HEAD OF "P" BRANCH

A.F.O. 2031/44

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ADMIRALTY FLEET ORDER

FIRE-FIGHTING IN H.M. SHIPS

ADMIRALTY, S.W.1,
13th April, 1944.

The following Order having been approved by My Lords Commissioners of the Admiralty is hereby promulgated for information and guidance and necessary action.

By Command of Their Lordships,

H.V. Markham

Distribution Limited.

To all Commanders-in-Chief, Flag Officers, Senior Naval Officers, Captains and Commanding Officers of H.M. Ships, Vessels and C.O. Craft (See A.F.O. 494/44.)

NOTE:—The scale of distribution is shown in the Admiralty Fleet Order Volume, 1941, Instructions, paragraph 10.

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2031.—Fire-Fighting in H.M. Ships

(DNC/P. 02971/41.—13 Apr. 1944.)

This Fleet Order is an amended version of C.A.F.O. 720/41, which is hereby cancelled.

General Notes

2. The secret of success in fire fighting is to attack the fire at the earliest possible stage.

3. The organization should therefore provide for the detection of all incipient fires followed by an immediate attack with suitable appliances.

4. A plan of action for dealing with possible fires should be considered before the event. Not only the organised fire parties but everyone in a ship should be a potential fire fighter and should know what appliances are available, where they are, which are the best ones to use, and how to use them.

5. Everything possible should be done to avoid conditions that may start a fire or cause it to spread. Waste and oily rags should be placed in proper receptacles. Bilges and flats should be clean and certainly free of oil. Petrol security arrangements should be carefully observed (*see* Pamphlet supplementary to the N.M.E.R.). Electric heating appliances should be switched off and unplugged when not in use. Clothing should not be aired in front of electric radiators. Cigarette ends and used matches should be carefully extinguished. The closing of watertight doors, hatches and ventilation valves is an anti-fire precaution as well as a precaution against flooding. In case of fire the doors and openings above the water line may be as important as those below the water line.

Fires and Principles of Extinction

6. Fire is a chemical process—usually a violent chemical reaction stimulated by the oxygen present in the atmosphere. Nearly all elements combine with oxygen and in the process heat is given off, so a fire once started spreads rapidly as long as inflammable material and oxygen are available.

7. The two principal rules of extinction are :—

(*a*) Cooling down to a temperature below the point of combustion.

(*b*) Smothering by cutting off or diluting the air which supplies the oxygen to support combustion.

8. There are exceptions, such as celluloid, thermite and other substances that provide their own oxygen to support combustion, and substances, such as phosphide of calcium and calcium carbide that combine with water to produce an inflammable gas. These exceptions, however, do not affect the two general principles of extinction which apply to the majority of fires that are likely to occur in H.M. ships.

9. (*a*) For cooling down, water is by far the most effective agent.

(*b*) For smothering, the media most generally used are foam, sand, carbon tetra-chloride, carbon di-oxide, methyl bromide and steam.

10. It should be kept in mind that stopping the supply of fresh air to a compartment in which there is a fire assists in fighting that fire, and if the smothering media available fail to defeat the fire, the object may be achieved by sealing off a compartment and letting the fire burn out until the oxygen is exhausted. In this case it is necessary to cool the boundaries of the compartment.

Extinguishing Agents

Water Jets

11. It is perhaps in the use of water that the technique of fire fighting in ships differs most from that of fire fighting ashore. Shore fire brigades use high pressure pumps, necessary for reaching the tops of tall buildings, and this involves using large nozzles and a correspondingly high water consumption. There is no very great reason ashore why water consumption should be studied to the extent that it is essential to study it for ship work.

12. As an illustration of the above, the maximum vertical height of water jet obtainable with a $\frac{13}{16}$-in. nozzle is 130 ft. ; requiring a water pressure at the nozzle of 115 lbs. per square inch, and a water consumption of 45 tons per hour. With a 1-in. nozzle the maximum vertical height of water jet is 80 ft., requiring a water pressure of 71 lbs. per square inch and a water consumption of 13 tons per hour.

13. At higher water pressures than those quoted above for the respective nozzles, tests show that the maximum height of the water jet will be reduced.

14. At the same water pressure there is relatively little difference in the vertical jets of $\frac{13}{16}$-in. and $\frac{1}{2}$-in. nozzles, for example, at a pressure of 35 lbs. per square inch the $\frac{13}{16}$-in. nozzle gives a vertical jet of 68 ft., and the $\frac{1}{2}$-in. nozzle 60 ft. with water consumptions of 25 tons per hour and nine tons per hour respectively.

15. The figures quoted above are the theoretical heights of jets and water consumptions. Actual figures may be from 5 per cent. to 10 per cent. less than those quoted.

16. In H.M. ships it is seldom necessary to project water to great heights or distances and the disadvantages of using more water than is necessary on fires are :—

(*a*) Loose water in a ship adversely affects stability. As far as possible it should be pumped out as quickly as it is pumped in.

(*b*) It is unsound to have an equipment where one branch pipe absorbs an unnecessarily large proportion of the output of one pump.

(*c*) The pressure drop in the fire main increases rapidly as the amount of water flowing is increased and if large jets are used the nozzle pressure is likely to be too low to ensure an effective jet.

17. Generally, the large amount of water used by a branch pipe is not appreciated. Cases are known where the number of branch pipes used for fighting a fire was beyond the capacity of the running pumps, with the result that the jets were so poor that damage to the fire main was quite wrongly assumed. Good hose streams for several branch pipes working together cannot be obtained unless sufficient pumps are running.

18. For the reasons outlined above it has been decided to reduce the nozzles of all Pattern 1521 branch pipes from $\frac{13}{16}$-in. to $\frac{1}{2}$-in. bore.

19. There is no advantage in the large quantities of water used by the larger nozzles. If the seat of a fire can be reached with a water jet it is remarkable how little water is ordinarily required to extinguish a relatively large fire.

Water Spray

20. Water spray, as opposed to a water jet, is one of the more modern developments in fire fighting methods and its potentialities are far reaching. Water spray is effective for smoke driving and so facilitates the approach to a fire. For cooling the boundaries of an evacuated compartment on fire, spray is more effective than a jet.

21. An important feature of spray is its ability to deal with oil fuel fires. In this type of fire a water jet is the last thing that should be used, as the burning oil merely floats on the water and spreads as the compartment is overfilled. The spray, however, smothers the fire due to the formation of a froth and cools the oil surface, so preventing re-ignition.

22. An initial difficulty with these spray nozzles was to produce them to work satisfactorily at the water pressures available in ships, but they have been specially designed and tested to work at a pressure of 35 lbs. per square inch.

23. Jet/spray nozzles are convertible from jet to spray by merely twisting the knurled fitting at the nozzle end. The Oilfyre nozzle is a spray only. In an experiment with an Oilfyre nozzle an operator, without any breathing apparatus, drove his way through a passage 15 ft. long which was full of smoke and extinguished an oil fuel fire in a compartment at the end of the passage. It should be noted that the water consumption of both these spray nozzles is approximately 20 per cent. greater than that of a $\frac{1}{2}$-in. jet nozzle.

24. Spray is reasonably safe to use in compartments containing live electrical apparatus whereas a jet would be definitely dangerous. In this connection, however, it should be noted that all the claims concerning the ability of spray to deal with electrical fires are based on the use of fresh water. Experiments with fresh-water spray against 20,000 volts and in one case against 98,000 volts gave satisfactory results with no leakage to earth from the nozzle. With salt water, however, there was a decided leakage at 5,000 volts. Although a salt-water spray is probably safe at the low voltages usually met in ships, a certain amount of caution is necessary. A pair of rubber gloves should be used by the operator.

In any case when an electrical fire occurs action should be taken to switch off the current from the machines or circuits concerned.

Foam

25. This is a smothering agent.

26. The Pattern 4726 foam extinguisher (two gallons) and the Type 77 Phomene generator produce a chemical foam, but this is not as effective as mechanical foam produced by the foam-making branch pipes.

27. Foam is suitable in the case of a petrol fire or a fire involving any inflammable liquid and will adhere to irregular surfaces. It is particularly suitable for dealing with aircraft fires and is used by the Admiralty and Air Ministry for this purpose.

Sand

28. Sand is effective for small surface fires. It is naturally difficult to apply effectively to a fire. It is more useful in preventing spilt oil from extending over a larger area and to spread on oil splashed over a deck which would otherwise become dangerously slippery.

Carbon Tetra-Chloride (C.T.C.)

29. C.T.C. is used in Pyrene chemical extinguishers, Pattern 4723 and 4724.

30. C.T.C. is a liquid which at 170° F. becomes a gas four and a half times as heavy as air. The volume of gas generated is 233 times that of the liquid used and it is this gas that blankets the fire by diluting or displacing the air in the immediate vicinity.

31. C.T.C. extinguishers are supplied for use on small petrol fires and in W/T offices and switchboard rooms for dealing with fires involving electrical apparatus, as they can be used without danger from electric shock to the operator and do not cause damage to delicate electrical instruments. When C.T.C., however, comes in contact with red hot metal, phosgene is liberated and this gas is particularly lethal.

32. A service respirator is a safeguard against C.T.C. fumes and "phosgene," but is no safeguard against CO_2 or CO, both of which are liable to be present at a fire.

33. The "Salvus" breathing apparatus or the Pattern 230 breathing apparatus is safer when using C.T.C., but generally for the type of fire ordinarily dealt with by C.T.C., the prompt action necessary prohibits the use of respirators or breathing apparatus.

34. If a Pyrene extinguisher is used in a confined space the operator, unless suitably protected, must immediately withdraw.

35. The dangerous nature of C.T.C. should be known to all potential users, as also should the obvious necessity for well ventilating a compartment in which C.T.C. has been used, before anyone re-enters.

Carbon Di-oxide and Methyl Bromide

36. These are both smothering gases.

37. A methyl bromide equipment is much lighter than a carbon di-oxide equipment and methyl bromide is equal to, and possibly superior to carbon di-oxide as a fire-fighting agent. The objection to methyl bromide is that it is an extremely poisonous gas.

38. It has been decided generally not to extend the use of methyl bromide, because of its toxicity, and where it is at present being used—in certain petrol-driven motor boats—its dangers should be impressed on operators and every precaution should be taken to ensure that the gas is not inhaled and that the liquid methyl bromide does not come in contact with the skin.

39. Carbon di-oxide is supplied for use on the flight decks and in the hangars of aircraft carriers.

40. In a demonstration using a CO_2 equipment of the type being supplied for aircraft carriers, a running petrol fire about 20 ft. long and 10 ft. wide, fed with petrol issuing from a $\frac{3}{8}$-in. pipe was completely extinguished in about 10 seconds.

41. In merchant ships, the flooding of hold compartments with carbon di-oxide is one of the approved methods of dealing with cargo fires. Carbon di-oxide, however, being a heavy gas diffuses slowly and some doubts have been expressed

as to the efficiency of these flooding systems, especially in holds packed with cargoes that absorb air. Certainly fires in cargo holds drenched with carbon di-oxide have been known to re-ignite on removing the hatch covers, ten days after the initial outbreak of fire.

42. The above note is included because suggestions have been received from the Fleet concerning the use of carbon di-oxide, and at first sight it does appear that the discharge of a bottle of CO_2 into a closed compartment on fire may be the simplest and least damaging method of dealing with the situation. It would not be easy, however, to use ships' CO_2 bottles for fire fighting for the following reasons :—

(*a*) Not being fitted with internal syphon pipes, ships' bottles if used upright, discharge gas instead of liquid.

(*b*) The outlet is so small that the issuing gas will freeze into solid CO_2.

(*c*) If the bottle is inverted the outlet is liable to become choked with scale or foreign matter in the bottle, and in any case the outlet is too small.

(*d*) The number of bottles available in ships, even if they could be satisfactorily used, would be sufficient only for a small compartment.

43. It is estimated that one bottle of CO_2 (about 320 cu. ft. of gas) would extinguish a fire in a sealed compartment of approximately 1,200 cu. ft., large numbers of properly designed CO_2 units would therefore be necessary to give the concentration required in large compartments. The possibility of using the ship's supply of CO_2 in an emergency should, however, be borne in mind ; the compartment should be sealed and the gas admitted through the air testing plug ; adaptors will be necessary for connecting a hose to both bottle and test plug, and these should be provided by ships' staff.

Steam

44. Steam admitted to a compartment, will, if in sufficient quantity to compensate for leakage and condensation losses, prevent air gaining access to the fire. Its supply must be maintained for a sufficient period to ensure complete extinction as a partial vacuum is formed in the compartment when it is shut off and air sucked in would cause a further outbreak of fire if only partial extinction has been achieved.

New Equipment

45. *Foam generators.*—This equipment is being supplied to all ships of cruiser category and above. Each unit produces about 680 gallons of foam per minute when supplied with water at a pressure of 35 lbs. per square inch and uses 80 gallons of water per minute.

To blanket an oil fuel fire a rate of application of one inch per minute is desirable.

With the Type "C" generator used between decks the two branch pipes would have to be used together to produce the full rate of discharge of the unit. The two branch pipes on this type of unit were introduced because they are of a more convenient size for use between decks, and it is an advantage to be able to introduce foam simultaneously at two or more points in a large compartment.

46. *Carbon Di-oxide Units.*—These are supplied to aircraft carriers only. On the flight deck, during flying operations, they should be manned ready for instant use. At a demonstration fire, using one of these units, the operator wore ordinary clothing, but in a fierce aircraft fire, where it is a matter of rescuing the occupants, asbestos suits should be worn by the operators. The unit is very quick in operation, and even for aircraft fires not involving immediate danger to life, should be used until the foam apparatus can be got into operation. Similarly in the hangars of aircraft carriers, the speed with which these units can be made to function is the reason for supplying them.

47. *The Jet/Spray Nozzle.*—These nozzles are intended to take the place of an equivalent number of Pattern 1521 branch pipes and should be distributed about the ship.

48. *The Oilfyre Nozzle.*—These are spray nozzles only and the spray cannot be varied. They are being supplied to ships for use below in compartments that have adjacent oil fuel tanks.

49. *Two-man Manual Pumps and Foam Branch Pipes.*—These are issued to destroyers, sloops and corvettes.

50. *The Nuswift Extinguisher.*—This is essentially a first-aid appliance for general use.

51. *Diesel-driven Portable Fire Pumps.*—These are supplied to cruisers and above and supply is being extended to destroyers and sloops.

Hangar and Magazine Spraying

52. The spraying arrangements fitted in the hangars of aircraft carriers and catapult ships and in the magazines in all ships should be tested periodically as laid down in the various regulations on the subject.

53. Particular attention is drawn to Clause 462 of the Damage Control Handbook, which states that :—

> "Spraying should usually be sufficient for saving the contents of the magazine, and further, spraying does not necessarily put the magazine permanently out of action."

54. Clause 142 of the Damage Control Handbook refers to the manning of the main and secondary magazine flooding positions in action, and Clause 158 deals with the definite instructions that should be issued in all ships concerning the responsibility for working the magazine flooding and spraying arrangements.

First Aid Appliances

55. The capabilities of first aid appliances should be known to ships' companies. Practice ashore should take place on a test fire made up in a tray about 3 ft. 6 in. square as follows :—

Mineral lubricating oil—2 gallons.

Petrol—1 pint.

Wood—4 lbs.

Waste—1 lb.

Oil fuel—2 gallons. (Used or waste lubricating oil should be used for this purpose.)

The fire should be allowed to burn for 1¼ minutes before operating the extinguishers.

56. The importance of such tests is stressed not only in order to ensure that fire parties, and in fact all officers and men, are made familiar with each type of apparatus and its method of operation, but these tests will demonstrate the ability of any particular appliance to deal with such a fire.

57. In this connection it is often surprising to find how effective two gallons of water can be if the whole of the two gallons can be directed to the seat of the fire. With the Nuswift extinguisher, for example, which contains two gallons of water that can be discharged under pressure, either as a spray or a jet, the whole of the contents can be used efficiently. If the same quantity of water were thrown from a fire bucket the result would probably be most unsatisfactory. Using a bucket, it is difficult to throw the water exactly where it is required, and a large proportion of it would be wasted.

58. First aid fire-fighting appliances and refills should be distributed about the ship ready for immediate use. All the apparatus required for action fire parties should be stowed in positions readily accessible to the fire parties.

59. Electric torches should be supplied to action fire parties, and it is probable that the Pattern 16034 headlamp will prove particularly useful.

Asbestos Suits and Protective Clothing

60. Asbestos suits, overshoes and flame-proof gauntlets are supplied to certain ships. Particular attention is called to the precautions regarding the use of these suits. The question of issuing additional asbestos suits of lighter pattern is being considered.

61. For use in action, fearnought suits and gloves are supplied for fire parties (Damage Control Handbook, Clause 314.)

Breathing Apparatus

62. In most cases of fire in H.M. ships approach can only be made from above, and the means of access also act as a chimney for smoke, fumes and heat. Access to the seat of the fire can then only be attained with the use of a breathing apparatus ; it should, however, be remembered that conditions as regards temperature and visibility may well be better at a lower level.

63. Anti-gas respirators should not be used for fire-fighting in an enclosed space.

64. Two types of breathing apparatus are supplied to ships for use by men working in vitiated air or in smoke :—

(*a*) *Smoke Helmet, Pattern 230.*—This consists of a face piece to which a breathing pipe 120 ft. in length, fitted with an air valve, is connected and led to the open air.

(*b*) *Salvus, Patterns 3484 and 3485.*—These are self-contained apparatus in which the wearer is supplied with a regulated amount of oxygen from a flask which he carries.

65. The Pattern 230 is less bulky than the "Salvus" apparatus, but the wearer is handicapped by the length of piping which he has to drag around with him. The Pattern 230 cannot be used during a gas attack, but it can be worn with no previous training. On the other hand, wearers of the "Salvus" must know how to operate it.

66. Smoke generators are now supplied to ships for training fire parties. Personnel should be trained in the use of the two types of breathing apparatus and also in the use of spray nozzles, using these smoke generators.

Portable Salvage Pumps

67. The portable salvage pumps supplied to ships can be used as fire pumps, and as they are independent of the ship's firemain system, they may prove extremely useful in an emergency. It is recommended that salvage pumps should be tried in all ships as part of the fire-fighting exercises, and these exercises will enable ships' officers to determine the best method of using the pumps.

68. The following notes on the various salvage pumps supplied, or being supplied, are for guidance only as their performance for fire purposes has not in all cases been tested :

(*a*) *70-ton electrically driven portable pump.*—The ships involved are capital ships, aircraft carriers, cruisers, depot ships, repair ships, net layers and destroyers.

These pumps with a suction head of from 15 to 20 ft. should be capable of giving a good water jet from a single, Pattern 1521, branch pipe when modified to ½-in. discharge orifice as now approved. As the discharge connection from this pump is a No. 4 bayonet joint, an adaptor, Pattern 1523, will be necessary to convert it to a No. 3 bayonet point.

(*b*) *Petrol-driven pumps.*—The ships concerned are armed merchant cruisers, ocean boarding vessels, ships of the First Minelaying Squadron and depot ships.

The pumps supplied are not all of the same type or performance. Some are fitted with two No. 3 size bayonet joints and others with four No. 3 size bayonet joints on their discharges.

Generally the pumps have ample capacity to supply all the discharge connections fitted and will probably have to be throttled down to give the best water jets. The best discharge pressure will probably be about 70 lbs. per square inch using the modified, Pattern 1521, branch pipes.

(*c*) *American Type Submersible Pumps.*—These are being supplied to certain destroyers in lieu of the 70-ton electrically driven pump.

These pumps should be capable of supplying one reasonable water jet using a Pattern 1521 (modified) or a Pattern 1520 branch pipe. The pump discharges are fitted with an adaptor to convert the American screw discharge connection to a No. 3 bayonet joint. If it is found on trial that a Pattern 1520 branch pipe gives better results, a Pattern 1522 adaptor should be fitted to the discharge when used as a fire pump.

Fire Risks in Ships and Methods of Dealing with them

69. The following statement is a revised and simplified version of Appendix I to the Damage Control Handbook.

Type of Fire	*Recommended Fire Appliance*
Structural and general fires ...	Hose and jet. Spray where smoke driving is required.
Electrical fires...	Pattern 4723 or 4724 Pyrene. Water spray. CO_2 apparatus in Carriers.
Magazines and shell rooms ...	Spray or flood. Cool surrounding bulkheads with spray or jet.
Oil fuel fires in boiler rooms ...	Hand foam appliances, Pattern 4726. Improvised steam drenching. Foam generators. If boiler room has to be evacuated—steam drenching.
General oil fuel fires	Hand foam appliances. Spray or foam generators.
Inflammable liquids	Foam. Flood spirit room or inflammable store, if necessary.
Aircraft fires on deck	CO_2 units for life saving (Aircraft Carriers). Foam generators.
Fire in hangars	Hand appliances. CO_2 units (Aircraft Carriers). Foam generators. Spray hangar.
Other petrol fires	Hand appliances. Foam generators.
Cinema films in projectors ...	The standard Admiralty pattern cinema projector, Pattern 7501, has an automatic CO_2 fire extinguisher. Pattern 7534.
Cinema films in stowage locker	Water spray or jet to cool surroundings.
Fire out of control in a compartment.	Seal the compartment as far as possible and cool the boundary bulkheads by means of spray or jet. If possible admit foam or steam.

70. Hydrogen bottles need not be discharged provided they are stowed in the open. They should be stowed horizontally and close to the deck.

(C.A.F.O. 720/41 is cancelled.)

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