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en donde usted puede leerlo directamente en su formato original y acceder al resto del sitio.

Se refiere al hundimiento de la SHEFFIELD, publicado por el Ministerio de Defensa de Gran Bretaña.
A efectos de preservarlo como documento histórico para el caso en que el archivo original o el sitio que lo contiene no figurasen más en internet, a continuación se ha realizado una copia.

COMMANDER-IN-CHIEF FLEET

LOSS OF HMS SHEFFIELD
BOARD OF INQUIRY

Annex M

FIRE AND MATERIALS

Scope

1. This annex describes the onset and spread of fire in SHEFFIELD following the impact of an AM39 EXOCET missile, the immediate effects of burning propellant, the general effects of heat and smoke, the effectiveness of the ships design in countering these, the flammability of materials used in construction and their contribution to fire and toxic hazards.

The Onset and Spread of Fire

2. The ship was in State 2 Condition YANKEE. All ZULU and some YANKEE doors and hatches were open (see Annex K). The missile impacted starboard side at 2 Deck level in J Section. Immediately there was a large amount of smoke. The colour and density of this smoke varied. It spread rapidly down 2 Deck passageway into the MCR/HQ1 area forcing evacuation. Q4928 Q6434

3. Dense acrid black smoke spread very quickly up through open hatches and doors to the accommodation spaces in H and J sections 1 and 01 Decks, and to the Bridge, 02G, via passageways, fan compartments, ventilation trunking and lift shafts. The Engineers Workshop and Electrical Shop, 1K, rapidly filled with black smoke. Smoke was also reported in the MCO and AER within two to three minutes of impact. The extent of the initial fire was not known at this stage. One casualty in the FAMR reported a fire in the starboard after corner. It was probably a diesel fuel fire as his overalls were alight. He escaped via the port escape hatch, having negotiated a wall of fire by J1 Diesel Generator. Another casualty in the FER saw a blinding flash and the compartment filled with grey smoke. Q4911, Q5253 Q7368 Q4394, Q7090 Q4957, Q5291 Q3999 - Q400 Q5465 Q5407 Q5427

4. The initial blast spread up the 2/1J ladder to the Senior Rates' Servery and WR Pantry, continuing up to 01 Deck and to the 966 Office Lobby, 02J. A fireball followed this blast causing fires in the POs' Dining Hall, CPOs' Mess and WR Pantry. The blast also travelled along 2 Deck port and starboard passageways, damaging watertight doors (see Annex K). Q4911 Q5253, Q5333 Q5107, Q4947 Q5093

5. Meanwhile on 2 Deck smoke and fire spread aft. 2H/J starboard door was hot to touch after approximately three to four minutes and was probably distorted as smoke was also issuing forward. 2 K/L starboard door was never reached and remained open. 2 K/L port door was shut by the blast and damaged. 2 G/H starboard door which was open at impact, was blown shut by the blast, and damaged with a man trapped in it. All damaged doors leaked smoke profusely. Description of the subsequent spread of fire and of firefighting is at Annex K. Q6487, Q6502 Q7165 Q5501, Q5503

The Effects of Burning Propellant

6. The AM39 had probably flown for 12nm and, on impact, would have used only 40% of its fuel, leaving about 90 kg of residual propellant. The propellant is a mixture of nitrocellulose, hexogene (HDX) and nitroglycerine with aluminium and lead additives (1). Q7345

(1) DSWP(N) SX1/10/2/192/82 dated 30 Jun 82.

is a dense grey or white smoke in fresh air but its colour and constituents vary with temperature and environmental conditions. The principal constituents are listed at Appendix 1. There is no doubt that burning propellant was a major factor in the very early spread of dense smoke through large areas of the ship.

The Effects of Smoke

7. In SHEFFIELD the greatest problem for the ship was smoke. Obscuration by smoke led to disorientation of many personnel in passageways and other areas which prevented efforts to find the fires and isolate and shut bulkhead doors and impeded personnel escaping from forward. One man died in trying to abandon the Naval Stores area in dense smoke. As the main 2 deck bulkheads in SHEFFIELD were not airtight, smoke was able to spread from one section to another. Smoke also spread through the ventilation system.

Q218, Q1862
Q2818 - Q281
Q2963, Q6434
Q6484 - Q650
Q3960, Q3961
Q6484 - Q650

8. In SHEFFIELD the speed with which smoke, and to only a slightly lesser extent heat, spread to engulf large areas of the ship, was the most significant factor in the early loss of control of the ship, the destruction of her fighting capability and the fact that fires subsequently got out of control, leading to the eventual loss of the ship. This is totally consistent with EXOCET trials experience (2). Despite the removal of all combustibles and fuel prior to the trial, the EXOCET firing against UNDAUNTED in 1974 produced an intense fire with dense smoke, in addition to substantial damage. In RAPID, in 1981, the impact of two EXOCETS was followed immediately by the spread of dense black smoke.

Materials

9. Modern weapons cause extensive damage and the resulting fires will be fierce. The expensive measures necessary to reduce the fire hazards must be weighed carefully against the extremes of saving a ship or gaining time to enable the rescuing of casualties. In considering the fire characteristics and toxicity of materials it is important to retain a sense of balance. A typical Type 42 Destroyer carries:

Non flammable material	3000 tonnes.
Fuels and oils	720 tonnes
Plastics, wood, paint rubber	100 tonnes
Ammunition, propellants	40 tonnes.

In practical terms there is only scope within the 100 tonnes to reduce the materials fire risk. Soft materials tend to be flammable often producing thick black smoke. Research funded by Ship Department has enabled low toxicity, retardent cables to be developed, however this research and development has been emasculated by financial constraints(3).

(2) DG Ships/05.3/06/02 dated Apr 75.
(3) Annex A to DG Ships D/8/212c/1570/59/2 dated 1 Jul 82

10. In SHEFFIELD the combustibility of upholstery, fittings and furnishings in mess areas allowed fires to take hold quickly in the WR, POs' Dining Hall, and CPOs' Mess. Subsequent fires in 1H and 01H Cabin Flat are described as very fierce indeed. Undoubtedly these fires produced a large amount of smoke and heat. Appendix 2 lists the materials used in these and other compartments in Type 42 Destroyers with their risk ratings (3).

11. Fumes from burning materials affected personnel re-entering forward. Because men could not re-enter wearing ICABA due to the small escape manhole, BA had to be donned in the ship at 1½C deck. The fumes caused considerable distress to some personnel. The After Section Base area became uncomfortable due to fumes. The precise content of these fumes is not known; however examples of the principal gases evolved from three materials used in Type 42 Destroyers shown are in Table 1M. (4)

Q6142
Q7052
Q6142 - Q614
Q6179

TABLE 1M

Material	Principal gases evolved (litres per Kg)					
	Carbon Dioxide (CO_2)	Carbon Monoxide (CO)	Hydro-chloric Acid (HCL)	Nitrous Fumes (NOx)	Sulphur Dioxide (SO_2)	Hydro-cyanic Acid (HCN)
Polyurethane Foam (mattresses, upholstery)	4053	37.0	-	11.0	-	1.5
PVC (cable insulation)	1050	21.0	74.7	0.23	-	-
Rubber HYPALON (CSF) (cable insulation)	471	37.7	18.8	1.37	2.3	-

(3) Annex A to DG Ships D/S/212a/1570/59/2 dated 1 Jul 82
(4) Annex A to AMTE DL WRM/P339/82 dated Jul 82

12. Further fire and toxicity problems may arise from for example, petroleum for boats, paints, awnings and wooden gratings, packaging and stationery stowed throughout the ship, and PVC covers on upper deck equipment. In SHEFFIELD only the minimum requirment of petroleum was carried, the surplus had been ditched. Paint had been off loaded except about 10 gallons which were in the Buffers Store, 1M. Some private boats were abaft the funnel. Most personal gear had been packed and stowed in the Paint Shop, 2A. Q5978, Q5979 Q5976 Q5984

Summary

13. Propellant smoke and vast quantities of dense black smoke from burning diesel fuel spread rapidly from 2 J starboard aft down the passageways to the MCR/HQ1 area and up through the midship messes, ventilation trunking, fan compartments, lift shafts and to the Bridge. Visibility rapidly diminished, breathing was seriously impaired and early evacuation from key areas was necessary. The heat and smoke later led to disorientation during re-entry attempts with BA, hampering Damage Control. Fumes from burning materials impeded re-entry forward and affected men at the aft Section Base. Flammable upholstery and fittings in cabins and messes on 1 deck and above contributed to the fierce fire in these areas.

Appendices:

1. Combustion Products of EXOCET Fuel.

2. Materials.

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

COMBUSTION PRODUCTS OF EXOCET FUEL

1. A PERME Computer printout (1) of the content and molecular fractions from the combustion of the AM 39 Propellant, permits calculations which indicate that the 90kg of remaining propellant could have produced up to 750,000 litres (approx 26,000ft^3) of smoke and combustion products. The predominant products are:

Substance	Molecular %
a. Nitrogen	56%
b. Carbon Dioxide	13.5%
c. Water	13%
d. Carbon Monoxide	6%
e. Oxygen	3%
f. Nitric Oxide	1%
g. Hydrogen	1%
h. Aluminium Oxide	1%

2. Other substances such as lead, aluminium, hydrocyanic acid and nitrogen dioxide are also present in very low concentrations.

3. The volume of these products within the area of 2J and K sections would produce an untenable atmosphere. 1% Nitric Oxide is virtually instantaneously lethal and 6% carbon monoxide is lethal within a few minutes.

(1) PERME listing of ACI PROP 5 OUT - A (1/) 2 Jul 82

APPENDIX 2 TO
ANNEX X TO
SHEFFIELD BOI REPORT
DATED 22 JUL 82

MATERIALS

Combustible Materials - Flammability/Smoke/Toxicity Ratings

MATERIAL	USE	FLAMMABILITY RATING	SMOKE RATING	TOXICITY RATING
Mineral Fibre Marine Board	Insulation	1	1	1
Plasticell D77	C/W S/W Insulation	2	3	3
Polyurethane Foam (Propocon)	Cold Room Insulation	2	3	3
Polyurethane Foam Slab	Cold Room Insulation	3	3	3
Crown 12 CCF	Cold Room Insulation	1	1	1
Rocksil RFS	Cold Room Insulation	1	1	1
Glass Cloth HD	Cold Room Insulation	1	1	1
Glass Cloth LW	Cold Room Insulation	1	1	1
Silicon Rubber	Cable Insulation	1	1	1
Erthylene Propylene	Cable Insulation	2	2	2
PVC	Cable Insulation	3	3	3
Vinyl (PVC Tiles)	Deck Covering	2	3	3
Carpet	Deck Covering	1	1	2
Cork Filled Latex	Deck Covering	1	1	1
Polymeric Epoxy Terrazzo	Deck Covering	1	2	2
Foam - Upholstery	Obvious	3	3	3
GRP	Lockers, Boats	2	3	2
MRL (Melamine Plastic Ram)	Table Tops, Linings	1	1	1
Wood	Battens, Cupboards, Tables	1	1	1
Cotton	Upholstery, Covers	1	1	1
Cotton/Rayon	Curtains	1	1	1
Linen	Ironing Board Covers	1	1	1
Wool/Viscose/Nylon	Loose Covers	1	1	2
Polypropylene	Chairs	3	3	2
Vinyl or PVC fabric	Chair Covers, Bunk Facings	3	3	3
Terylene	Straps	2	1	2
Acrylic Sheet	Cupboard doors)	3	2	2
Transparent Plastic	Displays, Key Boxes)			
Rubber	Hoses, Shock Mounts	2	3	2
Linoleum	Deck Covering	2	3	2
Canvas	Stretchers, Awnings	1	1	1

Rating - 3 High Hazard
2 Medium Hazard
1 Low Hazard
0 No Hazard

Additional Relevant Items

Darvic: (PVC Sheeting) in bulkheads messes, dining halls and Ops Room.
HP Air: 200ft^3 at 4000 psi provides substantial oxygen source if ruptured.
Personal Effects: Unofficial bars, decor improvements, unofficial carpetting, hazards unknown.