CHAPTER 21

FIREFIGHTING PROCEDURES

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CHAPTER 21

FIREFIGHTING PROCEDURES

2101. Preparations

Serious damage through fire can generally be attributed to late discovery, faulty technique (including misuse of appliances), or the rapid growth of fire following explosion:

a. Early discovery of a fire can be helped by conscientious regard of all automatic warnings and by the use of diligent patrols/rounds personnel who frequently visit all compartments, including storerooms.

b. Faulty technique can be eliminated by good training, which starts at the firefighting schools and must continue in the ship. Every opportunity must be taken to carry out realistic and imaginative exercises and all personnel should know where to find and how to use all firefighting appliances/equipment and breathing apparatus with confidence.

c. The possibility of rapid growth of fire (from any cause) calls for a carefully prepared organisation, the strategic stowage of appliances and the ability to concentrate appliances and firefighters rapidly in adequate but not excessive numbers. Complex situations may arise when more than one compartment and/or a variety of materials are involved or threatened. Explosives, combustibles, gas cylinders, etc, are possible complications. Structural damage, which might include jammed doors and hatches, will make the firefighting task more difficult. These situations can be met with confidence if the officers and key ratings likely to be called upon to direct operations have used imagination in assessing the risks before the fire occurs and if they have a thorough knowledge of their ship and the firefighting procedures.

2102. Management of Firefighting Equipment and Personnel

The limited amount of firefighting equipment and personnel in a ship necessitate careful management of resources. In particular:

a. When firefighting, positive efforts are required to salvage firefighting appliances from teams being relieved. Personnel must be trained to ensure that all equipment is kept under control and not needlessly lost.

b. With the possibility of firefighters in EDBA working for nearly an hour, the signs and symptoms of heat stress and physical exhaustion must be understood. An organised system of feeding/watering firefighting teams is essential. Supplies of drinking water must be easily available to all manpower containing the incident and those working in spaces where temperature has risen due to the fire.

c. Accurate identification of compartments can save wasted effort. A combination of location markings and compartment name should be used.

d. Running portable diesel or gas turbine pumps for long periods requires good fuel supply management.

2103. Sources of Compartment Information

Detailed information about compartments can be made available to firefighting teams from the following sources:

a. S.3021 - Firefighting Kill Cards (see Annex 21J).

b. In Type 23 frigates, the Damage Control Data Retrieval System (DCDRS).

c. Personally, from departmental specialists.

d. Electronic management systems eg Machinery Control and Surveillance (MCAS) and Damage Surveillance and Control (DSAC).

2104. Smoke Alarm - Reaction

Guidance on the reaction of personnel, in the event of a smoke alarm sounding, is given at Annex 21I.

2105. First Report and Action

a. The person discovering a fire is not necessarily on duty or a member of the ships firefighting team. He is known as a first aid firefighter and his immediate action must be to shout a loud vocal alarm and, together with those personnel in the vicinity who respond to his alarm, use the equipment at hand to extinguish or contain the fire. If the attempt is unsuccessful, the first aid firefighter with the vital information about location, seat of fire, type of fire, etc, must report to the person who arrives to take charge of the incident and remain with him until ordered otherwise. After debriefing, he is to be escorted to HQ1 for further debriefing and, if necessary, to the sickbay for medical examination.

b. Correct and prompt action by the person discovering a fire can make the difference between the fire causing minor damage and becoming a major conflagration. The action depends on whether the fire is in an open or closed compartment.

(1) **If Smoke is seen to be issuing from Beneath a Closed Door.** Suspect fire but do not open the door because, if the door is opened, the fire might flare up fiercely and spread rapidly. Raise the alarm by shouting **"FIRE, FIRE, FIRE"** and inform the Command by the quickest method, ie 999 call on the ships automatic exchange, or DC telephone to HQ1/SCC/Quartermaster, or Bridge, depending on the state of readiness. Pass a clear accurate message stating the location of the fire, return to the scene of the incident (SOTI) and rig hoses for containment/re-entry.

(2) **If the Door is Open or the Fire is not Behind a Door.** If a fire is discovered in an open compartment, raise a loud vocal alarm by shouting **"FIRE, FIRE, FIRE"** and try to extinguish it with the equipment to hand. The command must be informed by the quickest method (if a second person is present he must attend to this).

If the finder is doubtful of his ability to extinguish the fire, he should shut all openings to the compartment, rig hoses for containment/re-entry, ensure the Command is informed and report to the person who arrives to take charge of the incident. If the retreating personnel have time, it may be possible to remove the blanking cap from a through-bulkhead HPSW connector. This would aid subsequent survey of the closed compartment.

2106. Continuous and Aggressive Attack

a. Fires will usually spread quickly if the firefighting effort is interrupted, so it is essential that a continuous and aggressive attack (CAAA) is maintained from the moment of discovery. If First Aid Firefighters are unable to extinguish a fire, they should attempt to maintain the CAAA until the Attack Party take over. To maintain the CAAA firefighting equipment should be supplied to firefighters in accordance with Para 2123. The rules regarding the use of lay flat hoses within HV compartments (see Para 1958) must be strictly adhered to. If the compartment becomes untenable the First Aid Firefighters may have to retreat to the door or hatch to maintain the CAAA. In this instance, they should attempt to limit smoke and flame exiting the compartment without shutting the door or hatch. This can be achieved by the use of a waterwall nozzle or Fixed Hatch Waterwall (FHWW), with their use left to the discretion of the I/C but if operated HQ1 must be immediately informed; HQ1 retain the option to veto their use. This will obviate the need for a compartment full re-entry. Once a door or hatch is closed the waterwall nozzle or FHWW must be shut off until it is either required for re-entry or, in the instance of cooling down a MMS hatch prior to re-entry.

b. The same applies to the Support Party relieving the Attack Party. The standard time, within which the Attack BA should arrive at the Scene Of The Incident (SOTI), is 2 mins. The Support Party should report to the I/C FCP within 8 mins of the alarm being raised. These times are for during normal working hours and it is accepted that during silent hours it may take longer for personnel to arrive.

c. The CAAA must not be allowed to endanger the ship or personnel. If firefighters are inadequately protected or equipped, they may be beaten back (eg while waiting for a waterwall nozzle). If this happens, the compartment door or hatch should be closed and preparations made for a full re-entry. The decision to shut the door or hatch must be taken by the person at the scene of the incident.

2107. Important Questions at a Fire

a. The initial concerns of the person taking charge at the Forward Control Point (FCP) must be to find out:

(1) Where is the fire? The scene of the incident (SOTI)?

(2) What is burning?

(3) When did it start?

(4) How did it start?

(5) Is there anybody fighting the fire? Has a continuous and aggressive attack been maintained?

(6) Are there any casualties present?

(7) Have the boundaries of the fire been established and is monitoring/cooling under way.

(8) What are the immediate dangers? (eg fuel tanks/magazines, structural damage).

(9) Has communication been established to HQ1/SCC?

Note. *These initial questions must be asked, within the first 2 mins. The discoverer of the fire, if there is one, may well be able to answer most of these.*

b. From these broad considerations, more detailed questions arise:

(1) Have all the Attack Party arrived and are they using the right equipment?

(2) Has effective control over smoke been achieved, with smoke boundaries identified? (see Annex 21C)

(3) Has ventilation been crash stopped?

(4) Has the FCP been established in the right area, affording the best entry into the scene of the incident?

(5) Has the Command Aim been given? (In Damage Control States 1 and 2).

(6) Are any more appliances required from other parts of the ship? Will more personnel be required?

(7) Is smoke present in such a manner as to give false impression of the seat of the fire?

(8) Are Support Party personnel available and getting dressed?

(9) Have all relevant isolations been made?

(10) Are HQ1/SCC aware of the water levels?

c. When the fire appears to be extinguished, the following questions remain:

(1) Is it really extinguished? Have charred solids been broken up and wetted? Is any insulation still smouldering?

(2) Is there any danger of spontaneous re-ignition? Can the danger be prevented? Has a sentry been posted?

(3) What damage is there to electrical apparatus? Has HQ1/SCC been consulted about the precautions that might be necessary?

(4) Are all personnel accounted for?

(5) How is smoke and water clearance going to be achieved?

2108. Control of Firefighting Operations

a. A serious fire cannot be effectively controlled unless there is well co-ordinated control of the firefighters (see Chapter 20). The direction of all firefighters in a single fire zone must be unified and remain so. Takeover of control by a senior person, if necessary, must be carried out with the greatest of care and only after he has assessed the situation. Inopportune taking over, contradictory orders from different sources and overcrowding of a FCP constitute serious hindrances to firefighting. While the first actions at a fire are with the person who discovers it, hands should not join in the fighting of an established fire except as directed by the person in charge at the FCP. Spare hands should be mustered, (Emergency Stations at sea or Emergency Clear Lower Deck in harbour) clear of the fire zone, where they will be immediately available when needed. Sentries, if possible, should be posted to keep the fire zone clear.

b. Except in very small ships (and then only in emergency), the person in charge of the FCP should not actively operate a firefighting appliance. It is his duty to ensure the fire is being aggressively attacked and that the fire is not spreading beyond the established boundaries, to appreciate any possible complications and take anticipatory action, and to keep in touch with HQ1/SCC and in particular, be responsible for the safety of personnel. The person in charge should position the FCP as close as possible to the SOTI outside the danger area and smoke boundary. Whenever possible, he should try to utilise fixed communication systems to HQ1/SCC.

2109. Choice of Firefighting Method

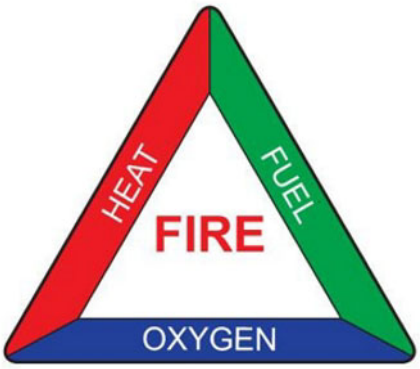
Having discovered the fire situation, the person in charge at the FCP must choose the most suitable technique and call for appliances, some of which may have to come from other parts of the ship. Speed is essential in the first attack, but should the first measure fail to contain the fire, a careful assessment of the situation is as important as speed. The right action in good time is better than the wrong action too quickly. Since fire depends upon a reaction between two substances and is sustained by self-generated heat, there are three ways of extinguishing a fire:

a. Take away the heat faster than it is generated.

b. Separate the substances.

c. Interfere with the chemical reaction that takes place between the fuel and the oxygen.

Fig 21-1. The Fire Triangle



Note. *The fire triangle is explained in simple terms in BR 4007 - Guide to Ship Firefighting.*

2110. Principle of Extinction

Assuming that a fuel is burning in oxygen drawn from the air, two methods of separating the substances may be possible. Either air or fuel may be prevented from reaching the fire. Consequently, the firefighter has three aims:

a. To starve the fire by removing solid combustibles or by cutting off the supply of fuel either in its liquid or gaseous state.

b. To cool the fire and its surroundings to a temperature at which it dies through lack of heat.

c. To smother the fuel by preventing air from reaching it, or by diluting the air with some form of inert gas.

d. These aims are the principles of firefighting and self-descriptive names can be given to them: **STARVING, COOLING** and **SMOTHERING.**

2111. Application of the Principles

a. Firefighters should keep all three principles in mind when attacking a fire. They should use the structure of the ship itself and the various installations, to assist the fire appliances they are using. The closing of watertight doors and hatches or the shutting down of appropriate valves on fuel supply lines and ventilation systems may prove as important as the use of any fire appliance. In fighting major fires, a change in the course of the ship may be warranted to prevent fires from being fanned and to assist in smoke clearance.

b. More than one principle is brought into effect from most firefighting appliances even though a single principle dominates the extinguishing process. If this is understood, firefighters may safely classify their appliances according to their major function.

2112. Starving

There are certain obvious ways of starving a fire. Take combustibles away from a fire and the fire will not burn so long. With uncontrolled fires, removing combustible solids from the immediate vicinity will limit the spread of the fire. If a fire is fed by liquid fuel flowing from a burst pipe, isolation by the appropriate control valve is an essential precaution. If a fire can be completely isolated it will eventually die from lack of fuel. Allowing a fire to burnout in this way is justifiable in some cases when the burning substance contains or produces oxygen, however this means of extinguishing a fire is hazardous and slow.

2113. Cooling

a. Heat is a form of energy, and cannot be destroyed. Cooling is the alteration of this energy from a destructive force into innocuous energy. Water is an excellent cooling agent. Projected on to a fire it takes a certain amount of heat to bring it to boiling point and about six times as much to turn it to steam. The firefighter must initially seek to remove the heat energy by cooling the flame and not the fuel. In an open area, steam carries the heat away. In a partially closed compartment, both the heat and the steam may fail to escape entirely, but the heat will be distributed and the temperature of the fuel will be reduced. The steam will also produce a smothering effect.

b. The absence of flame does not necessarily mean that the fire has been extinguished. Transfer of heat within the fuel may lead to the renewal of flame (this may occur hours or even days afterward). Therefore, when the flames disappear, solids must be separated and broken up so that the insides, as well as the outside, are cooled. A metal compartment in which a fire has been burning may have parts hot enough to re-ignite the contents. Hence, the whole fire zone must be cooled to a temperature well below that at which flames disappear. The decrease in temperature of hot substances, and the prevention of cool substances from getting hotter, is closely related in the processes of fire extinction. Both ideas are inherent in the principle of cooling.

c. Water is available in a plentiful supply from the sea, so there is a temptation to be extravagant with its use and this can be almost as dangerous as the fire itself. Water should therefore always be used as a spray except when it is necessary to break up and drench masses after the flames are extinguished. The following facts about water must always be remembered:

(1) It is heavy where 1 ltr of water weights 1 kg. Water partially filling any compartment, has a free surface that will hamper the stability of the ship. The higher in the ship or the further from the centre line, the greater the problem.

(2) Most liquid fuels are lighter than water so they will float and may continue to burn while doing so. This may become a serious hazard in bilges, tanks etc. If water is introduced to a burning liquid that is at such a temperature, the water will boil and turn to steam. The expansion will cast the burning liquid out violently.

(3) Sea water is liable to cause permanent damage to electrical equipment and temporary damage to most machinery. It may cause lethal shock when used as a jet on live electrical equipment. The use of fresh water does little permanent damage to machinery and the dangers of shock are not so high as with seawater.

(4) Application of water will prevent the transfer of heat from bulkheads, etc or from one explosive charge to another, and thus prevent ignition. It will not necessarily stop an explosive charge from burning once it has become ignited. Oxygen continues to be evolved by the explosive even when it is drowned in water.

(5) Water, a very stable compound, is composed of oxygen and the flammable gas hydrogen; it can react chemically with some substances:

(a) Even when cold, it reacts violently with some substances to produce flammable gas. Potassium, sodium and calcium, which are found in some medical stores, react producing hydrogen.

(b) When very hot, certain light metals used in the construction of aircraft react with water. These metals are able to burn in air. If water is applied at a slow rate, the generation of hydrogen may cause an intensification of the fire but, providing that the metals are not present in great quantities and the rate of water applied is high, the cooling effect outweighs any danger from hydrogen generation.

(c) Iron will not burn in air, but at 700°C it can burn in the presence of steam with the generation of hydrogen.

(d) When limited quantities of either water or steam come into contact with hot carbon, a result is ‘water gas’, a flammable mixture of both hydrogen and carbon monoxide.

d. With these facts in mind, the most efficient use of water must be made to extinguish fires. For most situations a spray will be used. Water broken up into the fine particles that form a spray has a larger surface area than the same volume of water projected in the form of a continuous jet. In contact with a large hot surface, the transfer of heat to the water particles is very rapid. Hence, the cooling effect is very rapid and spray is particularly suitable for cooling large surfaces. The jet is most effective in dealing with structural fires and other fires involving metals.

2114. Smothering

a. Smothering is the process of preventing oxygen from reaching a fire. Applying a wetted, or even dry cloth over a chip pan on fire, can smother it. Shutting all doors and hatches to a compartment and crash-stopping ventilation is another way to smother a fire. But, because many combustibles contain oxygen, the process can be slow. As mentioned earlier, the discoverer of a fire must raise the alarm to summon help. If the fire is obviously beyond the capabilities of the discoverer to extinguish or even control, he must contain it by shutting all openings to the compartment, to prevent air (oxygen) from getting to the fire.

b. AFFF is the most effective and readily available smothering agent, especially against burning hydrocarbon liquid fuels that are not miscible. It rapidly produces an air (oxygen) excluding film of water over the surface of the burning liquid and even when that film is disturbed, it will quickly reform. AFFF is also effective against paper, wood rags, etc, because it improves the penetration of water to extinguish deep-seated fires.

c. Dry powder is a quick and effective smothering agent but the extinction is often only temporary. Its most effective use is against low flash point liquid fuel fires. Its swift 'knock down' effect on the flames is very effective in preventing further fire spread, allowing firefighters access to burning aircraft etc. However, dry powder does not form a permanent seal or remove heat, so AFFF must be used immediately as back up.

d. Carbon dioxide (CO_2) is an inert gas and will neither burn nor support combustion. It is heavier than air and displaces oxygen by forming a temporary blanket. It is mainly used for electrical fires but some ships have CO_2 drench (smothering) systems fitted to machinery spaces. It must be remembered that CO_2 will not support life in concentrations over 17% in the atmosphere.

e. Halon 1301 (BTM) has some minimal smothering qualities but its main extinguishing method is by chemically interfering with the reaction that takes place between the fuel and the oxygen. It is normally used in machinery spaces.

f. Steam is an inert vapour but it is lighter than air and must be blown into the compartment. Steam drench systems are fitted in nuclear submarines. It is very effective in a compartment properly closed down but has no cooling effect.

2115. Precautions and Limitations of Smothering

Ships' staffs are to ensure that relevant closing down and evacuation procedures appertaining to them are clearly laid down in Ships CBRNDC Orders (BRd 2170 Volume 7 Series) and understood. The following points must be considered:

a. Trying to smother a fire where all the oxygen required to complete the combustion process is mixed with the fuel, as with explosives, would be ineffective. Such an attempt would interfere with the venting of the products of combustion and increase the rate of flame generation and pressure. Consequently, explosives burning comparatively slowly might explode.

b. Smothering methods are slow and unpredictable if some of the oxygen required for combustion is held within the body of the combustibles (eg textiles, wood and other organic substances).

c. Hydrocarbon liquid fuels do not liberate oxygen so require an independent source of oxygen if they are to burn.

2116. Flashover

A flashover occurs in fires when there is no shortage of oxygen. In any compartment fire there may be a stage where the radiated heat from fire and hot gases at deckhead level are sufficient to ignite much of the remaining combustible material in the compartment. This transition from a localised fire to total compartment fire can be very rapid.

2117. Backdraught

A backdraught can only occur in fires where there has been a period of oxygen starvation (ie a compartment closed down). The heat in a compartment will still decompose the materials within, producing flammable gases but due to the lack of oxygen they will not ignite. The introduction of new fresh air results in these gases igniting, possibly explosively. This backdraught can take place immediately or when a new source of ignition is introduced, such as firefighters exposing smouldering material. Gases produced in a fire may well escape the compartment via cable runs, vent trunking, etc and build up in another compartment away from the initial fire source. These gases in turn could ignite with the introduction of a separate ignition source such as sparking from electrical equipment.

2118. Firefighting - Ventilation Control - Standard Procedure

a. The aim of this procedure is to reduce the flow of air to a compartment and limit the spread of smoke, in the shortest possible time, after the discovery of a fire. It is easily understood and can be applied in all Damage Control states, and conditions, at sea and in harbour, namely by:

(1) Crash stopping all ventilation fans as soon as the alarm is raised. This action contributes significantly towards the aim and also produces a known state of ventilation, which is essential for subsequent control procedures (the various minor disadvantages, which will result from a complete crash stop of ventilation in some ships, must be identified and overcome by good training, and discipline, in the standard procedure).

(2) Closing smoke curtains in the ship section containing the fire and in adjacent sections.

(3) Restoring power to all ventilation systems so that they may be restarted (under the control of HQ1/SCC or OOD) in order to:

(a) Supply ventilation to essential systems.

(b) Supply ventilation to areas of the ship not affected by the fire.

(c) Contain the smoke within the desired boundary.

(d) Reduce the supply of air to the fire.

(e) Remove smoke from areas adjacent to the fire.

(f) Remove all smoke and fumes after extinction.

b. The CBRNDC Orders concerning firefighting in DD/FF and MM/PP are to reflect the following paragraphs concerning ventilation control. Larger ships are to adapt these instructions to suit their particular ventilation design features, possibly on a damage control section basis. In all ships the Officer in Charge of firefighting operations must have the authority to modify the instructions if exceptional circumstances warrant it. A generic example of a Smoke Clearance Plan is at Fig 21J-3.

2119. Stage 1 - Crash Stop Ventilation

Immediately the fire alarm is raised the following actions are to be taken:

a. Open all main machinery and general ventilation breakers at the switchboard or SCC/MCR central crash-stop panel. After a pause for five seconds, re-close the breakers to restore the electrical supply to local fan starters. However, those ships with in-line switches fitted to some general ventilation fans (ie 6 inch fans in MMs) must ensure that these switches are opened before their respective breakers are re-closed, otherwise these fans will restart automatically.

Note. *In Condition ALFA a balance must be struck between the need to prevent the spread of smoke and the risk of contaminating the citadel. When the BRACE pipe is made, AFUs are to remain running in the crash stopping of ventilation. Where AFUs are connected to the crash stop circuit they are to be restarted immediately after any precautionary crash stop of ventilation.*

b. Trip the local starters of general ventilation fans, which are not controlled, from the ventilation breaker (see Note 1 below).

c. Re-set ventilation moulded case circuit breakers (MCCBs) tripped when breakers were opened (ships fitted with Electrical Distribution Centres (EDCs) only).

Notes:

1. The following fans should not be stopped because they will not spread smoke to other areas, and their continuous operation is required. If affected by fire, the electrical supplies to the system or unit should be isolated in conjunction with other equipment in the compartment.

a. ACUs fitted in individual compartments to re-circulate cooled air in that compartment only.

b. Full re-circulation ATU systems serving only unmanned spaces for equipment cooling purposes.

c. Closed-circuit equipment cooling systems that are independent on the ships ventilation system.

2. The effectiveness of this procedure depends on regular and thorough briefing of the personnel nominated for the various tasks, and their practice in the drill.

2120. Stage 2 - Restart Selected Ventilation Systems

Electrical supplies must be made available to all ventilation systems as soon as possible after crash stopping so that systems essential to the ships function and which do not interfere with the firefighting operations, or the establishment of a smoke boundary etc, can be restarted. The following guidelines are to be used by personnel tasked with using the ventilation systems to control contain or remove smoke during and after a fire:

a. The spread of smoke is a major factor in preventing a clear appreciation of the source and extent of a fire and in preventing the adoption of effective firefighting measures. Regular practice, using smoke generators and Ramfans and detailed ship knowledge are essential, always bearing in mind that cold smoke does not always behave in exactly the same manner as hot smoke.

b. It is vital that, in the earliest stages of a fire, efforts are made to isolate the smoke into the smallest area that is consistent with the need to gain access to the fire (see Annex 21C).

c. Early consideration must also be given to the removal of smoke in order to assist with containment. In almost all cases this can be done effectively by selective use of the ventilation systems, (the Ramfan can assist in this removal but consideration must be given to the effects on the HPSW main) but this requires great care since forced smoke removal may encourage the fire. When planning smoke clearance routes, the effect of smoke in previously uncontaminated spaces must be taken into account.

d. In general, ventilation systems should not be used to remove smoke from a compartment in which a fire is burning, and care is necessary in removing smoke from a compartment adjacent to the fire and through which the firefighting team will have to pass in order to reach the fire. Withdrawing smoke by means of an exhaust fan which is sited at some distance from the scene of the fire may fill previously clear compartments with toxic smoke and become a hazard to unprotected members of the firefighting and containment teams.

e. The most effective fans for the clearance of smoke are those in the main machinery spaces and the galley, and dedicated smoke clearance fans.

f. Care must be taken that smoke is not picked up by the suctions of the HP air compressors, or systems supplying habitable compartments.

g. When using main exhaust fans a route to atmosphere must be opened up to allow make-up air into the ship.

h. Should the ship suffer major structural damage above the waterline, the use of the newly created opening should be considered for blowing smoke through to the atmosphere.

i. Smoke may be removed by blowing or sucking. Except in the simplest cases, eg where the fire area is adjacent to an upper deck opening or, in action, a hole in the ships structure, sucking is to be preferred because it gives much better control of the smoke. It is not possible to predict where smoke will go when it is blown.

j. Consideration should be given to altering the ships course relative to the wind in order to blow exhausted smoke away from ventilation inlets or areas in use on the upper deck.

k. The air supply from AFUs can be effective to blow the smoke out through a machinery space in Condition ALFA.

2121. Stage 3 - Prepare to Shut Down Machinery Space

If the fire is in a machinery space, immediately following the crash stop, all supply and exhaust ventilation flaps are to be closed to seal a main machinery space on fire, in case the first aid firefighting measures fail and the fixed firefighting installation has to be used at short notice.

Notes:

1. When using steam drench or CO_2 fixed firefighting systems, one pre-designated exhaust ventilation flap is to be left closed but unclipped to prevent over pressurisation when the system is used. When the system has been discharged, and the pressure relieved, this flap is to be clipped shut. This ruling does not apply to compartments fitted with BCF or BTM gaseous fixed firefighting systems where all ventilation flaps should be shut and clipped before use.

2. Detailed procedures for Main Machinery Space fires are at Annex 21F.

2122. Stage 4 - Restore Essential Ventilation

As soon as possible after the crash stop, the Officer in Charge of the firefighting operation must assess the fire situation, and with the aid of reports from the scene of the incident, and the ventilation information held in HQ1/SCC, ensure that smoke boundaries to the affected areas have been established. He should then issue the necessary instructions to restore essential ventilation, in accordance with the Command Aim (having ensured that smoke will not be drawn back into the ship from the weather deck terminals of any exhaust fans used by the ships firefighters). A record of the smoke boundary established, and subsequent restoration of essential ventilation, should be kept in HQ1/SCC. Thorough training and exercises are necessary to ensure that the time taken to restore ventilation is minimised, and that it is restored without further spread of smoke.

2123. Rigging of Hoses and Nozzles for Fire Incidents

WARNING

FIREFIGHTERS MUST BE AWARE OF THE HAZARD OF ELECTRIC SHOCK IF WATER IS SPRAYED ON LIVE EQUIPMENT DURING THE INITIAL ATTACK PHASE.

Each fire incident must be individually assessed, but generic guidance for the rigging of hoses and nozzles is as follows:

a. During the initial attack phase for a carbonaceous fire, if the initial attack with extinguishers proves ineffective, the early deployment of a firefighter nozzle, used in ragged spray or CFHR in foam, may well extinguish the fire. All internal hose baskets are fitted with firefighter nozzles. They can be safely operated by one person and can also be used for boundary cooling and in personal protection mode should it be necessary to withdraw from the compartment.

b. If heat or smoke forces the initial attack personnel to withdraw to the compartment door/hatch, consideration should be given to rigging a waterwall nozzle or fixed hatch waterwall (FHWW) (see Para 2106). If either is operated HQ1 is to be informed immediately due to the possible hazard of electric shock and the large amount of water (over 10 ton/hr) that can be discharged into a compartment. This will allow the door/ hatch to remain open for the Attack BA wearers or first two dressed Support Party members to continue the attack on the fire. Note however, that extinguishers do not have the force to effectively penetrate a waterwall. The Waterwall Operator must also be backed up when operating the nozzle through its full range.

c. When rigging for a 3 hose re-entry, the Ship Protector hose should be rigged first, underneath the firefighter and waterwall hoses. This will help to minimise the problems of hoses snagging against each other during the re-entry.

2124. Firefighting Techniques

a. Re-entry firefighting techniques are detailed in Annex 21A and illustrated in BR 4007. The techniques are based on easily accessible doors and hatches, but in battle conditions the firefighting teams, in particular the Team Leader, may have to modify them. Very few hatches in a ship have enough space around them for the full team to get into ideal positions before re-entry.

b. Flame, smoke, heat, darkness and structural damage may hinder access to the seat of a fire. With the aid of breathing apparatus and good ship-knowledge, smoke need not be an insurmountable barrier. Some protection from flame-lick can be gained by the use of a waterwall. When fighting a fire without the aid of a BA, the firefighter should crouch on one knee, because at this level there is usually a layer of clear and cooler air. Once firefighters start to tackle the fire using first aid appliances, the steam produced may force the smoke layer down, rendering the compartment untenable.

c. Before opening the door or hatch to a compartment containing a fire, the following preparations must be made:

(1) Rig hoses of sufficient length to reach the furthest part of the compartment. Water supply to each hose should be from separate hydrants. A ‘Y’ piece should not be used to supply a team’s waterwall and firefighter hoses.

(2) All hoses should be fitted with the correct nozzle (and fully charged where possible) prior to the support party ‘going on air’.

(3) When using a FB5X foam making branchpipe, consideration should be given to use of a FBU5X inline inductor adjacent to the hydrant. This can be outside the smoke boundary, allowing easier tending of the foam drums.

(4) If the entry door opens away from the firefighters, a lanyard should be attached to the handle so that the door can be pulled shut if necessary.

(5) If the re-entry is from below, a waterwall mounting pole will be required.

d. If damage to the structure prevents a direct approach to the seat of a fire, it may be necessary to use portable cutting equipment, but only on the orders of HQ1. A hole just large enough to take a firefighter nozzle may be all that is necessary. Before cutting a hole, the following points should be considered:

(1) If possible, the pressure in the compartment should be tested, using an indicator test plug.

(2) Signs of blistering or charring may be useful in choosing the best location for a hole.

(3) The effect on watertight or gastight integrity may not be acceptable.

(4) The admission of air though the hole may increase the fire.

(5) Damage to essential services on the other side of the bulkhead may be minimised if the hole is cut in a known clear area.

2125. 4 Man Firefighting Team

For a relatively simple re-entry into a compartment containing a fire, a 4 man team, such as the HFEP Support Party, can be used:

a. **Team Leader.** Leads the team, and carries a TIC and opens hatches.

b. **Waterwall Operator.** Operates the waterwall nozzle.

c. **Firefighter.** Operates the firefighter nozzle or FB5X foam making branchpipe and opens doors.

d. **Hydrant Operator.** Operates the hydrants and tends the hoses (including the fixed hatch waterwall, if used).

2126. 5 Man Firefighting Team

For a more complicated re-entry, a 5 man team can be used:

a. **Team Leader.** Leads the team, carries the TIC and opens hatches.

b. **Waterwall Operator.** Operates the waterwall nozzle.

c. **Firefighter.** Operates the firefighter nozzle or FB5X foam making branchpipe and opens doors.

d. **Ship Protector.** Operates the ship protector waterwall nozzle.

e. **Hydrant Operator.** Operates the hydrants and tends the hoses.

Note. *Any number of additional Hose Tenders may be necessary.*

2127. Actions to be Taken when a BA Whistle Sounds

a. The overriding principle upon a whistle sounding is a safe withdrawal of the team, consolidating their attack on the fire wherever possible. This should be accomplished by withdrawing the team to the door or hatch, shutting the door or hatch, leaving whichever member of the team has the highest pressure as a sentry with a controllable source of water and to withdraw the remainder of the team back to the FCP.

b. Alternatively, in order to maintain contact with the fire, if only one team member's whistle is sounding the Team Leader may, providing it is not his own whistle, use his discretion to decide if the position of the person whose whistle is sounding can safely be taken by another member of the team and that the loss will not compromise either the firefighting effort or the safety of the remaining members of the team. Depending upon the circumstances this may be conducted within the compartment or by withdrawing the team back to the door/hatch. If this action is taken, the person who's whistle is sounding should be sent back to the FCP, with an escort if possible. In making this decision, the Team Leader will need to take into account the condition of the rest of his team and the remaining EDBA pressure.

2128. Cyalumes for Firefighting Team Identification

In circumstances of low visibility, eg a smoke-logged compartment, the delay caused by firefighters trying to identify who they are to relieve may result in the initial re-entry team being relieved after their whistles have sounded. To alleviate this problem, personnel involved in firefighting management are to employ the following guidelines for identification of key firefighting re-entry team members:

a. A coloured cyalume, dependent on the re-entry team member's function is to be connected to the rear of the team member's BA bellyband by a cable tie. Activation and fitting of the cyalumes should be completed just prior to the re-entry brief.

b. The following colour coding is to be used:

(1) Team Leader - Green.

(2) Firefighter - Red.

(3) Waterwall Operator - Blue.

(4) Hydrant Operator - Green (may wear 2 if considered necessary).

c. Cyalumes are only to be used by a re-entry team following the complete closure and containment of a compartment and their provision must not interfere with the efficiency of a continuous and aggressive attack on the fire.

d. A minimum of 6 green, 3 red, and 3 blue are to be stored in each fire locker and upper deck re-entry locker (see BRd 2170(3) for stock numbers).

2129. Boundary Monitoring and Cooling

Guidance on monitoring and cooling the boundaries of ship fires is at Annex 21D. Intact bulkheads and decks lined with fire barrier insulation (eg A60 bulkheads, fully described Para 2817 and Para 2818) will effectively contain a fire for a limited period without cooling. In such situations, priority should be given to temperature monitoring, rather than cooling.

2130. Ship Stability and Firefighting

Ship stability is dealt with in Chapter 29. The officer/rating in charge of firefighting operations may not be in a position to judge the effect of firefighting water on ship stability, so guidance must be given by HQ1/SCC. It is advisable to remove water as quickly as it is introduced to a fire, by pumping out or draining down/out. In newer ships, drain plugs are fitted in some decks for this purpose. A ship could be in more danger from 'free surface' water than it is from the fire.

2131. Aluminium Structure and Fire

Unless aluminium structure is suitably protected by insulation (lagging) or by the cooling effect of water when involved in fire it will, in simple language, melt. Aluminium is non-combustible and will neither contribute fuel to, nor assist in, the spread of fire. However, at temperatures above about 250°C the load carrying capacity of aluminium is seriously reduced. It melts at about 650°C. Therefore, in that respect, if an aluminium structure is involved in a ship fire, it can materially assist in the spread of fire by no longer acting as a fire boundary. Fallen cables and other services that had been secured to the deckhead/bulkhead by aluminium hangers, which are destroyed in fire, may seriously hamper firefighting measures.

2132. Glass Reinforced Plastic (GRP) and Fire

a. Use of Glass Reinforced Plastic (GRP) for construction of ships poses two particular problems in respect of fire:

(1) Dense smoke is evolved from burning of the surface resin.

(2) There may be a marked reduction in strength of GRP with increase of temperature.

b. The GRP beneath the layer of surface resin is very resistant to penetration by fire and the structure is an effective insulator. A fire in one compartment will not create a localised 'hot-spot' in an adjacent space. However, heat will be transferred laterally across the GRP laminate and can cause remote hot spots in through bulkhead pipework, cabling, securing bolts, etc. When the surface resin is heated it produces a strong pungent smell before ignition, thus providing an effective early warning of potential fire. Boundary coolers must be extremely vigilant and ensure that likely heat-soaks are regularly monitored and prompt action taken, should secondary fires occur. Notwithstanding the excellent insulation properties associated with GRP, the basic principles of boundary cooling still apply, ie a minimum of a CFHR or a charged hose with a firefighter nozzle (nozzle turned off until required).

2133. Fires Involving Hazardous Stores

Details of the chemical constituents of codified hazardous stores are available on the Hazardous Stores Information System (HSIS), which is held on CD by Naval Stores. As the hazard from such stores may be increased in a fire, it is important that this information is readily available. BRd 2170(5) - Embarked Aviation Crash Fire Rescue (CFR) 2013 Edition contains specific information on materials used in aircraft, their associated hazards and the resultant firefighting procedures.

2134. Fuel and Lubricating Oil Tanks

a. Fuels and lubricating oils can present a considerable hazard in the vicinity of a fire. However, cold liquid fuel in a full tank is safer than fuel vapour in a partially filled tank. The following questions should be considered by the MEOOW/MEOOD when advising the MEO/OOD and by the MEO in State 1:

(1) Is there associated action damage or is it solely a fire incident?

(2) If there is action/heat damage, is a ready-use tank or associated pipe work ruptured, and therefore supplying fuel to the fire in that space?

(3) Are emergency dump or rundown facilities fitted to the tank? Compartment Kill Cards should state this information. If this is so:

(a) Would dumping reduce the amount of fuel and so assist the extinction of the fire?

(b) Would pressing the fuel tank full cause further supplies of fuel to reach the fire via damaged fuel transfer pipes?

(4) Where does the dumped fuel go? If to an adjacent overflow tank or bilge, have they sufficient receiving capacity and would this promote further hazards?

(5) Would vital power supplies still be available if the tank contents were dumped?

(6) Is it possible to fill the tank 100% full, ie does it have a float operated inlet valve and does it have an overflow? If it has an overflow, where does it overflow?

b. Bulk storage tanks pose additional questions:

(1) Is the tank seawater compensated and therefore already full?

(2) If the tank is structurally sound and the systems are intact, is fuel likely to escape from dip tubes or air escapes when it is pressed full? If so, take precautions to ensure that the fuel is not allowed to overflow via these openings.

2135. Machinery Space Fires

Guidance on fighting machinery space fires is given at Annex 21F.

2136. Galley Fires

a. Fire in a galley is usually the result of spillage and/or the overheating of trays and utensils in ovens or on hot plates, particularly when the equipment is left unattended. Deep fat fryers present a serious hazard because of the quantity of fat or oil they contain. In common with all other galley equipment, deep fryers should never be left unattended when they are switched on.

b. If a galley fire breaks out, the immediate local action must be:

(1) Switch off power to the equipment locally, stop the galley vent and raise the alarm.

(2) Shut the fire baffle locally (see Chapter 18).

(3) If the fire is in the deep fryer, attack the fire with a 6 ltr Wet Chemical Extinguisher (Fry Fighter) or 9 ltr SPE(AFFF). On completion shut the lid.

c. If the fire is not extinguished by the above immediate local action:

(1) Switch off power at master switches sited outside the galley door.

(2) If local closing of the fire baffle is not possible shut it by remote operation at the galley door, stop the galley vent and raise the alarm.

(3) Shut the weather deck terminal to the galley exhaust trunking. Cooling the trunking with water spray may help to prevent the spread of fire.

d. A fire that is beyond fighting with first aid measures should be attacked with a FB5X foam making branchpipe, used under close supervision because of the dangers inherent in a fat fire. Fire parties must be exercised regularly in the correct drill to deal with a galley fire. Water must never be used except for boundary cooling, and CO_2 is not recommended because it has insufficient cooling effect and re-ignition is most likely once the CO_2 has dispersed (see WARNING at Para 2309).

2137. Gas Cylinders

All cylinders containing compressed or liquefied gases are potentially dangerous in the presence of fire. As the cylinders get hot, the gas pressure increases and if it rises excessively the cylinders may explode. There is a double risk with highly combustible gases such as hydrogen and acetylene; the cylinders may explode and the gas, when released, may cause further explosions. This latter risk is greater between decks. If a flame is seen coming from the gas tubes of cutting/welding apparatus, the first need is to shut off the gas at the cylinder valve; the flame will then go out. If the flame is put out first, an explosive mixture might build up before the gas supply is shut off. Relevant personnel must ensure they have immediate access to all data and safety sheets of combustible gas cylinders. Gas cylinders should, if possible, be removed from the fire zone. If this is not possible they must be kept cool with a continual spray, ie acetylene, if involved in a fire must be cooled for a minimum of one hour before it can safely be moved, and then placed in a bath of water for a further 12 hours.

2138. Danger from Oxygen Enrichment

Normal air contains 21% of oxygen. In air which contains more than that (oxygen-enriched), flammability, ie ease of ignition, combustion rates and combustion temperatures all increase. Materials such as clothing, which do not burn readily in air, burn much more actively in an atmosphere that is enriched with oxygen. An oxygen content increase of only 4% gives rise to a particularly dangerous situation. A further hazard is that, under pressure, and in the presence of heat (such as can be generated by opening the valve of an oxygen cylinder too rapidly), oxygen will react to oil and grease with a violent explosive force. The utmost care must be exercised whenever oxygen is being used onboard ship, particularly if within a confined space. Oxygen cylinders must be turned off and the reducing valve removed whenever they are unattended.

2139. Electrical Fires

a. Electrical fires are so called because, usually, some fault in a live electrical circuit has generated enough heat to ignite insulation, paint, or some other combustible substance close to it. Giving the name electrical to this type of fire serves to inform the firefighters of the precautions they must take and enables the correct firefighting technique to be employed. A fire that may start with solids or liquid fuels and subsequently involves live electrical equipment or circuits becomes, in effect, an electrical fire. It is important, therefore to switch off all electrical circuits in the vicinity of a fire, provided that it can be done without detriment to essential services, eg firefighting pumps. When power is off, what was an electrical fire is a straightforward fire of the combustibles present and should be attacked with the appropriate equipment. In the event of minor fire symptoms, eg a small smoke emission from within an electronic cabinet or switchboard, these may all disappear once all power supplies are removed. Some discretion is therefore necessary in the initial firefighting action.

b. The actions, which should be taken, are:

(1) **Fire in Low or Medium Voltage Equipment.** Isolate the power supply and attack the fire with CO_2. The use of CO_2 should not be delayed if power cannot be removed. However, re-ignition is likely until isolation is achieved. If this action does not extinguish the fire it should be treated as an ordinary fire and attacked with water. If the power cannot be switched off, it is possible, at voltages up to 440V AC or 800V DC to use water in the form of a spray, provided that the nozzle is not nearer than 1.8 m to any live equipment, irrespective of the type of water (fresh or sea) being used.

(2) **Fire in High Voltage (HV) Equipment.** Due to the energy inherent within a HV system (above 1000V AC or 1500V DC), high voltage electrical fires will not be extinguished until electrical power has been disconnected. Therefore, manual injection of CO_2 should only be undertaken once power has been disconnected; however, fixed CO_2 systems may be operated prior to disconnection. Although electrical disconnection is likely to occur either through the correct operation of the safety protection devices or due to high energy discharge through the fault region resulting in an open circuit, firefighting action must only be taken once disconnection has been confirmed. Water, even in the form of spray or AFFF foam, must not be used for firefighting on live HV equipment (see Chapter 19 Section 3).

(3) **Fire Within a Live HV Compartment.** Where all HV equipment within the compartment has ingress protection (IP) of IP56 or greater and the integrity of the HV equipment is not endangered by the fire, then manual firefighting is permitted using dry powder and CO_2 extinguishers or CFHRs. Where any HV equipment within the compartment has an ingress protection of less than IP56, then manual firefighting is limited to CO_2 and dry powder extinguishers. For other than strictly controlled training serials, lay-flat hoses are not to be deployed and used within any HV compartment where the ingress protection of the HV equipment is less than IP57 (submersible) until such time that it has been confirmed that power to all HV equipment has been disconnected. Once disconnection has been confirmed, normal RN firefighting procedures are to be followed. Fixed water and AFFF spray systems may only be operated on live HV equipment in an extreme case and where the ingress protection of all the HV equipment is IP56 and all personnel have been evacuated from the compartment. Detailed guidance is given in BR 2000(52)(1) - Operating Guidance for High Voltage Systems in HM Ships, Submarines and the Royal Fleet Auxiliary (also see Chapter 19 Section 3).

(4) **Fire in Electronic Cabinets.** Isolate power if the local switch is accessible, and attack with CO_2 through the injection nozzle when fitted, or where practicable by opening doors/covers when not. Switch off and remove fuses from all power sources (including alternatives) to the equipment. If these actions do not extinguish the fire it should be treated as an ordinary fire and attacked with water, observing the precautions regarding voltages given above. When the fire has been apparently extinguished, all drawers or sections of complex equipment should be opened to confirm that the fire is extinguished.

(5) **Sting Ray Torpedo Battery Fire.** This battery contains (amongst other substances) magnesium, and the fire is to be fought using copious amounts of water (see Annex 21G for fires in air weapons magazines). It is most important that the firefighters must wear BA and, should their clothing become contaminated with thallium effluent, it must be thoroughly washed after removal (see BR 8680(A)(2)(5(1)).

2140. Explosives and Pyrotechnics

Firefighting in magazines and the behaviour of explosives and pyrotechnics is discussed at Annex 21G. The effects of fire on aircraft armaments and pyrotechnics are covered in BRd 2170(5).

2141. Fires in Aircraft Hangars

a. Detailed information on aircraft firefighting is contained in BRd 2170(5) and BRd 766. Large aircraft hangars are divided into sections that can be isolated from each other by closing fireproof curtains. The whole hangar is regarded as a DC section. The Hangar Control Position (HCP), from which the Hangar Control Officer (HCO) supervises safety arrangements and the movement of aircraft in the hangar, is equipped as a Damage Control Section Base and has communications with fuelling positions and HQ1. The fire curtains can be operated from the HCP, inside the hangar on either side of each curtain and in the access lobbies. Each hangar section has one access lobby to port and starboard.

If fire breaks out in the hangar, ventilation should be crash stopped, but it is recommended that the trunking is not closed because, if spraying is started, the sudden drop in pressure may damage the fire curtains. On the first instance the fire must be attacked with 9 ltr foam (AFFF) extinguishers, CO_2 (if appropriate) and, possibly, main foam appliances. As soon as it becomes obvious that the first aid firefighting measures are having no effect, the Command should consider the use of fixed installations (hangar sprays) and Command approval must be authorised prior to their use. Preparation to activate the fixed installation must be made from onset of the fire and very early action must be taken to drain back any aviation fuel from charged systems.

b. The danger from composite fibre materials in a fire (see BRd 2170(5)) will be compounded in an enclosed area such as a hangar, so early use of breathing apparatus will be essential. After a fire in a hanger, involving composite fibres, great caution must be exercised to contain contamination and to establish a safe working environment. Access is to be strictly controlled; protective clothing and BA will be necessary until it can be ascertained that no fibre dust is present. This may require the removal and cleaning of all equipment in the hangar.

2142. Floating Oil or Fuel

This hazard is sometimes met in harbours and basins. If ignited it could cause a ship fire. Alternatively, with a ship on fire, floating oil or gasoline in the basin, or discharged from the ship, might result in a ship-to-ship fire. Floating burning fuel should be attacked with AFFF, although high flash point fuel can usually be broken up with water jet and then isolated portions cooled and quenched with water spray. A patch of burning fuel can be prevented from spreading by using the wash from ships' boats.

2143. Firefighting in a Chemical Environment

a. The citadel entry procedures after firefighting in a chemical environment are detailed in BRd 2170(2). The protective clothing for these operations is detailed in Chapter 25. The BA procedures, including changes between EDBA and General Service respirator, are detailed at Annex 21K.

b. Before committing firefighters to an incident where contamination is suspected, the following points should be considered to reduce the risk of contamination to personnel and equipment:

(1) If fixed firefighting systems have been used and all indications are that the fire is extinguished, consider delaying re-entry to allow purging of the compartment to help disperse the contaminant. Once re-entry by minimum number of personnel has confirmed that the fire is extinguished, withdraw firefighters and carry out monitoring and then decontamination if required.

(2) Consider all entry/exit routes to/from compartment, including escape routes. Machinery spaces may, for example, be entered via a pressurised airlock and exited via escape route to the upper deck. Contaminated personnel can then re-enter the citadel via normal cleansing stations. Equipment should be weathered for 24 hours before monitoring and cleansing routines to bring it back into service.

(3) If liquid contamination is suspected, firefighters are to dress in full IPE. This gives minimal heat protection and they must therefore stay behind a waterwall until fire is confirmed extinguished.

(4) Always have a relief team standing by, but consider minimising the number of personnel exposed by using only one team for the firefighting effort. The team maybe briefed to consolidate and withdraw to the airlock/entry for a rest and cylinder change at a pre-determined BA pressure.

2144. Search and Rescue

Search and Rescue operations in a fire environment are detailed at Annex 21H.

2145. Post Fire Precautions - Fire Sentry

In any firefighting situation, a sentry will need to be posted at the scene of the fire after it has been extinguished to report and attack any re-ignition. Initially, the sentry may be provided by one of the withdrawing Support Party, if his BA has sufficient air remaining. The requirement for follow on fire sentries is:

a. To be detailed from the pool of spare personnel, not from the Firefighting Team, who will need rest.

b. To be dressed in full firefighting rig and in communication, via FFHBC, with the FCP, the FRPP or HQ1. A BA controller will be required.

c. To be provided with a charged hose fitted with a firefighter nozzle, or centre feed hose reel of sufficient length to reach all areas of the compartment under surveillance.

d. To patrol a number of compartments, if they are on the same deck and it is practicable to do so. If there is requirement to patrol on different decks, then further sentries must be posted.

e. To remain closed up until relieved. A sentry will be required until the person in charge of firefighting is satisfied that there is no possibility of re-ignition.

2146. Welding and Burning Sentries

Instructions to Welding and Burning Sentries are contained in BR 2000(20) - Ship Engineering Practices: Safety Considerations and Precautions.