# CORRESPONDENCE

Sir,

## Fire-fighting Problems in Warships

I have read with much interest Mr. Faulkner's article 'Fire-fighting Problems in Warships' (*Journal of Naval Engineering*, Vol. 20, No. 2). His excellent article covers much of the future design options now becoming available to the ship designer. Nevertheless, there are still many lessons to be learnt from past designs but which are not mentioned in his article. Although he may be well aware of them, there are many officers and ratings at sea who would be pleased to hear that designers were taking steps to prevent repetition of past shortcomings.

As the Marine Engineer Officer of a Guided Missile destroyer, I would like to make specific points about shortcomings in this Class which should be borne in mind when designing a new Class of ship.

It is no secret that a GMD is constructed with the Seaslug Missile magazines above the main machinery compartments and consequently well above the waterline. This vulnerable position, together with the use of Dieso as the main fuel for burning under the main boilers as well as in the gas turbines, makes the main machinery compartments into high fire risk areas. Therefore, it is most important that every precaution is taken to prevent the outbreak of fire, or if there is an outbreak, to ensure that it is extinguished with the utmost possible speed.

The use of fuel header tanks and even the installation of Diesel generators relatively high in the gas turbine room increases the fire risk, particularly if fuel leaks on to a hot surface; below the Diesel generators, the auxiliary boilers glow red when in use. This type of Diesel engine is prone to failure of fuel injector pipes due to vibration and metal fatigue. Every effort, therefore, has to be made to use only one Diesel generator at a time and the opposite auxiliary boiler when in harbour. This inevitably means that the emergency gas turbine generator is nearly always used in harbour and thus accumulates hours at a high rate. Whenever this arrangement is not possible, a watchkeeper is placed in the gas turbine room to ensure that immediate action is taken to stop the Diesel generator if fuel is leaked on to the glowing auxiliary boiler below. It has been known for the Minerva fire alarm to fail to operate because the ventilation air-stream takes the smoke away from the pick-up. Even A and A 832 will not prevent a fire but only provides a means for stopping each Diesel from within the gas turbine control room. No provision is made to shut the fuel supply valve below the ready-use tank from a remote position.

There are sixteen H.P. air storage cylinders in the gas turbine room which, if subject to high temperature, may explode. It is virtually impossible to resite these cylinders elsewhere within the ship. Therefore, a method is required to reduce the pressure quickly for maximum safety: a dump valve should be fitted to relieve air from the H.P. cylinders or the H.P. system to a position external to the citadel.

Mr. Faulkner mentioned the increased allowance of Damage Control Breathing Apparatus (DCBA) and International Compressed Air Breathing Apparatus (International CABA Mk 2) to combat smoke. Four sets of breathing apparatus have been removed from the DC Section Base lockers and are now permanently stowed adjacent to the main machinery compartments on the port and starboard sides of No. 2 deck passageways. In addition, four Pattern 5665 Breathing Apparatus are placed on the same principle because the self-contained sets restrict the movement of the wearer within the machinery compartments and because it is quicker to put on than a self-contained set with extension hose.

Smoke is considered to be the initial hazard and, therefore, the initial action in the event of fire in a main machinery compartment is to stop the ventilation supply fans. When a door or hatch is opened to allow entry for a fire-fighter, the exhaust fans will draw fresh air in with him. The emergency stop switches for the ventilation fans are only sited on No. 2 deck port passageway. This is the less convenient side because the principal accesses to the main machinery compartments are on the starboard side because of the accesses to the control rooms. There is no direct way on No. 2 deck to traverse from starboard to port aft of 45 bulkhead. For effective and rapid control of ventilation, the emergency stop switches should be duplicated on No. 2 deck starboard passageway.

Speed is essential in fire-fighting: one man with a 2-gallon gas/water extinguisher early is likely to be more effective than the whole support fire-party with the paraphernalia of hoses, jet/spray nozzles, breathing apparatus and fearnought suits later. There is, however, the in-between stage when one man is needed with just a little more water than the 2-gallon extinguisher. The amount of water supplied by the extremely cumbersome canvas hoses and their instantaneous connections can be far too much and far too late because of the obsolete design. The old design has little to justify its retention except the amount of water it can supply in the event of massive boundary cooling or salvage. The quantity of water delivered is enough to do far more damage than good in the vast majority of compartments. It requires too many men to rig and operate it. It cannot be drawn through a doorway or round a guardrail stanchion without each coupling being individually lifted or edged round the sill or stanchion.

It is not possible to connect a run of hose going forward through a passage bulkhead hose connection without the use of a double male and a double female adaptor; it will be noticed, however, that it is possible to connect a hose run going aft without the use of adaptors. The length of canvas hoses supplied for the hose baskets are invariably too short and one or more extra hoses are required (to be obtained from adjacent baskets) to ensure that the nozzle is within striking distance of the fire. It can, therefore, be seen that there is a tremendous need to introduce retrospectively the (garden) hose reels mentioned by Mr. Faulkner. So long as there is a valve incorporated in the nozzle assembly, one man on his own will be able to apply a continuous stream of water onto the source of the fire. The operation of this type of equipment should be extremely easy, even while wearing breathing apparatus if the compartment is already filled with smoke. The siting of the hose reels and the length of hose should be determined so that the furthest corner of each compartment may be reached.

There are also several aspects of fire-fighting in other compartments which require up-dating as a result of recent experience. Many compartments contain primarily electrical or electronic equipments. The majority are vital to the operation of the weapons systems and are not duplicated. The electronic equiments frequently do not give satisfactory service for quite some time after even a short power cut. In the event of fire, therefore, it is most important that the power is not removed from these vital equipments until it is absolutely necessary to do so to preserve the safety of the ship. This may mean delaying the boundary cooling as long as possible and then making the maximum use of the minimum amount of water. This is possibly an additional argument for the use of the garden hose fitted with a fish-tail spray.

The contents of a modern mess or messdeck would give a professional fireman a heart attack: there are dozens of men living in three-tier bunks without an ashtray in reach; the furnishings such as curtains, covers, and carpets are ever on the increase without any indication that adequate fire-proofing has been carried out. Once ignited these items would without doubt, produce dense smoke. If ventilation fans are not stopped immediately, smoke would soon be dispersed throughout the local ventilation system. The ventilation can only be crash-stopped by opening the electrical breakers on each main switchboard and, unless these are constantly manned, there is bound to be a delay while a man goes below. It is suggested that this could be done remotely and more effectively by a watchkeeper in H.Q.1 or in the ship control centre.

A galley fire is almost always taken to mean a fire in the deep fat frier, and quite rightly so. Closer examination of the main galley deep fat friers shows that both are sited as a combined unit with a surrounding lip and a dividing lip. This would mean that two separate sources of foam would have to be applied in order to cover both pans of fat. A great improvement would be gained if both pans were fitted with a common foam tube which could be supplied with foam from a safe position external to the galley. Incidentally, the 2-gallon foam extinguishers are sited inside the galley and so close to the friers that it is doubtful if anyone could reach them in emergency, particularly if the fire was discovered while the galley was locked and there had been time to gain some heat.

It is fully appreciated that these are small problems compared to the higher principles of fire-fighting but no one can doubt the damage that is caused by lack of attention to detail.

(*Sgd.*) E. R. Chapman
*Commander, R.N.*

*Ship Department Comment*

The remarks of Commander Chapman are fully appreciated as designers can never have too much feedback of user experience.

Machinery spaces by virtue of their contents and layout are inevitably high fire-risk areas in a ship; Guided Missile destroyers are certainly no exception and the short-comings are well known. Attention has been focussed on a number of these following fire incidents in ships of the class and a number of alterations and additions have been raised to correct or mitigate where practicable the more serious deficiencies; other short-comings have been noted and will be avoided in future designs.

Regarding the hazard from fuel header tanks, arrangements are being made to lead the air vents down to the bilge.

The limitations imposed by the auxiliary boilers and the Diesels are well known; nevertheless, it must be remembered that the original concept for this class was that the gas turbine room was also the harbour machinery space. However, the point made by H.M.S. *Norfolk* is relevant and has been noted for future new construction.

Trials of new type fuel-injection pipes designed to overcome the problems envisaged in Cdr. Chapman's letter are currently in hand.

A and A 832 provides for the Diesel to be stopped from a position outside the GTR; it also provides for the Diesel generator fuel supply to be shut off remotely by stopping the transfer pumps.

Reports from the Fleet indicate that a bigger problem with Minerva fire-alarms is the incidence of *false* alarms rather than failure to operate in the event of fire. This aspect is currently the subject of close investigation by the Ship Department. Failure of Minerva alarms to operate or respond speedily in the event of fire should be included in fire reports. Following investigations into poor performance of these detectors in H.M.S. *Glamorgan*, A and A 814 has been raised to cover the provision of additional detector heads at positions recommended by Messrs Minerva Ltd. in the machinery spaces in Guided Missile destroyers. It is understood that this has not yet been implemented in *Norfolk*.

Stowage of unprotected H.P. air storage cylinders in the gas turbine room is unsatisfactory and will be avoided in future designs. The cylinders are unlikely to explode; in a fire in the GTR of a GM destroyer, the 'O' ring seals were damaged by fire and the air thereby released. A and A 864, issued after Cdr. Chapman's letter was written, covers the requirement to exhaust the H.P. air bottles rapidly; As and As 828 and 840 cover the modifications to the H.P. air system following the fire in H.M.S. *Fife*.

Cdr. Chapman's remarks regarding breathing apparatus are noted with interest. The Ship Department is not, however, entirely convinced that the use of smoke masks is to be recommended or preferred to the self-contained breathing apparatus. The objections are the danger of the air hose becoming entangled round equipment, structure or fittings; the necessity to keep the access hatches open; the vulnerability of the hose to damage, albeit small; the risk of inhalation of products of combustion, should these escape into the passage via the open hatch—the latter is unlikely provided exhaust fans only are running as indicated in Cdr. Chapman's letter. Section 122 of the Ship Department would welcome further comments from the Fleet on the pros and cons of using self-contained breathing apparatus and smoke masks when fighting fires in machinery spaces.

Regarding the siting of emergency stop switches, it is agreed that these should preferably be sited at the principal accesses to machinery spaces. The penalty in terms of wiring and cost for the provision of emergency stops at all accesses cannot be justified. Duplication of stop switches on No. 2 deck starboard passageway will be investigated.

Cdr. Chapman's comments supporting the provision of hose reels to bridge the gap between portable extinguishers and the hoses provided are noted with considerable interest. There is growing support for this equipment and investigations are being made into equipment suitable for service use; the reels must be shock resistant and the hoses must not deteriorate rapidly in ship environments. Hose reels are being provided in the machinery spaces of new designs and consideration is being given to extending their use elsewhere between decks in future designs. We would be reluctant at this stage to replace hydrants, required for use with foam-making branch pipes and foam inlet tubes and for tackling serious fires which could develop between decks due to action damage. Provision of hose reels additionally would, therefore, incur penalties in cost, weight, and space; the latter can be quite a problem in cluttered passages. While sympathizing with the plea for hose reels in GM destroyers, it is unlikely that the cost of retrospective fitting can be justified in the present climate of severe financial restraint.

The criticisms of standard hose arrangements are noted. Double hose-baskets with 40 ft. and 20 ft. lengths of hose are recommended at each hydrant. The type, size, and lengths of hoses is currently under review in light of the standardization agreed by other services and accepted for naval shore establishments.

Cdr. Chapman's comments on weapon/electrical compartments are noted and generally agreed. The risk of damage to equipment by water has to be weighed against the cost of further fire damage if the use of water is withheld. In general, however, in a serious fire situation, speedy extinction of the fire is of paramount importance and transcends the risk of some water damage to equipment. This argument is particularly relevant where fixed water spray systems are installed.

It is perhaps opportune to emphasize that, where a fire is developing rapidly and not responding to first aid sources, the fixed foam systems should be used soonest—particularly where the fire is seated in the bilges or tank top, and in ships so provided there should be no hesitation in evacuating the compartment and using steam drenching. This is most important where a serious fire has become established at higher levels.

The potential hazards associated with the use of modern materials, notably plastics, are well appreciated and serious efforts are being made to mitigate them. Small sample fire propagation and smoke tests have been and are being carried out by the Admiralty Marine Engineering Establishment and at the Central Dockyard Laboratory; these tests are on habitability materials and other plastic materials considered for applications elsewhere in the ship, and materials exhibiting particularly undesirable properties are banned. Particular attention is being paid to improving the fire resistance of material systems; currently a series of large scale fire tests of bunk assemblies of different mattress pad materials and bedding (including proofed and unproofed linen) and recreation space settee/lining modules is being carried out at the AMEE. It is hoped shortly to make recommendations which will significantly improve the fire resistance of these systems to fire propagation. Tests confirm the protection afforded by wool blankets; one message (loud and clear) is that the made-up bed is much safer than one with the bedding deranged and blanket turned back. Improvements are already being made, for example: all textiles are now required to meet BS3121 in respect of fire resistance and to be tested in accordance with BS2963. This means that cotton covers and curtains will in future have to be permanently fireproofed. PVC and loose cotton covers for settees and chairs are being replaced by fitted wool covers and wool coverlets will be specified for bunk bed covers. Carpets have a high wool content and are not easily ignited. All wood is fireproofed and does not burn easily. Fires in accommodation areas are, in general, quickly detected and are not difficult to extinguish at the early stages before the smoke obscures the seat of the fire. Cdr. Chapman's remarks regarding

the distribution of smoke via the ventilation system are noted and agreed. A crash-stop facility from the ship control centre/NBCHQ is now specified and is being provided in all current designs.

The Ship Department is investigating the possibility of using fire-detectors, sited in air treatment units, to switch off the fans automatically on the arrival of smoke, i.e. as a form of smoke control with secondary function as 'long stop' fire-detectors when all the compartments served are unmanned; this latter will rarely be so for ships in service.

Recent experience does not confirm that a galley fire is almost always a fire in the deep fat fryer. Although this used to be so, the introduction of dual temperature cut-outs has decreased significantly the incidence of reported fires in deep fat fryers: of fourteen fires reported in galleys in the last five years, only three involved deep fat fryers and only one of those had a dual thermostat fitted.

The proposal to fit a foam tube to fat fryers has been considered previously and rejected. Injection of foam remotely via a tube from a portable chemical foam fire-extinguisher would not be effective; something approaching a foam-making pipe via a large tube would be required. This would need capping at its free end to avoid entry of foreign particles; it would interfere with the fryer covers; there would be a danger of splashing the burning fat and spreading the fire; and the tube itself would tend to become coated with oil and grease and itself pose a fire hazard. It is agreed that the portable foam fire-extinguisher should be sited away from fryers.

Finally regarding the selection of fire-fighting equipment for the Navy, although well aware of the wide range of excellent fire-fighting and fire-protection equipments available, we do not necessarily attempt to provide the optimum equipment and installations for every conceivable fire situation. The reason for this is that it is recognized that naval personnel are not professional fire-fighters and, therefore, apart from obvious considerations of cost, space, weight, and ability to survive warship environment in peace and war, equipment should be simple to use, reliable, easily maintained, and—most important—the range of equipment should be kept to a minimum.

Feedback from the Fleet on fire topics is always welcome, and Cdr. Chapman is thanked for his interest and comments.

Sir,

**Main Engine Failure—H.M.S. 'Naiad'**

Although the article by Lieutenant-Commander Goldie on the main engine failure in H.M.S. *Naiad* (Volume 20, No. 3) gives a most interesting and factual account of the event as seen by the ship's staff, it does not, understandably, attempt to analyse the cause of the failure. The metastream coupling failed with disastrous results, but the question is raised why did it fail and, more important, are other similar failures likely to occur?

It must be understood that metastream couplings are designed to cater for clearly defined axial and angular misalignments and, for a given angular misalignment capability, the allowed vertical/horizontal movement increases as the length of the coupling increases. The coupling which failed in H.M.S. *Naiad* was fitted between the steam turbine and the main gearbox where angular misalignment is predominant and, due to the existing machinery installation, the coupling was very short. Calculations undertaken before the coupling was fitted for trial indicated, however, that misalignment should not be a problem in service.

Extensive investigations undertaken following the failure show that the turbine after bearing pedestal was not firmly secured, being free to move to such an extent that an angular misalignment of more than 150 per cent of the designed maximum was present, and had been for a considerable time before the failure. In retrospect, therefore, failure was not surprising.

Metastream couplings have been used in the Royal Navy for over twelve years and, of more than one hundred now in service, there is only one failure. As already mentioned, the coupling on trial in H.M.S. *Naiad* was very short compared with other metastream couplings in service, being approximately one-quarter of the length of the next shortest and, it follows, had only a quarter of the vertical/horizontal misalignment capability.

These is, therefore, no reason to doubt the reliability of the other metastream couplings in service and metarstream couplings will continue to be fitted in new construction ships. It is hoped that the above will restore confidence in the coupling and save a few grey hairs among sea-going engineers.

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