PRINCIPLES OF FIRE ORGANIZATION IN SHIPS AT SEA AND IN PORT

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MAN AND HIS FIRE SHADOW

Man has been a fire-using animal since the dawn of history and, always, the fire risk which he alone creates stalks him as relentlessly as his own shadow.

Natural fire, that is fire totally unconnected with man or his works, is relatively rare. Excluding Divine fire, it is limited to conflagrations caused by electric storms, volcanic eruptions or the oxidation of nodules of iron pyrites in shales. It is also possible for natural accumulations of decaying vegetation to heat and ignite spontaneously, but, with the foregoing exceptions, whenever the "Beast" does get out of control there is a man-made cause somewhere. Usually this is direct lapse by an individual. Less often it is indirect, the presence or failure of some contrivance in unforeseen circumstances. Either way, man's fire shadow has caught up with him.

Early man's fire risks were simple and obvious, the open flames of torch and hearth, or the little fire pot of charcoal which he clasped to his belly†. Those which XXth Century man must face are often latent or disguised, needing conscious thought to visualize.

Although modern centralized power production has vastly reduced the number of open flames to be guarded, ashore and afloat, the obvious risks of torch and hearth have been replaced by the hidden risks inherent in every inch of electric cable and every machine or appliance served. Such risks are only to be held disarmed so long as overload protection is perfectly designed and maintained and cables remain intact.

In man's latest venture, power from atomic energy, fire risks are even more effectively camouflaged, there being neither flame nor combustion. But the utilization and control of the heat in a reactor carries a fire risk which increases as reactor design becomes more efficient and a fast breeder reactor is unlikely to go to sea commercially until man has learned more about the fire risks which, amongst many others, surround this enterprise.

With man so completely unable to escape from his fire shadow and often directly responsible for the disaster which can follow forgetfulness of its presence, the first requirement for the success of any fire organization in any ship is constant awareness of its need.

Intangible, incapable of proof, or measurement, or demonstration to an observer, constant realization of the shadow is a more potent catalyst for the prevention of fire than any other agency. Costing nothing, it is, when attained, priceless.

MATERIALS IN RELATION TO FIRE RISK

Clearly, the less combustible the ship and her fittings the better, and much good work is being done both on the development of new materials and on classification according to comparative fire resisting and retarding characteristics. Careful assessments of total fire potential in terms of B.T.u's have been made of the contents of spaces and these in turn have been related to the capacity of boundary construction to prevent transmission of fire to an adjoining space, whether by conduction or by physical collapse. All this is of great value in helping to exclude weaknesses against which subsequent fire fighting might be powerless.

But this approach, which seeks to specify boundary design in terms of assumed fire potentials of the contents of the spaces separated and the relative hazards in each, has one grave danger and many limitations, some of which are listed below:—

(i) The danger is that overemphasis, or unwise advertisement, of fireproofing tends to inculcate belief that there is, or could be, such a thing as a fireproof ship. In fact, almost everything forming part of, or carried in, a ship can burn given the right conditions, even steel itself, as some boilers could testify. Any teaching which undermines belief in this fact at once damages that constant awareness of risk referred to earlier and leads to dangerous relaxation of fire defence standards.

(ii) A merchant ship, except for single cargo types, has fire potentials which vary widely according to the cargo present. Rarely are the same conditions repeated. Also, the space contents in a cargo ship always present far higher fire potentials than the structure and permanent fittings. It follows that the assumed conditions of the calculation may be very different from actuality. The same argument applies to passenger accommodation. Short of actual search and inventory it is impossible to assign a value to the fire potential or hazard represented by one passenger's baggage or one mail bag‡. In naval ships, on the other hand, circumstances are much more stable and the calculations more realistic.

(iii) In regard to the fire resistance of bulkheads the use of light alloy instead of steel complicates matters still further. The argument here is that additional insulation is needed not only to prevent the transmission of fire of hypothetical intensity by conduction and rise of barrier surface temperature, but also to prevent rupture of the barrier by physical collapse and even more serious consequences with load-bearing structures. This is a highly complex matter which could go far beyond the limits of this paper, but the following two points might repay thought and are inserted accordingly.

(a) It has been proved, but may not be widely known that oxy-acetylene flame cutting equipment capable of dealing quickly and neatly with several inches of steel plate is completely unable to sever the alloy wing roots of certain bomber air-

* A director of Thos. and Jno. Brocklebank, Ltd., and of The Cunard Steam-ship Co., Ltd.

† Still in use in Northern India.

‡ After a fire in mailbags it was found that the mail included large quantities of strip matches. These were probably stock transfers between dealers catering for collectors.

craft*. This exemplifies the resistance of alloy to deformation under very high temperature attack when conductivity is adequate and radiation is not impaired by close fitting insulation.

(b) The high heat conductivity of alloy exemplified in the foregoing suggests that there is at least a case for examining the fire resisting properties of a naked and uninsulated bulkhead whose outer face (i.e. away from the source of fire) can be continuously cooled by water spray from hand controlled fixed spurge pipes. Provided the rate of transfer of heat from the alloy to its spray "jacket" were sufficient, the bulkhead would not collapse.

There is some controversy in regard to the use of wood in accommodation. In naval ships the aim has long been the exclusion of all combustible matter and this has been reinforced by the arrival of atomic weapons. It has been suggested that merchant ships should do likewise. In a totalitarian world this might be possible, but while choice and personal preference still remain, crews and passengers have to be attracted rather than directed and very few individuals genuinely prefer life in a metal box. There are also many who are strongly allergic to the feel of metal furniture no matter how cunningly disguised. It seems likely that somewhat similar aversions may presently become noticeable in regard to the feel of plastic finishes in all except purely utility articles. There is need for a sense of proportion in this matter. No one will agree to wear asbestos pants in order to make his personal fire potential match that of his surroundings and yet, to be logical, that is what the metal box advocates should demand. So long as civilised men and women appreciate fine woodwork in their homes, wood is likely to be used for furniture and surface finish in ships where appropriate and it need not add significantly, if at all, to the fire hazard.

In every detail in accommodation and elsewhere the search for improved materials goes on. Reduced fire hazard and fire potential certainly rank as improvements, but in a merchant ship they are by no means predominant, many other factors claiming equal or prior consideration.

PREVENTION

Prevention here refers to outbreak or ignition and not to spread of fire.

In general terms prevention should be able to reduce, if not to eliminate, fires which result from direct lapse by individuals aboard the ship. Good fire organization therefore aims first and foremost at reducing any such lapses and the principal ingredient is a first-rate ship's company. Only this and the discipline which is implied can forestall the well-known risks which result from cigarettes, accumulated rubbish, oily rags and the like.

Such a ship will be clean and tidy throughout. All maintenance having any connexion with fuel or electricity will have received scrupulous attention. If the ship has recently left a port where shore gangs have been carrying out repairs while the regular crew was on leave, this work will have been subjected to special scrutiny on rejoining and there will be knowledge of exactly what work has been done. There will be no oil leaks anywhere, nor loose oil on tank tops. Any electrical fault will have been promptly traced. Records of routine cable and machine insulation tests will be up to date. There will be no loose or damaged lighting switches or socket outlets. Inspection of cargo lights and engine room portables will show no damaged or oil-soaked flexible cables. Continuously running motors outside the engine room will have been visited once per watch. Any circuits not used at sea will have been isolated and such as penetrate cargo spaces will either have had fuses or special links withdrawn, or switches locked. Completion of this will have been reported and logged. The chief officer will have an accurate stowage plan for each cargo hatch. Any cargo with a known heating hazard will have been noted and loaded accordingly and appropriate ventilation arranged. If the ship has mechanical hold ventilation and it is the practice to record exhaust air conditions as part of routine humidity control, the officer or apprentice in charge of each hatch will know exactly what cargo it contains and exhaust air temperatures will have been regularly logged, preferably in graphical form. These measurements will have been made by hand psychrometer inserted into hand holes in exhaust ducts and on each occasion the officer or apprentice will have used his nose, the most sensitive fire detector known.

And so the recital could be continued.

In short, the picture is of a ship extremely well maintained and in the care of men who are alert, trained and conscious of the known risks which they have taken every step to counter.

In port, the degree of hazard changes rapidly and almost from hour to hour. The ship may have just arrived with a full crew still on voyage articles and hatches still closed. Her fire risks are then very little worse than at sea, the slight increase being due to the presence on board of a number of individuals not under ships' discipline and often without risk consciousness. The fire hazard rises sharply when hatches are lifted and cargo is worked. It rises still further if shore repair gangs get busy and welding is in use. The principal risk here is ignition of inflammable material on the further side of whatever is being welded. The precautionary drill of unshipping linings, etc., being expensive and irksome, is often neglected. With electric welding there is the further risk of fire arising up to 30 feet from the point of application due to a high resistance earth connexion†. The ship may also have a much diminished crew, often composed of relieving personnel who may not have the same intimate knowledge of the ship as the regulars. The cigarette risk is then very real. The ship's officers cannot be everywhere and there is no limit to the folly which may be committed. Almost without exception when cargo has been worked examination will disclose cigarette ends and matchsticks wherever the darker recesses of 'tweendecks provide cover from view. The author has even found such evidence near the doors of ammunition magazines where loading was being continuously watched by service security police and ammunition experts. With a ship fitting out, or under survey in shiprepairers' hands, the situation may be even worse. The offenders are then normally the employees of outside contractors, not the yard men, and are often quite brazen about it. Full employment does not make this problem any easier to handle and greatly increased crew leave entitlement, by compelling the dilution of those aboard who are fully risk conscious, renders it more difficult again.

There is only one type of ship in which these strictures will not be found justified, namely tankers, where fires due to smoking are virtually unknown.

These perils can only be met by increased vigilance, coupled with every possible step to induce responsibility amongst heedless people whose normal attitude may be . . . "couldn't care less".

In the engine room, oil risks in port are well known by the ship's staff and the main danger is from inexperienced labour employed on repair and maintenance. Here again full employment has reduced the standard and ships' engineers must be on the watch for ignorant folly, especially when welding equipment is present.

By and large it must be admitted that fire risks are far less when the ship is at sea. In each of two fleets engaged in very different trades, current records show that a fire in port is 3½ times more likely than at sea. In a third fleet in yet another trade the ratio is even higher. It is something of

* A large number of aircraft were involved and the most efficient method of reducing them for road transport prior to conversion to scrap metal proved to be men with felling axes.

† Welding repairs were needed inside the shaft tunnel of a refrigerated ship. The insulation was carefully removed over an area on the outside of the tunnel in way of the position of the repair. A fire was started in the insulation 30 feet from the site of the welding, due to an indifferent earth connexion.

a paradox that despite close contact with shore resources, when every other hazard has diminished, that of fire should be 350 per cent up. How is it that with foreknowledge of these additional risks the ratio remains so high and the problem so intractable? Ports may be vicious, but surely not to the extent of making people 3½ times more heedless than the ordinary seafarer afloat. Some other factor is at work and the author suggests the following.

The ship herself, from drawing board to breakers' yard, is wholly designed, built, maintained and operated to offer the greatest resistance, consistent with her function, to the hazards of the oceans, including fire when at sea. Likewise, the ship's company is selected, trained and organized, as well as powerfully impelled by tradition, craft pride and self respect, to give of its best when at sea. It is only then that the combination of man and his handiwork becomes a single entity with every part fulfilling its designed purpose and each individual performing the duty which is his own and yet is essential to the team. These may well be the reasons why serious fire at sea is both relatively and actually rare, but there is no doubt that as the ship and her crew leave their sea environment the strength of the combination is progressively weakened. Something intangible but very vital is missing when the ship eventually ties up and few seamen will question either the fact, or its relevance to the present subject.

Whether at sea or in port there remain the unpredictable risks against which no preventive measures can be applied other than those inbuilt in the ship. For example, an oilpipe may fracture due to accident, inherent defect or fatigue. This event cannot be foreseen, but if the layout of such pipes has been considered in relation to the possibility of hot surfaces on to which escaping oil might spray, fire will have been prevented.

With cargo, apart from substances having a known heating hazard such as coal, wool, jute, oilcake and the like, the most likely cause of unforeseeable risk lies in a wrong or insufficient description of contents, especially with any package containing chemicals. "Generators Smoke", for example, is quite insufficient. Some are intended to ignite if wetted, while others, when in danger of becoming heated, must be soused to prevent ignition. The precise chemical constituents of such things must be available if there is any doubt. It is also not unknown for contents to be deliberately falsified. Misguided security once shipped torpedoes as "iron tubes in cases" and the stores officer on being challenged blandly volunteered that they "travelled cheaper that way"! Under special conditions arson has to be looked for although it is true that the only recent suspected instances known to the author also indicated insanity. The classic example of an apparently safe article becoming a very serious fire hazard was that of the "Compo Pack Rations". These were broached on a large scale during loading in order to extract the chocolate. The boxes of safety matches which were also in the cartons were invariably thrown away since the "V" sign proclaimed their origin. Although labelled "safety" it was found that these matches would readily ignite if rubbed on the deck and since they were strewn everywhere the peril was very real. At the subsequent inter-Services enquiry nearly everyone was surprised to learn that the word "safety" on a box of matches implied only "non-poisonous if eaten". There is thus no limit to the knowledge and vigilance required from ships' officers.

The unpreventable fires, if any, and those that should have been prevented must be taken care of by the second and third lines of fire defence, namely "warning" and "fire-fighting".

There are no short cuts to prevention of outbreak. In this matter age of ship makes little difference. The biggest risks are those of direct human lapse and the following comparison is startling.

In one voyage of a certain passenger ship some 2,100 tons of fuel oil will be burned. 87,000,000,000 B.t.u.'s will have been liberated in six boilers. The fire potential is colossal, but those flames will have been guarded to the limit of human skill and duty.

During that same voyage some 300,000 cigarettes will also be burned. They will have entailed the ignition of 300,000 matches or lighters. These 600,000 operations will be distributed haphazard throughout the ship and each cigarette, unless consciously extinguished, will burn to its very bitter end. Though representing a measured fire potential of but 17 B.t.u.'s apiece, they constitute by far the greater fire hazard.

WARNING AND IMMEDIATE INDIVIDUAL ACTION

When prevention has failed there is paramount need for early warning and immediate action. These two should always be linked both in thought and fact.

It is in connexion with automatic warning or extinguishing systems actuated by heat or smoke that reduced fire damage should be achieved in modern ships, but it does not always work out that way. Warning systems convey their information to the bridge or the central fire station where attention is attracted audibly or visually, or both, and the exact site of the outbreak indicated. It is an obvious weakness that such stations may not always be manned. The bridge, for example, in port. It could of course be arranged for audible alarm to be given all over the ship, but this would be most unwise and the electrical extensions so involved are themselves vulnerable.

Though many arrangements are possible, the two which have survived and are in common use are sprinklers and smoke detectors. The sprinkler system is the only one in which extinguishing is the primary function and warning is secondary and derived. No electricity is involved other than for indicator lamps. Maintenance is virtually nil and reliability extreme. Extensively used in accommodation, the records of one company covering many years and ships do not show one instance in which sprinklers have failed to extinguish a fire of sufficient intensity to cause sprinklers to operate, or have needed to call on pumps to reinforce with salt water the original charge of fresh. In some installations it has been found prudent to provide automatic warning in the central fire station of the closing of any sprinkler section control valve as well as the normal security of locked valves. Experience shows that where a sprinkler system exists, heads should be fitted in all lockers, especially those used by stewards. Fire has a way of attacking the weakest place.

Smoke detectors in their simplest form are equally robust and reliable, but need both human watch and human decision before extinguishing can begin. A photo-electric cell circuit is frequently added to provide an automatic alarm, but the arrangement needs to be self-monitoring to discount electrical failure. When both automatic alarm and automatic extinguishing are added, the electrical complexity is considerable and in the author's view undesirable. Smoke detectors find their greatest use in spaces such as cargo holds, which are not inhabited, are difficult to visit and where automatic extinguishing is not desirable anyway.

A failing of both sprinklers and smoke detectors is that a sizable fire can exist before they function. If sensitivity is increased so does the risk of false alarms. Both systems are in fact far less sensitive than the human nose which has proved itself capable of diagnosing fire fourteen hours before any smoke or rise in temperature could be detected under the closest scrutiny and probably days before either warning system could have operated*.

* In one cargo liner fleet it is routine practice to record the dew-point of ventilating air entering and leaving each space, using hand psychrometers. In a ship carrying wool the apprentice in charge of one hatch reported an odd smell from the exhaust duct. Fire was eventually suspected and the hatch covers were lifted. No smoke or heat could be detected. Hatches were replaced for the night and ventilation stopped, except for sampling. Next morning ventilation was resumed but still no smoke or temperature rise. Hatches were again removed. Eventually, 14 hours after the original warning, presence of fire was confirmed. Several bales of pie wool were involved. Presumed cause was excess grease in this wool. In the absence of these routine measurements of wet and dry bulb readings this fire would have been far more serious.

Their greatest value lies in the continuous watch, silently and unobtrusively maintained.

A very recently developed example of automatic and self-monitored warning conveyed by the reduced visibility between a light source and a photo-electric cell has been applied to indicate risk of crankcase explosion in Diesel engines due to lubricating oil mist formed by local overheating. Such a warning system, backed up by pressure releasing crankcase covers, should go far to eliminate this peril and with it the subsequent oil fire which could follow*.

Unfortunately the normal type of smoke detectors cannot work in holds with the hatches off. During maintenance or alteration to accommodation, sprinklers must at times be inoperative. Such reliance is placed on sprinklers that these periods become special risks. Human fire patrols need to be at work before sprinklers are shut off. So important is this that there is frequently a standing order that sprinklers are never to be shut off without the written consent of the Master.

In the case of ships having push button fire alarm and fire patrol time clock systems, the wiring has to be installed long before the ship is delivered. The sites for these fittings can only be selected with full knowledge of crew strength, stations and duties and after the fire patrol routes have been worked out. These in turn depend on assessed hazards and the number of men who will be available for patrols. Such matters cannot be decided by shipbuilders alone, or even in conjunction with specialist sub-contractors. They merit the closest attention of future owners and will vitally affect the safety of the ship at times of greatest risk in port.

For immediate action to be effective, the siting of hand extinguishers needs closer study. The impression is gained that more attention is often paid to the presence of requisite numbers according to a prescribed scale than to optimum siting for efficient use. In ships with women on board hand extinguishers should be mounted at or near deck level and not shoulder high on the bulkhead on a lift-off fitting. Instructions for their use are commonly in small sized type on transfers applied to the cylindrical surface. Never very easy to read and often too verbose, they soon become illegible. All that is needed for immediate action can be conveyed in not more than six words which should be incised on a panel at eye level in letters half an inch high, obviating any need for spectacles. At this stage every second counts.

The practice of employing special fire watchers in port is on the increase. Originally mainly cargo watchers to check pilferage, they now commonly perform both duties. Many liner companies employ their own men but there would seem to be a case for considering whether in some of the larger home ports there could not usefully be an establishment of trained marine fire and cargo watchers operated on the lines of the Corps of Commissionaires and available on demand.

In every ship, no matter how "fireproof", or how protected with devices, there may come the moment when presence of fire is first known through one of the senses of one individual, who, from that instant, and for several minutes, carries more responsibility than the Master. There are at least four things requiring simultaneous and immediate action and he, or she, has only one brain with which to decide and one pair of hands, two feet and one voice with which to act.

Give the alarm.
Stop ventilation.
Use a hand extinguisher.
Pull clear anything which might feed the fire.

With members of the crew a great deal can be done by individual training based on the application of these four needs in hypothetical cases. Faced by unexpected emergency some find quick thought difficult and a few impossible. If the situation has been envisaged during training, the right action is instinctive. The question as to what should be done first should not be prejudiced. It should be left to the individual and his power of appreciation and decision quickened by training. It is a known and natural British characteristic to act sensibly and calmly in such circumstances and there are countless examples of serious fires being averted by the action of one individual, often in quite a humble position. There is also pride in this capacity and usually a ready willingness to develop it. It is suggested that much more could be done on these lines than is commonly attempted and that such training neither requires special musters nor wastes time. It does demand, however, that an officer shall know his men and, incidentally, help to achieve that end.

In the never ending war between man and his fire shadow the enemy always has the initiative. The speed and effectiveness with which man can counterattack depends very much on the standard of training. In the author's view it is here that the greatest weakness lies.

Neither on the bridge, nor below in the engine room, is a man placed in sole control and responsibility until he has had much experience and been found fit for watchkeeping. The situations which have to be tackled are many and various, but it cannot be claimed that they are more serious than those arising out of fire. Further, these watchkeeping situations in varying degrees have been met and handled day in and day out and have formed the subject of examination for promotion. Fire on the other hand is a type of emergency which is relatively extremely rare and is not susceptible of demonstration and practice aboard ship other than in imagination. Nor does fire fighting figure seriously in examinations for promotion.

Thorolf Wikborg† has calculated that out of every 100 ships above 500 tons, in one year one only will experience a serious fire. Taking a 25-year ship life, three ships out of four will never experience such a fire. With the frequent turnover between sea and shore employment which exists in the engineering department today, it is very likely that amongst the engineer officers in a given ship there may be no one who has experienced an oil fire. While many things can be learned from books, efficiency in fighting an oil fire is certainly not among them. Such a ship may be excellently equipped, but unless a proportion of her engine room complement has had actual experience in dealing with an oil fire that ship is in jeopardy. This experience is fortunately available and for the asking at either the naval fire fighting courses or those run by Port Fire Service Authorities, but, except in those concerns where it has been actively encouraged, engineer officer attendance is infrequent.

THE PLANNING OF COMBINED DEFENCE

The amount of published matter dealing with the extinguishing of fires far outweighs that on any other branch of fire defence in ships. To some extent this may be a legacy from a past in which extinguishing tended to be the whole of fire defence and was typified by the "two powerful jets" which dominate the fire appliance rules.

Today fire defence should be defence in depth, with every emphasis on prevention, early warning and immediate dousing by individual action wherever possible, backed up by the heavy weapons of organized fire fighting should need arise. The "two powerful jets" are still very necessary, preferably armed with dual purpose nozzles for jet or fog. It is rare for a hold fire of any size to be extinguished without the aid of water, which is still the final means of extinction when the source of a fire has been uncovered. Fire hoses, steam injection, CO_2 and the recently developed substitute manufactured on board as needed, also foam for oil fires—these are the main armaments involving combined action which it is the business of good fire organization to train and direct.

* "The Shipping World", Vol. CXXXII (1955), p. 495; and Transactions of Institute of Marine Engineers, Vol. 67, August 1955, p. 255. Also relevant B.S.R.A. reports.

† Thorolf Wikborg, Deputy Chairman of Norske Veritas: "Fires in Ships", a paper read before the International Union of Marine Insurance at San Sebastian, 18th September 1953.

At Sea

When news of fire first reaches the bridge (or central fire station in a large ship) there will be no certain knowledge regarding its extent and no chances can be taken. Good fire organization will ensure that, once set in motion, the necessary action takes place speedily, smoothly, and without noise, all concerned knowing their duties.

The first action taken by the bridge will be to warn the engine room and alert the duty fire party giving to both any information available regarding site of outbreak.

The strength and composition of the duty fire party will vary with the type of ship, but the essential features where good organization exists will include the following: —

All members must have been warned in advance; they must know how they will be alerted and where to rendezvous.

Their training will have been such that they automatically take the correct preparatory action in regard to equipment.

As soon as the duty fire party has gone into action, the fire party next for duty will be formed up and will remain in readiness. The engine room will have stopped automatically any mechanical ventilation in the area affected and the officer in charge of the fire will be urgently seeking an answer to that most difficult and vital question, "What is burning and where?"

Such in brief could be the opening phase in the deployment of the ship's fire fighting forces when at sea. The chief characteristic is a complete absence of alarm, whether audible or mental, incidentally perhaps the most unfortunately chosen word ever to be connected with fire. An onlooker should see only the efficient performance of a well-rehearsed drill. A point to note is that when the action starts, unless the fire is reported as being in a space such as a cargo hold, neither the bridge nor any of the forces set in motion will know whether individual action with portable appliances, or sprinklers, has already extinguished it. What the onlooker thought was a fire drill may well prove to have been one if the enemy has been stopped in the forward zone.

In Port

While the ship is at sea, outbreak of fire will always find key positions manned and the execution of fire plans is a matter of routine. In port, however, the situation varies rapidly and fire fighting organization must keep step. The problem is twofold: firstly, the modifications to the ship's "at sea" arrangements to meet the changing needs in port; secondly, the steps necessary to ensure that the utmost support is received from whatever shore based fire services are available.

Under the first heading will come consideration of the following points according to circumstances: —

Organization of duty fire parties.

Continuity of power and water for fire fighting.

Organization of fire patrols with special attention to the periods which follow cessation of work.

Deployment of fire parties and appliances which may be needed to cover the handling of hazardous cargo or repairs with special fire risks.

Maintenance and inspection of fire appliances.

On paper that list may seem straightforward enough, but to secure effective defence during every minute of the port life of a ship against a menace which may never become a serious emergency for three ships in four, demands extreme alertness and a meticulous performance of duty by all involved.

It is perhaps in the natural perversity of things that the proven necessity for rigid fire precautions in port should be accompanied by circumstances which render a slip-up all too easy. The work is often dull and has to be repeated time after time without tangible result. It is carried out amidst distractions and interruptions of every sort. Forgetfulness does not usually bring automatic retribution. Experience shows that it is neither safe for the ship, nor fair to the individual, to rely on a man's unaided memory in fire routine matters. Positive checks on completed duty are desirable. This implies neither criticism nor lack of confidence, but is both admission and reminder of the ceaseless vigilance needed against an enemy that never sleeps.

It is probably in connexion with assistance to be obtained from shore based fire services that the greatest opportunities lie. Admittedly the scope for such assistance will vary widely. In many major ports the only limitation will be the degree of co-operation which forethought, personal trouble and goodwill on both sides can achieve. Where repeated calls are made at such ports efficiency can be very high. Plans of the ship will then have been lodged with the Fire Service whose leading personnel will be familiar with the layout of the ship and with the ship's appliances. There may also be permanent telephone connexion between the ship's central fire station and the shore fire station. At the other end of the scale a ship may put in to a small port abroad where, after due investigation, the Master may rightly conclude that the safety of the ship will best be served by a policy of self reliance and a very close watch on the gangway.

In all normal cases there is one permanently adverse factor to be overcome. The ship is only going to be at berth X in port Y for a few days and unless high standards of conduct exist on both sides co-operation will suffer accordingly.

Taking as an example a ship making a first visit to a major port abroad, the first essential is personal contact with the Fire Service chief concerned. Amongst the matters to be discussed will be the following: —

Communications.

Plans of the ship and her fire fighting arrangements.

Nature of cargo and any special hazards involved.

Dockside water supplies.

Shore based mobile equipment available and where stationed.

Selection of sites for this equipment alongside.

Arrangements for keeping these sites clear and access to them unhindered.

Organization of fire boats.

Decisions as to need for rigging permanent hose connexions to points on the quayside to enable ship's fire mains to be reinforced rapidly.

Hose coupling adaptors.

Gangways to be maintained.

Current fire potential of transit sheds alongside, if any.

The key to efficiency will nearly always depend on the quality of the personal relations involved and it is in the ship's interest to see that these are well maintained. The initiative lies with the ship and it is very true that, by and large, the ship will get the service she deserves.

CONCLUSION

The immense diversity of ships, of the trades they serve, of the ports they use, of their crews and the cargo and passengers they carry, precludes all possibility of the existence of a single master plan, or even framework, for fire organization.

There are only two unalterable basic factors, the physical nature of combustion and the fallibility of man.

From the first, flow all the technical measures which, subject to constant improvement and new strange nuclear influences, form part of fire organization. Here we are on fairly firm ground, but with scope closely limited by the overriding need that the ship must trade effectively in a world market where the rules are not kept.

No matter how far technical provision may go, and in this direction the law of diminishing returns is already strongly operative, human fallibility remains the controlling feature. The degree of fallibility is in turn dependent on the outlook of man towards his fire shadow, which he alone has created, but can neither destroy, nor put back in the bottle.

If he forgets his shadow, it will catch him unawares and destroy him physically. If he panders unduly to its menace, he forfeits all self respect and his claim to be *homo sapiens* and responsible for the consequences of his acts.

Somewhere in between lies his best course, accepting all the help his technicians can give consistent with the ship being able to fill her economic purpose, but never abating the need for constant vigilance and rational conduct from all who go up the gangway, or down to the sea, in ships.

APPENDIX

Salient details of all fire incidents during twelve consecutive years in the lives of two large passenger liners.

The two tables V and VI, show the division between incidents at sea and in port. Of the total of forty-nine, thirty-five or 71 per cent occurred while the ships were in port and mostly during periods of overhaul. Only fourteen occurred at sea.

As these ships spend more time at sea than in port, if the time element is included the likelihood of a fire incident in port is more than four times greater than at sea, and each ship may expect to steam for a whole year for each incident which occurs at sea.

All incidents, no matter how apparently trivial, have been included. They range from a bucket of sawdust to a medical store.

In only six was the damage sufficient to warrant a claim for recovery from underwriters.

Over the twelve years the total so recovered was £9,003, of which the medical store accounted for no less than £6,189. The inadvertent omission of a sprinkler head in this temporary structure was significantly expensive.

There was only one solitary fire incident in machinery

TABLE V. FIRE INCIDENTS IN PORT

Site	What burned	Cause – known or attributed	Category: Smoking	Electrical	Welding	Galley Stoves	Sabotage	Unknown	Notes
Passenger cabin	Mattress and bedding	Unknown						√	
Passenger cabin	Bedding	Unknown						√	
Public room	Panelling	Insufficient stripping of B.H. prior to welding			√				
Pantry	Door and curtain	Unknown						√	
Engine room	Oil soaked lagging	Piece of burned metal from welding done previous day			√				
Funnel	Wooden welding stage	Burned metal from welding			√				
Passenger cabin	Mattress	Smoking by unauthorized person	√						
Drying room	Towels and furniture	Cigarette end in rubbish bag	√						
Passenger cabin	Mattress, etc.	Smoking by unauthorized person who entered with pass key	√						
Passenger cabin	Pillows in wardrobe	Unknown						√	These 5 occurred during annual overhaul when large numbers of workmen were on board.
Passenger cabin	Mattress and lifebelts	Unknown						√	
Passenger cabin	Pillow	Unknown						√	
Passenger cabin	Furniture	Arson by half-wit (pile of furniture built under sprinkler)					√		
Passenger cabin	Pillow	Unknown						√	
Crew cabin	Radio set	Fault in radio set connected to ship's mains		√					
Crew cabin	Mattress	Smoking	√						
Crew cabin	Bedding	Smoking	√						
Fan room	Pair of oily overalls	Smoking	√						
Crew accommodation	Circuit breaker	Overloading of circuit breaker in metal box due to use of unauthorized appliance		√					
Passenger cabin	Bedding and lifebelts	Unknown						√	Occurred within two hours of each other on different decks.
Passenger cabin	Bedding and lifebelts	Unknown						√	
Medical stores	Stores	Unknown						√	Temporary structure unsprinklered.
Public room	Panel in deckhead	Insufficient stripping prior to welding			√				
Passenger cabin	Mattress	Smoking by unauthorized person entering with pass key	√						
Restaurant	Dumb waiter	Insufficient heat insulation to electric heater		√					
Passenger cabin	Bedding	Cigarette end in wastepaper basket	√						
Galley stove	Grease	Insufficient routine cleaning under top plates				√			
Passenger cabin	Bedding	Smoking by workman	√						
Locker	Bucket of sawdust	Smoking	√						
Passenger cabin	Wardrobe	Unknown						√	Both occurred while extra fire watch precautions were in force. Cotton waste in one.
Passenger cabin	Bed end	Unknown						√	
Lavatory	Towel	Cigarette left burning on edge of washbasin	√						
Locker	Rubbish can	Smouldering cigarette end	√						
Alleyway	Panelling	Insufficient stripping prior to welding			√				
Lifeboat	Sea anchor	Cigarette end dropped overside from funnel base	√						
Total 35			13	3	5	1	1	12	Many of the 'unknown' probably smoking.

TABLE VI. FIRE INCIDENTS AT SEA

Site	What burned	Cause – known or attributed	Category					
			Smoking	Electrical	Welding	Galley Stoves	Sabotage	Unknown
Passenger cabin	Bedding and furniture	Unauthorized reinsertion of heater circuit fuse during repairs		√				
Crew quarters	Lifebelts and door	Careless disposal of cigarette in rubbish carton	√					
Crew quarters	Berth and bedding	Electric fire left on too near to settee and bedding		√				
Promenade deck	Cable insulation	Broken strap wire in cove lighting fitting		√				
Film room	Two film reels	Not known						√
Stewards' quarters	Bedding and settee	Not known						√
Alleyway	Cable insulation	Arcing due to broken or loose conductor in fuse box		√				
Passenger cabin	Cable insulation	Insulation failure due to penetration by moisture		√				
Locker	Canvas rubbish bag	Smouldering cigarette end from ashtray	√					
Locker	Linen and rubbish bag	Unknown						√
Crew quarters	Bedding	Smoking in bed	√					
Pantry	Cable insulation	Faulty insulation inside fuse box		√				
Locker	Rubbish bag	Cigarette end from ash tray	√					
Galley	Fat in fish frier	Inadequate cleaning under top plates				√		
Total 14			4	6	–	1	–	3

spaces. Some oil-soaked lagging was found to be smouldering the day after a welding job had been carried out nearby.

There were only two fire incidents in a passenger cabin at sea and both of these were electrical in origin.

Although not true throughout the fleet as a whole, there is no recorded instance of a fire incident being due to the action of a passenger in either of these ships.

Neither in these two ships, nor in others in the fleet, is there any instance on record of a sprinkler head failing to operate when under the designed conditions of ambient temperature. In the case of the medical store referred to above, the sprinklers in adjacent spaces prevented the spread of the fire.

Of the total, only seven could possibly have been avoided if all wood had been rigorously excluded from the ships. None of these occurred at sea and three out of the seven were due to welding.

Again, it is probable that at least 80 per cent of the total were due to direct individual human lapse.