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**Se refiere al hundimiento de la SHEFFIELD, publicado por el Ministerio de Defensa de Gran Bretaña.**

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**COMMANDER-IN-CHIEF FLEET**

**LOSS OF HMS SHEFFIELD  
BOARD OF INQUIRY**

**Annex L**

POST ATTACK ANALYSIS

1. Scope. This annex comments on some aspects of the events described in Annex K, in particular the damage at impact, the reasons why firemain pressure was never achieved, the lessons learnt from the Damage Control and Firefighting phases and a number of miscellaneous aspects. Finally, it includes a list of suggested points for action.

General

2. When the missile hit, the ship was in Damage Control State 2 Condition YANKEE with the Starboard Defence Watch closed up. Of the remainder of the Ship's Company many were resting and sleeping. The ship did not go to Action Stations or Damage Control State 1 Condition ZULU. There was undoubted confusion after impact and so fast did events occur initially that many key Officers and Senior Ratings were unaware for some time of the extent of damage or location of fires.

3. Without orders, as a natural reaction, the majority of the Ship's Company immediately endeavoured to get to their Action Stations. They were hampered in their attempts by smoke and jammed doors in the port and starboard passageways. Indeed, many never reached their Action Stations. Several casualties were seen within seconds of impact and this added to the total surprise, shock and general bewilderment. Several key Officers and ratings were suffering from shock which was not immediately apparent. It was 10 to 15 minutes before effective control was established.

Q1860  
Q8712

4. Following the group discussions and statements made for the SHEFFIELD Report of Proceedings and with the benefit of photographs, and hindsight, witnesses gave evidence in which it became difficult to differentiate between facts, actions and recollections of their own and the experiences of others.

Direct Damage

5. Missile Impact. The missile struck the ship in J Section at 2 Deck level from a relative bearing of about GREEN 45. The resultant hole was 15 ft long and 4 ft wide peeling back the ship's side to 27 Bulkhead. Petalling outward around the hole occurred, particularly at the top, extending approximately two feet out from the ship's side. From photographic interpretation (see Annex K, Appendix 2) the missile penetrated the FAMR, Galley and PER, thus rupturing 27 bulkhead and most probably one or more of the FAMR Fuel Service and Ready Use Tanks which held a combined total of some 30 tonnes of Diesel.

Q1829

6. EXOCET Warhead. The question of whether or not the EXOCET Warhead exploded has been considered at length. The Board called in expert witnesses and a full Report is at Appendix 1. Their conclusion, that it did not explode, is agreed. (see also Appendix 4)

Q7337

7. Blast and Other Effects. Immediately, blast was experienced in the vicinity of impact and more generally in C, H, J, K and L Sections on 2, 1, O1 and O2 Decks. In addition, the blast travelled along both port and starboard 2 Deck passages and caused



J1 Generator may, by now, have shed its load. N Fire Pump was defective. In the absence of a removable access plate the Ship were unable to effect repairs despite the fact that the replacement motor was held onboard. C Fire Pump was not running due to a reported problem of losing suction at sea. Sometime later C Fire Pump would not start. XXXXXXXXXXX account of C Fire Pump electrical state is consistent with its normal supply from K 1 EDC not being available. However, Alternative supply from N2 EDC was available. The starter for C Fire Pump is sited on the starboard ship's side, and it is likely to have suffered shock damage.

Q2571 et seq

Q2617

338, 340, 341

12. There was no evidence to suggest that the firemain system was damaged other than in the starboard midship area. The discharge of water seen shortly after impact could only have been produced by the restarted L Fire Pump. This ceased after about 10 minutes when, it must be assumed, L Fire Pump stopped. XXX planned his re-entry to 2M Starboard to start L Fire Pump, having established that supplies from N EDC were available, and to isolate the Fire-main forward of the Pump Riser on 2 deck starboard. The previous isolations in 2L and 2N were in conflict with this plan since they would have prevented L Fire Pump discharge being effective aft. Evidence about the precise location of the previous isolation was very uncertain. However XXXXXXX in charge of the After Section Base, was aware of these isolations. Additionally, K Fire Pump could not be reached because 2K/L Port door was jammed shut.

338, 340

344

Q2833-Q2837

Q4158-Q4173

338, 340,

344

#### Damage Control and Fire Fighting

13. Forward Section. The Forward Section rapidly filled with dense smoke. Smoke boundaries were never effective. The 2F/G Starboard Door was not an effective seal either because it was not fully clipped or it was damaged. The 2F/G Port Door was open for a considerable period to allow the escape of the MCO and Ops Room crews. Smoke clearance was attempted. However, ventilation had been crash stopped and G EDC which contained the breakers, was inaccessible. Fans, therefore, could not be restarted. DB fans might have helped but were not tried. The many re-entry attempts were frustrated by inadequate size of the Poc'ale escape manholes through which men cannot pass in BA. They also proved a particularly awkward route for casualty evacuation. The Forward Section Base was evacuated after about 20 minutes and no fire fighting from this section was achieved.

Q3851

Q5501-Q5516

Q5544

14. After Section. Smoke boundaries were established at 2M/N Bulkhead. Smoke clearance using the AAMR Port Exhaust Fan, forward of this boundary, was tried but this may have assisted the spread of the fire. It was later stopped. Upper deck vent flaps in N and F Sections were closed. The After Bathroom Exhaust Fan was started and this proved effective in clearing smoke from the After Section. Establishing smoke boundaries at 2L/M Bulkheads was not attempted. They would have proved beneficial. The re-entry up the Starboard Passage to restart L Fire Pump was a brave attempt. There was some confusion about its objective due to the JRs apparently hearing some earlier conversation about CO<sub>2</sub> drenching, but XXXXXX was quite clear what was being attempted.

338, 340, 341

15. Incident Board. The lack of a Whole Ship Incident Board at the After Section Base inhibited attempts to assess whole ship damage.

Q2718

16. CO<sub>2</sub> Drenching Arrangements. The CO<sub>2</sub> drench operating positions on 2 Deck were unapproachable. The firing of one bank of CO<sub>2</sub> from the upper deck was considered ineffective. The inability to reach the control cabinets at 2 Deck starboard highlights a design weakness in this system. The duplication of firing positions and salt water back up connections should receive early attention.

Q2678  
Q3382

17. Upperdeck. Firefighting attempts on the Upperdeck were far removed from the seat of the fire and largely restricted to boundary cooling on external decks and bulkheads. Connection of ARROW's hoses to the firemain might have helped but was not tried. The re-entry attempt at 1H Starboard and other Upperdeck fire fighting incidents demonstrated a weakness of the present Fearnought Suit which allowed scalding water to impinge upon heads and run down necks. Fire fighters wore both tin helmets and anti-flash hoods and neither were effective.

Q5800-Q5804

18. Rover Gas Turbine Pump. SHEFFIELD's Rover Gas Turbine Pump appeared to be regularly maintained and despite an earlier OE Report (1) of a starting chain defect had proved reliable. The restrictions on the maintenance schedule weekly running routine while at sea should be investigated and the provision of suction stand pipes to enable regular running whilst at sea considered. XXXXXXXXXXXX reluctance to connect the running Rover Gas Turbine directly to the ship's firemain system due to his previous experience and the unknown state of the firemain, is reasonable; but reduced firemain availability to other users, and the need for long hoses, resulted from this decision. The capability of the Rover Gas Turbine Pump to supply the firemain system, the numbers of hoses it can effectively support, and the ability to lift a suction to the Poo'sale should be investigated. Coase necks for all four shore firemain deck connections should be available to assist fire main breaching over the upper deck. The Rover Gas Turbine will not pass through the Flight Deck hatch.

532, 510, 244  
Q2669 at seq

19. Portable Pumps. Electrically powered portable pumps were used successfully to fight fires in the initial stages. Difficulties were experienced because with a long swell and the ship moving through the water they tended to bounce and lose suction. Sparking occurred in some and one became defective. Their weight may have sometimes been supported on the supply cable. The bulkiness and weight of their portable starters was commented on, particularly Forward where the starter would not go through the Forward Escape Manhole.

Q7728

Q5016

20. Hoses and Couplings. Vital moments were spent in reconnecting hose couplings. Although all plastic end couplings manufactured by Lindley Plasticene had been inspected the effectiveness of these hose couplings is suspect. In addition, some hoses burst and leaked. Regular use of hoses charged with water must be encouraged.

Q2584

21. Escape. Escape was achieved from smoke filled compartments by many of SHEFFIELD's Ship's Company. Use of AGRs and crawling on decks was obviously helpful in many cases. SSDs were not used, but only 11 were fitted in SHEFFIELD, ten in machinery spaces and one in the UAA1 Bearing Head Compartment. Additional SSDs in other areas could have been highly beneficial. Escape arrangements from the

(1) SHEFFIELD 250/2 dated 4 Mar 82

FMR are poor. Several ME Senior Rates had tested the route prior to entering the TEE and found it daunting and inadequate, particularly when having reached the hatch it proved so difficult to open. The Naval Stores had no escape hatch, whereas the recently built Type 42s have. The non implementation of this A and A should be investigated.

Q5468-Q5472

Q5005

22. Smoke. The spread of smoke was made easier by the ship being in Condition YANKEE. At impact, all 2 Deck YANKEE doors were shut except 2G/H Starboard (see Appendix 2). 2F/G and 2M/N doors were secured on two clips. 2G/H doors are quick release central hand wheel type. Some of these doors were damaged and this combined with the fact that there is no longitudinal sub division from G to M sections inclusive meant that the original smoke boundaries were at 2F/G and 2M/N. The smoke boundary aft was effective at 2M/N. However, 2F/G Starboard Door was not securely clipped and was probably damaged. No attempt was made to secure that door with all clips. 2F/G Port Door was open for a considerable period to allow escape. This door was then shut by xxxxxx and appeared to be effective. Appendix 4 shows smoke on the upper deck.

Q3851

S38, S40, S41

### Ventilation

23. AAAs. DG Ships expert witnesses presented a paper on Ventilation (2) to the Board. It was established that SHEFFIELD had not had a number of important A and As completed. Had they done their effects would have been:-

Q7372

a. AAs 175, AAs 110 and AAs 255 would have made all bulkheads on 2 Deck passageway watertight to a height of six feet and smoke and firetight for the remainder.

b. AAs 195 would have replaced additional ventilation on/off switches with fan starters enabling them to be crash stopped.

c. AAs 172 would have overcome the problem that when doors, hatches and vent trunks are shut in Condition YANKEE, re-circulation is prevented and pressure build up is caused.

24. In relation to the spread of fire and smoke it was learnt that:-

a. 90% of fan trunks are made of Aluminium.

Q7369

b. In SHEFFIELD, fans were fitted with old type nylon flexible connections which disintegrate at quite low temperatures.

Q7368

25. The Board felt that in the guidance to MEDs in BR 6612(010) the Ventilation system drawings were clearly in need of improvement. In general, the outstanding ventilation AAs clearly indicate that improvements had been put in train but that the subject of ventilation, smoke clearance and establishment of smoke boundaries was an area requiring a full study. SHEFFIELD reported that there are anomalies between the watertight control markings of doors and ventilation valves in some sections of the ship (see Annex W).

Q7363

(2) DG Ships D/S/2120/1570/59/2 dated 1 Jul 82

26. SHEFFIELD had not implemented DCI 500/81 to produce a new style ventilation board. Ships were directed to compile their own.

Q2605

27. Machinery Space Ventilation Flaps. (See Appendix 3). The closure of FMR Machinery Space Ventilation Flaps was considered. These are near the foot of the foremast areas. The smoke and heat in this area made it impossible to close them. Closing the FER Ventilation Flaps was also considered. The exhaust flaps have remote operated handwheels in the JRs Dining Hall and were obviously inaccessible. Both supply flaps are operated by a lever near the forward base of the Funnel. This area was also inaccessible. Closure of the AER and AAMR Vent Flaps was not considered at this stage and no evidence was produced to say that they had been closed subsequently. The Exhaust Flaps for both the AER and AAMR are operated at 2 Deck level from the MCR and Canteen Flat respectively. These arrangements clearly require review.

Q2698-Q2900

Q2681

#### Machinery Operation

28. Because the MCR was immediately affected by the blast and rapidly filled with smoke from the starboard passage leading to its evacuation, there is a dearth of direct evidence. The Main Machinery Console was lifted appreciably by the blast, and control of main engines and most auxiliary machinery was lost. The Starboard Tyne was shut down as ordered, but the mechanical trip linkage had to be used. Restarting of the After Fuel Boost Pump, both MD Forced Lub Pumps (fitted with Auto Changeover Switches), both MD CPP Pumps and L Fire Pump was possible. It is believed both J1 and M1 Generators were still running at this time. It is also believed that indication defects on the console existed as a result of shock. Later, in thickening smoke, XXXXXX had doubts whether J1 Diesel Generator was running. The MCR was evacuated before he could start the standby Diesel Generator, or make electrical supplies available to the Forward Section.

533, 545,  
July

29. Evidence suggests that J1 Diesel Generator continued to generate for one and a half to three minutes. It then shed its load. With only M1 providing electrical supplies the effects, which are confirmed by subsequent events, would have included:-

Q2194  
Q1641  
Q1700  
Q1710

- a. The AER Port Exhaust fan would have lost its normal supplies K2 - 30.
- b. The AAMR Port Exhaust fan would have its normal supplies M2 - 14 available.
- c. C and E Fire Pumps would have lost normal supplies but alternative supplies would have been available.
- d. The Port Steering Motor would have normal supplies available, and the Starboard Steering Motor alternative.
- e. The ATCAT Fuelling Pump would have normal supplies available.
- f. The After Hydraulics Pump would have normal supplies available.

30. The Port Tyne continued to run, presumably with fuel supplied by the Aft Fuel Boost Pump until M1 Generator stopped and by the gravity fuel tanks thereafter. With the exception of shutting down the Auxiliary Boilers and the Evaporator Plant no other





37. Smoke Curtains. The provision of an extensore smoke curtain proved effective. Consideration should be given to providing smoke curtains and associated fittings at key doors throughout the ship.

Q2770-Q2771

38. NBCD Class Book. The NBCD Class Book for Type 42 Destroyers still indicates that they have a three Sub Citadel System whereas, in fact, they only have two Sub Citadels.

39. Upperdeck Lockers. Upper deck DG and FF lockers would have aided operations. Smoke caused desperate measures to be taken in the Forward Section to recover equipment in order to fight the fires from the Upperdeck.

#### External Assistance

40. The assistance provided by ARROW was outstanding. Ship-handling was excellent and the hoses passed facilitated important re-entry attempts. A great deal of direct boundary cooling was achieved by ARROW from alongside. She re-charged a lot of BA and, finally, took off most of SHEFFIELD Ship's Company.

Q2497 et seq

Q2692, Q3395

41. YARMOUTH's position was more difficult. She was on the windward side and was also more affected by the swell. She encountered considerably more difficulty in achieving a satisfactory alongside position, and in fact never really did so. It was particularly difficult to direct hoses into the missile entry hole because of the large out-turned lip along the upper edge. YARMOUTH used foam which made hitting the hole even more difficult, but was nevertheless the right choice as the fire in the PAMR was undoubtedly burning Diesel.

Q2497 et seq  
Q2505-Q2506

Q2703

Q5796

42. The support provided by helicopters, particularly in providing fire fighting equipment and evacuating casualties, was excellent. Flying conditions must have been extremely difficult at times, mainly due to smoke, but operations continued to SHEFFIELD Flight Deck and Rec'ale. The attempted use of helicopter rotor downdraught to clear smoke from Upper Deck openings was not successful and was abandoned. The use of SHEFFIELD's LYNX to fly thexxxxxxxxxxxxxto HERMES, to make a personal report to CPO, was most sensible. An annoying but unavoidable delay was caused by the need to unload a Sea Skua missile to reduce ANW.

SBS, SNC,  
Syc

43. With all the wisdom of hindsight, the Board do not consider that any of the reported sonar contacts or torpedo alarms were genuine. Of course, in the circumstances, they had to be taken seriously, but a more rigorous approach to classification would have reduced the extent to which these spurious alarms reduced the assistance given to SHEFFIELD.

Q2498, Q3701  
Q6590-Q6597  
Q6188-Q6194

44. Most of SHEFFIELD's portable communications equipment was inaccessible after impact, it being in the NCO or on the Bridge. VHF sets were flown in and proved adequate, if not ideal, for communication between SHEFFIELD, YARMOUTH and ARROW. V/S communications were not used.

Q2497  
Q2509

#### Command Aspects

45. Three aspects merit comment; the failure to establish an emergency HQ or command position, the lack of coordinated control of manpower and checks on quarters, and the Captain's decision to abandon ship.

46. Emergency HQ1. A Type 42 which loses HQ1, the Forward DG Base, the Bridge and almost all internal communications, and has damage and serious fires amidships, is not well placed. The After Section Base is not equipped to control operations throughout the ship. In SHEFFIELD's case, a lot of good individual and team firefighting efforts continued, despite the lack of any central control. Nevertheless fragmentation and lack of coordination reduced their impact and, probably, time and resources were wasted. There were plenty of Officers and Senior Ratings available, and the establishment of a rudimentary emergency HQ1 and command position, possibly in the Hangar or on the EOP or Gemini Deck, centred on XXXXXXXXXXXXXXXXXXXX and to which the XXXXXXXXXXXXXXXX could turn to ask for information or give orders could have been very valuable. Establishing such a facility on the EOP would have had the additional advantage of co-location with XXXXXXXXXXXXX

Q2658

Q2520, Q2748

S38/240,  
E44

47. Manpower Control. Connected with the above, the Board felt there was not enough effort, and what little there was was unsuccessful, to check and control manpower. Attempts to muster personnel on the Poc'ale and in the Hangar were unsuccessful as so many were carrying out emergency tasks. They were hampered by the absence of Master-at-Arms WELSH, killed at impact, and the failure of Officers or Senior Ratings to organize a system. There were two unfortunate consequences. No one was specifically worrying about those still closed up below and it was some time before the Computer Room Crew and the Supply Officer were registered as missing. It was then probably too late. The other result was that in a few cases the most suitable man was not used for a demanding task. Senior Ratings were dumping ammunition while young and inexperienced men were fighting fires in BA and fearnought suits. The inevitable chaos after impact and the fact that some key personnel were shocked, may well have had a bearing in this respect.

Q2517-Q2519  
Q2520

Q2748

Q2712

48. Abandon Ship. The Board consider the Captain's decision to abandon ship necessary, brave and right; and further consider the timing to have been correct. In the circumstances it was clear that the combined efforts of three Ship's Companies were not availing, indeed they were losing ground. SHEFFIELD had ceased to be a viable fleet unit. She had virtually no residual fighting capability, there was a slight, but increasing, risk of a major magazine explosion and the tactical situation, as appreciated, indicated continuing risk of attack on the other escorts. The probable internal state of the ship at this time is illustrated at Appendix 5.

#### Summary

49. The Board's analysis of the fire fighting and Damage Control carried out in SHEFFIELD indicates that action is required in the following areas:-

- a. XXXXXXXXXXXXXXXXXXXXXXXX
- b. Inclined ladders

S26

- c. Quick Release Single Action Doors
- d. Smoke-tightness of Doors
- e. Smoke clearance
- f. Smoke curtains
- g. Smoke boundaries
- h. Maintenance of Firemain Pressure following damage
- j. N Fire Pump portable access plate
- k. C Fire Pump loss of suction in a seaway
- l. Provision of four shore connection goosenecks
- m. Foc'sle Escape Manholes
- n. FAME escape route
- p. Duplication of CO<sub>2</sub> Drench firing positions
- q. Incident Board
- r. Fearnought suit hood
- s. In line starters for Portable Pumps
- t. Fire hoses and couplings
- u. SSDs
- v. Aluminium fan trunking
- w. Fan flexible connections
- x. Ventilation Drawings
- y. Machinery Space Ventilation Flaps
- z. Through bulkhead connections
- aa. NBCD Class Book
- bb. Upper Deck DC/FF lockers
- cc. Emergency HQ<sup>1</sup>
- dd. Ability to pass pumps through Flight Deck Hatch
- ee. Allowance of BA
- ff. Smoke Canisters for training
- gg. Complete Naval Stores Escape Hatch A&A in all Type 42s

Appendices:

1. HMS SHEFFIELD - Direct damage inflicted by EXOCET AM39 (and enclosure).
2. Details of No 2 Deck Doors Port and Starboard.
3. Machinery Space Supply and Exhaust Flaps.
4. Photographs - Smoke and Missile Entry Hole: Comparison HMS RAPID and HMS SHEFFIELD EXOCET Hit.
5. Situation at time of Abandon Ship - Smoke and Fire.



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APPENDIX 1 TO  
ANNEX L TO  
SHEFFIELD BOI REPORT  
DATED 22 JUL 82

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The President  
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Our Ref:  
 SX1/30/5/SJ246/82  
 Your Ref:

Date:  
 8 July 1982

HMS SHEFFIELD - DIRECT DAMAGE INFLICTED BY HIOCET AM39

1. The Board of Inquiry into the loss of HMS SHEFFIELD recently requested that DSWP(N) consider the evidence available to the Board and, in conjunction with other expert advice, to present an informed opinion as to how the HIOCET AM39 missile had functioned after it struck HMS SHEFFIELD.

2. A number of authorities with relevant expertise were consulted and the conclusions are attached.

XXXXXXXXXXXXXXXXXX  
 XXXXXXXXXXXXXXXXXXX  
 XXXXXXXXXXXXXXXXXXX  
 XXXXXXXXXXXXXXXXXXX  
 XXXXXXXXXXXXXXXXXXX

533, 540, 544

COMMANDER, ROYAL NAVY  
 for DSWP(N)

enc1

ENCLOSURE TO  
 SX1/30/5/SJ246/82 DATED  
 JULY 1982

DIRECT DAMAGE INFLICTED BY EXOCET AM39 ON HMS SHEFFIELD

INTRODUCTION

1. The UK EXOCET Project Leader (DSWP(N)/SJ1) was tasked by the Board of Inquiry into the loss of HMS SHEFFIELD to consider the evidence available to the Board and to formulate an informed opinion as to how the EXOCET AM39 had functioned after it struck HMS SHEFFIELD.

2. A meeting was held at ASWE on 5 July 1982 to consider the evidence. Representatives of DSWP(N), D/ASWE, RARDE, PERME and DG Ships attended. The factors considered by the meeting and the conclusions are detailed below.

AIM

3. The aim of this paper is to record the evidence and arguments considered during the meeting described above and to list the conclusions.

THE EVIDENCE

4. The following damage evidence was considered:

- a. External photographs of HMS SHEFFIELD.
- b. A part elevation drawing of HMS SHEFFIELD's starboard side provided by the Board.
- c. Photographs of EXOCET MM38 warhead missile attacks on HMS UNDAUNTED and HMS RAPID.
- d. Films of inert and warhead missile attacks on ship targets by HARPOON and EXOCET MM38.
- e. Known missile parameters.
- f. A general arrangement drawing of HMS SHEFFIELD.
- g. Past experience of those present.

5. Additionally, DSWP(N) described the most probable terminal behaviour of the missile: an approach at 7 m altitude until 375 m from the target, followed by a shallow dive to 4.2 m at the point of impact (an angle of approximately  $9^\circ$ ). RARDE described the structure of the warhead. PERME described the behaviour of the sustainer motor after impact.

6. The Board of Inquiry provided DSWP(N) with a verbal summary of evidence given by survivors. This evidence was presented to the meeting. The following points were mentioned:

- a. The missile approached the ship and impacted at an angle approximately  $40^\circ$  with respect to the starboard bow.

- b. The sound of the impact was variously described as a 'loud crash' by some close to the impact and as 'a dull thud' by some farther away. No 'double bang' was reported.
- c. A pressure wave swept through the ship shutting some doors and shattering lightly constructed doors as far aft as the sick bay and CPO's cabin flat. One man was blown across the ship on 2 Deck adjacent to the sick bay.
- d. The majority of shock mounted equipments survived the impact without visible damage.
- e. A degree of mechanical shock damage was experienced; ceiling tiles, fernica panels, mirrors and other fixings were thrown to the deck. Some doors and hatches were jammed. Some metal pads adjacent to door coamings were sprung loose.
- f. A number of men were thrown 8-12 feet, but were otherwise unhurt.
- g. No burst eardrums were experienced even by men in close proximity (within 30-40 feet) to the impact.
- h. There was no evidence from any casualties of shrapnel wounds although there were personnel in several compartments adjacent to or in near proximity to the impact (Forward AMR, Forward Engine Room, MCR, Naval Store, CPO's Dining Hall). A few minor puncture wounds had been observed, probably caused by relatively slow moving debris.
- j. A very few men had received flash burns.
- k. The galley was not on fire immediately (30 seconds) after the impact.
- n. Within 30 seconds of the impact thick black smoke was forced on to the bridge under pressure. Some personnel in the Operations Room reported feeling 'a hot wind'. Many compartments in the ship rapidly filled with smoke.
- n. Serious fire broke out in the Forward AMR almost immediately. This was preceded by '2 fireballs'.
- p. Within a very short time the ladder on the forward bulkhead of the Forward Engine Room was too hot to touch. The survivor received flash burns.
- q. A number of whizzing 'Catherine Wheels' were observed in the CPO's Dining Hall. Four survivors suffered only minor injuries.
- r. A 'ball of fire' was projected upward through the Senior Ratings servery above the galley and up the hatch above to O1 and O2 Decks.
- s. All 5 personnel in the MCR survived, one with serious and one with minor flash burns. An officer seated by the aft bulkhead was thrown forwards, but otherwise uninjured. An instantaneous flash of 'high intensity' was observed.
- t. A flash was seen in the general fitting shop.

#### CONSIDERATIONS AND JUDGEMENTS

7. The facts in Paragraphs 4-6 were considered and the following judgements were made:

- a. The external evidence of entry damage was consistent with a high subsonic missile impact at a high angle of incidence. Very similar entry damage had been inflicted by inert SEA EAGLE missiles at comparable angles of incidence. In particular, the rectangular section of plate laid back to 27 bulkhead was a typical result of such an impact.
- b. The damage around the entry hole was not caused by the warhead exploding. By design the warhead should have exploded approximately 10-14 feet after penetrating the hull. This manifestly did not occur. The guard rails, upper deck fittings and boat above the impact point were undamaged. The deck and superstructure were intact.
- c. There was no evidence either from the photographs or from survivor's accounts that correct warhead detonation had occurred. The primary mechanism of the hull rupture seen in HM Ships UNDAUNTED and RAPID is the shock wave from the warhead and not pressure build up. The hypothesis that large uptakes and downtakes in the Forward AMR and Forward Engine Room might have vented the explosion was not supported. Additionally, no damage to the funnel or foremast intakes was evident. Very significant structural damage would have been experienced if the warhead had detonated late in either of these compartments.
- d. There was no evidence of fragmentation damage caused by the warhead. Fragmentation damage should have been readily noticeable, both to structure and personnel. The close proximity of so many survivors to the point of impact was incompatible with warhead detonation.
- e. The EXOCET semi-armour piercing warhead is extremely robust and was most unlikely to have been damaged by the impact even by hitting in the plane of 2 Deck. If the warhead had lodged in the central area of the ship, it was thought most likely that it would have 'cooked off' in the subsequent fire. There was no evidence of this. There was no evidence of the warhead exiting on the port side. There was conjecture as to whether the warhead had ricocheted out of the starboard entry hole. No definite conclusion could be reached.
- f. At impact, at least 70 kg of propellant was thought to have been remaining in the sustainer motor. The motor case of steel would have contained a combustion pressure of around 1000 lb/in<sup>2</sup>. The impact would have ruptured the motor and vented the pressure. A vigorous pressure pulse would have been experienced over a large section of the ship by this mechanism alone. Low velocity fragments from the motor case would have been experienced, burning propellant would have been scattered around and fires would have been caused. The emission of a large quantity of black smoke was not thought probable. Some white smoke was more likely to have resulted. Damage of this nature including fires was observed on film of inert EXOCET firings. A bright flash was also observed on the film of one impact of an inert EXOCET. These effects were thought to be consistent with the experiences of HMS SHEPPFIELD's crew.
- g. It was considered most likely that the missile had ruptured the diesel tanks in the Forward AMR and that either the kinetic energy at impact or burning propellant would have been capable of igniting the fuel.

#### CONCLUSIONS

8. The following conclusions were reached:
- a. The missile's warhead did not explode.



b. The entry damage was similar to that inflicted by other missiles during oblique impact trials with inert warheads.

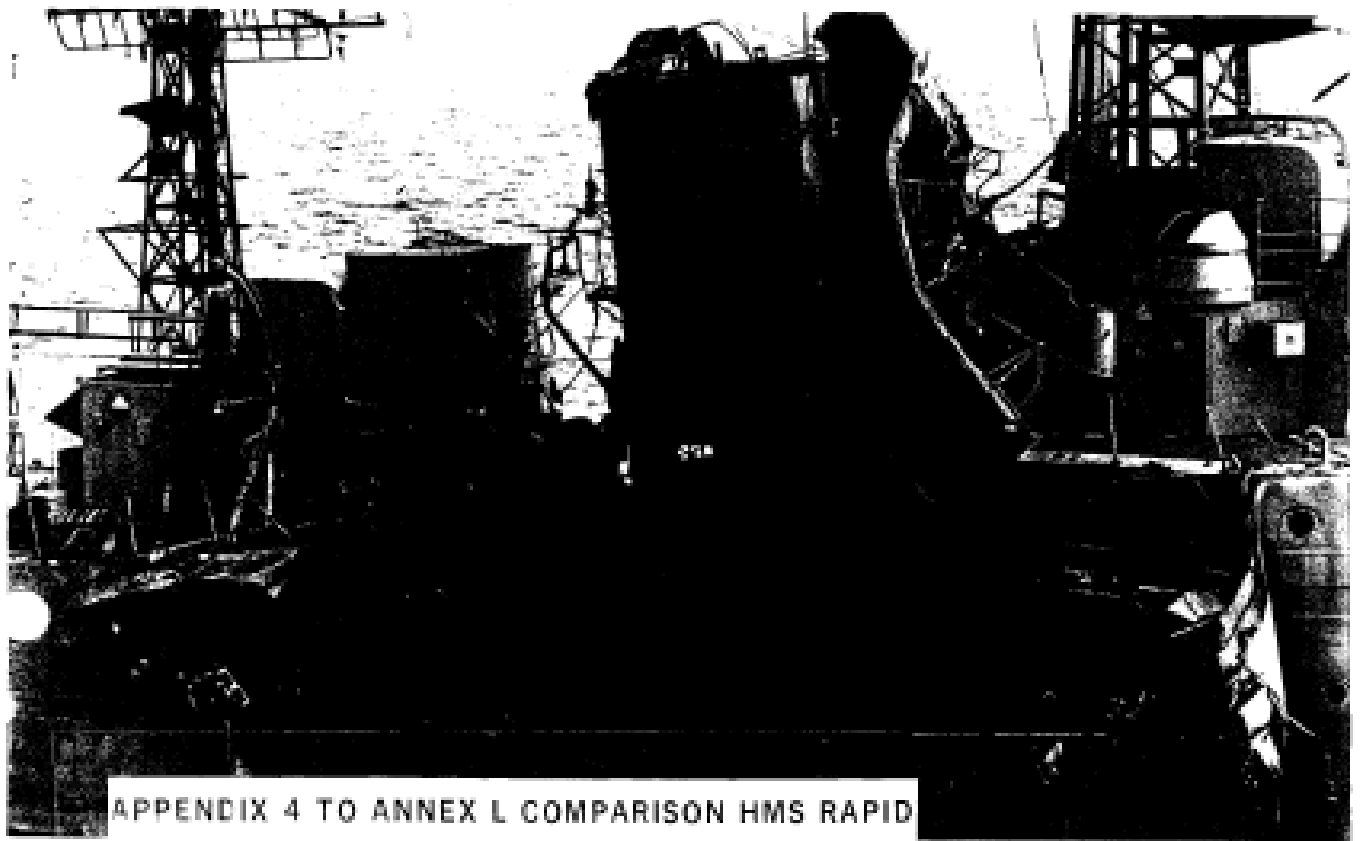
c. The pressure pulse, shock, flash, structural damage and whizzing 'Catherine Wheels' recounted by survivors were all explicable by the impact of a high subsonic EXOCET missile whose sustainer motor ruptured venting its pressure and contents into the ship.

*Appendix 2  
to Annex L to Sheffield BOI report  
- withheld under s26*

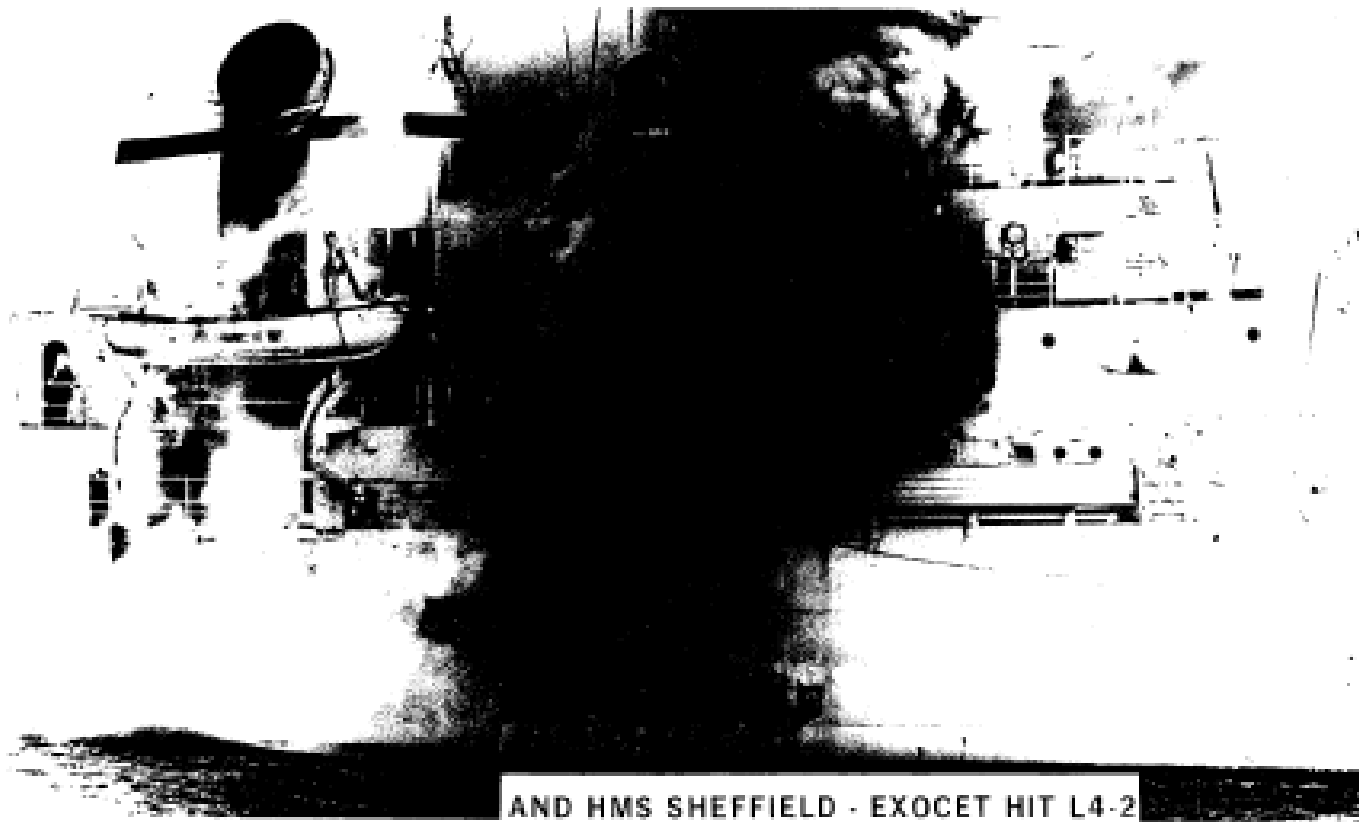
*Appendix 3  
to Annex L to Sheffield BOI report  
- withheld under s26*



APPENDIX 4 TO ANNEX L SMOKE AND MISSILE ENTRY



APPENDIX 4 TO ANNEX L COMPARISON HMS RAPID



AND HMS SHEFFIELD - EXOCET HIT L4-2

*Appendix 5  
to Annex L to Sheffield BOI report  
- withheld under s26*