a curve showing changes in severity rates is generally rather irregular, a more or less steady decline may be noted for automobile construction, machinery, steel production and general industry. By contrast, the curve relating to shipbuilding and repairing, which had also shown a falling trend since 1950, rose sharply in 1960. However, the exceptionally high frequency rate of fatal accidents of 0.21 in 1960 as compared with a level which had remained between 0.08 and 0.04 from 1950, would suggest that the extent of the rise shown by Chart 2 does not indicate a lasting deterioration of safety in this branch.

As regards France, Table I, which gives the frequency and severity rates for the metalworking industry for the years 1959-61, shows that here again the frequency rate in shipbuilding and repairing is distinctly higher than the average for other branches. Although it is below the level for iron and steel production, heavy forging, foundry operations, production of rolling stock, boiler making and structural metal products, and at a level comparable to that for machinery, it is above the level for the automobile, electrical machinery, aeronautical construction and precision engineering industries. Trends over the past ten years (see Chart 3) follow a curve roughly parallel to that of the frequency rate calculated for the metalworking industry as a whole: from 1950 to 1960, the two lines drop steadily from

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\[1\] Accident Rates 1961, op. cit., p. 55. It was in 1960 that a fire occurred on the aircraft-carrier Constellation, resulting in 49 deaths.
Chart 1
United States: Frequency Rate
1950-1960
(disable injuries per 1 million man-hours)
(based on figures taken from:
National Safety Council, Chicago,
Accident Rates 1961)

Steel
Machinery
Automobile
Shipbuilding and ship repairing
All industries
Chart 2
United States: Severity Rate
1950-1960
(two charges (days) per 1 million man-hours)
(based on figures taken from:
National Safety Council, Chicago,
Accident Rates 1961)

- - - - Steel
- - - - Machinery
- - - - Automobile
- - - - Shipbuilding and ship repairing
- - - - All industries
<table>
<thead>
<tr>
<th>TABLE I</th>
<th>Frequency and Severity Rates for Accidents in the French Metallurgical Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wage Earners Only</td>
</tr>
<tr>
<td></td>
<td>Wage Earners only</td>
</tr>
<tr>
<td>0 - Iron and Steel</td>
<td>10.24</td>
</tr>
<tr>
<td>1 - Electro-Metallurgy</td>
<td>4.96</td>
</tr>
<tr>
<td>2 - Heavy Forging</td>
<td>19.17</td>
</tr>
<tr>
<td>3 - Steel Tubes</td>
<td>9.36</td>
</tr>
<tr>
<td>4 - Wire Drawing and Rolling</td>
<td>11.21</td>
</tr>
<tr>
<td>5 - Machinery</td>
<td>11.26</td>
</tr>
<tr>
<td>6 - Foundry Operations</td>
<td>14.81</td>
</tr>
<tr>
<td>7 - Automobiles, Cycles</td>
<td>6.97</td>
</tr>
<tr>
<td>7 bis - Agricultural Machinery</td>
<td>10.4</td>
</tr>
<tr>
<td>8 - Rolling Stock</td>
<td>13.46</td>
</tr>
<tr>
<td>9 - Electrical Engineering</td>
<td>7.40</td>
</tr>
<tr>
<td>10 - Shipbuilding</td>
<td>11.12</td>
</tr>
<tr>
<td>11 - Aircraft Construction</td>
<td>5.82</td>
</tr>
<tr>
<td>12 - Foundry and Machinery</td>
<td>11.36</td>
</tr>
<tr>
<td>13 - Forging and Stamping</td>
<td>12.90</td>
</tr>
<tr>
<td>14 - Grinding and Abrasives</td>
<td>7.95</td>
</tr>
<tr>
<td>15 - Bolts and Nails</td>
<td>10.53</td>
</tr>
<tr>
<td>16 - Metal Boxes</td>
<td>6.89</td>
</tr>
<tr>
<td>17 - Electrical Equipment</td>
<td>6.49</td>
</tr>
<tr>
<td>18 - Boiler Making</td>
<td>20.32</td>
</tr>
<tr>
<td>19 - Structural Metal Products</td>
<td>12.99</td>
</tr>
<tr>
<td>20 - Precision Engineering</td>
<td>8.41</td>
</tr>
</tbody>
</table>

| TOTAL 1 | 9.87 | 4.35 | 9.50 | 4.50 | 7.69 | 3.14 | 7.16 | 3.29 | 7.09 | 3.86 | 7.14 | 3.89 |

1 From 1958 this no longer includes Iron and Steel.

Source: French Federation of Metal and Mining Industries (Paris), L'année métallurgique 1961, p. 112
Chart 2

French Frequency Rate
1950-1960
(accidents per 100,000 man-hours)

(Based on data provided by the French Federation of Metal and Mining Industries, Paris)
15.20 and 13 respectively to 8.85 and 7.09.

The severity rate for 1956 - 1961 (Table I) in shipbuilding and repairing was slightly below the level for the metalworking industry as a whole in the first two years (at a time when the iron and steel industry was included in the total figures); it drew level in 1958 and went higher in 1959 and even further in 1960 and 1961 (6.11 and 6.01 as opposed to 3.86 and 3.89). The incidence of fatal accidents here is evident with nine in 1960 out of a total of 42 throughout the metalworking industry (excluding the iron and steel industry).

Chart 4 reveals a spectacular decline since 1952 in the frequency rates calculated for a certain number of branches of the metalworking industry in Japan. Shipbuilding and repairing reflects this trend to an even greater degree than do other branches. Among the five branches considered, this one had the highest frequency rate until 1952 - when the metal products industry became the most hazardous - and its frequency rate of 14 is now comparable to those in the machinery industry (15.57), the transport equipment industry (including shipbuilding and repairing) (13.56) and the iron and steel industry (12.69).

The severity rates, as shown in Chart 5, are naturally less easy to improve, but they also are on the decline, the trend being definite although marked by wide fluctuations. The shipbuilding and repairing rate, which had remained steady around 2.70 between 1952 and 1957, has again been steady, but around 1.40, since 1958. It was 1.36 in 1960, which is below rates for the iron and steel industry (1.89) and the metal product industry (1.54), but above those for the transport equipment (1.06) and machinery (0.80) industries.

In the United Kingdom, the frequency rate of accidents in shipbuilding and repairing between 1950 and 1960, as indicated by the annual reports of the Chief Inspector of Factories (Chart 6), reveals an irregular but pronounced decline. It was 3.3 in 1950 and fell to about 2.01 in 1951, and returned to that level in 1958, 1959 and 1960, after an intervening rise to around 2.4. The curve lies below that of the iron and steel industry (2.2 in 1950), but above that for industry at large (1.7) and the motor vehicle manufacturing industry (1.1). Here again, although in a less striking form, appear the trends indicated by the Minister of Labour, as mentioned earlier.
**Chart 4**

**Japanese Frequency Rate**

1952-1960

(accidents per 1 million man-hours)

(based on figures provided by the Labour Statistics Research Division of the Labour Ministry)

<table>
<thead>
<tr>
<th>Year</th>
<th>Iron and Steel</th>
<th>Machinery</th>
<th>Metallic Goods</th>
<th>Shipbuilding and Ship Repairing</th>
<th>Transportation Machinery and Equipment (including shipbuilding and repairing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1953</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1954</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1955</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1956</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1957</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1959</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chart 5

Japanese: Severity Rate
1952-1960

(man-days lost per 1,000 man-hours)

Based on figures provided by the Labour Statistics Division of the Labour Ministry)

Iron and Steel
Machinery
Metallic goods
Shipbuilding and ship repairing
Transportation machinery and equipment (including shipbuilding and repairing)
Chart A

United Kingdom: Frequency Rate
1950-1960
(accidents per 100,000 man-hours)
(based on figures taken from
Annual Reports of the Chief Inspector
of Factories)
Instead of an actual severity rate, the Factory Inspectorate establishes the ratio of fatal accidents to all reported accidents. Table II shows that, under this heading, shipbuilding and repairing head industrial activities in 1960 with a rate of 4.3, as opposed to 2.3 for the whole of industry.

This situation is not peculiar to the period 1959 to 1960, but, by going back to 1950, it can be seen that the ratio of fatal accidents to all accidents reported is far higher over those ten years for shipbuilding than for manufacturing industry as a whole (Chart 7). The two curves expressing the trend of this ratio are very different. There is a regular decline in the average for all industry, but shipbuilding shows abrupt changes, the "severity rate" having been no higher in 1950 than in 1959-1960; the tendency to improve seems to become definite only after 1955, following a marked worsening in 1951 and 1952. It is recalled that these comments are based only on the incidence of fatalities, thus leaving aside cases of temporary or lasting incapacity which should also be included in order to obtain a really clear view of the situation.

What conclusions can be drawn from these data and comments? Here again, care must be taken not to compare things which are not comparable. The basis of calculation varies too widely for any attempt to be made to determine whether shipbuilding and repairing is more dangerous in any particular country than in another. Our purpose has been merely to bring together statistical data relating to a few industries in a certain number of countries.

There are two conclusions to be drawn from this comparison of data. The first is that, notwithstanding progress achieved, shipbuilding and repairing remains a branch in which the risk of accident, and of serious accident, is considerable. Of course it is in no way comparable with the building or mining industries, yet although the nature of the work does not expose workers to collective disasters such as those occasionally overtaking miners, shipyard workers have an enemy in common with building workers, and that is the force of gravity. One reason why frequency and severity rates are not so high as in building is that the proportion of work carried out at considerable heights in shipbuilding and repairing is less than in building, and most workers in shipyards, particularly where modern working
TABLE II

NUMBER OF FATAL ACCIDENTS PER 1,000 REPORTED ACCIDENTS
IN THE UNITED KINGDOM DURING THE PERIOD
1959-1960

<table>
<thead>
<tr>
<th>Processes</th>
<th>No. of fatal accidents per 1,000 reported accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building operations and works of engineering construction</td>
<td>12.7</td>
</tr>
<tr>
<td>Docks and warehouses</td>
<td>4.9</td>
</tr>
<tr>
<td><strong>Factory processes</strong></td>
<td></td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>4.3</td>
</tr>
<tr>
<td>Chemical industries</td>
<td>4.3</td>
</tr>
<tr>
<td>Clay, minerals, etc.</td>
<td>4.0</td>
</tr>
<tr>
<td>Metal processes</td>
<td>3.0</td>
</tr>
<tr>
<td>Wood and cork working processes</td>
<td>2.4</td>
</tr>
<tr>
<td>Other general engineering</td>
<td>1.8</td>
</tr>
<tr>
<td>Paper and printing trades</td>
<td>1.7</td>
</tr>
<tr>
<td>Food and allied trades</td>
<td>1.4</td>
</tr>
<tr>
<td>Textile</td>
<td>1.3</td>
</tr>
<tr>
<td>Electrical engineering</td>
<td>0.9</td>
</tr>
<tr>
<td>Wearing apparel</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Average - all factory processes</strong></td>
<td>2.3</td>
</tr>
</tbody>
</table>

Chart 7

United Kingdom: Severity Rate
1950-1960

(fatal accidents per 1,000 reported accidents)

(Based on figures taken from Annual Reports of the Chief Inspector of Factories)
methods have become general, operate under conditions similar to those obtaining in other branches of the metal trades. If shipbuilding and repairing are among the branches of metalworking most exposed to risk, it is because part of the work has to be carried out on slipways, in dry docks or alongside the hulls of vessels, where the risk of falling is considerable. In addition there are of course the risks inherent in specific operations, such as the maintenance and repair of tankers, to which reference is made below.

The second conclusion to be drawn is that safety standards would appear to have improved in recent years. We have intentionally avoided taking available statistics back to the war years, when the volume of production and the speed of shipbuilding were the primary consideration, and the workers paid a heavy toll to satisfy these requirements. It took some years for the return to normality to be completed. In this respect the curves based on figures since 1950 are more conclusive. Although some of them are very irregular, it is not incorrect to say, subject to the reservation that the basis of computation has sometimes changed since then, that the frequency rates have by and large fallen in shipbuilding and repairing, even if the same cannot be said of severity rates. Statistics for the Netherlands and Poland support these findings (Tables III and IV).

**TABLE III**

**FREQUENCY AND SEVERITY OF ACCIDENTS IN SHIPBUILDING AND REPAIRING IN THE NETHERLANDS**

<table>
<thead>
<tr>
<th>Year</th>
<th>Frequency Rate</th>
<th>Severity Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>208.2</td>
<td>-</td>
</tr>
<tr>
<td>1951</td>
<td>187.8</td>
<td>-</td>
</tr>
<tr>
<td>1952</td>
<td>205.7</td>
<td>6.77</td>
</tr>
<tr>
<td>1953</td>
<td>191.0</td>
<td>6.69</td>
</tr>
<tr>
<td>1954</td>
<td>195.5</td>
<td>6.03</td>
</tr>
<tr>
<td>1955</td>
<td>189.0</td>
<td>6.36</td>
</tr>
<tr>
<td>1956</td>
<td>178.0</td>
<td>6.71</td>
</tr>
<tr>
<td>1957</td>
<td>182.5</td>
<td>7.88</td>
</tr>
<tr>
<td>1958</td>
<td>168.1</td>
<td>5.00</td>
</tr>
</tbody>
</table>

TABLE IV

FREQUENCY OF ACCIDENTS IN SHIPBUILDING AND REPAIRING IN POLAND

<table>
<thead>
<tr>
<th>Year</th>
<th>Frequency Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>79.6</td>
</tr>
<tr>
<td>1951</td>
<td>75.3</td>
</tr>
<tr>
<td>1952</td>
<td>72.1</td>
</tr>
<tr>
<td>1953</td>
<td>60.2</td>
</tr>
<tr>
<td>1954</td>
<td>65.7</td>
</tr>
<tr>
<td>1955</td>
<td>79.7</td>
</tr>
<tr>
<td>1956</td>
<td>63.7</td>
</tr>
<tr>
<td>1957</td>
<td>60.0</td>
</tr>
<tr>
<td>1958</td>
<td>60.2</td>
</tr>
<tr>
<td>1959</td>
<td>51.2</td>
</tr>
<tr>
<td>1960</td>
<td>45.2</td>
</tr>
</tbody>
</table>

Source: Communication by the I.L.O. Correspondent in Poland.

The decline varies according to the country and the undertaking. Some shipyards keep regular records, examples of which are given below.¹

A Danish undertaking engaged in shipbuilding and repairing as well as in large-scale manufacture of marine engines reports the following frequency rates from 1949 to 1960;

<table>
<thead>
<tr>
<th>Year</th>
<th>Frequency Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949</td>
<td>15.9</td>
</tr>
<tr>
<td>1950</td>
<td>12.1</td>
</tr>
<tr>
<td>1951</td>
<td>11.7</td>
</tr>
<tr>
<td>1952</td>
<td>10.6</td>
</tr>
<tr>
<td>1953</td>
<td>11.7</td>
</tr>
<tr>
<td>1954</td>
<td>10.3</td>
</tr>
<tr>
<td>1955</td>
<td>9.2</td>
</tr>
<tr>
<td>1956</td>
<td>9.8</td>
</tr>
<tr>
<td>1957</td>
<td>8.9</td>
</tr>
<tr>
<td>1958</td>
<td>8.3</td>
</tr>
<tr>
<td>1959</td>
<td>10.5</td>
</tr>
<tr>
<td>1960</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Statistics supplied by different undertakings in France appear in Table V.

¹The figures quoted were supplied by the undertakings themselves.
### TABLE V

**FREQUENCY AND SEVERITY RATES IN OME FRENCH SHIPYARDS, 1950 - 1960**

<table>
<thead>
<tr>
<th>Year</th>
<th>Yard No. 1 (Ship building)</th>
<th>Yard No. 2 (Ship building)</th>
<th>Yard No. 3 (Ship repairing)</th>
<th>Yard No. 4 (Ship repairing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Severity</td>
<td>Frequency</td>
<td>Severity</td>
</tr>
<tr>
<td>1950</td>
<td>17.64</td>
<td>3.16</td>
<td>6.43</td>
<td>3.04</td>
</tr>
<tr>
<td>1951</td>
<td>18</td>
<td></td>
<td>5.07</td>
<td>3.45</td>
</tr>
<tr>
<td>1952</td>
<td>9.68</td>
<td></td>
<td>3.94</td>
<td>3.83</td>
</tr>
<tr>
<td>1953</td>
<td>11.55</td>
<td></td>
<td>5.21</td>
<td>2.74</td>
</tr>
<tr>
<td>1954</td>
<td>9.58</td>
<td></td>
<td>4.59</td>
<td>3.67</td>
</tr>
<tr>
<td>1955</td>
<td>10.58</td>
<td></td>
<td>3.83</td>
<td>4.07</td>
</tr>
<tr>
<td>1956</td>
<td>9.49</td>
<td>3.16</td>
<td>3.89</td>
<td>3.19</td>
</tr>
<tr>
<td>1957</td>
<td>8.51</td>
<td>2.85</td>
<td>5.04</td>
<td>3.56</td>
</tr>
<tr>
<td>1958</td>
<td>7.11</td>
<td>5.87</td>
<td>3.68</td>
<td>3.61</td>
</tr>
<tr>
<td>1959</td>
<td>6.88</td>
<td>4.45</td>
<td>2.84</td>
<td>2.58</td>
</tr>
<tr>
<td>1960</td>
<td>2.89</td>
<td>3.35</td>
<td>6.81</td>
<td>2.92</td>
</tr>
</tbody>
</table>

Source: Figures supplied by the shipyards.

1 Basis of computation modified from 1958 onwards
An Italian shipyard reports that the frequency rate fell by 28 per cent. in 1960 and the severity rate by 27 per cent., as compared with 1959.

A Japanese company gives the following safety figures for all its shipyards:

<table>
<thead>
<tr>
<th>Frequency Rate</th>
<th>Number of Fatalities</th>
<th>Number of Man-Days Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>157</td>
<td>22</td>
</tr>
<tr>
<td>1951</td>
<td>125</td>
<td>15</td>
</tr>
<tr>
<td>1952</td>
<td>57</td>
<td>7</td>
</tr>
<tr>
<td>1953</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>1954</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>1955</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>1956</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>1957</td>
<td>5.6</td>
<td>7</td>
</tr>
<tr>
<td>1958</td>
<td>6.3</td>
<td>7</td>
</tr>
<tr>
<td>1959</td>
<td>3.3</td>
<td>1</td>
</tr>
<tr>
<td>1960</td>
<td>2.8</td>
<td>0</td>
</tr>
</tbody>
</table>

A Swedish shipyard gives the following figures regarding the frequency rate:

<table>
<thead>
<tr>
<th>Year</th>
<th>Frequency Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948</td>
<td>24.4</td>
</tr>
<tr>
<td>1949</td>
<td>13.5</td>
</tr>
<tr>
<td>1950</td>
<td>11.4</td>
</tr>
<tr>
<td>1951</td>
<td>8.8</td>
</tr>
<tr>
<td>1952</td>
<td>5.5</td>
</tr>
<tr>
<td>1953</td>
<td>5.5</td>
</tr>
<tr>
<td>1954</td>
<td>5.3</td>
</tr>
<tr>
<td>1955</td>
<td>4.1</td>
</tr>
<tr>
<td>1956</td>
<td>3.8</td>
</tr>
<tr>
<td>1957</td>
<td>3.2</td>
</tr>
<tr>
<td>1958</td>
<td>3.1</td>
</tr>
<tr>
<td>1959</td>
<td>2.7</td>
</tr>
<tr>
<td>1960</td>
<td>2.3</td>
</tr>
<tr>
<td>1961 (first half)</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Severity rates do not always reveal improvements, but there is no doubt about frequency rates. The previous observation with regard to the shipbuilding and repairing industries as a whole in a certain number of countries is thus corroborated - that the shipyards which keep accurate up-to-date records are generally those with a well-organised safety service, so that they can be expected to give more regular attention to safety matters than other undertakings. Progress is due in part to better safety organisation, both inside shipyards and through outside services, that is to say, through the management, the safety departments, the labour inspectorates, the occupational associations and various public and private organisations whose activities will be discussed in the next chapter. A further cause is the beneficial influence of certain techniques whereby men are replaced by machinery, their work lightened or performed under better conditions.

Attention should be called, however, to the relatively small proportion of accidents reported - that is to say those accidents resulting in loss of work which must be reported on the basis of a standard minimum which varies from one insurance scheme to the next - in relation to the total number of accidents which occur. When the waiting period is three days, as is the case in the United Kingdom, an astonishing number of minor accidents without serious consequences are passed over in the statistics. This is the case with grazes, burns, cuts, strains, arc flashes, dust in the eyes, etc. One British shipyard, for instance, reported 582 accidents in 1959 and 508 in 1960 (i.e. a decrease in accidents reported), but its dispensary treated 69,426 and 73,100 "cases" respectively (i.e. an increase in slight accidents), while, during this period the workforce fell from 8,899 to 8,559.

The great majority of accidents are therefore not serious. None the less they call for constant attention for they all involve some harm to workers' physical health and disturb production at least momentarily; but they may also assume more serious forms. Nor must it be overlooked that there are very many virtual accidents, those which do not occur or which cause no physical injury simply by good luck. Some operations are dangerous by nature; they carry the germ of accidents which will occur if the necessary conditions are present.

Such cases may include several visits by the same worker (e.g. to have a bandage changed).
The upshot of these various considerations is that a great deal remains to be done in order to ensure optimum safety in shipyards. The length and the difficulty of the stages to be gone through vary according to the country and the particular shipyard. Yet everywhere, irrespective of the degree and the quality of protection facilities, the kinds of risk are the same. We shall now consider them.

II. The Nature of Occupational Risk in Shipbuilding and Ship Repairing

A. Accident Risks

There are various possible classification systems, and each has its pros and cons. Since our aim here is purely descriptive, it would be simple just to follow the series of operations from the plate yard to the fitting out berth, or to go through the various jobs such as those of welder, painter or crane operator. However, this would mean a great deal of repetition, since many risks are common to several operations and occupations. It is, therefore, better to concentrate on the causes of accidents, without forgetting that every accident results from the unforeseen combination of a series of different causes - which is in fact the definition of chance - and that the role of accident prevention is to prevent such a combination by eliminating as many as possible of these causes. The method of description which will be followed is based, subject to the adaptation necessitated for ease of presentation, on the method recommended in the United States for statistical registration of the causes of industrial injury.¹

The risk of accidents in shipyards will therefore be described in the light of: (1) material causes (material agent and physical circumstances), (2) human causes (physiological and psychological).

1. Material Causes

These include the "material agent", which is the object or substance most directly connected with the accident, and the physical circumstances in which the accident occurs.

(a) Material Agent

Among material agents likely to cause accidents in shipyards one may include machinery, hand tools, lifting gear and means of transport, corrosive or hot substances, and electricity.

Machinery

One need only mention in passing the dangers arising through the various items of machinery that cut, drill, engrave, shape, grind or plane metal or wood and are used in engineering or carpenters' shops in shipyards. These risks are not peculiar to this branch of industry. Transmission shafts, belts, chains, cutting, perforating or abrasive elements - all of these are blind instruments which hold the careless, the ignorant and the unwary at their mercy. If the guard has been removed or does not work properly, or if the machine is not used in the right way, there may be an accident which may range from the harmless projection of a metal shaving to the severing of a limb or to death.

Hand Tools and Welding Equipment

In an address to the Newcastle Conference already mentioned, the Chief Inspector of Factories of the United Kingdom stated that hand tools were responsible for 11 per cent, of accidents in shipbuilding and repair yards and that the risk of being injured by such tools was twice as great in shipyards as elsewhere in industry. He quoted in particular hammers whose handles come off or split, or whose heads form a mushroom from which splinters break away; spanners whose jaws are put out of shape or expanded and are adjusted by inserting a wedge, with the danger of the spanner slipping on the nut; screw drivers, files and scrapers with broken handles. Tools that are defective, badly maintained, wrongly used or used for purposes other than those they were intended for, constitute so many probable causes of accidents.

It may be convenient here, to consider the category of hand tools as including welders ' torches or electrode holders, and to list some of the risks peculiar to welding operations.
We have seen that welding is becoming more and more common in shipbuilding and repairing, so that precautions in this connection are of particular importance.¹

The various welding processes may be classified under two main categories: gas welding and electric welding.

The most important risk involved in welding and cutting by gas is the risk of explosion. The presence of from 2 to 82 per cent. of acetylene in the air creates an explosive atmosphere. Acetylene can also explode under excessive pressure even in the absence of air. Propane also forms an explosive mixture with air. Since it is also heavier than air, it accumulates in bottoms and may form flammable concentrations. Any leakage of one of these gases may therefore result in a serious accident. Reference will be made to this point below.

If the torch is blocked for one reason or another, oxygen may be forced back into the acetylene hose and carry the flame to the generator or the acetylene cylinder. When the flame is thus forced back it causes the torch to give off a loud cracking sound and may cause the generator or the cylinder to burst into flame or explode.

Since the torch gives off considerable heat, the proximity of combustible materials, - wooden deck covering or bulkheads, waste and more particularly flammable liquids - constitutes a risk of fire, specially if any faulty handling accelerates the flow of oxygen into the torch nozzle.

A further danger arises through the projection of metal particles or burning slag. Hands, face and in particular eyes are of course most exposed. The danger of burns from direct contact with the flame or with heated metal is very clear.

In addition, the intense luminous radiation of the flame and of the incandescent metal constitute a considerable hazard against which the operator and those in his vicinity must take special precautions. Moreover, prolonged contact of the acetylene flame with the metal mass may cause nitrous fumes. Further reference will be made to this particular risk below.

By the very nature of the heat source used, electric welding has the particular disadvantage of exposing workers to electric shock. The tension at which arc welding equipment operates does not normally exceed 80 or 100 volts A/C. when the arc strikes, this being considered a safe voltage under normal working conditions, and the voltage is considerably reduced during the actual welding operation. However, if the operator comes in contact with the electrode at a tire when the arc has not struck and if he is standing on a grounded metal structure or in a damp place, which frequently happens in shipbuilding and repairing, he may be rendered unconscious and may die if prompt assistance cannot be given, as when work takes place in an isolated situation, such as the double bottom or tank of a vessel, or he may have a fatal fall.2

Burns and fires are also specific dangers in electric welding. The presence of oil or grease on welders’ clothes or the proximity of flammable materials, projection of sparks and splashes of slag or molten metal, contact with hot metal and arc radiation are the causes of these types of accident. Welders’ conjunctivitis, or "eye flash" is a further hazard that occurs in electric welding.3 This is caused by even momentary exposure to the ultra-violet rays the arc produces and is particularly insidious since the flash appears perfectly harmless to persons who are not aware of the danger and the sufferer is apt to feel the very painful effect only after some time. The welder himself is normally well protected, but those around him less so. His helper or a passer by or a person working nearby may be taken


3Ibid., p. 22.
unawares by the striking of the arc.

Irritant vapours are emitted by certain forms of electrode coatings, such as those which are used in welding non-ferrous metals and some steels (e.g. manganese-steel, and which contain fluorides or alkaline earths. Also, certain coated metals can give off harmful fumes while being welded. The whole question of fumes will be discussed below.

Finally, a few words must be said regarding inert-gas arc welding (for example argon welding). This process calls for particular care. Since the equipment is more delicate than that used for other forms of arc welding, special precautions are needed in its manipulation. It is fed by means of a large number of cables and hoses which have to be kept tidy. In addition, the arc is initiated by means of a high frequency spark which may cause deep burns if the welder is not fully protected. The arc itself is more intense than that produced by ordinary processes and the welder has to use darker glasses. The fumes produced by welding aluminium, the metal most commonly treated by this process, are particularly harmful.

These are the principal risks involved in welding operations, although others could of course also be mentioned. This list gives a fair idea of the hazards to the safety and health of welders who fail to take the necessary precautions.

Lifting Machinery

As already mentioned, the part played by lifting machinery in shipbuilding is of prime importance and has developed greatly with the adoption of prefabrication methods. The size and weight of the objects that have to be moved make the operation of cranes and gantries an exacting task. If such objects fell there would be great risk of serious physical and material damage. In addition, the operator is normally some way from the load to be moved. Judgement, vigilance, perfect discipline in carrying out instructions and knowledge of what the machine can do are the essential requirements, and the operator has to ensure that the load does not hit any object or person as it moves. The slinger has to secure the load properly, choosing the correct sling, chain and link, checking the lifting clamps and shackles and avoiding the use of makeshift appliances. The publication Accidents, issued by the Factory Inspectorate in the United Kingdom, reports the
case of a shipyard plater who made his own lifting hook. This hook was not proof tested and the worker hid it in his tool box to avoid inspection. It worked perfectly well for several years, until the hook suddenly fractured at its heel and the load fell and struck a helper, injuring his knee.

The particular circumstances in which an operation is carried out call for precautions determined by the responsible operator's judgement, as illustrated by the following example:

A mobile crane was moving backwards and transporting the wing of a prefabricated bulkhead. The jib fouled the derrick guy rope. This guy rope had been temporarily secured to a staging upright which was to be used later on. The upright was of braced steel construction, 18 ft. 6 ins. high; it overbalanced, crushing as it fell one of the men steadying the load and killing him instantly. The upright should have been adequately lashed; the guy rope should not have been secured to the upright; and the crane driver, who was looking out of the cab to the rear, that is in the direction of motion, should also have been watching the movement of the derrick and of the load.

A second illustration, drawn this time from ship repairing, highlights the dangers of lifting processes carried out in small spaces where mechanical equipment cannot be used and where such equipment as simple chain blocks have to be applied.

The tailshaft of a vessel had to be removed for the purpose of inspection of the stern-tube bearings. In order to withdraw it into the shaft tunnel, a section of intermediate shafting approximately 21 ft. long and weighing nearly 7 tons had to be slung clear. The operation was to be carried out by means of three chain blocks, with anchoring points on the tunnel arch approximately 3 ft. from the vertical centre line of the shaft. All the coupling bolts had been removed and then tension was gradually applied to the shaft in order to free the intermediate section. This swung over, pendulum fashion, trapping eight of the men against the side of the

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1 Accidents, Vol. 30, January 1957, p. 20
2 Accidents, No. 44, July 1960, p. 11.
tunnel; two were killed and two very seriously injured. The main mistake here was in the whole approach to the operation. Chain blocks should have been placed on both sides of the tunnel in order to maintain constant control over the movements of the section of the shaft.1

**Handling and Transport**

In his address at Newcastle, already quoted, the Chief Inspector of Factories of the United Kingdom stated that handling of heavy objects was the operation involving the greatest risk of all. 23 per cent. of accidents occurring in shipbuilding and repairing were due to this cause, and the accident risk was one-and-a-half times greater than for industry at large. Irrespective of technical progress, manual handling remained necessary. There were good and bad ways of lifting weights. Most people tended to bend their backs rather than keep them straight and use the powerful muscles of their lower limbs. The result was shown in slipped discs, strains, hernias or worse. In British shipbuilding and repair yards, one accident in eight in connection with manual handling operations was due to strain to the trunk.

Transport of workers and materials is also the cause of numerous accidents. What with lorries, trucks, mobile cranes, tractors and trailers, there is ceaseless movement in shipyards. Many yards date back a considerable time, and there is not sufficient room for transport to move in accordance with modern requirements. In one French shipyard, of five fatal accidents that occurred between 1957 and 1960, two were transport accidents: in 1957, a train driver fell from his locomotive under the wheels of a truck, and in 1960 a worker fell from a trailer, breaking a shoulder blade and dying from subsequent complications.

**Corrosive or Hot Substances**

Although shipbuilding is concerned essentially with engineering and sheet-metal operations, and little use is made of chemical processes, there are a certain number of operations requiring the use of chemical substances, the handling of which calls for extreme care. This is the case with galvanising operations, by means of which tubes are protected against corrosion. The tubes are successively immersed in a 70 per cent. solution of hydrochloric acid, dried, plunged in

ammonia and then placed in a zinc bath at 450° centigrade. Immersion is particularly delicate, for, however much care is taken in placing the tubes in the baths, the air inside is forced out in such a way as to cause projections of liquid. There is also the obvious catastrophic result of any break in the chains holding the tubes when they are above one of the baths.

There is also a risk of burns inherent in any work on metal at high temperatures, such as riveting, forging or moulding.

In the United Kingdom, of 6,691 accidents reported in 1960 in shipbuilding and repair operations, 211 were due to contact with chemical or burning substances. The breakdown was as follows:

- contact with electrical or other heating appliances; contact with hot machine surfaces: 26;
- burns by molten metal: 9;
- contact with corrosive substances: 8;
- scalding by hot liquid: 29;
- other burns and contact with very cold surfaces: 139.1

Electricity

As already mentioned, one of the most serious dangers involved in arc welding is electric shock, but there are, of course, other operations involving this danger. Any electrical equipment that is insufficiently insulated, not correctly earthed or not earthed at all or that is handled without necessary protection is liable to cause serious accidents. The danger is particularly great in damp or wet workplaces or with natural conductors such as metal tanks or boilers, when the operator is perspiring or has wet hands or shoes or particularly when he is barefooted.

1 Annual Report of the Chief Inspector of Factories, 1960, op.cit. p. 124
The dangers of high-voltage currents are clear enough to constitute a warning, but it is less common knowledge that low voltages (110 to 220 A.C.) can also cause fatal accidents. ¹

"An employee of a ship-repair company reached out of a manhole to move a 110 volt electric blower. He received a shock. Almost anyone reading this could say: I've had a shock or two from 110 volts, and it didn't do me any harm. Very true, but in this case the man was electrocuted."²

If the worker had been leaning against dry wood and not metal all he would have felt would have been a slight shock. Nevertheless, since the amperage (or intensity of current) is defined as a ratio of voltage to resistance, only a very low tension (24 volts) is not liable to cause a fatal shock. Even a 50-volt current can cause a fatal shock if the worker is sweating; resistance of dry skin is calculated at 100,000 to 500,000 ohms, but sweat can reduce resistance to as little as 1,000 ohms. The duration of contact and the path followed by current in passing through the body may also affect the severity of accidents.

Electricity may also be the cause of accidents other than electric shock. Fire is a major hazard for vessels, owing to the great quantity of flammable material present. Everyone is aware of the tragedy that occurred on the American aircraft carrier Constellation, which was ravaged by fire on 19 December 1960, before its completion. Forty-nine people died and over 300 were injured. Electricity is one of the leading possible causes of fire on board ship, in addition to flame welding and cutting as described above. Contact between a conductor and a flammable liquid or a simple short circuit may result in a disaster.


The following is an example of the first of these possibilities:

Four pipefitters were working in the pump room of a tanker. A valve flange broke and some fuel oil leaked into the bilge. The workmen were using a simple naked bulb and not a safety lamp and this fell into the bilge. One of the men lifted it out but when it cleared the water it exploded and set fire to the fuel which had leaked on to the surface of the water. The four men were seriously burned.

Short circuits are frequently due to the unsatisfactory state of cables used in welding, lighting and supply systems for electrical apparatus. There are many ways in which materials can become worn: rubbing against corners, crushing under loads or under workers' feet. Even when they are properly installed they no longer provide a complete guarantee of safety after prolonged use, and short circuits may become more frequent. This is often the case, on board liners, during the final stages in the shipyard.

(b) Physical Conditions

Under this heading, consideration will be given to workplaces and the physical conditions in which work is performed as possible causes of accidents, with reference to staging and means of access, bad housekeeping, composition of the atmosphere, effects of weather, lighting and noise.

Staging and Means of Access

At the Newcastle Conference, the Chief Inspector of Factories of the United Kingdom quoted figures relating to falls in ship building and repairing. 13.5 per cent. of all accidents in 1960 were due to falls and the risk of accident from falling was three times greater than throughout industry at large. There were 945 falls from heights recorded in the United Kingdom in 1960.

The material cause of the majority of these falls was a staging or a means of access to a high place (ladder,

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gangway) which was incorrectly installed or used. There are a large number of reports of such accidents in specialised journals; some examples are given below.

In order to facilitate machinery assembly work in a new tanker, a staging squad erected in the engine room a stage consisting of three planks, one end of which rested on a bracket suspended by means of a bar having a short angle lug at its upper end which in its turn was connected to a stiffener bar. Three of the workmen went on to the stage and their movements subjected the flat bar to a fore and aft bending movement, which its relatively weak section (quarter inch) was unable to resist. One of the workers was able to save himself by grabbing an overhead ventilator. The two others fell to a nearby stage but one of these, a sixteen-year-old apprentice shipwright, was knocked off this second stage by one of the falling planks and fell about 20 feet to the engine room floor. He died the following day. The weakness of the support was obviously the cause of this accident.1

Two men were scaling the shell plates of a ship in dry dock. They were using a working platform supported by trestles erected on the dock bottom. By pushing against the ship's hull with their tools, while scaling, they displaced the staging and they fell on to the cement base.2

A similar case occurred in a dry dock where a scaler was working on a mobile staging alongside the hull of a ship. His movements caused the staging to move, one wheel dropping into a drainage gully some eight inches deep. The staging tipped, and although it did not overturn the man lost his balance and fell fourteen feet, sustaining head injuries.3

1 Accidents, volume 33, October 1957, page 5.
2 Accidents, volume 44, July 1960, page 14
3 Ibid.
In both cases, the staging should have been of adequate stability and firmness.

A coaster was being repaired in a dry dock scarcely wider than the vessel itself. In view of the limited space between the hull and the dock side, no normal staging could be used. A shoring sill was used to support the thwarts of the working platform, the short ends bearing upon a strip secured to the ship's side. While three men were working on the platform, part of the temporary shoring sill gave way, causing the platform to collapse as a result of one of the bolts securing the timber beams being pulled out of the concrete. The men fell to the dock bottom. In this case it was the fixing of the beams in the cement by bolts which was wrong.

To start work one morning a worker hoisted himself on to the staging of a floating platform. He overbalanced and fell backwards on to the deck ten feet below, sustaining serious injuries. The night before, the platform had been raised, but the back-rail had not been replaced.

What these five accidents have in common is that an essential precaution had not been taken when the staging was put in place. Four of these took place during maintenance or repair operations. That is when the risk is greatest: because repairs have to be carried out rapidly or because it is a small job, those concerned do not take the time or the trouble to put up a proper staging. The situation in shipbuilding is more satisfactory in this respect. Stagings are carefully erected, installed for fairly long periods and adapted to the ship that is being constructed. None the less, the workers engaged in ship construction must also observe the greatest care.

The same is true for gangways, ladders and other means of access, which may also result in serious accidents if they are incorrectly constructed or used.

1Accidents, Volume 44, July 1960, page 14

A plumber, carrying a pipe over his shoulder, came on board a ship that was being fitted out. There was a gangway between the dock side and the bulwark, but since the bulwark was approximately four feet above the deck level, a wooden box was used as a stepping platform. The plumber stepped heavily on to the box from the gangway and his foot went right through it, causing him to fall and so injured his shoulder and leg.¹

A ladder that is at too great an angle, too straight, too short, not fixed at the top or wedged at the base or which is not sufficiently firm constitutes a further risk of falling. There is also danger if a worker uses a ladder when he is carrying too heavy a load or if he leans over to work outside his normal reach or if he goes on to the ladder when someone else is on it. Similarly, uncovered and unguarded manholes are a source of numerous accidents.

Working at heights is not only a risk for the persons performing such work, who are exposed to falls of varying severity for lack of necessary precautions. Such work may also endanger persons beneath, who may be hit by falling objects.

Again, according to the Chief Inspector of Factories of the United Kingdom, 11 per cent. of the accidents reported in shipbuilding and repairing are due to falling objects; this is 2.25 times greater than for all industry. A chain or a hook may snap and the load fall to the ground. But other objects as varied as hammers and other hand tools, rivets, nuts and bolts also obey the laws of gravity if a clumsy movement dislodges them from a staging, a beam, a pipe or a gangway on which they may have been carelessly left.

Poor Housekeeping

It is possible to fall from a considerable height and escape without serious injury. It is also possible to fall

simply from one's own height and injure oneself badly. The severity of an injury is a matter of chance. The risks of falling on the level must therefore be combated with the same vigour as the risk of falling from one level to another. At the Newcastle Conference, the Chief Inspector of Factories stated that 13 per cent. of accidents in shipyards were caused by stepping on objects or striking against them and that the risk of such accidents was two-and-a-half times as great in ship building and repairing as it was elsewhere. He therefore encouraged his audience to give the greatest attention to proper order, tidiness and cleanliness in workplaces.

Badly arranged objects or objects jutting out where people have to pass by; tools, materials or waste left lying on the ground or on stairs; planks with protruding nails; tangled piping and cables on gangways, on deck and on dock sides; uneven surfaces or surfaces made slippery by spilt liquid; windows or lamps so dirty as to shut out light; these are things still occurring often in a great number of shipyards, each of them representing a possibility of slipping, stumbling and sustaining a more or less severe injury. A badly stacked pile of planks may fall on to a passer-by; a badly placed tool may injure someone with its point or with its cutting edge. Disorder and lack of cleanliness mean waste and increased risk of accident and fire.

**Composition of the Atmosphere**

The effect of some operations is to alter the composition of the atmosphere in the workplace to such an extent that it threatens the health or safety of the persons working there. One of the dangers is that the air becomes deficient in oxygen. This deficiency can only be detected with measuring instruments and is therefore particularly dangerous. The most frequent cause of it is the formation

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of rust on metal walls in a place where the air has not been renewed for a long time. The following example is a perfect illustration of the kind of accident that can occur.

A floating pontoon composed of six compartments that had been hermetically closed for ten years was brought to dry dock for carseening. A manhole had been previously cut in each of the two central compartments to fill them with water to make the pontoon heavy enough to pass beneath a fixed platform. Two employees whose job it was to assess the amount of painting required inside the pontoon first went down into the two central compartments, which had since been emptied, and carried out their job normally. They then went on to a third compartment in which a manhole had just been cut. As soon as they descended, they felt unwell and attempted to get out. Only one of them managed to do so and called for help. The other fell to the bottom of the compartment. A fireman with a filter mask descended but also fainted. The two bodies were finally recovered, but the first man could not be brought round. The inquest found that the workman had been asphyxiated by the confined atmosphere from which the oxygen had been removed by the rust which had formed on the walls of the compartment.

The atmosphere is also frequently contaminated by toxic agents. The increasing variety of chemical products transported in bulk exposes maintenance and repair workers to considerable danger of poisoning if proper precautions are not taken. A number of paints are poisonous, particularly those used to cover hulls to prevent barnacles from adhering. But the greatest risk occurs in welding and cutting plates. The toxic effect of fumes caused by flame cutting of galvanised plates or plates covered with lead or cadmium paint is well-known. Workers are perhaps less conscious of the risk arising from the effect of nitrous vapours produced by the prolonged action of flame on a mass of cold metal, which is the case when plates are subjected to localised heating in order to straighten them. The following is an example of such poisoning.

1 Travail et Sécurité (National Safety Institute, Paris), April 1958, page 163
In a compartment with no other ventilation except by a companion way, ten men were engaged in replacing a crosshead. Since this was a rush job, it was decided to use three oxy-propane burners to enable the heating up to be done more quickly. The work was completed in just under two hours. Some hours later three men developed tightness of the chest and coughing. They had been poisoned by nitrous fumes and were off work for periods of one to three weeks.

Carbon monoxide poisoning is even more dangerous since those who are affected are least aware that something is wrong, and research is still being conducted into its causes. It is known that welders, and particularly oxy-acetylene welders, may be poisoned by carbon monoxide even when no traces can be detected in the atmosphere. Systematic blood tests have revealed a carbon monoxide content of up to four times the normal; in several cases where workers have been breathing air heated by contact with incandescent ferrous materials chronic carbon monoxide poisoning has been diagnosed.

Where a shipyard includes a foundry, the carbon monoxide habitually given off and the fumes emitted by combustion of certain organic substances added to moulding sand to give the desired properties to the metal must also be mentioned.

As well as causing accidents, anomalies in the composition of the atmosphere as described above may result in occupational diseases, which are discussed below. There are others which, because of the sudden and violent reactions they cause, may lead to spectacular and dramatic events: fires and explosions.

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3See Ministry of Labour and National Service: "Conditions in Iron Foundries" (H.M.S.O. 1956) and "Conditions in Steel Industries" (H.M.S.O. 1961).
In 1960 seven workers employed by private shipyards in the United States were killed and 20 injured as a result of six fires or explosions during repairs to vessels. These seven fatal accidents represent a quarter of those which occurred in 1960 in shipyards subject to the Longshoremen's and Harbor Workers' Compensation Act. Two of these explosions took place when tankers were being cleaned; two others were due to paint or protective coatings; one worker was killed when spraying paint and the other when burning old paint inside a tank.

Although fires and explosions on board tankers undergoing repairs are relatively infrequent, their consequences are so serious that the greatest precautions are taken. Nevertheless, it is impossible to provide for every eventuality and some details may be occasionally overlooked. Of the following two examples, the first illustrates what might be termed ill-luck, while the second reveals lack of care in observing regulations.

A ship had run aground and the bulkheads had been damaged, making it impossible to open the valves because the valve shafts running up to the deck were twisted. Furthermore, the ship's list had caused fuel oil to remain in the piping. The inspector did not know this and his test revealed no gas. When the ship went into dry-dock certain plates were removed from the bottom of the ship, so that the bulkheads became less distorted, the valve shafts straightened out and it was again possible to operate the valves. The pump master opened one of the valves in the piping containing fuel oil at the very moment when certain plates were being cut loose with gas burners. The oil caught fire from a spark from the torch. One man who happened to be close by was doused with flaming oil and burnt to death.

1Paul A. Reyff: "Shipyard Control for Flammable and Toxic Hazards", op. cit.


3International Metalworkers Federation, Minutes of the Conference of Shipyard Workers, op. cit., p.39.
A tanker was found to be free from gas and sailed into a shipyard. However, some tanks contained water which had been used for ballast and had been let out. A foreman ordered work to be begun in one of these tanks as he thought the whole of the ship was free from gas. While the workers were operating with the gas burners used for cutting, fire broke out in the bottom of the ship. The two workers there hurried up the ladder, but before they had reached safety there was an explosion which hurled them through the tank opening on to the deck, injuring both of them.¹

Gas tests are certainly an indispensable precaution, but for how long do they guarantee safety? Petroleum deposits are not entirely removed each time the cargo is unloaded, nor are rust scales scraped, since complete cleaning of walls and bottoms would be far too expensive. This means that the gas accumulated in sediments and under rust seeps out and forms dangerous concentrations again, particularly when the ship is exposed to the heat of the sun for any long period. Therefore, inspection has to be repeated.

A further danger comes from volatile solvents given off by paint spraying, which form explosive mixtures with the air. Some paints and coatings dissolve in flammable toxic and volatile solvents whose flash point is below 26-27⁰ centigrade. Use of these paints is particularly risky since their composition frequently remains a manufacturer's secret and the drums containing them merely mention the essential precautions to be observed.

The following example illustrates this type of risk, which although not peculiar to shipyards calls for particular notice since many operations in shipyards have to be performed in confined spaces.

In a ship which had just carried a load of vegetable oil, four workmen, protected by a hood supplied with compressed air pumped from the deck, were spraying the inside of a tank. By verbal recommendation of the supplier, acetone had been added to the paint. There was a sudden explosion which caused very serious burns to all four workers.

¹I.M.F., Minutes of the Conference of Shipyard Workers, op.cit, p.40.
Investigation revealed that the explosive atmosphere was formed by the mixture of air and acetone vapour.

Any accumulation of gas in a confined space is dangerous in itself. As mentioned above in connection with the use of welding torches, the mixture of combustible gases with air may constitute an explosive atmosphere liable to react in contact with a flame or an incandescent object. Any excess of oxygen may also result in fire. Piping or valves in a poor condition, lack of attention or carelessness are the most common causes of such accidents, many of which are recorded by shipyards. The following are a few examples.

A large piston from a marine engine needed repair; a screw hole had to be built up by welding, and two men set about the job. Before the work started, some acetylene and oxygen found their way into the piston from the welding torch. When a light was applied there was a most violent explosion: one of the men had an arm almost torn off and the other was burned.

Two men were welding up rivet holes in a bulkhead where the rivets had worked loose, using oxy-acetylene burning tubes. When they had completed the work on the portside, they left the oxygen valve on the burner, cracked open to sweeten the atmosphere, and came ashore for the midday break. Upon returning they prepared to do the same job on the starboard side, but as soon as the arc was struck, the sleeve of the welder burst into flames and both men suffered severe and extensive burning.

Some welding had been done in the engine room of a ship and the propane and oxygen were turned off at the local main supplies in the shipyard. A little later two men went to do some other work in the engine room. Unknown to them, the oxygen had been turned on again, presumably inadvertently, and the torch that was still in the space had not been turned off fully.

1 Travaux et Sécurité, Feb. 1954, p. 44.
2 Accidents, No. 44, July 1960, p. 18
One of the men lit a cigarette. There was a violent conflagration and both men were burnt to death instantly.¹

Four men died and twelve men were injured when a violent explosion occurred during welding operations aboard a ship in dry-dock. A fuel oil service tank in the hold deck had never been filled with oil, but on investigation it was found that a torch burner had been left throughout one night in a confined space near at hand. The Pyrogas cylinder spindle was found to have been badly maintained, probably because the valve key did not fit properly, and there was a leakage resulting in a mixture which caused the explosion.²

Effects of Weather

In the preceding chapter, it was pointed out that the proportion of work performed out of doors has fallen in recent years as a result of the adoption of new techniques. Nevertheless, such work cannot be entirely eliminated and in some shipyards it is still very considerable. The proportion of shipbuilding and repairing workers exposed to climatic conditions is therefore far from negligible.

It does not call for any long arguments to demonstrate the disadvantage or even dangers inherent in such operations. Cold, rain, snow and heat are obvious nuisances. Cold has a numbing effect and inhibits manual dexterity. This action may be intensified by the wind, which also carries dust, grains of sand and other noxious particles which get into workers' eyes and cause many brief stoppages. Frost is responsible for many falls and snow may paralyse all outdoor activity. Rain is so considerable a source of discomfort that some undertakings pay double-time for work performed in wet weather³, but it also increases the

¹Accidents, No. 44, July 1960, p. 19.
risk of electric shock. At one Italian shipyard a worker was killed when he used an electric welding machine which had remained out of doors in heavy rain; there had been a short circuit and when the operator pressed the switch he received a shock of 380 volts\(^1\). When there is excessive heat workers' fatigue is increased and there is a temptation to put aside protective equipment, so that great strength of mind and a clear awareness of the danger are called for.

The effect of weather also contains a threat to workers' health in view of the colds and other more serious diseases caused by exposure to cold and rain.

**Lighting**

The need for satisfactory lighting is recognised in all branches of industry, and the permanent fixtures in shipyards, whether in workshops, on outside roads, in assembly yards or in shipways, are of an increasingly high quality. The short period of daylight in winter and the need to perform certain operations at night, particularly repair jobs, cause managements to provide sufficient lighting throughout the premises, so that work can go on at the speed and with the precision required and without risk of falls or other injuries that would arise through poor lighting. Nevertheless, there are still some shipyards where, for want of rational installations, there are unlighted areas or excessive contrasts of dark and light.

Work on board ship has its particular problems. When the permanent lighting of ships is not yet installed, workers have to use mobile equipment; this is true also for those parts of ships which have no permanent lighting (double bottoms, tanks, shaft tunnels, etc.). All too often, this important item is not given sufficient attention, and a certain number of accidents are due to the rudimentary nature of facilities, as shown by the following example.

Men were being employed to clean out a deep tank. Access was by means of a manhole in the top of the tank leading to cleats fitted to the bulkhead. These cleats led to the stepped top of a small subsidiary

\(^1\)A. Cergna, *loc cit.*, p. 151.
tank, inside the deep tank, and thence to further cleats fitted to the outside of the shaft tunnel. A floodlight had been installed with its light directed to the starboard side where the men were working at the time. One of the men entered the tank, which was in shadow. He stepped into the open space when he moved towards the top part of the shaft tunnel.

This example illustrates the need not only for sufficient light, which there was in this case, but also to direct it so that heavy shadows and direct glare are avoided.

Noise

As pointed out in the preceding chapter the new techniques used in shipbuilding have considerably modified the background of sound in shipyards. The replacement of riveting by welding is the main cause of improvement in this direction, and it seems fair to say that noise is no longer a dominant characteristic of shipyards.

Nevertheless there are still a certain number of operations that are particularly noisy. Riveting has not disappeared entirely, since some lines of rivets remain in most welded ships and damaged plates of older ships that were assembled by riveting must be repaired in the same manner. Compressed-air appliances, such as slag chipping hammers are used, and some operations such as boiler making, forging and sand blasting remain noisy by nature. Some of this noise goes far beyond the highest intensity tolerable to the human ear, which is fixed by most authorities at from 85 to 90 decibels: riveting ranges from 115 to 130 decibels and pneumatic hammers from 110 to 115. At such a level noise impairs hearing and nervous stability and reduces the capacity for reaction in danger. A worker who is deafened by the din around him may misunderstand instructions or a call for help, or may not hear the warning signal of a moving vehicle and thus cause an accident or suffer one himself.

The cases described above constitute a survey of the principal material causes that may lead to accidents in shipyards. For reasons of convenience, they have been considered separately, but in practice it often occurs that an

1 Accidents, No. 44, July 1960, pp. 11 and 13.
2 See in particular Trémoliéres, Besson and Mazarakis: La lutte contre le bruit dans la cité et dans l'industrie (Paris, 1955)
accident is due to the combined action of one or more material causes. In addition, in order to obtain full explanation of an accident it is generally necessary to consider the effect of a different type of cause, commonly called the human factor, the influence of which has been evident in most of the cases described.

2. Human Causes

In its most generally accepted meaning, the "human factor" concept, when applied to accident causes, relates mainly to the physical and psychological shortcomings of workers. Such shortcomings obviously do occur and they are justifiably reckoned among the causes of accidents in the same way as the material factors considered above. Their influence in the causation of accidents will now be examined. It is advisable, however, to include in the concept of "human factor" also the shortcomings of the employer and his deputies, and even the constructor or vendor of the equipment used. It was shown earlier that machines and tools are responsible for numerous accidents; the responsibility of management and its role in the organisation of safety are dealt with in the following chapters.

In one Italian shipyard, an investigation was recently carried out regarding workers who had suffered more than three accidents over a period of ten years. The total of accidents suffered by such workers represented 43.40 per cent. of all accidents recorded during that period. Of these workers, 40 per cent. had 4 accidents,

23 " " " 5 "
13 " " " 6 "
10 " " " 7 "
 5 " " " 8 "
 5 " " " 9 "
 4 " " " 10 or more.

This concentration of accidents among a restricted number of individuals is not an unknown phenomenon and it is in no way peculiar to shipyards. It reveals the possible influence on the individual's safety, irrespective of the material circumstances, that both physiological and psychological states may have, if a clear distinction can be drawn between the two. This effect is such that the health and safety committee of a large French shipyard goes so far as to declare in one of its annual reports that 88.5 per cent. of accidents are caused by the human factor.

1 Proceedings of the National Conference on Safety in Shipyards, op.cit., p. 57
a) Physiological Causes

Physical Deficiencies

Full possession of one's physical faculties is undoubtedly one of the best forms of protection the individual can have against risk. The perils of deafening noise and even more so of actual deafness have just been seen. Shortsightedness and other defects of sight are also possible causes of injury. Workers subject to vertigo must of course take extra-special care against falling. The severity of an accident may also vary with the individual's power of survival. Some will be able to resist suffocation for longer and may therefore be saved in time.

Age

One might imagine that the decline of physical faculties with the years would mean that workers become increasingly vulnerable as they grow older. However, this is not proved, as statistics classifying accidents by the victims' age groups do not normally show the total of workers in each group. It may well be that the loss of physical capacity due to old age is made up for by experience, by increased skill and a more acute sense of danger, whereas young people frequently suffer from the results of their impulsive or careless behaviour. At the Newcastle Conference, the Minister of Labour gave alarming figures concerning the heavy tribute paid by young workers in shipbuilding and repairing in the United Kingdom. Over 600 had suffered accidents in 1960, and this was one of the most serious problems the industrial sector had to cope with.

Fatigue

Many authorities believe that fatigue increases the risk of accident: it makes workers less attentive, slows their reflexes and puts them off their guard. The problem is fairly complex and does not lend itself to categoric assertions. Although it seems clear enough that fatigue lessens the individual's defences against danger this

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factor is difficult to isolate from others concurring in the circumstances of an accident. The incidence varies according to the physical or moral state of the worker concerned at the particular time, and in many cases work itself is not the only element responsible for fatigue. One need only think of the effect the next day that a game of football can have.

However, extreme fatigue seems to have an undeniable effect on safety, but it should be added that this follows from common sense rather than from statistical evidence. In the Italian shipyard quoted a little earlier it was found that 39 per cent of accidents occurred during the first two hours of the morning, 15 per cent in the following two hours, 19 per cent in the first two hours of the afternoon, 11 per cent in the following two hours and 16 per cent in hours worked after the normal daily period of work.

A French shipyard also classified accidents according to the hour of work, as follows:

<table>
<thead>
<tr>
<th>Hour of Work</th>
<th>1957</th>
<th>1958</th>
<th>1959</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>7.51</td>
<td>8.71</td>
<td>7.22</td>
</tr>
<tr>
<td>Second</td>
<td>12.40</td>
<td>11.40</td>
<td>12.75</td>
</tr>
<tr>
<td>Third</td>
<td>10.14</td>
<td>11.09</td>
<td>12.07</td>
</tr>
<tr>
<td>Fourth</td>
<td>8.76</td>
<td>6.37</td>
<td>5.49</td>
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<tr>
<td>Fifth</td>
<td>8.60</td>
<td>6.78</td>
<td>6.42</td>
</tr>
<tr>
<td>Sixth</td>
<td>10.77</td>
<td>10.05</td>
<td>8.15</td>
</tr>
<tr>
<td>Seventh</td>
<td>12.27</td>
<td>13.20</td>
<td>15.05</td>
</tr>
<tr>
<td>Eighth</td>
<td>15.65</td>
<td>17.00</td>
<td>13.96</td>
</tr>
<tr>
<td>Ninth</td>
<td>13.90</td>
<td>15.40</td>
<td>18.89</td>
</tr>
</tbody>
</table>

It is obvious that the figures obtained in these two yards do not really tally. However, it can be seen in both cases that the first hours of the working day show a high accident rate, although there is no satisfactory explanation for this. In the second instance the last hours of the day appear the most exposed in each of the three years. The safety officers point out, however, that many workers wait until the end of the day to report and request treatment for small injuries sustained during the afternoon.

Thus it is not easy to make any clear statement with

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1 Atti del Convegno Nazionale sulla Sicurezza nei Cantieri Navali, op. cit., pp. 57-58
regard to fatigue when the normal hours of work lie between 8 and 10 per day. When repeated overtime is worked the risk of excessive and dangerous fatigue is obviously much more marked. This is frequently the case in ship repairing but only in exceptional circumstances in shipbuilding, for instance when unexpected delays have to be made up and delivery dates have to be met. The Italian Federation of Metal Workers noted a rise in accidents and particularly of serious accidents, and considered that the principal cause was the quickening tempo of work and the excessive hours which sometimes amounted to 12 per day or even more, whereas the normal hours of work in Italy are 48 per week. The Italian Federation of Metal Workers also states, however, that reduction of hours of work has been agreed in some large shipyards in the case of particularly arduous or dangerous operations such as welding, smelting, forging, etc. In Japan wages paid in 1960 in the shipbuilding and repairing industry in respect of overtime represented 25.7 per cent. of the total remuneration. The overtime rate being 15 per cent. above the normal, this means that the number of hours of overtime worked was equivalent to some 23 per cent. of total time worked. 1

Legislation or collective agreements in many countries limit the amount of overtime which may be worked; in certain cases, application has to be made to the labour inspectorate and the trade unions must be consulted. Maximum hours of work are fixed at 60 per week in France and in Italy. In Poland, where the normal hours of work are 46 per week, up to 120 hours' overtime may be worked in a year. In the Netherlands, 12 hours per day may be worked and up to 16 hours once a week; however, the weekly total may not exceed 58 hours, this maximum being reduced to 168 hours over a period of three weeks and 192 hours over a period of four weeks. In Sweden, the number of hours of overtime that may be worked amounts to 200 per year, in addition to which there is a reserve of 150 hours for exceptional circumstances. In the United Kingdom, where normal hours of work have been reduced to 42 per week, it is unusual for workers to be required to work more than two hours' overtime per day in shipbuilding operations,

1 The Oriental Economist, Tokyo, December 1960, pp. 693 ff.

2 This limit applies not only to shipyards but also to industry in general. Concerning the question of hours of work, reference should be made to Chapter IX of Report I prepared for this session.
the actual weekly hours amounting to 47; in ship repairing, hours of work are naturally much less regular and vary from one trade to another.

The distribution of work can be no less a source of fatigue than the actual hours worked. But continuous work is exceptional in shipbuilding. Night work is even prohibited in Sweden except in the case of repairs. Two-shift operation is fairly infrequent and affects only a small number of workers in most countries; only urgent jobs and the use of expensive materials require such operation. In the United Kingdom, the trend towards the five-day week results sometimes in special arrangements regarding the last shift in the week which is worked on Friday evening instead of Saturday morning, the men leaving work on Friday afternoon and returning the same evening. This system has been chosen by the workers for their own convenience, but it has the disadvantage of considerably extending the last day of the week.

Extension of hours of work and night work are obviously not the only possible causes of abnormal fatigue. Other elements include the arduous nature of work, whether this is due to the job itself or the conditions under which it is performed, such as the uncomfortable position, excessive heat, noisy surroundings, or polluted atmosphere. Finally, it should be mentioned that breaks have a favourable influence on nervous stability and well-being of workers, particularly when the work is performed at a fast rate or under difficult conditions; such breaks delay the time when fatigue is felt and may therefore be considered to constitute a safety factor.

b) Psychological Causes

Failure to observe safety rules

Many accidents are due to the fact that one or more safety rules were not observed. This is due to ignorance and above all to negligence.

Ignorance results from incomplete training. This is one of the reasons why young people are so vulnerable: they have not yet any experience of the various risks inherent in their occupation and have not had the time to assimilate the various recommendations with which their instructors and foremen assail them.

An apprentice burner had difficulty in doing his
job and increased the pressure of his oxygen equipment. There was a flashback and the hose caught fire. The apprentice was severely burned on his right leg when he attempted to extinguish the fire by kicking the hose. However, a foreman had previously instructed him about using too high pressure.

Lack of experience may also be due to excessive manpower turnover. When workers stay at one job for a short time only, particularly if they were previously employed in another branch of industry, they have insufficient time to acquire the safety habits which give a worker who is conversant with all aspects of his trade a high degree of immunity, whatever the particular operation. The safety officers in a Danish shipyard, where statistics showed a considerable increase in accident rates in 1945–1946, attributed this to the high rate of labour turnover at the time, which was due to the resumption of free employment after the war.

Apart from such exceptional circumstances and irrespective of the efforts made to inculcate safety consciousness in workers, there remain the numerous accidents due to lack of discipline or to negligence. In shipyards, just the same as in factories, many workers have been injured as a result of bravado, showing off, or refusal to realise the justification of safety measures. How many workers obstinately refuse to wear a helmet on ships that are being built or repaired, because they are afraid to stand out if it is not general practice or to appear to be sissies, although the undertaking provides free helmets.

Excessive familiarity with the possible dangers of an operation may also mean that the risk is underestimated and the necessary precautions overlooked. Everything goes all right for months and years until the accident risk that had been forgotten takes its toll.

1Accidents, No. 44, July 1960, p. 19.
A worker had been employed for ten years in removing waste left by a shearing machine. Access to the machine was barred by a chain, and a board gave warning of the danger of approaching the machine. The worker was required to pull the waste material, plate cuts and chips with a hook. But for the sake of convenience he had become accustomed to unhooking the chain and removing the waste by hand, until one day he happened to get caught between the slide and the frame of the machine.

Failure to observe safety rules may also be due to the desire to earn more. When wages depend on the tempo of work, workers are tempted to neglect their safety in order to increase their output and earnings. They tend to reject safety devices and adopt a method that is more direct but at the same time more dangerous. Shipbuilding does not really seem particularly suitable for scientific job evaluation and therefore for remuneration by piece rates owing to the variety of ships. Nevertheless, according to an inquiry conducted by the International Metalworkers' Federation, 60 per cent of workers in shipyards were paid on job rates in the Federal Republic of Germany in 1958, 65 per cent in Denmark, 85 per cent in France, 80 per cent in Italy, 90 per cent in Sweden and 60 per cent in the United Kingdom. As a matter of fact, it is frequently a combined system of piece rate and time rate. In one Italian repair yard, for instance, there is a fixed hourly rate, but there is an additional premium if the work is carried out in less than the prescribed time. This prescribed time is calculated with an 8 per cent margin and bonuses may amount to as much as 60 per cent.

The effect of piece rates on safety in shipyards is fairly controversial. There are many authorities who believe that there is no effect on accident rates. Some believe that the speed at which a job is carried out finds its natural limit in the quality of work. On the other hand, the Chief Inspector of Factories of the United Kingdom noted in his report for 1956 that cases of lead poisoning had been reported in shipbreaking and added: "In some instances the men work on piecework, a system

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1I.F.M., Inquiry into Conditions of Work and Remuneration in the Shipyard Industry, 1958
conducive to negligence in the use of respirators and in the taking of other precautions". He also quoted the case of an undertaking which was reconstructing a naval vessel. The firm had arranged for a band of paint six inches wide to be chipped from the surfaces to be cut, but "owing to the incentive of piecework, this had not always been done". 

Other Psychological Factors

However carefully prepared and well suited to working conditions they may be, safety regulations cannot always overcome all risks, and the fact that a potential accident actually takes place or not frequently depends on the attitude of the men concerned. Without actually failing to carry out some particular rule, they may cause an accident through their reactions or their behaviour.

A ship was moored in a wet dock and work was proceeding on the placing of a shell plate near the stern, for which purpose a suspended scaffold had been erected. A scow was immediately below the scaffold, and was moored by two slack ropes. Suddenly the propeller began to turn slowly, one blade picking up the mooring rope, thus drawing the scow to the propeller, causing it to capsize. Engineers were carrying out adjustments to the main engine without bothering about the other repair work in process.

Workers were replacing a section of steam piping when the chief engineer opened the steam inlet valve, although he had been informed of the work taking place. His oversight caused the death of two workers and three others were severely burned.

Accidents of this kind, which are due to failure to

1Annual Report of the Chief Inspector of Factories for the Year 1956, H.M.S.O., Cmd 329, pp. 114 and 117

2Accidents, No. 44, July 1960, p.13

co-ordinate between various gangs or between crews and shipyard workers, happen all too frequently: there are instances of painters or riveters on a boatswain's chair being scalded by a jet of hot steam, of boiler makers being scalded in empty boilers as a result of the blow-down of another boiler forming part of the same range, of riggers being struck by radar scanners suddenly starting up and so on. In addition to the routine precautions that need to be taken, general safety therefore depends on each worker being aware of the possible repercussions of his actions on the safety of others.

Sometimes it is a wrong reflex or a panic movement that causes the accident.

A shipyard carpenter was working on deck beneath a life-boat. A crew member accidentally moved the handle of the winch and the lifeboat began to descend. The carpenter panicked and jumped down to the pier 25 feet below and broke both legs.

A plate weighing several tons slipped from the bending machine which two men were operating. One of them instinctively jumped aside, but the other tried to hold the plate which the machine manipulated so easily, and his foot was crushed.

A painter was working while sitting on the rail of a travelling crane. The crane approached. The worker was not deaf and heard the warning signal yet he failed to move. No-one could explain this fatal accident.

The safety officers in one Swedish shipyard calculate that mechanical failures are rare and that 70 to 80 per cent. of accidents are due to lack of attention or reflection. Distraction, for which personal or family pre-occupations are frequently responsible, can have fatal consequences, but the same is true of impulsive action.

Noticing that one of his work mates was lying unconscious at the bottom of a tank, a workman immediately went to help him without stopping to reflect that the same cause - the absence of oxygen,

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1Robert P. Robert, op cit, p. 43.
which had affected his work mate - would also make him unconscious.

Without going into so complex a question in detail, we shall finally refer to the possible effect of the psychological climate on safety, and particularly the relations between workers and employers. If there is tension, if wages are not satisfactory, the workplace unpleasant or social services and health provisions mediocre, this will certainly have an unfavourable impact on safety.

B. Occupational Diseases

Following the survey of the possible causes of accidents in which we have considered the various risks to which shipbuilding and repair workers are exposed, we must also refer to occupational diseases which may be contracted in shipyards.

Such cases are fairly infrequent. Although there were seven reported cases of lead poisoning in the shipbreaking industry in the United Kingdom in 1956, with 13 in 1957, 11 in 1958, 15 in 1959 and 10 in 1960, only one was noted in shipbuilding in 1956 and none at all in the years 1957, 1958, 1959 and 1960. Nevertheless, the risk of disease does exist and calls for effective measures for the protection of workers. Without giving an exhaustive list of such effects, we shall refer to those calling for particular attention.

1. Dermatoses

In the first place there is the benign but widespread complaint known as "oil spots". This is due to contact between the skin and lubricating materials, particularly cutting oils. This may occur, for instance, when oil is projected by lathes and impregnates the legs of unprotected trousers, the friction against the skin frequently causing this complaint to occur.

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Other materials used in shipyards may also result in dermatoses: glass wool, creosote and other wood-preserving materials. Special mention must be made of solvents and other paint components which, apart from the toxic action mentioned below, also irritate the skin. Benzene, for instance, dissolves the fats in the skin and its penetration is revealed by irritation; carbon tetrachloride, the chlorinated derivatives of ethylene, etc. also cause cutaneous reactions.

2. Poisoning

(a) Lead Poisoning

If lead is brought to a temperature of 500°C it produces, under the influence of air, white smoke consisting of very fine particles of lead oxide which may be absorbed by breathing. Lead dust also adheres to the unprotected parts of the body and to clothes, pollutes food and liquids and thus enters the digestive tracts. The poison absorbed in this manner is only very slowly eliminated and the time comes when the quantity accumulated in the organism reaches the limit of tolerance.

In the shipbuilding industry, the jobs liable to cause lead poisoning are first and foremost the preparation and application of paints and varnishes with a base consisting of a lead compound such as minium. Paint spraying is particularly dangerous since this causes aerosols which easily penetrate the respiratory tract. Further operations include scraping and burning of painted surfaces, particularly in the case of very old vessels whose original paint had a white lead base. The risk of lead poisoning is therefore greater in ship repair and shipbreaking.

(b) Benzolism

Even at ordinary temperatures benzol gives off benzene vapours which mix with the air and thus penetrate the alveoli of the lungs. Death occurs after five minutes' exposure to an atmosphere containing 60 mg of benzene per litre, but the lower limit of toxicity is around 0.1 mg per litre. Approximately 30 per cent. of inhaled benzene goes into the blood. Part of this is eliminated but the

\[1\] See Travail et sécurité, July 1959, p. 260 ff.

\[2\] Ibid, November 1959, pp. 48 ff.
rest is fixed in the fatty tissues and particularly in the marrow, which is the organ that controls regeneration of the blood; the result may be progressive anaemia leading to death.

Since benzol is frequently used as a solvent, the work most liable to produce benzolism in shipyards is that involving paints, varnishes and glues containing benzol. Once again, paint spraying requires particular precautions. The operations of paint removing, cleaning and degreasing by means of benzol also involve the danger of poisoning.

(c) Welders' Ailments

As already indicated above, welding operations, and in particular arc welding, produce irritant or even toxic fumes, owing to the very high temperatures involved and the chemical composition of the coating of certain electrodes. The effects are transient and do not appear to have any lasting effect on the organism provided that work is carried out under normal conditions of ventilation. However, the question has been raised as to whether poisoning due to welding might not result in certain pathological conditions. The question is subject to great controversy and a great deal has been written about it. The best course will therefore be to reproduce the main conclusions reached in a study which is regarded as authoritative and which has already been quoted.

"In regard to welding of uncoated mild steel the following conclusions may be drawn:—

1. Welders do not suffer from any specific disease due to their occupation that could be described as 'welders' disease'.

2. Occupational dermatitis in welders does not appear to be a frequent or serious cause of disability.

3. Electric welders and those exposed to the rays emitted from the arc may suffer from acute irritation of the superficial parts of the eyes, a condition known as 'arc eyes'. This is a transient condition which has no permanent effect on the vision or on the deeper structures of the eye. Electric welders, however, do suffer to a greater extent than other workers from a slight superficial non-disabling chronic inflammation mainly affecting the eyelids.

\[A.T.\text{Doig and L.N.\text{Duguid}}: \text{The Health of Welders, op. cit., pp. 74-75.}\]
4. Slight irritation of the throat is not uncommon in welders who have been exposed to high concentrations of fumes. The discomfort usually passes off in a few hours. No serious effects on the throat or nose were observed and there was no evidence to suggest any implication of the larynx. The incidence of nasal catarrh and frequent colds is higher than would be expected in the general population, especially in welders working in enclosed spaces and with galvanised metal.

5. The incidence of symptoms related to the respiratory tract, mainly cough and sputum, was higher than would be expected in a comparable non-welding group, and the evidence suggests that abnormal physical signs in the lungs are also more frequently to be found. These symptoms indicate a mild form of bronchial irritation and are not associated with evidence of pulmonary fibrosis or of impaired exercise tolerance.

6. In a certain number of welders with a long duration of employment, particularly those who have performed much enclosed work, abnormal x-ray appearances are observed. These indicate the deposition of fume in the lungs. This fume consists mainly of iron oxide. When exposure to fume decreases or stops the particulate matter may be removed by the normal scavenging action of the respiratory tract so that the abnormal x-ray appearances eventually disappear.

7. Exposure to welding fume does not predispose to pulmonary tuberculosis; pulmonary tuberculosis developing in welders does not run a more severe course than would be expected in non-welders. There does not appear to be an increased liability for old lesions to be re-activated.

8. In regard to gastro-intestinal troubles the evidence suggests that, although temporary symptoms may follow exposure to high concentration of fume the incidence of peptic ulcer and chronic indigestion is

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1 In an article on "Welders' Ailments" (L'Usine nouvelle, monthly edition, December 1960, p.81), Dr. de Frémont notes: "Pulmonary fibrositis is not rare in these occupations together with bronchitis, coughing and sputum; this state of irritation, which has a tendency to be chronic and quickly becomes inflammatory, might constitute a fairly certain link with tuberculosis."
no higher in welders than in the general population...

13. Blood examinations showed in certain cases changes of a slight nature suggesting a stimulation of the blood-forming organs. There was no suggestion of organic changes in these organs, and no abnormal blood cells have been seen.

14. There is little danger of gassing during welding in conditions of good or moderately good ventilation.

In ill-ventilated spaces, welding or burning may cause considerable discomfort, or respiratory, or gastro-intestinal upset. Severe respiratory symptoms are usually due to the inhalation of oxides of nitrogen which are especially liable to be produced in toxic concentrations by the use of the gas flame for welding or burning. The fumes from galvanised metal may also lead to severe chest illness in enclosed spaces. The danger from gases other than oxides of nitrogen is remote."

The authors add that statistical research has not gone far enough and that the influence of poisoning by welding on pulmonary or gastro-intestinal disorders is not definite enough. Welding and burning of metals covered with a coating of certain alloys and non-ferrous metals involve specific risks such as lead poisoning.

These conclusions by Doig and Duguid undoubtedly constitute an excellent synthesis of the dangers to welders' health and they usefully supplement the preceding comments regarding the risk of accidents in this branch of shipbuilding whose importance has increased so strikingly in recent years.

3. Diseases due to Dust

The generic name for lung diseases due to the action of dust is pneumoconioses. Certain so-called ultramicroscopic particles varying in dimension from one quarter to a 100th of a micron, go directly into the blood, resulting in "smelters' fever" (particularly zinc smelters),

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1 See Travail et sécurité, July 1960, pp. 302 ff, and August 1960, pp. 338 ff.
which disappears after a few hours without any trace. The fine dust of between 5 microns and a quarter of a micron remains in the pulmonary tissue and results in radio-opacity. Some particles such as those of iron oxide, as mentioned above in connection with welder's ailments, are known as "inert" and do not affect the alveoli of the lungs. They cause only benign pneumoconioses (siderosis in the case of iron oxide), which cease when exposure to dust ceases.

Other forms of dust, known as "active", cause fibrous nodules, and this fibrositis continues to extend even after exposure to dust ceases. These active dusts include free silica and asbestos, which are responsible for silicosis and asbestosis respectively, which may be contracted by shipyard workers engaged in particular occupations. These include, in the case of silicosis, the operations of sand-blasting and sand removal in foundries, and plate-stripping or polishing by sand. In addition some authorities have considered whether silica freed by certain welding processes might not be harmful to welders' health. Asbestosis may affect workers engaged in lining boilers, tubes and other installations with asbestos for heat insulation.

4. Ionising Radiations

As in other metal trades, ionising radiations have come to be applied in shipbuilding. The property of x or gamma rays of passing through bodies with a power of penetration that varies according to the density of the substance is used in order to ascertain the quality of certain manufactured metal products. The process of radio-metallography based on this principle consists in

placing a radiating source at one side of the article to be examined and at the other a sensitive film which, when developed, reveals flaws in a casting or the porosity of a weld bead.

In addition, as mentioned in Chapter I, nuclear power for ships is likely to come into increasing use, and the risk of exposure to radiation in shipyards where atomic vessels are built or repaired will therefore increase accordingly. Ionising radiations are extremely dangerous and it is particularly important to avoid any failure of man or materials in their use. External irradiation, which is the form concerning us at present, leads to skin complaints: x-ray dermatitis, radio-necroses, cancer, and blood disorders similar to those produced by inhaling benzene (anaemia), quite apart from the genetic effects whose nature and scope are still not properly known.

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With these very brief remarks concerning the occupational diseases to which workers in shipbuilding and repair yards are exposed we come to the end of this survey of the risks against which these workers must be protected. There are not really any risks which are specific to their occupations, such as firedamp - the terrible scourge of miners. Each of the trades carried on in shipyards has its own dangers, just as when those trades

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1For the sake of conciseness certain disorders have been deliberately omitted which are not considered by all national regulations as occupational diseases, such as deafness in boilermakers, or other ailments which only rarely occur in shipyards, such as poisoning by carbon tetrachloride or trichloroethylene.
are carried on in other industries, but with the added danger of work in the open air, at heights, or on vast masses of metal. Owing to the great diversity of trades concerned and the different risks incurred in each of them, safety precautions require, no less and perhaps even more than in other industries, that there should be regulations covering all risks as far as possible, but it also needs the goodwill of the two parties directly concerned: employers and workers, as well as wholehearted collaboration between the various authorities and individuals responsible for safety.
CHAPTER III

THE ORGANISATION OF SAFETY IN SHIPBUILDING
AND SHIP REPAIRING

A good many of the occupational hazards that have just been listed are, of course, common to a number of industries, so that the principles governing accident prevention in industry as a whole are directly applicable to shipbuilding and ship repairing. Nevertheless, owing to the distinctive features of work in shipyards, which the two previous chapters have sought to bring out, safety officials in most of the countries concerned, both at the national level and in individual shipbuilding firms, have been led to take special measures, either of a statutory or of a practical nature, to deal with the extra hazards involved.

An effort is made in the following pages to show how the desire to protect shipyard workers as effectively as possible is translated into practice.

Safety at the National Level

The organisations responsible for combatting work injuries and occupational diseases vary in character from one country to another. In some cases they are state bodies, in other semi-public or private agencies, while elsewhere they may be trade unions. But everywhere, safety is a joint matter, whether those involved are mainly concerned with regulation, enforcement, scientific research or education.

The public authorities naturally play a part which, if not preponderant in every country, is invariably fundamental. The Prevention of Industrial Accidents Recommendation, 1929 (No. 31)\footnote{T.I.O., International Labour Code, 1951, Vol. I, Articles 496-519} lists no less than 20 fields in which they should operate. But it must be obvious that their essential functions include passing legislation and enforcing its application. In some countries, as will be seen later, they delegate these functions either wholly or in part to other bodies.
Laws and Regulations

The 1929 Recommendation states that, to be effective, preventive measures must have a statutory basis. Laws on safety matters are usually confined to laying down the main principles and are then used as a basis and framework for a mass of detailed regulations, decrees and orders issued by the appropriate government departments, as their need or advisability becomes apparent. Thus, the establishment of safety regulations is a continuous process. Sometimes there is a landmark in the shape of a codification or of an up-to-date or remodelled version of existing legislation, e.g. the 1937 Factories Act in the United Kingdom or the Presidential Decrees on employment injuries and occupational hygiene in Italy in 1955 and 1956. But such remodelling only takes place at infrequent intervals, and normally the basic legislation is enriched from year to year with new regulations covering hazards encountered in a particular type of operation or occupation, specifying precautions to be taken in employing a new technique, or simply defining and correcting an older regulation. The final result is a tangle of provisions which cannot always be unravelled without difficulty.

Shipbuilding and repair yards in each country are subject to general laws and regulations in the same way as other industrial establishments and hence are subject to the same inconveniences from this complexity. At the same time, the question may arise whether, despite the multiplicity of regulations in various countries, they are not in some cases inadequate on imprecise and whether the special circumstances of the shipyards are wholly covered.

Some countries have accordingly felt it necessary, in the interests of clarity and to make full allowance for the special hazards of the industry, to supplement their general safety regulations with special reference to shipyards.

Some have found it best to issue a special set of regulations covering the whole industry, e.g. the Federal Republic of Germany, where shipbuilding regulations are in force which were drawn up in 1934 by the Mutual Insurance Association for the Iron and Steel Industry in the North-Western Region.

1 Unfallverhütungs-Vorschriften der Nordwestlichen Eisen und Stahl-Berufsgenossenschaft: 35.0, Schiffbau.
In this country the mutual insurance associations (Berufs­
genossenschaften), which are responsible for enforcing the 
Employment Injury Insurance Act of 1885, also have power to 
issue "regulations for the prevention of accidents" (Unfall­
verhütungs-Vorschriften); these regulations must be endorsed 
by the Minister of Labour and they supplement the Federal 
legislation and "police ordinances" (Polizeiverordnungen) 
regulating a certain number of operations in industrial 
establishments. The mutual insurance associations also issue 
"directives" (Richtlinien) for the protection of workers 
between such hazards as electricity, welding, lifting 
operations, etc.

In the United Kingdom, shipbuilding and repairing were 
until 1961 subject to special regulations issued in 1931. 
New regulations came into force on 31 March 1962, which bring 
up to date and supplement the existing regulations in the 
light of modern methods and working conditions and extend 
their scope. The new instrument provides shipyards with a 
comprehensive code which lays down in detail the precautions 
to be taken in order to ensure the safety of workers in all 
the operations in which they are engaged.

Special provisions have also been drawn up in Poland, 
in the case of shipyards, under the heading: General Instructions 
Respecting Safety and Health in Shipbuilding. 2

A special problem is created in the United States by the 
dual jurisdiction arising out of the Federal Constitution. 
The Federal Government is responsible for all aspects of inter­
state travel and commerce. Any work performed on a vessel 
engaged in inter-state commerce - and a fortiori with a foreign 
country - is therefore subject to federal supervision. 
It follows, according to the interpretation which has prevailed 
hitherto, that ship repairing is within the province of the 
federal authorities, while shipbuilding and shipbreaking are 
within the province of the state authorities. Basing itself 
on Public Law No. 85-747 of 1958, the Federal Department of 
Labor issued a set of regulations for ship repairing on

1 The Shipbuilding and Ship-Repairing Regulations, 1960, 
Statutory Instruments, 1960, No. 1932, H.M.S.O.

2 Instrukcja bezpieczeństwa i higieny pracy dla 
nowoangazowanych pracownikow do przemyslu stoczniowego.
31 March 1960. It is now planning to extend its regulatory functions to shipbuilding and ship breaking. At the present time the regulations on this subject vary from one state to another. In some cases the regulations apply to all workers, while in other states, such as California, there are special regulations for shipbuilding.

In certain respects a similar situation is encountered in Italy, where the 1955 and 1956 Decrees quoted earlier apply to shipbuilding but not to the shipping industry. While ship repair work carried out in workshops is subject to the general regulations there is some overlapping in the powers of the Ministry of the Merchant Marine and the Ministry of Labour as regards work carried out on board. Furthermore, according to circles in the industry itself, the decrees are also in some cases incomplete, imprecise or difficult to apply. As a result, the Genoa Port Authority decided to bring up to date, as regards ship repairing, the safety regulations which had been in force in the port since 1926 and which applied to all industrial and commercial operations. For this purpose it appointed a committee composed of representatives of the employers, the workers, the labour inspectorate and the E.N.P.I. (Ente nazionale per la prevenzione degli infortuni - National Accident Prevention Institute). The Draft Regulations for the Prevention of Accidents and the Maintenance of Hygiene in Ship Repairing, Handling, Conversion and Breaking produced by this

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2 Ship and Boat Building Safety Orders (State of California, Department of Industrial Regulations, Division of Industrial Safety).

3 Decreto del Presidente della Repubblica, 27 aprile 1955, No. 547: Norme per la prevenzione degli infortuni sul lavoro (Supplemento ordinario alla Gazetta ufficiale, No. 158, del 12 luglio 1955); Decreto del Presidente della Repubblica, 19 marzo 1956, No. 303: Norme generali per l'igiene del lavoro (Supplemento ordinario alla Gazetta ufficiale, 30 aprile 1956, No. 105).

4 Progetto di regolamento per la prevenzione degli infortuni e per l'igiene dei lavori di riparazione, manutenzione, transformazione e demolizione di navi (Consorzio autonomo delporto di Genova, 5 May 1960.)
committee are based on the new general regulations but adapt them to the special conditions of the industry. They were presented to the Port Authority on 5 May 1960 and were then submitted for examination and approval to the authorities in Rome. The Ministry of Labour and Social Welfare states for its part that it is now working on draft legislation to regulate accident prevention in shipbuilding and repairing, bearing in mind the special circumstances of the industry.

Other countries, without possessing comprehensive regulations dealing specifically with shipbuilding and repairing or either of these industries, have nevertheless felt it advisable to issue provisions covering certain operations which are quite common in shipyards.

A number of countries have devoted special attention to the maintenance and repairing of oil tankers owing to the particularly serious hazards involved. In the Federal Republic of Germany, for example, the Mutual Insurance Association for the Iron and Steel Industry in the North-Western Region introduced regulations on this subject in 1934. In France, an order was issued in 1958 laying down the safety measures to be observed in carrying out work of this type. Denmark, Finland, Iceland, Norway and Sweden have appointed an inter-Scandinavian committee to draw up common regulations for the degassing of oil tankers; a draft enactment has been submitted to the trade unions in each country for its information, and the final version will probably be issued in 1962 or 1963.

In Poland, a number of regulations have been issued regarding the construction of hulls, lifting gear and dry docking. Since 1947, Denmark has possessed regulations dealing with scaffolding used in building steel ships.

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1 Unfallverhütungs-Vorschriften der Nordwestlichen Eisen- und Stahl-Berufsgenossenschaft: 36.0, Tankreinigung- und Ausbesserungsarbeiten auf Schiffen mit Öltanks.

An order on the same subject was issued in France in 1957. Also in France, an order was issued in 1956 to regulate the protection of workers against electrical dangers in shipyards.

The origin of the above mentioned French orders is worth special mention. In France, as in the Federal Republic of Germany, the Social Security Funds have regulatory powers—the regional Funds have "the power to issue general regulations requiring employers in the same industry within their area to take certain preventive measures" subject to approval by the labour inspector. In addition, on the recommendation of the national technical committees, "the National Social Security Fund may have...extended to the whole country the preventive measures ordered by a regional Fund either in the form in which they have been ordered by that body or subject to such amendments as may be made by the appropriate national technical committees." It goes without saying that the regional committees with large shipbuilding and repairing concerns within their areas attach special importance to the safety problems peculiar to the industry, and, in point of fact, the three orders which are specifically applicable to shipbuilding were simply an extension to the whole country of "general regulations" which had earlier

1Arrêté du 18 février 1957 fixant les mesures de sécurité relatives à l'édification des échafaudages mis en œuvre dans les chantiers navals (Journal officiel, 27 February 1957).

2Arrêté du 25 mai 1956 relatif à la prévention des accidents susceptibles d'être provoqués par l'électricité dans les chantiers navals (Journal officiel, 1 June 1956, and erratum, 15 June 1956).

3The Order of 23 September 1946 set up in each of the main branches of industry a "national technical committee to assist the Governing Body of the National Social Security Fund in the technical study of all general matters relating to accident prevention, statistics, insurance and classification". The Order of 4 October 1945 had already set up technical committees to assist the governing bodies of regional social security funds in dealing with employment injuries and occupational diseases.
been in use by certain regional social security Funds.¹

It is, of course impossible, within the scope of this report, to summarise all the national regulations applicable to shipyards. It must suffice to refer to the special provision made for shipbuilding and repairing in certain national safety regulations.

Inspection

Unless enforced, safety regulations are liable to remain a dead letter.² The regulations applicable to shipbuilding and repairing are subject to such enforcement, but since there are no special arrangements for the industry, the subject can be dealt with fairly briefly.

In most countries, the safety regulations are enforced by officials of the labour inspectorate, e.g. in Australia, Belgium³, Denmark, France, India, Japan, Norway, the Netherlands, Sweden and the United Kingdom. At the state level this also applies to the Federal Republic of Germany.

In the United States, the division of powers referred to earlier in the case of the laws and regulations also applies to inspection. In practice this does not cause any

¹For an account of the history of one of these regulations see Travail et sécurité, November 1957, pp. 493-494.


³In Belgium, enforcement is the responsibility of the Labour Safety Department, which has a fairly small staff of technical inspectors. The inspectors of the Labour-Management Relations Department are not responsible for safety matters and merely inform their colleagues of the technical or medical inspectorate of any shortcomings in safety or health which they may have noticed during their inspections.
the principal labour inspector of the Ministry of Heavy Industry, and the labour inspectorate of the Shipbuilding Workers' Union. In the U.S.S.R., safety standards in industry are enforced by the trade unions, and the technical inspectors in each branch of industry have wide powers for this purpose. In fact, no undertaking may be brought into service without their authorisation. They have access at all times to all premises and are empowered to order the work to stop if conditions are not in accordance with the regulations. They register accidents, report on their causes, assist management in improving safety precautions and penalise managements severely in the event of any deliberate obstruction. Standards of hygiene are enforced by inspectors of the Ministry of Health.¹

Lastly, in some countries, certain types of installation (lifting equipment, electrical installations, etc.) are inspected by public or private bodies which operate in shipyards in the same way as in other branches of industry. The E.N.P.I. in Italy and the Belgian Manufacturers' Association are examples of bodies of this type.

Information, Propaganda, Research and Technical Assistance

The Prevention of Industrial Accidents Recommendation, 1929, makes a number of suggestions for the benefit of public authorities which can be classified under this heading. In practice, while labour inspectorates, wherever possible, carry on such activities as publicity, propaganda, research and technical assistance in safety matters, in some countries these aspects are the responsibility of a number of bodies which work in close co-operation with the public authorities.² Since shipbuilding and repairing are hardly ever singled out for special attention in these matters, a rapid glance will be sufficient. The part played here by the employers' and workers organisations is described later.

In the Federal Republic of Germany, the mutual insurance

¹Communication from the Government of the U.S.S.R.
²Travail et Sécurité, special number, May 1961.
associations act as clearing houses for information and propaganda material in addition to their regulatory and inspection functions. They do this mainly through the publication of journals and pamphlets such as the *Unfallwehr* (Accident Prevention) and *Betriebswacht* (a booklet providing engineers and supervisors with a mass of useful information, such as a table of the maximum load for chains of drawn round steel, and of M.A.C. values (maximum allowable concentration) i.e. the maximum concentration of fumes and harmful gases which can be safely borne by the human body). Pamphlets of a more general character are also issued, illustrating the hazards involved in gas or arc welding, electricity, lifting operations, spray painting, etc. The Federal Labour Protection Institute and the Dust Research Institute also do a great deal of research and publicity work.

In Belgium, the General Labour Promotion Commissariat, which was set up in 1945, is concerned, inter alia, with the psychological aspect of accident prevention. The methods it uses are conferences, mobile exhibitions, seminars, etc. The Antwerp Safety Institute also carries out research and education, its two best-known achievements being its permanent exhibition - the Safety Museum - and its bi-monthly review "Doet veilig" (Do it Safely). For its part, the Belgian Manufacturers' Association referred to earlier has a well-equipped laboratory for the study of various preventive techniques. It is equipped, for example, to carry out fatigue tests of ropes used in lifting equipment. The Association also has special equipment for carrying out psychological and physiological tests on drivers of travelling and other cranes, power trucks, locomotives, lorries, etc. Its laboratory vans visit firms which wish to have checks or tests carried out, and it has established safety departments in many concerns. The National Association for the Prevention of Employment Injuries (A.N.P.A.T.) is mainly concerned with propaganda and its chief instrument is the poster.

In France, regional social security funds, as has been seen, have regulatory and inspection powers, but they also engage in publicity and provide technical assistance. They issue posters, handbooks and safety films, supply firms with advice, make analyses of working conditions on request, and employ a wide range of equipment for this purpose, e.g. light meters, explosimeters, ionometers, devices for the detection of benzene, hydrocarbons, carbon monoxide and dusts, for measuring the resistance of earth plates, etc. They are in constant touch with the National Safety Institute, a private association established in 1947 by the National Federation of Social Security Organisations, the French National Council of Employers, and the four leading organisations of wage-earners and supervisors. This Institute engages in research and technical studies. It holds advanced training courses for safety officers and engineers, for the regional social security funds and for
labour inspectors and their assistants. Lastly, it is an active information centre for supervisors, safety officers and workers. It makes use of pamphlets, folders, posters, the journal *Travail et Sécurité*, the newspaper *Risques du Métier*, films, exhibitions, etc. Among the pamphlets which particularly affect shipbuilding and repairing, mention may be made of: "Ventilation of Working Premises", "Safety and Maintenance of Electrical Equipment", "Health and Safety in the Use of Benzols", "Spray Painting", "Gas Welding", "Arc Welding", and above all, "Shipbuilding - Safety Advice for Workers".

In India, the Department of the Chief Adviser of Factories issues posters, pamphlets, folders and safety films. It has also been decided to attach safety centres to the regional labour institutes which the Indian Government is now setting up in accordance with one of the recommendations of the First Five-Year Plan. The Central Labour Institute in Bombay will co-ordinate the work of the regional institutes in matters of safety, health and well-being.

In Italy, the E.N.P.I., (Ente Nazionale per la Prevenzione degli Infortuni (National Accident Prevention Institute) must, to quote its own rules, "promote, develop and extend the prevention of employment injuries and occupational diseases, together with occupational health". For this purpose the organisation is divided into three main departments; the technical department, in addition to the technical inspection referred to earlier, also gives advice and information to firms which ask for it. It carries out research and submits proposals to the authorities for the enforcement of current standards and the introduction of new standards, and, for these purposes, has its own experimental laboratory. It tests protective equipment which bears its label if approved. The health department provides doctors to conduct pre-employment examinations and periodical checkups for firms which do not have their own medical services, organises and runs factory infirmaries, trains industrial doctors, carries out research in occupational diseases, etc. The propaganda department issues posters, makes films and organises conferences and congresses, the Trieste congress on safety in shipyards (1958), which has been referred to a number of times in this report, was held under the auspices of the E.N.P.I. Illustrated pamphlets are issued to publicise safety standards. One of them - Industria Meccanica - closely concerns shipyards.

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1 Institut National de Sécurité, Paris: "Constructions Navales: Conseils de Sécurité au Personnel".
since it deals with machine tools, other forms of machinery, welding, falls, eye accidents, etc. Mention should also be made of pamphlets entitled "Pericoli da Elettricità" (dangers from electricity), and "L'Abbigliamento da Lavoro" (working clothes). The E.N.P.I. also publishes three journals for those who are concerned with the prevention of employment injuries and occupational diseases, viz., Securitas, Sicurezza nel Lavoro and Rassegna di Medicina industriale; lastly, the organisation has set up an Italian Centre for Safety Officials (Centro italiano addetti alla Sicurezza) for voluntary safety officials, which coordinates the work of safety committees.

In Japan, a number of bodies, such as the National Labour Safety Museum, the Labour Safety Institute and the Federation of Labour Safety Associations, publish the results of their work every month and help to give wide publicity to the more serious accidents.

In Norway, the employers' and workers' organisations cooperate with the public authorities in "Vern og Velferd" (Safety and Welfare), a body which co-ordinates activities in the field of safety and also acts as an information centre.

The Polish Central Labour Protection Institute is a body subject to public law which is mainly concerned with devising and perfecting technical and psychological methods for improving protection against injuries and occupational diseases. It is, in other words, mainly a scientific research body. It co-operates with the authorities in the establishment of occupational safety and health regulations, statistics, etc.

In the United Kingdom, the Ministry of Labour plays a leading part in safety propaganda. It will be recalled that it was under the auspices of the Ministry that a national conference on safety in the shipbuilding and ship repairing industry was held at Newcastle in 1961; this conference was attended by representatives of both employers and workers in the industry. Here the Minister himself gave a general survey of the safety position in the shipbuilding industry and emphasized the responsibility of governments, which he summed up in four words: legislation, enforcement, information and advice. The Industrial Health and Safety Centre, which is in fact a museum of industrial health and safety, and over which visitors are conducted by factory inspectors, is another example of the importance attached to information. Further examples are the many

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1 Press releases by the Ministry of Labour 7 and 16 October 1961.
publications issued under the auspices of the Ministry of Labour, a number of which have been quoted earlier, on such subjects as electric arc welding, the health of welders, conditions of work in foundries, etc. The immense experience accumulated by the factory inspectors is widely publicised by the quarterly journal *Accidents: How They Happen and How to Prevent Them*, in which accounts of actual accidents — and those that occur in shipyards are often chosen — are used as an invaluable source of practical advice. The Government also gives its full support to a number of voluntary organisations which help to improve safety standards, e.g. the Royal Society for the Prevention of Accidents, which is referred to below, and others, such as the British Standards Institution, the Institute of Welding and the British Welding Research Association.

The Royal Society for the Prevention of Accidents was set up to organise accident prevention in industry, on the roads, in the home and in agriculture. Of its four departments, it is of course the Industrial Safety Division which concerns us here. This division has a publications department which is at the disposal of its subscribers and which issues three periodicals: *Industrial Accident Prevention Bulletin*, *British Journal of Industrial Safety* and *Safety News*. It also prepares pamphlets, leaflets and posters on such subjects as eye protection, safety belts, compressed gases and tubular scaffolding. A series of pamphlets have been issued explaining how to organise safety in industry, e.g. the way to use accident statistics, the functions of a safety committee and safety officials, etc. Three times a year, the Association holds training courses for safety officials, the courses being given by factory inspectors, safety officials in industry and engineers of the Association.

The United States Department of Labor does not confine itself to the establishment and enforcement of regulations. It has offices in 17 ports, with responsibility for maintaining safety standards among dockers and ship repair workers.¹ Special care is taken in the collection of statistics: returns are required once a quarter from firms covered by Public Law No. 85-742 quoted earlier, and the figures are used as a guide in planning the safety programmes, and particularly the training programmes,

organised by the Department. It also issues publications which help in the task of information and propaganda. The Bureau of Labor Standards for its part issues a bi-monthly review - Safety Standards - together with a series of folders - "Occupational Safety Aids", "Occupational Safety Charts" - which explain how to perform with safety such operations as lifting, welding, erecting scaffolding and using ladders, and using electrical equipment. A recent bulletin, the Maritime Safety Digest, is designed to help employers and workers to achieve the standards laid down in Public Law No. 85-742. Another series, Maritime Safety Data for the Ship Repair Industry aims at fostering safety consciousness among workers engaged in ship repairing. The Bureau of Labor Standards is also endeavouring, in conjunction with the unions, to hold safety training courses for workers in the ship repairing industry.

Among voluntary organisations, special mention should be made of the National Safety Council, which is engaged mainly in research and propaganda but covers industry, agriculture and transport throughout the United States. It would be impossible here to go into detail concerning its organisation and facilities. It should merely be mentioned that it issues a large number of publications, that shipbuilding and repairing are among the 40 or so branches of industry with which it deals and that its maritime section organises a safety competition every year among the shipyards affiliated to it.

Some of the research work carried out by universities and other bodies is of special interest to the shipbuilding industry. For example, the Atomic Energy Commission entrusted the Stanford Research Institute with making a survey which could be used as a basis for a series of courses on certain aspects of nuclear technique, especially the precautions to be taken against radiations. These courses were held in the spring of 1960 in a naval shipyard and a number of reports and guides for inspectors were drawn up for the occasion.1

In the U.S.S.R., institutes for research into labour protection are attached to the Central Federation of Trade Unions and, in conjunction with the occupational health institutes attached to the Ministry of Health, have drawn up

standards for environmental conditions, e.g. lighting, heating and ventilation. Standards for protection against noise have been determined scientifically and made compulsory in all industrial establishments. The Leningrad Research Institute has designed a set of inspection instruments for the measurement of noise, light, the amount of gas in the atmosphere, etc. Special attention has also been devoted to the supply of protective clothing. In addition, the Labour Protection Department of the Central Federation of Trade Unions has a council which reviews the programmes of research institutions, gives its opinion on safety and health regulations and comments on the quality of various propaganda media such as posters and pamphlets.

Functions of the Employers' and Workers' Organisations

Naturally, neither of the two parties most directly concerned with labour protection can be indifferent to the problem of safety - the employers because accidents are expensive, the workers because they suffer physically and their earning power is affected, and both parties because, in any well-ordered society, man is entitled to protection while he is at work. The efforts made by both employers' and workers' organisations will be apparent from the preceding pages, but are worth describing in further detail. It should be added, however, that in some countries the employers, and more particularly the workers, have no organisations of their own catering solely for the shipbuilding and ship repairing industries, so that, at the national level, their safety policies often form part of a broader policy for the entire metal-working industry, or even for industry as a whole.

(a) Employers' Organisations

In some countries, the employers' organisations are closely concerned with the establishment of safety regulations. In the United Kingdom, for example, the Shipbuilding Employers' Federation appointed a special subcommittee in 1956 to examine each of the successive versions of the new regulations for shipbuilding and repairing in the light of the comments made by shipyard managements; this subcommittee then submitted its criticisms and suggestions to the Ministry of Labour. Similarly, in the United States, in 1959, the Bureau of Labor Standards asked for the comments of employers and workers on its draft safety regulations for ship repairing, and the Shipbuilders' Council of America set up a committee which it instructed to collect the observations submitted by the shipyard managements; the final version of the regulations
took these comments fully into account.\(^1\)

In France, participation by the employers' organisations in the establishment of regulations takes a different form but is none the less effective. The employers' organisations are represented on the occupational Safety Committee and the Industrial Health Committee set up to advise the Minister of Labour. They are also represented on the technical committees which the social security funds are bound to consult.

Similarly, the Belgian employers' organisations are represented on the National Safety, Health and Amenity Council which is responsible, inter alia, for advising the Minister on new regulations and for submitting such regulations itself.

Employers' organisations also take part in research. Some of them do so by giving their support to specialized institutions, e.g., the French National Council of Employers which, as mentioned earlier, was one of the founders of the National Safety Institute. Others play a more direct part. For example, the Japanese Shipbuilders' Association appointed an industrial health committee in 1950, the work of which, on occupational deafness, has led to the laying down of diagnostic standards by law. The committee has also carried out a survey of welding diseases, such as ocular lesions, poisoning and pneumoconiosis. It has tried, by research into 28 types of electrode, to ascertain whether arc welding gives off free silica. Another investigation has been carried out into radiation dangers.

However, it is in providing information and assistance to shipyards that the employers' organisations exercise their most direct influence on safety.

The main shipbuilders in the Federal Republic of Germany have, under the auspices of the Mutual Insurance Association for the Iron and Steel Industry in the North western Region, combined to set up a technical safety committee (Sicherheitstechnische Arbeitsgemeinschaft der Schiffswerften) which holds annual meetings on safety problems in shipyards.

In France, the Shipbuilders Association has a safety engineer on its permanent staff who visits shipyards and advises their managements. At a higher level, the Metallurgical and Mining Industries' Association invites its members to national conferences on safety and to large numbers of regional meetings. It publishes a "Manuel pratique d'hygiène et de sécurité"

\(^1\)Shipbuilders Council of America, Annual Report, 1 April 1960, p. 25.
containing all the laws and regulations on accident prevention with which those responsible for safety must be familiar. It also distributes articles, posters and pocket-sized booklets on safety, and supplies its members with films and slides. In addition it processes statistics forwarded to it voluntarily by shipyards, and in return circulates the results to enable them to compare their own figures with the average rates for the industry.

The Norwegian National Shipbuilders' Association performs much the same services. In 1955 it issued a guide for the protection and welfare of workers in shipyards.1

The Shipbuilding Employers' Federation of the United Kingdom recently published a pamphlet2 in which it reproduced the whole of the Shipbuilding and Ship-Repairing Regulations, 1960, and followed each section with explanations which specify who is responsible for carrying out the section and goes on to analyse the text in detail, emphasising the important points, recalling certain interpretations by the courts and, if necessary, suggesting ways and means of carrying out the regulations. Earlier, in 1957, the Federation circulated a series of recommendations to its members regarding precautions to be taken during electric welding in confined spaces.

In Japan, the Committee on Industrial Health set up by the Shipbuilders' Association engages in safety education and propaganda as well as in research. It makes awards to shipyards with the best performance, organises contests of skill, e.g. between crane drivers, and has also issued a number of publications such as its "Safety Manual", "Safety Standards at Work", "Serious Accidents". It shows films and slides to shipyard workers and holds courses for industrial doctors and other persons responsible for safety and health.

(b) Trade Unions

The importance attached by the trade unions to safety in shipyards was expressed recently at the international level at two major meetings which took place almost at the same time.

1 Veiledning for vernearbeidet i skipbyggerier.

The first, at Genoa, on 14 and 15 March 1960, was held by the International Shipbuilding and Ship Repairing Committee of the Trade Unions International of Metal and Engineering Industries (a trade secretariat of the World Federation of Trade Unions). The international programme of demands by workers in shipbuilding and repairing, drawn up by the Committee, included the following points: maintenance of health and safety standards; improvement of preventive and protective measures; establishment of safety committees in all shipyards; and the election of permanent safety officials on the recommendation of the representative trade unions. For its part, the shipbuilding conference of the International Metal Workers' Federation, held at Hamburg on 24-26 March 1960, devoted special attention (as was seen earlier) to the dangers of explosion during the repair of oil tankers. Its final resolution urges governments, in the interests of increased protection to the workers, to endeavour to adopt uniform legislation.

At the national level, the trade union organisations can play their part in a variety of ways. Where regulations are being prepared, they are consulted in the same way as the employers' organisations. For example, they gave their views, together with the employers, when the United States and United Kingdom regulations referred to earlier were being drafted. In Belgium and France, their representatives sit with those of the employers on the advisory bodies to which draft regulations are submitted. In Italy, the committees set up by the Genoa Port Authority to prepare regulations for ship repairing also included workers' representatives.

While the unions do not always have large-scale research facilities of their own, they are at least in a position to have investigations carried out on their behalf. For instance, in the United Kingdom, the British Welding Research Association, at the request of the United Society of Boilermakers, Shipbuilders and Structural Workers, carried out an inquiry into the risks of pneumoconiosis from electric welding in confined spaces. The Antwerp Federation of the Belgian Confederation of Metal Workers has instructed a group of doctors to carry out a similar investigation.

But the field offering the widest scope for trade union activity in safety is provided by training and educational activities. In many countries the unions publish articles on safety matters in their magazines and issue pamphlets on safety problems for the benefit of their officials. Committees are set up to study the regulations, to review the work of safety committees and sometimes, as in the case of a committee appointed by the Belgian Confederation of Metal Workers, they
investigate specific technical points, such as electrical installations, oxy-acetylene and electric welding and explosion risks.

In some countries the unions also do a great deal to foster safety education among the workers. For example, the Federation of Metallurgical Workers of the French Confederation of Christian Workers organises safety meetings, while the American trade unions (as was seen earlier) are associated with the training and safety programmes for ship repair yards, recently launched by the Bureau of Labor Standards.

It is naturally in the Socialist countries that the trade unions have the widest responsibilities in safety matters. Mention was made earlier of one characteristic fact, i.e., that in Poland and the U.S.S.R. the tasks which elsewhere fall to the labour inspectorate, such as the enforcement of the safety laws and regulations, are performed by the trade unions. They also play a leading part in national and local training schemes and publicity campaigns. In Poland, for example, the standard publicity material (pamphlets, folders, posters, films, etc.) is supplied to undertakings by the Central Council of Trade Unions; the Shipbuilding Workers' Union also organises conferences and exhibitions on the protection of labour.

To conclude this section on the organisation of safety at the national level in shipbuilding and repairing, it may be said that one of the salient features of the unceasing efforts being made in this field is, as in other industries, the indispensable co-operation of all concerned.

There must be co-operation between different government departments such as labour administration, health, and social security, co-operation between public authorities and research institutions whether public, semi-public or private, and co-operation between government departments and employers and workers' organisations.

Last but not least, there must be co-operation between the employers' and workers' organisations, which jointly examine their common problems in the many bipartite and tri-partite bodies on which they are represented. Usually this
co-operation is a working arrangement which is not expressed in the form of an official declaration, but the atmosphere may benefit from a statement of principle such as that signed in 1961 by the Belgian employers' and workers' organisations. This statement, which was particularly welcomed in the metal-working industries, declares that safety and health standards must never take second place to financial considerations and that the committees on safety, health and amenities must play a leading part in accident prevention. It recommends that a standing national body should be set up to deal with safety organisation and propaganda and to co-ordinate the work of official and voluntary institutions. It also urges safety committees to propose ways and means of improving safety, health and amenities in the industry with which they are concerned.

The degree of national co-operation varies from one country to another, but there can be no doubt that everything is to be gained by encouraging it as much as possible, if only because it ensures that the necessary co-operation takes place at the shipyard level.

Safety Organisation at the Shipyard Level

Employers and workers both have a strong interest in safety, and workers can only be protected if each party carries out its responsibilities to the best of its ability. However, while in the last analysis, it is the worker who, by his movements, can create the circumstances in which an accident may or may not occur, it is up to the employer to take action at the source to reduce as far as possible the chance that such circumstances will occur. Accordingly, both legislation and collective agreements assign the primary responsibility to him and place him under an obligation to take due care to ensure his workers' safety.

The Role of Management

Because of this responsibility, top management in shipyards must of necessity take an active interest in safety matters. It must ensure that the safety regulations are known and carried out and that working methods and equipment safeguard the workers as much as possible. It must also make a careful study of any accidents, so as to analyse their causes and circumstances in order to prevent their recurrence.
Safety must be provided for in designing methods and equipment and must inform production planning to the same extent as efficiency. It is also desirable that the layout of the shipyard should be designed with safety in mind. Many shipbuilders (as was seen in Chapter 1) are now modernising their yards to such an extent that the whole layout is being changed. Obviously the physical environment (ventilation, lighting, heating, etc.) can be greatly improved as a result, and transport accidents can be largely eliminated if, when the new layout is being designed, care is taken to keep the traffic lanes clear and to ensure that the routes by which materials travel intersect as little as possible. In other words, safety goes hand in hand with efficiency. Similar careful planning should make it possible to reduce to some extent the congestion of equipment and workers which is a feature of fitting-out operations and involves a number of hazards.

These obligations affect the managements of small as well as big shipyards. Sometimes managements of small shipyards tend to be satisfied with their safety standards because they only have a few injuries a year, and it does not occur to them that in relation to their limited labour force this may represent a high severity rate. Petrol fumes can explode in the hulls of pleasure boats as well as in oil tankers. Electrocution caused by faulty earthing has the same consequences whatever the size of the ship. And badly erected scaffolding, although admittedly less dangerous if it is not high, may also result in serious injury.

Irrespective of the size of the shipyard, the essential point is that the management should be convinced of the need to take every possible measure to protect the workers, that it should make its determination clear and that it should impress upon staff at all levels the need to carry out the policy laid down.

1 See Safety Standards, January-February 1961: Safety Rules Aid Small Shipyards Too".

2 By wearing helmets themselves when they go through the shipyard or climb aboard and by asking visitors to do the same, members of the management give an example which is more effective than mere exhortation.
Works rules.

In shipbuilding and repairing, as in other branches of industry, managements sometimes feel it necessary to supplement or clarify the general safety regulations. This is the purpose of works rules. Practice varies from one country to another and even within the same country. Most of the big shipyards in the United States have their own safety rules based on state regulations, whereas in the United Kingdom there appear to be no cases of this kind. Sometimes a whole code is set up, such as the model code of practice annexed to the regulations of the State of California for the shipbuilding industry. More often the rules only deal with one or more specific operations. Apart from its general safety rules for employees, one American shipyard has drawn up a set of safety regulations governing repairs and alterations to ships' compartments, tanks and pipelines. An Australian shipyard has its own rules for scaffolding, which have been approved by the State Department of Labour; other sets of rules in the same shipyard deal with lifting operations, electrical equipment, the wearing of protective clothing, etc. Some German shipyards have incorporated safety measures, such as the obligation to wear a helmet, in their works rules, so that the measures are compulsory. A Danish shipyard has drawn up its own rules on such measures as the driving of travelling and other crane. In Sweden, the experience of the large firms, which can afford to allocate large sums to safety precautions, also benefits the smaller shipyards by serving as an example and a guide. In due course the experience is embodied in the law - for example, the rules drawn up by one large shipyard for the protection of workers against asbestosis have now been extended to all Swedish shipyards. A number of French shipyards, without actually drawing up their own safety rules, issue booklets dealing with the use of welding torches, lifting equipment, etc.

Normally, patient training and persuasion are sufficient to ensure that the rules and regulations are observed. But sometimes more drastic means must be used, such as fines and suspension, to punish serious or repeated offences. In Swedish shipyards, drunkenness on the job leads to immediate dismissal.

Safety Services

The extent of their labour protection responsibilities and the burden of organising safety have led employers in many shipyards, at any rate in those of any size, to delegate all or part of their powers in this field to subordinate

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1 State of California, Department of Industrial Relations: Ship and Boat Building Safety Orders, Appendix A: Safety Practice Code.
They are in any case under a legal obligation to do this in a number of countries. In Belgium, for instance, section 830 and following of the General Labour Protection Regulations provide that a safety, health and amenities service for workplaces is to be set up in each undertaking. In the United Kingdom, section 81 of the Shipbuilding and Ship Repairing Regulations, 1960, provides that in any shipyard employing not less than 500 workers "a person experienced in the work of such yards shall be appointed and employed exclusively to exercise general supervision of the observance of these Regulations and to promote the safe conduct of the work generally". In Norway, the workers themselves are required by law to elect a safety officer (verneombudsmann) to ensure the observance of the regulations. Safety and health sections perform this function in Polish shipyards; their structure, powers and activities are governed by an ordinance of the Chairman of the Planning Commission dated 16 September 1953. Similarly in the U.S.S.R., technical safety departments are set up in undertakings; they watch over the enforcement of the safety and health rules, and help deal with the safety problems that arise at places of employment. The Government of India is contemplating an amendment of the Factories Act, 1948, to provide for the compulsory appointment of safety officers in industrial undertakings.

In certain shipyards, especially small or medium-sized ones, only the bare bones of a safety service exist, and an engineer is appointed to see to the organisation of safety along with his other duties. Sometimes the chief of personnel assumes this responsibility with the help of a full-time inspector who may have received no special training. In Australia, where the foreman is responsible for ensuring application of the regulations, full-time safety officers are sometimes appointed to co-ordinate and direct accident prevention activities, while the foreman remains directly responsible for the use of safety facilities. In an Indian shipyard, safety is the shop foreman's responsibility. In the Netherlands, a shipyard has among its personnel a safety inspector, who may or may not be a full-time employee and may or may not have assistants, according to the size of the undertaking. In theory such an inspector may only advise the management, but he is empowered to take immediate decisions in an emergency; for example, he may order the workers to stop work in a manifestly dangerous situation. His task is mainly one of supervising, advising and training the workers; accident statistics and reports also fall within his competence.

In certain shipyards, on the other hand, safety services take the form of organised bodies of specialists working
full-time on such assignments. This applies, of course, to very big shipyards. A few examples are given below.

The safety service in a French yard consists of an engineer and two full-time inspectors. The service is under the authority of the director in charge of welfare services, and performs three functions: (1) it ensures the application of safety rules, namely general protection and health measures and provisions relating to certain trades or processes, and draws up instructions for special purposes; (2) it develops accident prevention by compiling and studying statistics, systematically identifying hazards and searching for preventive measures; (3) it instils safety-mindedness in apprentices, workers and technical and supervisory staff. The engineer and his inspectors carry out frequent tours of workplaces and are immediately notified in the event of an accident; they keep constantly in touch with the engineers of the undertaking and with the labour and social security inspectors. Good results have often been achieved by applying the ingenuity and experience of all the staff concerned to the search for protective devices and safe working methods.

The safety service in a Danish shipyard consists of no fewer than 12 persons, including the engineer at the head of it. Moreover, this is only the central office, the functions of which are essentially the same as those of its counterpart in the French shipyard just mentioned. The service has ramifications in all parts of the undertaking; each workshop has contact men who are responsible for initial action in the event of an accident and to whom all unusual occurrences are reported. These contact men wear special badges and their names are posted up at the workshop entrance.

In a Swedish shipyard, safety organisation is the responsibility of one of the managers. The safety service proper consists of one inspector, three full-time foremen, each in charge of a particular sector, and one employee in charge of administrative instructions. In addition there are 82 safety men distributed among the various workshops. They can be recognised by their badges, which are the same throughout Sweden.

The safety director in a British shipyard has an assistant in each of the four departments (machinery, plate shop, slipways and repair yard). Three full-time employees move about the yard. They include two dealing with staging and hoisting appliances respectively. The safety director calls together the department heads and foremen from time to time. All accident reports are submitted to him and he tries to
interview the injured when they come back to the yard after their absence from work. Hoisting appliances are ordered through him, and he is responsible for having them overhauled at regular intervals.

In an American shipyard which is only a branch of a company with a large number of plants, the safety director is allowed to deal only with local arrangements, and the safety department at the head office is responsible for the general organisation. An inspection committee of four members (department heads and foremen), which is assisted by a safety engineer, is appointed every month by the general manager of the firm to inspect the yard. The safety department, the inspection committee, the foreman and the leadingmen study the cause of each serious accident, as well as the occupational experience of the worker who gave rise to the accident and the working method used. In addition, regular meetings at yard management level and between foremen and work teams, make possible a periodic assessment of the safety situation.

Safety services are certainly one of the pillars on which workers' protection rests. Rules must be issued and action taken to ensure that they are applied, and safety services have their part to play in these two fields, but they do more: probably one of the most progressive aspects of accident prevention work is the research they carry out with a view to discovering positive means of ensuring ever more comprehensive protection for the man on the job through various practical measures, of which a few examples are given below.

To eliminate one of the causes of poor housekeeping, the safety engineers of a United States shipyard had the idea of installing portable frames on board ships on the slipways and at the fitting-out quay to which all cables and piping are hooked in order to clear the decks; inside the ship, hangers welded to bulkheads perform the same function. One man has the special responsibility of removing all equipment which is no longer needed. In a British shipyard, refuse, off-cuts, etc., are cleared away during the midday break; in another, outside shutes are provided leading from the decks to receptacles below. Elsewhere oxygen and acetylene are distributed by a network of fixed pipes; this avoids having gas cylinders lying

about and eliminates the hazards involved in handling them.\footnote{This is the case in particular in certain Italian shipyards where this action was taken on the initiative of the Intersind Federation. (Information communicated by the Italian Government).}

Although it is difficult for regulations to deal with the matter, special attention is often devoted to heating, especially in new works. Thus the plate shop of a British shipyard, with a total floor area of 11 acres, was fitted with 480 gas-fired radiant heating panels fixed about 20 ft. above floor level. This ensured a constant temperature of 55°F.\footnote{The Times Review of Industry (London), January 1962 pages 12-13.}

The composition of paints is only rarely indicated on containers, but the precautions to be taken should always be stated. For this purpose a Swedish shipyard uses green, yellow or red labels, the colour of which alone is sufficient to reassure or warn the worker, and which also recommend, according to need, skin protection, the wearing of a respirator, the switching on of a fan, etc. Unstinted praise is due, in this connection, to a British paint manufacturer who has published a manual giving the composition and drying time for each of his products.\footnote{"A Useful Handbook", in Fairplay, 18 May 1961, p.31}

Shipyards are making great efforts to clear the air when the discharge of toxic, flammable or explosive gases or vapours is inevitable. In some cases the fumes are driven from spaces without natural ventilation by injecting compressed air; elsewhere magnetic clips allow intake hoods and ducting to be fixed in the most effective positions.\footnote{Annual Report of the Chief Inspector of Factories, 1959, op. cit., p. 33} Fixed welding stations are naturally equipped with exhaust ventilation, as are painting rooms and all shops where the operations are likely to lead to pollution of the air by dusts or toxic substances.
Special attention must of course be paid to sandblasting.

The safety services also strive to multiply safeguards to ensure the proper working of hoisting appliances and to prevent their faulty operation: for instance, the following are a few of the directives put forward by an Italian shipyard for the erection of prefabricated sections\(^1\): (a) there is to be a careful check of the appliances at regular intervals (a register kept for each appliance would allow its life history to be recorded); (b) only one man is to be in charge of the operation; (c) no person is to remain or pass within a radius of 30 ft. under the load; (d) the prefabricated panels are to be guided with suitable robes; (e) there is to be a check on the welding of clamps; (f) the load is to be lifted only slightly above ground; (g) when two cranes are used in conjunction, account is to be taken of the actual weight of the panel, and any rough empirical calculation when distributing the load between the cranes is to be avoided.

The introduction of electro-magnetic cranes has given rise to a special problem, viz. the risk of a failure in the power supply while the crane is in operation. To avoid this hazard, cranes have batteries of accumulators which are switched on automatically if the power fails and will last long enough for the operation to be completed.

The location, shape and arrangement of crane cabs and the layout of the controls are also of importance. This is, of course, a matter for crane builders, but it seems that safety men should have a say in the design of the cabs.\(^2\) In particular the crane driver's field of vision is an essential safety factor. The enormous size of modern cranes naturally makes his task more difficult, and new means of communicating with him have had to be used. In a Danish shipyard, for instance, there is a wireless link between the crane driver and the man on the ground who directs him.

Safety engineers have also used their imagination to improve the traditional type of staging - wooden platforms and uprights - or to substitute tubular structures which

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\(^1\) Tullio Premuda, "La posa in opera delle strutture prefabbricate", in Atti del Convegno Nazionale sulla Sicurezza nei Cantieri Navali, op. cit., pp. 75-83

\(^2\) On this point see RG. Sell, A.W. Box and K. Leyshon: "Ergonomic Thinking in Crane Cab Design", in Engineering, 20 October 1961, pp. 494-495
are easier to erect and more adjustable. Prefabrication methods have had an influence even in this field: in a French shipyard, the prefabricated sections are fitted before erection with staging that is already guarded with the regulation railings and toeboards, and the workers can work in safety on this staging as soon as the sections have been lifted into place by the cranes. In the same shipyard a special device known as "cathedral staging" has been thought up. It provides a safe workplace for the workers who have to weld the vertical joints between the prefabricated sections, and consists of a tower built of metal parts which is placed against the hull. It has a variable number of storeys, slightly higher than a man, and access from one storey to another is through a trapdoor in the floor.

The foregoing are some of the fields in which safety officers help prevent accidents by zealously and ingeniously complying with the regulations or by going beyond their requirements.

Safety engineers and inspectors are fully aware of the importance of their task, and some of them strive to extend their experience and knowledge through discussion. In the Netherlands, for example, they have founded a study group which meets three or four times a year. Similarly, the safety officers in shipyards in Scotland and North-East England attend information sessions called by the divisional labour inspector once a quarter.

The effectiveness of safety measures is evident from even a cursory examination of the figures. In a French shipyard where the safety service was established in 1929, the accident frequency rate, which had been about 12 in previous years, fell to 7.6 in the year in which the service was set up and is now below 3. The profitability of such a service is just as evident from the point of view of production costs. The direct annual cost of accidents in a shipyard of the United States Navy averaged $700,000 from 1937 to 1942. By 1953 it was only $49,000, by 1954 $37,000 and by 1955 $21,000; to this should be added $100,000 for each of those three years, to cover the overheads of the safety service and the salaries of its staff as well as the cost of protective equipment.

The Foreman's Role

Safety-mindedness, a knowledge of the hazards involved in a particular operation and with the ways of avoiding them are of as much value in a foreman as occupational skill and the gift of leadership. The foreman is management's representative on the job, and his attitude will set a standard for the workers he directs. The line of command passes through him, and in relation to the foreman - and executive and supervisory staff in general - safety officers should confine themselves to acting as safety advisers and experts, without trespassing on the responsibilities of line management, save in exceptional circumstances. The foreman is responsible for using proper and safe working methods, ensuring the observance of safety rules, arranging for good housekeeping, supervising the use of safety devices and, in most shipyards, taking initial action in the event of an accident. He is also responsible for drawing up a report on the circumstances in which an accident has occurred, and his responsibility in that connection is considerable, since a repetition of the accident may depend on the action taken on the basis of his report.

In most shipyards, therefore, tremendous importance is attached to ensuring that the foremen are fully aware of their responsibilities in this field and are properly trained to discharge them. Meetings and courses are organised for this purpose. In an Italian shipyard, the human relations service calls on the foremen at intervals to take courses dealing inter alia with safety, which are attended by about a dozen persons. In a United States shipyard, the foremen in each department, hold a meeting every month; it is organised by the head of the department and is also attended by the leading men. The subjects discussed include the latest accidents, the special hazards in the department concerned, the use of equipment and working methods. The company has also published a supervisory safety code.

Safety Committees

The description in the foregoing pages of the unceasing action required to ensure safety at work has been practically confined to the activities of shipyard managements, but there can be no real safety without the co-operation of the workers themselves, not only in the sense that in the last resort they are free to take or neglect the prescribed precautions but also because it is advantageous to give them a say in the search for ways of preventing accidents and in the decisions
which they will have to apply in their day-to-day work. Recognition of this fact accounts for the establishment of safety committees, with or without union participation. On the one hand, they enable the employer to explain his safety policy and have it endorsed or more easily accepted by the personnel, and on the other, they enable the workers to make known their difficulties or suggestions. This leads to increased confidence on the one hand and to more extensive and direct experience on the other. On the whole, safety in the undertaking is bound to benefit by this two-way flow.

In certain countries the establishment of such committees is compulsory. In Belgium, the General Labour Protection Regulations (sections 832, 837 ff) provide that any undertaking employing not less than 50 persons is to set up a Safety, Health and Amenities Committee. These committees, consist of representatives of the employer and of the employees. The employees' representatives are elected by secret ballot from lists of candidates put forward by the representative workers' organisations. They enjoy legal protection in the discharge of their duties. Model standing orders for such committees were adopted 25 June 1960 by the Metal Working National Joint Committee.

In France, the establishment of Health and Safety Committees was rendered compulsory by a Decree of 1 August 1947 in all industrial undertakings ordinarily employing 50 workers or more. These committees consist of the head of the undertaking or his representative (chairman), the head of the safety service or, in his absence, a head of department or an engineer appointed by the employer, the works doctor or a doctor from a joint medical service, the welfare officer, if any, and either six or three representatives of the personnel (including one or two for supervisors), according to whether the company or undertaking has more or less than 10,000 workers. In one of the biggest French shipyards, for example, the Health and Safety Committee (which is a somewhat larger body since it includes six workers' representatives - two for each trade union - and four representatives of the supervisors) meets under the chairmanship of the general manager himself. The shipyard is divided into ten sectors, each of which is visited once a year by an inspection team consisting of the general manager, the director for welfare matters, the safety engineer, and shop foreman, the labour inspector and several members of the Health and Safety Committee. The committee studies the reports on these tours and makes recommendations. In conformity with the Order of 11 August 1947 it forwards to the Labour Inspection Service a factual report on any serious accident, and also submits to it an annual report with statistics.
In Polish shipyards, occupational safety committees of between five and twenty-one members, according to the number of workers are attached to the works councils. They check the safety arrangements at workplaces, make proposals for their improvement and ensure that the management complies with safety rules.

In Sweden, the Workers' Protection Act of 1949 and the decree supplementing it provide for the establishment of a Safety Committee in an undertaking where 50 or more persons are regularly employed. On the basis of this legislation, the Swedish Employers' Confederation and the Confederation of Swedish Trade Unions concluded on 27 February 1951 an agreement on certain aspects of the working of these committees - composition, inspection of workplaces and frequency and agenda of meetings. It should also be mentioned that Works Councils are supposed, among other duties, to improve safety conditions. To take the example of a particular shipyard, the Safety Committee consists of one of the managers of the undertaking, five engineers, the safety inspector, the head of the transport department, the doctor, a shop foreman, two other foremen, two salaried employees and four wage-earners. The personnel elects its representatives itself without going through the union. The Committee meets every three months or more often if special circumstances so require. It examines how safety measures have been applied since the previous meeting and discusses the accidents that have occurred in the meantime, the hazards to be dealt with and various subjects submitted to it for prior consideration.

In the U.S.S.R., labour protection committees are attached to each works union. They carry out regular inspections, supervise the application of regulations, and discuss with the engineers, the shop foremen and other supervisors. The management of the undertaking is required to follow the recommendations of such a committee.

In the United States, there is no legal requirement to establish safety committees, but many collective agreements contain clauses dealing with the subject. For instance, the Pacific Coast Master Agreement signed in 1959 by the Shipbuilders' Association of that region and the trade unions concerned includes a provision (reproduced in the collective agreements of individual shipyards) for the constitution of a Safety Committee consisting of not less than three or more than five representatives appointed by the company and an equal number appointed by the union. This committee is to lend assistance and make recommendations to the safety engineer; it is to meet once a month.

In other countries, employers have the utmost freedom in this respect. According to the Metal Workers' Union in
certain big German undertakings the works council has set up a
safety committee consisting solely of workers' representatives
which sees to the application of safety rules, studies accident
hazards and submits suggestions to the management.

In Australia there is no rule concerning the existence,
composition or work of safety committees. A shipyard in that
country has such a committee, which is a joint body that meets
once a month to discuss the accidents that have occurred and
the suggestions and complaints received, and to make recom-
mendations to the management. In India, the governments of the
states encourage the establishment of such committees.

In Italy also, the establishment and composition of safety
committees depend on the employer's pleasure. In one of the
big shipyards in that country a committee was set up as early
as 1940; it consists of an assistant manager of the undertak-
ing, who acts as chairman, several heads of departments, the
secretary for personnel relations, the man in charge of safety
equipment, the personnel statistician, the works doctor, the
welfare worker and two workers appointed for two years by the
management. This committee meets once a month, or more often
if required by special circumstances, such as a serious acci-
dent or the entry into service of new equipment involving
certain hazards. Its duties are to suggest and initiate
action to instruct supervisors and to arouse the watchfulness
of the workers with regard to the hazards of their particular
occupation, and to study and adopt any provisions that can
improve the safety measures taken by the shipyard.

In Japan, the employer is required by law to consult the
workers on safety matters, but he is free to refrain from
setting up a committee for this purpose.

Most of the shipyards in the Netherlands have safety
committees consisting of the safety inspector together with
foremen and workers. At their meetings they discuss recent
events in the field of workers' safety and exchange views on
ways of improving it.

The trade unions consider that there are too few safety
committees in the United Kingdom, and labour inspectors share
their view. In most cases employers are not against such
committees but seem to fear that it may be rather difficult
for them to be set up and to operate satisfactorily owing
to the multiplicity of trade unions (as many as 21 in a
particular shipyard). Nevertheless, the idea is gaining
ground.
Safety Training and Safety Campaigns

Only a minority of the workers are members of safety committees or of other bodies which enable labour to play a part in the search for possible improvements. The "contact men" and other safety men to be found in certain shipyards swell the ranks somewhat; however, all the workers have to be brought into the accident prevention movement and taught the basic principles of safety.

This point generally receives the attention it deserves in shipyards, especially in the larger ones. Some of them run classes to train their apprentices, and the subjects taught include the rudiments of accident prevention. Safety mindedness must be built up during apprenticeship, and here again it is the foreman's responsibility to give the young worker the training required if there is no vocational school. There is no need to expatiate on the need for such training either in classes or on the job: it will suffice to mention the alarm voiced by persons concerned with accident prevention, in the United Kingdom for example, at the increasing frequency of accidents involving young workers.

This need is almost as pressing with regard to newly employed workers who have already completed their vocational training. Whether they come from another shipyard or from another sector of industry, it is advisable to give them brief but systematic instruction in the special characteristics of the undertaking that employs them and, if necessary, of the shipbuilding and ship-repairing industry. Practice differs according to the country and the particular shipyard, and the action taken along these lines is not equally vigorous in all cases, but there are many big firms which, when welcoming new entrants, issue them with a certain amount of printed material including extracts from the safety rules in force, leaflets illustrating the various hazards connected with the trade and the precautions to be taken, or pocket-sized cards on which the main rules are printed. An induction course often run by the head of the safety service can draw the attention of new entrants to the same points. Some shipyards have proper classrooms for this purpose, with blackboards, charts, specimens of safety equipment, film projectors, etc. - in short the now traditional arsenal of audio-visual aids.\footnote{It may be of interest to note that, at its Sixth Session (May 1962), the Chemical Industries Committee had this matter on its agenda. See the Report prepared for the meeting by the Office, under the title: Report II, Safe Practices by Audio-Visual Teaching Methods in the Chemical Industries. (Geneva I.L.O., 1962)} In some shipyards this...
theoretical introduction simply takes the form of a tour of the undertaking under the guidance of a safety inspector who gives suitable explanations on the way. On-the-job training is generally the foreman's business.

Safety officers and foremen are naturally given special training. First-aid courses are sometimes organised by the undertaking itself, but this practice is more common in big shipyards which have a large medical service; for instance, this service in a Swedish shipyard provides training in first-aid in the event of asphyxia (drowning, electric shock, etc.) for all apprentices in the undertaking as well as safety officers, firemen and foremen. Sometimes certain occupations also receive special attention: the safety department of a Danish shipyard itself issues "licenses" to crane drivers etc. after they have passed a searching examination.

In some shipyards refresher training is provided at intervals through briefing sessions for small groups meeting under the direction of the foreman or some other leader. In a United States shipyard, for example, there is a weekly meeting lasting five or ten minutes which is held in working hours by the leadingman and the workers under his orders; they discuss the work that is under way or scheduled, the hazards involved, and co-ordination among members of various trades, and the leadingman submits notes on the discussion to the foreman.

Owing to the changes in shipbuilding methods, it is also necessary to give the workers affected further safety training. The distribution of the labour force among the various trades is altering: many riveters, for example, have become redundant, and they have had to be trained for other jobs. Each trade has its own hazards, and workers who are transferred must acquire new safety reflexes at the same time as they acquire new vocational qualifications. Special training is also needed for the workers who are to operate any new machine (power presses, cranes, etc.).

It is a weakness of human nature that, in spite of good intentions on all sides, the monotonous daily round of uneventful work is apt to induce a false sense of security until a serious accident perhaps shatters the serenity. It is therefore better to anticipate and to dispel growing somnolence. That is the purpose of the safety campaigns launched from time to time in a number of shipyards.

These campaigns take a variety of forms - series of meetings, film shows, poster displays, etc. The management may make an all-out effort to persuade the workers to use some
item of protective equipment, such as a helmet: suitable posters are then put up, an exhibition of helmets that were damaged by falls but saved the lives of their owners is organised, and the safety inspectors are instructed to pull up any worker who neglects taking this precaution. Some years ago, a Japanese firm which was alarmed by its accident record launched a long-term campaign involving both management and labour. The main features of the campaign included the setting up of a standards committee to uncover defects in the plant and a good-housekeeping drive which transformed the yard "to such an extent that no-one would any longer have dreamed of describing it as a shipyard." In addition the system of inspection was overhauled in various ways; in particular, safety engineers were appointed to advise the management.¹

A method often used is that of safety competitions among the various sectors of the same yard. The winners receive cash prizes, safety footwear, or some other kind of reward.

It should be added that these competitions are not always well regarded by the trade unions, which claim that they have the drawback of inducing slightly injured workers to remain at work, and even to conceal the occurrence of an accident, in order to earn their reward. Employers reply that this drawback can be eliminated by strict supervision and does not outweigh the undeniable improvements that can be secured by this means.²

In any event, improvements secured by occasional campaigns are often short-lived; it must be emphasised that safety calls for a continuous effort. A permanent atmosphere therefore has to be created. Posters changed at regular intervals, leaflets distributed from time to time, a safety section in each issue of the works paper, suggestion boxes and permanent exhibitions are of considerable value in this respect.

In the Netherlands, certain undertakings organise educa-


tional and recreational evenings for their workers and their wives, and part of the time is devoted to safety. This idea of converting wives as well to the cause of safety has also been taken up by a Swedish shipyard, which sends its quarterly accident prevention leaflets to the workers' homes instead of distributing them in the works.

Medical and First-Aid Services

No accident prevention system would be complete if it did not provide for giving the injured, with the least possible delay, the care which may save their lives or reduce their injuries to a minimum. In addition, medical supervision of the shipyard workers is required owing to the possibility of occupational diseases. This brings us to the field of occupational medicine and to the medical services which large undertakings in various countries are required by law to establish on their premises.¹ There is no need to go into details at this stage; it will be enough to say that large shipyards generally maintain medical services staffed by one or more doctors and by quite a large number of nurses, one of whom often specialises in eye treatment. Sometimes the shipyard has a real hospital with consulting rooms, X-ray facilities, wards and rest rooms where the injured are looked after and where certain categories of workers - welders, sand blasters, and painters - undergo periodical medical examinations. Other shipyards have smaller medical services and first-aid posts, but in most cases the injured can at least receive treatment in an infirmary within the undertaking or at first-aid posts in the workshops.

Many statutory provisions require first-aid equipment to be always available. A few relating specifically to shipyards will be mentioned. The Brisbane Boat Building Award of 6 April 1959 provides that every employer is to have bandages, cotton wool, splints, and other material for dressings available and is to take any seriously injured man to the nearest hospital with all possible speed.² The New Zealand Shipwrights, Boat Builders, Ship Joiners and Joiners' Machinists Award of 8 October 1958 contains similar provisions. Section


² Queensland Industrial Gazette, 30 June 1959, p. 495.
79 of the British Shipbuilding and Ship-repairing Regulations, 1960 provides that, in every shipyard, there are to be provided and kept readily available a sufficient number of suitably constructed stretchers, reviving apparatus, etc., and that there is to be always readily available a responsible person or persons whose duty it is to summon an ambulance if needed. An ambulance room is to be provided in every shipyard in which the number of persons employed normally exceeds 500, or 100 if the shipyard is more than ten miles from a hospital. A schedule to the regulations lists the minimum equipment of such ambulance rooms. In the United States, section 8.58 of the Ship-Repairing Regulations of 1960 provides that the employer must make available a first-aid kit for each vessel on which work is being performed, and lists the standard contents of such a kit. The Pacific Coast Master Agreement provides that injured workers are to be quickly given first-aid; the location of first-aid posts is to be marked and first-aid workers must be easy to identify.

In various shipyards it has been thought appropriate to train a number of workers to render first-aid. This is the case, for example, at a French shipyard where a score of apprentices in their third year are trained by the Red Cross. Some authorities consider, however, that action by first-aid men may be ineffective or even dangerous and that it is better to leave first-aid to auxiliary medical staff who could get to the scene of an accident in a few minutes. It is apparently not denied, however, that it would be a good thing if a certain number of workers knew what to do in an emergency; for example, if they could apply resuscitation treatment in the event of drowning or electric shock, or knew how to transport a man who has just had a bad fall.

* *

In the field of safety as in the field of technical progress, big undertakings are, as already noted in passing, undoubtedly better off than small ones. The hazards are about the same whether the shipyard has 200 or 10,000 workers, but the facilities available are much more extensive in the latter case, in which the funds available allow more systematic and effective safety organisation. It is only fair to add, however, that small undertakings benefit indirectly from the experience acquired by the big ones. With regard to application of regulations much has been achieved by co-operation between labour inspectors and safety engineers who, in big yards, devote all their time to improving labour protection. As regards practical application, quite considerable
publicity is often given to the achievements of big undertakings, and there is nothing to prevent smaller ones from using this information for their own advantage.

There is an excellent "contact man" operating between the two, namely the labour inspector or his counterpart from the accident insurance scheme. They act not only as policemen but also as advisers.\(^1\) Their personal experience is being constantly enriched by what they see and hear and, through them, shipyards having no more direct contact are in a position to borrow tacitly from each other to the ultimate benefit of the party chiefly concerned, namely the man on the job.

Both at the level of the undertaking and at the national level, increased safety therefore depends on co-operation of many kinds - by each undertaking with public departments (the labour inspection service, the social security administration and the occupational health service), by undertakings with each other and, above all, as already stated, by labour with management within the undertaking.

\(^1\)On this point, see the Labour Inspection Recommendations, 1923 and 1947 (I.L.O., International Labour Code 1951, Articles 911 and 929).
CHAPTER IV
SUMMING UP

Despite the wide variation in safety provisions in the different countries and from one shipyard to another, the problems involved are basically the same everywhere. Most of these have already been mentioned in the preceding chapters. Some call for special attention, however, and while the basic facts are summarised it will also help the Committee's deliberations if these fundamental problems are highlighted.

The Workplace and Occupational Risk

Working conditions and safety in shipbuilding are closely bound up with the particular characteristics of the product manufactured in this industry, namely ships, and with the techniques used in production. It is a quite distinct industrial sector, but at the same time it has common features with engineering and the building industry. Therefore, some of the working conditions and the risks inherent in those branches also exist in shipyards. These include the forming, shaping, handling and assembly of metal parts of varying size, and work in the open and often high above ground.

The physical environment of shipbuilding is evolving rapidly at present. Although the very size of ships and the fact that only one or a very small number of the same model are produced preclude any general application of automation, the adoption of recent advances has revolutionised methods of work and greatly changed the aspect of shipyards. Examples of such advances may be found in the automatic cutting of plates, assembly by welding and prefabrication. This transformation does not affect all shipyards either to the same extent or at the same rate. Nevertheless, in order to remain competitive or to regain their competitive position, and irrespective of their volume of output, all shipyards have to enter into the process of modernising equipment and achieving the rapid rationalisation demanded by the new techniques.

The physical working conditions reflect the impact of these changes. As the proportion of work performed
under cover increases and machines take over from men, the working environment of shipyard workers tends more and more to resemble that of factory workers. As things stand, however, a large part of shipbuilding is still carried out in the open air and requires a high proportion of manual work.

In the case of ship repairing, the nature of operations is not such as to permit extensive transformation. Conditions of work have therefore changed far less rapidly. The occupational risks are the same as in shipbuilding, but there are others besides, arising largely from the urgent character of the work, the inconvenience resulting from space restrictions or the often congested conditions in the working areas, the character of certain types of cargo and the fact that many operations are not carried out on land but on the ship itself in either wet or dry dock.

It is difficult to determine the degree of occupational risk in shipbuilding and repairing since the available statistics relating to occupational injury in these industries are not very extensive and do not lend themselves to comparison. In order to establish and guide preventive action, what is needed is not only to know the degree of risk but also to identify its precise causes. Therefore, it would be desirable for each country to keep separate and detailed statistics for shipyards.

What figures are available would appear to indicate that, at the present time, this branch of industry is one of the most exposed to risk in the whole of the metalworking trades but that the safety situation has improved in recent years.

Regulations

Shipyards are subject to the general safety regulations applying in each country. In addition, special rules are issued as the application of new techniques or the recurrence of particular accidents reveal the need. The comprehensive body of laws and regulations nevertheless contains certain gaps or unclear passages with regard to the problems peculiar to shipbuilding and repairing. It might therefore be useful if all countries followed the examples
quoted in the previous chapter, by putting together in a single document for the use of shipyards the various general provisions at present scattered in different documents, subject to any additions or modifications required.

It has been suggested in certain quarters that it might be useful for regulations to be drafted, at least with regard to certain specific points. It was mentioned in Chapter III for example that the Scandinavian countries are endeavouring to establish common regulations on de-gassing oil tankers, and that the International Metalworkers' Federation has suggested uniform legislation in all countries for the protection of workers engaged in repairing tankers. Similar suggestions have been made by other authorities. Considering for instance, that a staging properly erected against the hull costs much more than a rudimentary form of staging, certain shipbuilders who, nevertheless, have to comply with stringent regulations, find this a disadvantage in competition with those who enjoy greater latitude. They would therefore like to see international regulations governing repair operations. There are many further examples which also argue in favour of international safety regulations in shipbuilding and repairing.

Without necessarily going so far as to advocate such a project, which would undoubtedly involve many difficulties, the Committee, should it discuss this point, might well bear in mind the method previously applied by the I.L.O. in various fields in drafting model regulations and codes of practice prepared by committees of experts at the request of the Governing Body, such as the Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry, the Model Regulations for the Building Industry, the Model Code of Safety Regulations for Underground Work in Coal Mines, the two Codes of Practice.

1See in particular: United Kingdom, The Shipbuilding and Ship Repairing Regulations 1960 (Statutory Instruments, 1960, No. 1932, H.M.S.O.); United States, Safety and Health Regulations for Ship-Repairing, June 1960 (United States Department of Labor, Bureau of Labor Standards), and Ship and Boat Building Safety Orders (State of California, Department of Industrial Relations); Italy, Progetto di regolamento per la prevenzione degli infortuni e per l'igiene dei lavori di riparazione, manutenzione, trasformazione e demolizione di navi (Consorzio autonomo del porto di Genova, 5 May 1960).
relating to Prevention of Accidents due respectively to Electricity and to fires Underground in Coal Mines, the Code of Practice on Safety and Health in Dock Work and the Model Code of Safety Regulations relating to Ionising Radiation.

The Model Code of Safety Regulations for Industrial Establishments naturally contains a number of provisions directly applicable to shipyards. They include those concerning the lay-out of premises, fire prevention, machine guarding, electrical equipment, hand tools and portable power-driven tools, gas cylinders, handling and transportation of materials, dangerous and obnoxious substances, dangerous radiations, health protection, personal protective equipment, safety organisation and medical aid.

Two other texts relating to branches other than shipbuilding and repairing may also be applied, by analogy, to a certain extent to shipyards. The first relates to workers engaged in loading and unloading ships. A Convention concerning protection of dockers against accidents was adopted in 1929 and revised in 1932. On the basis of this text a Committee of Experts prepared in 1956 a Code of Practice entitled "Safety and Health in Dock Work". Although its provisions are not binding, it presents a body of practical advice for those responsible for safety and health in dock work. Obviously, a large number of these instructions can be very usefully applied in the work of fitting out or repairing ships. Examples are those relating to housekeeping, lighting, ventilation, machine guarding, electrical equipment, ladders, hand tools, railings, fire protection, wharves and quays, means of access to ships, protection of hatchways, access to holds, loading and unloading machinery and gear, and personal protective equipment.

The second text which might also be applied, mutatis


mutandis, to shipyards is the Model Code of Safety Regulations for the Building Industry. A Convention on the safety provisions to be observed in this branch of industry was adopted in 1937, and supplemented by several Recommendations, one of which includes a Model Code which every member State of the I.L.O. not bound by the Convention should put into effect. The Convention and the Model Code contain a certain number of regulations concerning scaffolds and lifting gear which, in the absence of texts specifically conceived for shipbuilding and repairing, may be considered as applicable to this sector, allowing of course for its particular conditions (for instance, work on overhanging platforms alongside the hull).

**Particular Problems**

Irrespective of the particular form of the regulations applying to shipyards, whether the provisions are codified in each country or remain scattered in the body of regulations issued for use in industry, and whether or not the Committee expresses a view or the desirability of preparing a Model Code or a Code of Practice on safety in shipbuilding and repairing, the texts to be applied should cover a certain minimum of important matters, which are rapidly reviewed below. Even if these items are not all covered by the various national regulations, it is imperative that shipyards should pay the greatest attention to them.

**Scope of Regulations and Responsibility**

First of all, the scope of regulations and the division of responsibility should be determined. In this connection, it would seem that regulations should apply not only to shipbuilding and repairing yards but also to work on ships at sea, at anchorage or in wet or dry docks. The obligation of ensuring protection for workers falls upon the employer, but it is also necessary to establish who is responsible, for example, in the case of workers employed by a sub-contractor, and who is responsible on repair operations (the management of the repair yard, the ship-owner, or even the captain in certain circumstances). The United Kingdom Shipbuilding and Ship Repairing Regulations, 1960⁵, stipulate that the obligation to comply with provisions lies, according to the

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² The Shipbuilding and Ship Repairing Regulations, 1960, op. cit. (section 4)
particular case, with the employer performing the operation, the owner of the premises and plant used, the management of the shipyard, the port authorities, the ship-owner, the captain, or, in specified cases, the workers themselves.

The next thing is to determine in sufficient detail what precautions must be taken in order to guard against the risks described in Chapter II of this Report, with reference in turn to the various fields in which these risks occur and having regard to the features that distinguish shipyards from other industrial establishments.

Means of access

The first requirement relates to means of access to the ship, whether it is being built on a slipway or in a graving dock, whether it is being finished alongside the quay or repaired in wet or dry dock. Detailed requirements must be stated with regard to standards of construction and installation of gang planks, protection of surroundings of dry docks, hatchways and manholes, and the proper manner of constructing and using ladders, both within the ship and in any part of the ship.

Staging

Particular attention must be paid to stagings, which are used in the everyday work of a large number of shipyard employees. Minimum standards must be laid down for strength, width, protection against falls of persons (rails) or objects (skirting boards). Assembly and dismantling should be the responsibility of skilled gangs or should, at the very least, be under the control of a skilled person. Construction and suspension of mobile staging as used particularly by hull painters should also be covered by special provisions.

Handling operations

In view of the increasing volume of handling operations in shipyards, regulations should give particular attention to measures of protection in the construction and use of lifting gear and other handling equipment, and safety officers should give similar prominence to these questions. In particular, there should be periodical control of equipment and accessories, chains, pulleys, slings, hooks, links, clamps, cables, and the maximum working load should always be clearly stated.
Guarding of machinery

Guarding of machinery - motor, transmission, and area of operation - should also be covered by particular provisions, as well as the quality and maintenance of hand tools and portable power tools.

Electrical equipment

As pointed out in Chapter II, electrical equipment causes many accidents. Prevention of such accidents should therefore also be included in safety regulations. Particular attention will be given to questions such as insulation, earthing, main systems, use of portable lamps, periodical inspection of equipment and cables and use of temporary electrical equipment on board ship (problem of voltage, etc.).

Welding and cutting

Welding and burning of plates is now almost universal practice in shipyards, as elsewhere in the heavy boiler-making industry, and it is most important that precautions in the use of these techniques should be specifically prescribed and scrupulously observed. This is in fact one of the points on which, failing codification of texts relating to general operations in shipyards, it might be valuable to devote a special section in national regulations, defining

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1 The International Labour Conference is to study at its 1962 Session, with a view to adoption of one or more international instruments, the question of the prohibition of the sale, hire and use of inadequately guarded machinery. See International Labour Conference, 46th Session, 1962, Report VI (1), The Prohibition of the Sale, Hire and Use of Inadequately Guarded Machinery, (Geneva, I.L.O., 1961).

2 The provisions on this question are frequently scattered throughout a number of texts. In France, those concerning oxy-acetylene welding are contained in the Decree of 18 January 1943 concerning the use of gas pressure equipment (Journal Officiel, 23 Jan. 1943), the Order of 23 July 1943 concerning equipment for the production, storage or use of compressed, liquified or dissolved gases (Journal Officiel, 17 Aug.1943) and the regulations governing dangerous, unhealthy or inconvenient workplaces.
. in particular precautions to be taken in handling gas cylinders and piping, welding torches and electrode-holders.

Composition of atmosphere

Welding operations are liable to alter the composition of the atmosphere, and therefore entail the danger of asphyxia or poisoning. In explosive atmospheres, welding operations may also cause very serious accidents. This is why the precautions with regard to maintenance and repair of tankers are studied with particular attention by those concerned. These are not the only circumstances which may result in asphyxia or poisoning. Consequently, proper provisions should be issued for the protection of workers—particularly by blowing in fresh air and removing or renewing the polluted atmosphere—in order to counteract rarefaction of oxygen, the emanation of flammable or toxic gases or vapours and the production of dangerous dusts. Where such risks exist, the composition of the atmosphere should be measured whenever required.

Lighting

Satisfactory lighting helps to protect workers against falls and many other dangers. Regulations should therefore require proper lighting to be provided, both through permanent installations in workshops, construction sections, slipways, and ways of access, as well as through temporary facilities within ships that are being built or repaired. Lighting installations to be used in places where there is risk of explosion should be covered by specific provisions.

Housekeeping

The impression of disorder has long been a feature of shipyards, and this feature has been responsible for many falls and other accidents caused by slipping or stumbling. Proper provisions in regulations would undoubtedly help to promote the necessary housekeeping efforts, which could relate to the following principal questions: regular disposal of waste, removal outside the working area of such machinery or other equipment as is not being used, freeing ways of access, cleaning places that have been made slippery by leakages of oil and the proper arrangement of electric cables and gas piping.

Individual protective equipment

Although it is impossible to eliminate all risks or to neutralise them at the source by general protective methods,
it is absolutely essential to provide the workers themselves with individual protective equipment. Shipyards normally provide their workers, either free of charge or at very reasonable prices, depending on the type of equipment, with a considerable range of satisfactory protective devices: hard hats, goggles, individual screens, ear protectors, hoods, respiratory equipment, masks, gloves, dungarees, aprons, knee pads, leg guards, safety shoes, safety belts and ropes, life belts, etc. It would be a good thing to codify these provisions where there are no regulations existing.

Employment of young persons

There are a certain number of operations which, while dangerous in themselves, are even more so when performed by young workers. This is the case of work involving the use of asbestos or of any other matter that produces harmful dust, and work involving the risk of serious falls or drowning. The employment of young workers in such operations should be regulated or, in certain cases, prohibited altogether.

Safety services

It is important that, in shipyards of a certain size, the employer should entrust an experienced person with the job of enforcing labour protection regulations, or that a special service should be set up for this purpose. It might even be desirable for regulations to state the minimum workforce requiring a shipyard to appoint some such person or set up such a service.

It would also seem to be of advantage to make arrangements with regard to medical centres and first aid posts as well as health facilities.

The above are the main categories within which safety rules for shipbuilding and repairing could be organised, whether through an international set of rules or instructions or through national codes to be drafted in countries where none exist as yet, or simply by bringing general regulations

1See: U.S. Navy Manual of Safety Equipment, Department of the Navy, Office of Industrial Relations, Safety Division, 1954.
up to date. Obviously, the above survey is in no way exhaustive; other subjects could be added and this outline merely represents broad headings. Also, the Committee may prefer not to follow the complete pattern suggested, if it feels that any specific point should not be governed by regulations.

In any case, these are problems which should, and in fact normally do, claim the attention of employers and workers, for they hold the key to protection against occupational risks in shipyards. After all, these regulations represent no more than minimum requirements which have to be supplemented by means of the goodwill and imagination of the parties concerned. Employee attitudes provide a useful clue to the degree of cooperation in the undertaking.

**Inspection**

Enforcement of safety requirements in shipbuilding and repair yards is not covered by specific regulations in any country. This is part of the general safety set-up which is administered, depending on the particular country, either by officials of the labour inspectorate and/or by inspectors from the accident insurance schemes, or by the trade unions. It does not matter what particular system is applied: the essential thing is that observance of regulations should be subject to effective supervision in accordance with the principles laid down in international instruments.

**The Human Factor**

Among the material elements that may spark off an accident, the human factor plays an important part, as described in Chapter II. Both physiological and psychological causes intervene, and it is not always easy to establish a clear-cut distinction between them, but no accident prevention system can be really effective unless it allows for both factors. Physical deficiencies, the influence of age, fatigue—all these create a certain vulnerability. Ignorance, lack of experience, the desire to earn more, insufficient coordination between gangs, dissatisfaction with work, personal or family worries, sheer ingrained clumsiness or lack of self control are no less dangerous.

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Therefore, measures for the protection of workers should be planned on these two fronts. On the one hand the strenuous nature of work should be reduced as far as possible, the maximum daily hours limited wherever necessary, and persons who are not physically fit to perform certain jobs, in particular young people, should be given other work. On the other hand, safety-mindedness should be created or developed by giving workers the proper training and keeping them alert to safety questions.

Organisation of Safety

It is only rarely that shipyards are singled out by the various bodies concerned with information, propaganda, research or technical assistance on safety questions, although they are covered by the same token as are other industrial undertakings. In fact, investigation concerning the risks involved in certain operations (electric welding, for instance) is of particular interest to shipyards.

The same thing applies to the role of occupational associations in improving safety provisions. They undoubtedly have a major part to play, but this is generally in the wider field of the engineering industry at large or in the whole of the industry.

At the level of the undertaking, managements of the major shipyards discharge their obligation to safeguard their workers by entrusting the task of supervising safety provisions in respect of premises and materials to specialised engineering personnel or departments. In smaller shipyards, where prevention problems may occur on a different scale but remain of equal importance, the employer normally does this himself. Whatever system is applied, it is essential that top management should give due attention to such questions, clearly show its interest and impart its concern to supervisors, who functions in this field, as elsewhere, must be properly appreciated.

The workers themselves are frequently associated in this effort through their delegates and safety committees. In some countries this is a legal requirement. In view of the advantages of worker participation in prevention activities, it might well be desirable to extend this practice to countries or to shipyards where it is not yet normal, but might well be made so.

* * *
These are the various problems on which the Committee may hold a useful exchange of views, as summarised below in a detailed list of points. The problems are extensive and some of them may be particularly difficult to solve. Improvement of safety facilities in shipbuilding and repairing, as in any other branch of industry, is essentially the fruit of co-operation between the public authorities, specialist bodies, occupational associations, management at its various levels and the workers themselves. There is also the possibility of a healthy interchange between undertakings themselves, for small-scale shipyards which have smaller resources can benefit from the experience of other more powerful undertakings. A proper approach by all concerned could thus gradually overcome the unsafe working conditions that were for so long a feature of shipyards and which still too often recur through some cruel event which reminds us in this unceasing struggle that victory is never finally won.

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SUGGESTED POINTS FOR DISCUSSION

The Workplace

1. Characteristics of the workplace and physical conditions of work in shipbuilding: in workshops, in construction yards and in fitting out; progressive and uneven transformation of different shipyards and working conditions under the impact of new technical methods.

2. Working conditions peculiar to ship repairing.

Occupational Risk

3. The degree of risk: occupational injury and disease statistics in shipbuilding and repairing; need for proper statistics.

4. Extent and severity of risk:
   (a) degree of safety in shipbuilding and repairing work;
   (b) recent developments with regard to safety.

Regulations and Practical Measures

5. Laws and regulations: complexity of safety regulations applying to shipbuilding and repairing; need to codify these laws and regulations in each country concerned.

6. Desirability of drafting an international safety code, a model code of regulations or a code of practice covering all operations in shipyards or only some of them.

7. Desirability of covering the following aspects in national laws and regulations (and, if appropriate, in an international code, a model code of regulations or a code of practice) and of settling them in practice in a suitable manner:

   (a) scope and responsibilities:
      i) scope of the regulations;
      ii) determination of persons responsible for safety under various circumstances, in particular in the case of employees of sub-contractors and in the case of work on board a ship which is not owned by the shipyard;
      iii) respective duties of the employer and the worker;
(b) means of access:
   i) to ships under construction;
   ii) to dry docks;
   iii) to ships at dockside or in wet or dry docks;
   iv) to holds of ships;
(c) ladders (in cases not covered by (b));
(d) staging (including suspended stagings): protection against falls of persons or objects;
(e) protective measures in dry docks: fencings and rails;
(f) ways of covering openings such as hatchways and manholes;
(g) lifting gear and other means of handling and transport;
(h) other machinery;
(i) hand tools;
(j) electrical equipment:
   i) permanent;
   ii) temporary;
(k) welding operations:
   i) oxy-acetylene;
   ii) electric;
(l) precautions against asphyxia, poisoning and explosions:
   i) against shortage of oxygen;
   ii) against toxic emanations;
   iii) against flammable gases or vapours;
   iv) against dangerous dusts;
   v) in handling dangerous substances;
   vi) particular precautions in the maintenance and repair of petroleum and gas tankers;
(m) fire prevention and fire fighting;
(n) lighting of workplaces:
   i) permanent lighting of construction yards, dock sides and slipways;
   ii) temporary lighting inside ships under construction or repair;
(o) housekeeping;
(p) individual protective equipment;
(q) prohibition of employment of young persons in specific jobs;
(r) safety services and safety officers;
(s) medical centres and first aid posts;
(t) sanitary facilities;
(u) other points.

**Inspection**

8. The need for effective safety inspection.

**The Human Factor**

9. The importance of the human factor:

(a) physiological aspects:
   1) physical deficiencies;
   2) workers' age and safety;
   3) fatigue: influence of length of work and of night work on safety;
   4) strenuousness of work in shipbuilding and ship repairing; exposure to weather;

(b) psychological aspects:
   1) failure to observe instructions: ignorance, lack of experience, familiarity with risk resulting in negligence;
   2) effect of systems of wage payment;
   3) other psychological factors: absence of co-ordination among workers, poor reflexes, distraction, etc.; effect of the social climate.

10. Action to allow for physiological factors:

   (a) limitation of extension of the working day;
   (b) protection against the weather;

11. Action to take account of psychological factors, particularly by creating and maintaining safety-
mindedness in shipyards;

(a) safety training for workers:
   i) during apprenticeship;
   ii) upon engagement;
   iii) at the workplace;
   iv) upon introduction of new technical methods or machinery;
   v) for specific occupations;
   vi) training for employees assuming particular responsibilities with regard to safety;
   vii) training for first aid officers;

(b) propaganda in the undertaking, safety campaigns and competitions.

Organisation of Safety

12. Role of employer’s organisations: helping to draft regulations, research, information and propaganda, helping undertakings;

13. Role of workers’ organisations: helping to draft regulations, workers’ education;

14. Collaboration between authorities, institutions and organisations concerned;

15. Role of shipyard managements:
   (a) top management interest in safety questions;
   (b) works rules: their usefulness, items to be covered;
   (c) safety services and safety officers: efficiency of the system and value of applying it universally;
   (d) the functions of supervisors: their importance.


17. Medical services and first aid.

18. Organisation of safety in small shipyards: particular difficulties; the need for management and employees to give proper attention to safety problems, no less than in major undertakings.
19. The need for collaboration at the level of the undertaking between the management and public authorities, between undertakings, and between the management and employees of all grades.
APPENDIX

I.L.O. DOCUMENTS AND PUBLICATIONS RELEVANT TO SAFETY IN SHIPBUILDING AND SHIP REPAIRING

I. Conventions and Recommendations


Protection against Accidents (Dockers) Convention and Recommendation, 1929, and revised Convention, 1932 (Ibid., art. 587-609).


II. Model Codes


Model Code (Building), 1937 (The International Labour Code 1951, art. 544-584).

Model Code of Safety Regulations (Ionising Radiations), 1959.

III. Code of Practice

Safety and Health in Dock Work, 1958.
IV. Report


V. Miscellaneous


