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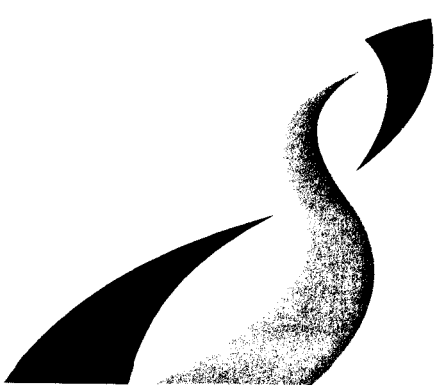
MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

Marine Accident Report 1/99

Report of the Inspector's Inquiry
into the sinking of the Fishing Vessel

SAPPHIRE PD 285

with the loss of four lives
on
1 October 1997



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March 1999

Marine Accident Investigation Branch
of the Department of the Environment
Transport and the Regions: London

Department of the Environment, Transport and the Regions
Eland House
Bressenden Place
London SW1E 5DU
Telephone 0171 890 3000
Internet service http://www.detr.gov.uk/

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Marine Accident Investigation Branch
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Carlton Place
Southampton SO15 2DZ

18 January 1999

The Right Honourable John Prescott MP
Deputy Prime Minister and Secretary of State
for the Environment, Transport and the Regions

Sir

I have the honour to submit the report of Mr J Lee, an Inspector of Marine Accidents, on the circumstances which led to the loss of four lives and the fishing vessel SAPPHIRE on 1 October 1997.

I have the honour to be
Sir
Your obedient servant

JS Lang
Rear Admiral
Chief Inspector of Marine Accidents

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1994

The fundamental purpose of investigating an accident under these Regulations is to determine its circumstances and the causes with the aim of improving the safety of life at sea and the avoidance of accidents in the future. It is not the purpose to apportion liability, nor, except so far as is necessary to achieve the fundamental purpose, to apportion blame.

CONTENTS

Glossary of Abbreviations

BST	–	British Summer Time
EPIRB	–	Emergency Position Indicating Radio Beacon
FISG	–	Fishing Industry Safety Group
FV	–	Fishing Vessel
GM	–	Metacentric Height
GPS	–	Global Positioning System
GRP	–	Glass Reinforced Plastic
GZ	–	righting lever measured between centre of gravity and the line of action of buoyancy force on hull
HRU	–	Hydrostatic Release Unit
kg	–	kilogramme
kHz	–	kilohertz
KN	–	righting lever measured between keel and the line of action of buoyancy force on hull
m	–	metres
mm	–	millimetres
MAIB	–	Marine Accident Investigation Branch
MF	–	Medium Frequency
MRCC	–	Maritime Rescue Co-ordination Centre
MSA	–	Marine Safety Agency (now named MCA (Maritime & Coastguard Agency))
rads	–	radians
RAF	–	Royal Air Force
ROV	–	Remotely Operated Vehicle
SAR	–	Search and Rescue
TPA	–	Thermal Protective Aid
UKFV	–	United Kingdom Fishing Vessel
UTC	–	Universal Co-ordinated Time
VHF	–	Very High Frequency
W/T	–	Weathertight

All times quoted are BST (UTC + 1 hour)

Compass headings are stated as combinations of north, east, south and west, i.e. SW is south-west, SSE is south-south-east, W by S is west-by-south, etc.


POSITION OF SAPPHIRE SINKING
OIL AND GAS FIEL
(see Note)
SCOTLAND
NORTH SEA
ENGLAND
WALES
IRELAND
REPUBLIC OF
NORTHERN IRELAND
SHETLAND ISLES
ORKNEY ISLANDS
HEBRIDES OR WESTERN ISLES
IRISH SEA
CELTIC SEA
ENGLISH CHANNEL
Moray Firth
Anton Dohrn Seamount
Rosemary Bank
Faeroe Bank
Viking Bank
Dogger Bank
Aberdeen
Edinburgh
Glasgow
Oban
Isle of May
Newcastle
Tynemouth
Middlesbrough
Flamborough Head
Hull
Liverpool
Isle of Man
Belfast
Londonderry
Dublin
Limerick
Waterford
Cork
Fastnet Rk
Tuskar Rk
Mine Hd
Mizen Head
Skerryvore
Barra Head
Flannan Is
Butt of Lewis
Cape Wrath
Duncansby Hd
Muckle Flugga
Sumburgh Hd
Fair Isle
N. Ronaldsay
Sule Skerry
Sula Sgeir
Foula
Bressay
Lerwick
Kinnaird Hd
Inner Dowsing
Great Yarmouth
Felixstowe
Orfordness
Harwich
Dover
Dungeness
Calais
Cap Gris-Nez
Boulogne
Southampton
Portsmouth
Bristol
LONDON
Cardiff
Milford Haven
Swansea
Falmouth
Truro
Taunton
Lundy
Trevose Head
Wolf Rock
Bishop Rock
Isles of Scilly
Pointe de Barfleur
Cap d'Antifer
Le Havre
Cherbourg
Ile d Ouessant
Brest
PARIS
FRANCE
Great Sole Bank
Little Sole Bank
Labadie Bank
North Channel
St George's Channel
Bristol Channel
ODAS K5 FI5(Y.20s
ODAS RARH FI5(Y.20s
ODAS K4 FI5(Y.20s
ODAS 24 GB FI5(Y.20s
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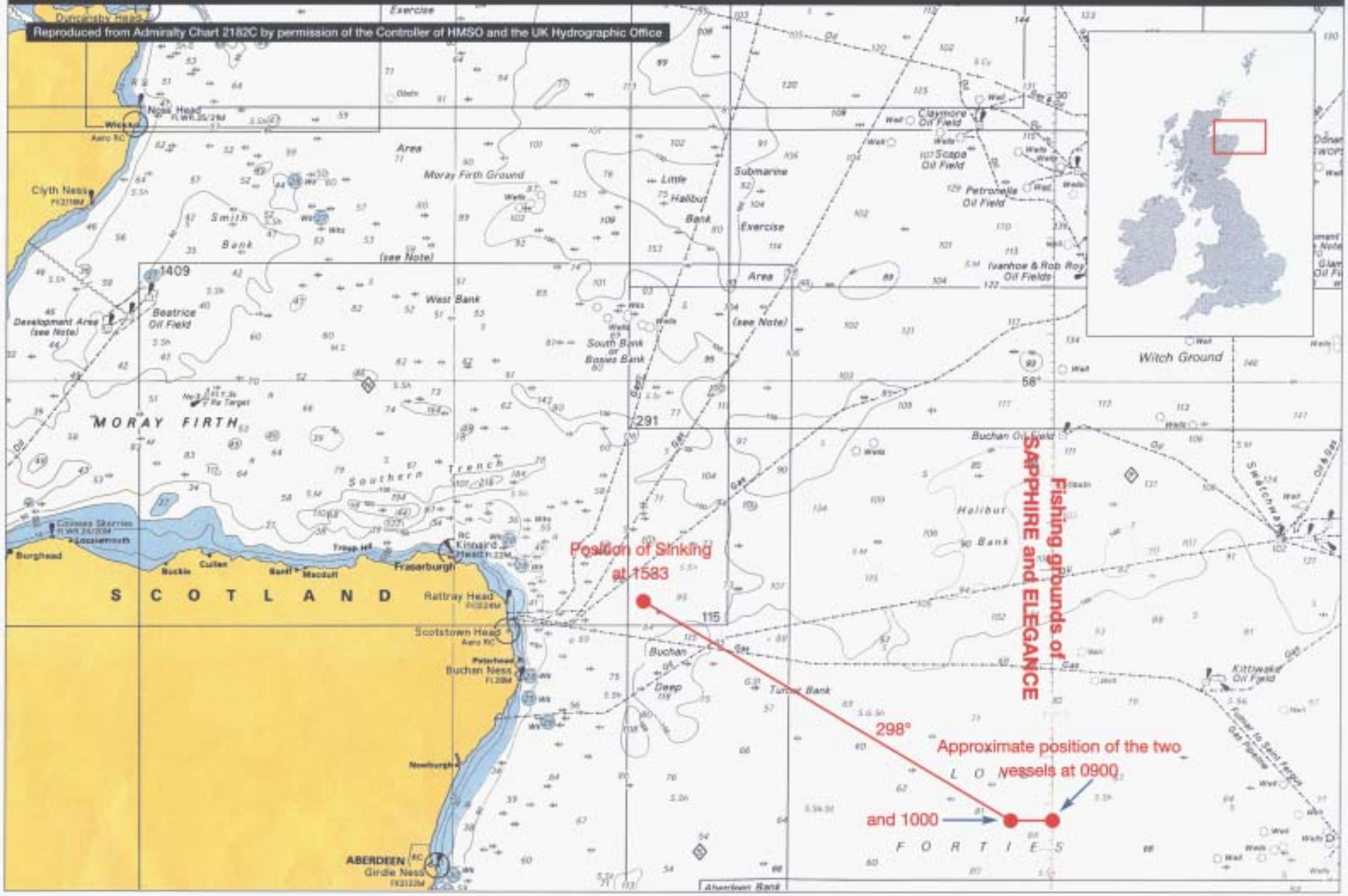
Reproduced from Admiralty Chart 4014 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 1: **Chart of area**



Synopsis

This accident was reported to the Marine Accident Investigation Branch on the evening of 1 October 1997. The investigation began the following morning and was conducted by Mr J Lee, Inspector.

Sapphire and *Elegance*, two Scottish fishing vessels of similar size and construction, operated as partner vessels in pair trawling operations. Having completed two days of successful fishing in the North Sea at the end of September, the two vessels headed for Fraserburgh at 1000 on 1 October. On the homeward passage weather conditions gradually deteriorated during the late morning and early afternoon, giving winds of force 7 to gale force 8.

Shortly after 1530, *Sapphire* capsized and rapidly sank about 12 miles from the Scottish coast, just north of Peterhead. Of her five crew, only the skipper managed to scramble clear and swim to one of the automatically released liferafts. The vessel's Emergency Position Indicating Radio Beacon (EPIRB) did not float free and went down with the sinking vessel.

The single survivor fired several distress flares, two of which were spotted by *Elegance* who alerted the Maritime Rescue Co-ordination Centre (MRCC) Aberdeen. A search and rescue operation recovered *Sapphire*'s skipper alive at 1746, but no other member of the crew was found.

From an underwater survey of the wreck and an inspection following its recovery, it has been concluded that the vessel most probably capsized due to progressive flooding of the fish hold through the unsecured hatch cover and of the engine room through open weathertight doors.

Two Safety Bulletins were issued by the MAIB shortly after the accident and a third following the collection of further evidence. These covered matters concerning maintenance of Hydrostatic Release Units (HRUs) fitted to EPIRBs and the securing of weathertight doors and hatch covers when a vessel is at sea.

Five recommendations have been made regarding the revision of stability booklets for fishing vessels, the marking of weathertight hatches and doors, the amendment of regulations covering EPIRB requirements and potential problems with HRUs within the industry. All recommendations have been addressed to the Maritime and Coastguard Agency (MCA).

SAPPHIRE leaving Peterhead Harbour [photograph courtesy of vessel's owners]

SECTION 1
Factual Information

1.1 PARTICULARS OF VESSEL AND INCIDENT

Name	:	*Sapphire*
Port of registry	:	Peterhead
Type	:	Fishing vessel (pair trawler)
Crew	:	5
Fishing number	:	PD 285
Official number	:	A13290
Registered length	:	20.56m
Overall length	:	21.95m
Beam	:	7.01m
Builder	:	J Hinks & Son, Appledore in 1986
Construction	:	Wooden hull (iroko on oak) shelter of aluminium and steel
Registered owners	:	V N, W & R M Robertson 83 Forman Drive Peterhead L Melville Little Cloffrickford By Achnagatt Ellon
United Kingdom Fishing Vessel Certificate	:	Issued 8 November 1995 at Aberdeen, valid to 24 September 1999
Position of accident	:	57° 36'16"N 001°23'25"W
Time and date	:	1533 on 1 October 1997
Casualties	:	Four crew members lost their lives

1.2 BACKGROUND TO THE VOYAGE

Sapphire and *Elegance*, two fishing vessels of similar construction and general arrangement, had operated as partner vessels in pair trawling operations since 1989/90. Their penultimate joint fishing trip, which proved commercially very successful, was in waters about 60 miles ENE of Peterhead and was completed on Friday, 26 September 1997. Owing to this success, the two skippers decided to head for these waters at the start of their next fishing trip, commencing Monday, 29 September.

1.3 HISTORY OF VOYAGE (FIGURE 1)

Elegance and *Sapphire* left Peterhead between 1100 and 1200 on Monday, 29 September for their chosen fishing grounds, again about 60 miles ENE of Peterhead. On arrival, the two vessels commenced fishing at 1700. They continued fishing until 1400 on Tuesday, 30 September when they headed SE for about 17 miles to a new area where they completed one fishing operation. They left this area at 2000 and steered SSW for another 18 miles and completed two further fishing operations by 0900 on Wednesday, 1 October.

To ease the crews' task of stowing fish, both vessels steered west for approximately one hour at about 4 knots to limit the motion. During this time *Sapphire*'s crew stowed the final 30 boxes of fish.

The task of stowing fish was completed at 1000. *Sapphire* then headed for Fraserburgh, on a course of 298° at about 8 knots and on auto-pilot with her skipper on watch. *Elegance* followed shortly afterwards at a distance of about 2 miles. They were within visual and radar contact of each other.

The wind was westerly, about force 4 to force 5. Upwind visibility was poor due to spray but was better on the beam and estimated at 4 miles. *Sapphire* was taking heavy spray over her wheelhouse but because *Elegance* was taking seas and spray over the bows her skipper reduced engine speed.

During a radio conversation between the two skippers, information on the size of the catch carried by each vessel was exchanged. *Sapphire* was carrying 410 boxes and *Elegance* 360.

Sapphire's skipper handed over the watch to Robert Stephen at 1030 with instructions that the engine room should be checked when he came off watch. This was anticipated to be about 1300 when Bruce Cameron was expected to take over.

Having handed over, the skipper went below to the engine room for a routine inspection. Both the main engine's lubricating oil and cooling water header tanks required topping up. No other tasks were seen to be necessary and the skipper made for his bunk in the aft port upper berth of the cabin.

At about 1330 the watchkeepers on *Elegance* changed. It was noted that *Sapphire* was gradually pulling ahead of *Elegance*. The wind had increased to NW force 7 to 8.

The last contact between *Sapphire* and *Elegance* occurred at about 1400 with *Sapphire* steaming about 4 miles ahead of *Elegance*. She was held on radar and was visible by the naked eye. Both vessels remained on a course of 298° to 300°. Radio contact was also made at this time but this was accidental and no conversation of any importance took place.

Between 1430 and 1500 the head salesman for the vessel's agents telephoned *Sapphire*. The call was answered by Robert Stephen who said the skipper was not expected to be called until 1630. This was the last known contact with *Sapphire*.

The skipper of *Sapphire* was woken at about 1530 by the vessel listing heavily to starboard. Initially thinking they were turning sharply to port, he got out of his bunk to find out why. While making his way to the wheelhouse the list continued to increase to about 60° and he realised there was something desperately wrong. As he made his way to the wheelhouse the skipper called for all the crew to 'get up'.

On reaching the wheelhouse the skipper, followed by Adam Stephen, found the watchkeeper, Bruce Cameron, sitting in the starboard chair holding the armrest with his left hand and leaning on to the instrument console with his right. The whereabouts of the other two crewmen was unknown.

The skipper initially elected to send a MAYDAY but changed his mind before he had selected the correct channel and tried instead to activate the distress alerting function of the telex. At this stage he asked Bruce Cameron whether *Elegance* had been informed of the situation and was told that she had not. A call was then made for everybody to evacuate the accommodation. The starboard windows of the wheelhouse were, by now, immersed in the sea.

The skipper then tried to call *Elegance* on the Medium Frequency radio (MF) but, before he was able to read the vessel's position from the Global Positioning System (GPS) display, the power supply failed. Water began to enter the port aft window of the wheelhouse, which was open.

The wheelhouse filled rapidly with water, sweeping the skipper towards the open port aft window which was, by now, underwater. The open window provided the means by which he escaped from the sinking vessel.

On finding himself in the sea, the skipper saw that only part of *Sapphire*'s hull remained above the surface. He began swimming towards a trawl float but, before he reached it, he heard the sound of escaping gas. *Sapphire*'s two inflatable liferafts had been released from their cradles and were inflating.

Sapphire sank at about 1533.

None of *Sapphire*'s remaining four crew members escaped from the vessel.

The skipper made his way to one of the liferafts and climbed onboard. The canopy tube of this liferaft had not yet fully inflated and he found himself lying on top of the canopy. He located and opened the liferaft's pack containing flares and set off two parachute flares.

Shortly afterwards, the skipper sighted *Elegance* and set off two more flares and a smoke float. The liferaft was on the port beam of *Elegance* at a distance of approximately 1 mile.

Beginning to feel cold, the skipper wrapped a thermal protective aid (TPA) around his shoulders. Finding himself continually sprayed with sea water he climbed beneath the liferaft's canopy which then appeared to inflate. The liferaft contained a significant quantity of water by this stage and the skipper proceeded to bale out. The wind was force 7 to 8 giving poor conditions.

It was about 1545 when the watchkeeper on *Elegance* observed a single red flare on the port beam. He called the skipper of his vessel who, on entering the wheelhouse, noticed a second red flare in the same direction. The *Elegance* was making 5-6 knots at this time. Attempts to contact *Sapphire* by Very High Frequency radio (VHF), MF and telephone were unsuccessful.

At 1603 the *Elegance* made a report on 2182 kHz of having sighted flares about 15 minutes previously. This report was received by Stonehaven Radio who relayed it to the Maritime Rescue Co-ordination Centre (MRCC) Aberdeen.

Contact between MRCC Aberdeen and *Elegance* was established on VHF Channel 67 at 1608. *Elegance* gave her position as 57° 35'N 01° 25'W, and said that the flares had been sighted to the south of this position. *Elegance* added that a shadow had been observed on the same bearing about 4 miles away and might have been that of a vessel. *Elegance* also mentioned that attempts to contact her partner vessel, *Sapphire*, had failed.

Elegance was requested to head towards the position of the flares by MRCC Aberdeen and, in response, altered course to W by S.

Having failed to see any sign of *Sapphire* or debris, *Elegance* reported this to MRCC Aberdeen at 1710. Observing a rescue helicopter en route to an area to the north of her and hearing reports of debris in an area 4 miles to the north, *Elegance* again altered course and headed in that direction.

Rescue Helicopter R137 was on scene at 1714 and within 3 minutes had sighted a liferaft and survival suit in the water. This was followed by making visual contact with smoke and light coming from a liferaft at 1726.

At 1746 Rescue Helicopter R137 reported she had recovered one survivor from *Sapphire*, the skipper, Victor Robertson. The position of the liferaft at the time of recovery was 57° 34.55'N 01° 18.69'W.

Search and rescue (SAR) operations continued until 2326 that evening and recommenced the next day at 0720, 2 October, using air and surface units. No further items of significance were found and the operation was terminated at 1100 that day.

Eighteen surface vessels, two RAF helicopters and an RAF Nimrod took part in the SAR operations.

1.4 GENERAL ARRANGEMENT OF *SAPPHIRE*, PD285 (FIGURES 2, 3, 4 & 5)

Sapphire was a wooden hulled trawler with a layout typical of many vessels operating from Scottish ports. The hull was divided into four compartments and, from forward to aft, were fore peak, fish hold, engine room and cabin.

Situated over the engine room was a deckhouse which, at main deck level, contained a galley, toilet, shower, skipper's cabin and a communicating transverse passage. It had become the practice of the skipper to share the main cabin with the other crew members, with the skipper's cabin being used as a store space. The port side of the deckhouse extended to the vessel's side but the starboard side terminated short, to create a fore and aft

working passage between deckhouse and bulwark and enclosed by the shelter. A weathertight door at the end of the transverse passage opened on to the starboard working passage.

The main cabin was divided into two by a longitudinal bulkhead. Each half housed three berths, two forward, upper and lower, and one aft.

Above the galley and toilet, at the forward end of the deckhouse, was the wheelhouse. At the aft port side of the wheelhouse was a door leading on to the upper part of the shelter aft, accommodating a net pound and articulated power block.

A vertical ladder between the wheelhouse and the transverse passage, and another between the transverse passage and cabin, provided access between these spaces. A third vertical ladder gave access to the engine room via a weathertight door from the starboard passage.

A non-weathertight shelter, extending from the stem to just aft of the wheelhouse, covered the working area of the main deck. The upper deck formed by the shelter was level with the deck of the wheelhouse. Set in this shelter deck were three hatches: bag hatch, landing hatch and emergency escape hatch. Each was fitted with a cover capable of being secured closed.

At the forward end of the working deck was the fishing winch and a store. Central in the working deck was the main fish hatch, positioned directly beneath the landing hatch in the shelter deck. When fishing, towing warps from the winch passed through the top of the shelter via ports and integral blocks. The store was accessed via a doorway slightly to starboard of centre. No door was fitted to this access.

A small area of working deck, aft of the deckhouse at main deck level, accommodated a net drum. The emergency escape hatches from the engine room and cabin opened on to this deck.

The bulkhead between the fore peak and the fish hold was of watertight construction, having a drain cock fitted to allow drainage of the fore peak into the fish hold.

The bulkhead between the engine room and fish hold was also of watertight construction.

The division between the cabin and the engine room was not watertight due to the arrangement of the propeller shaft, passing aft through the cabin, which allowed the cabin space to drain into the engine room.

1.5 WHEELHOUSE ARRANGEMENT

An instrument panel and control console extended the full width of the wheelhouse forward and continued slightly down either side. A 'conventional' steering wheel was situated centrally on this console, with a well padded chair either side. Between the two chairs was a small console at a lower level than the main one.

Distributed across the main console were two radars, GPS, Decca Navigator, two fish/depth sounders, colour video plotter, Decca Fishmaster, auto-pilot with a watch alarm facility and a telex with printer. To the right of the starboard chair were the engine/gearbox control levers. There was also a television set in the wheelhouse.

Figure 2: **General Arrangement**

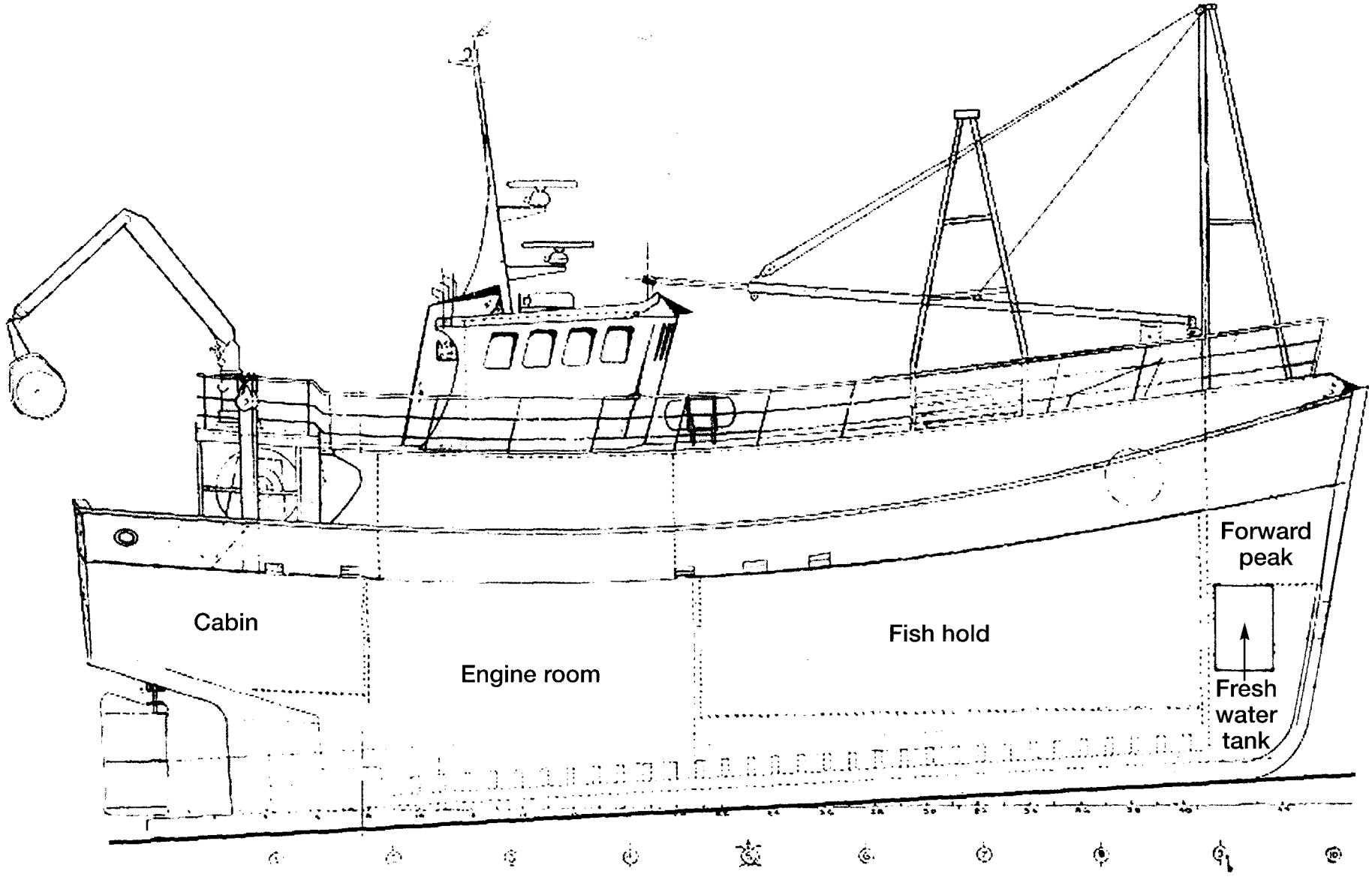


Figure 3: **Deckhouse and Main Deck Arrangement**

a	Skipper's cabin	k	Toilet
b	Net drum	l	Mess/galley
c	Cabin escape	m	Shower
d	Engine room escape	n	Wheelhouse access ladder (up)
e	Starboard passage	o	Engine room door
f	Aft starboard weathertight door	p	Main fish hatch
g	Forward starboard weathertight door	q	Fishing winch
h	Transverse passage	r	Forward store
i	Weathertight door to transverse passage	s	Hatch to forward peak
j	Cabin access ladder (down)		

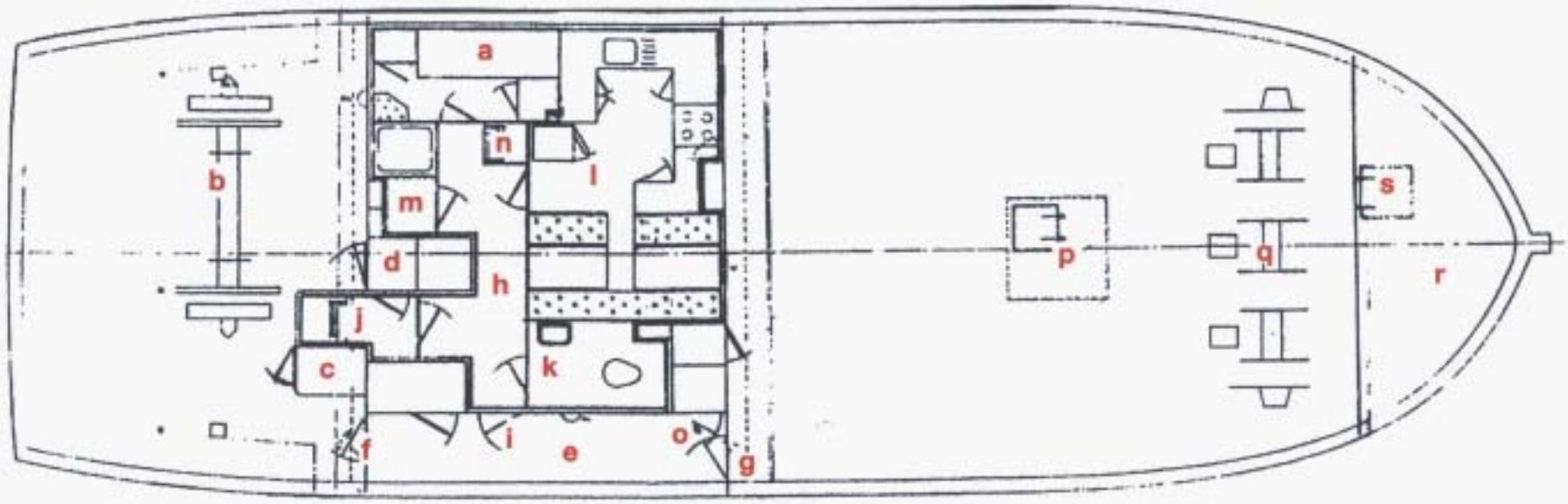


Figure 4: **Arrangement of Main Hull Compartments**

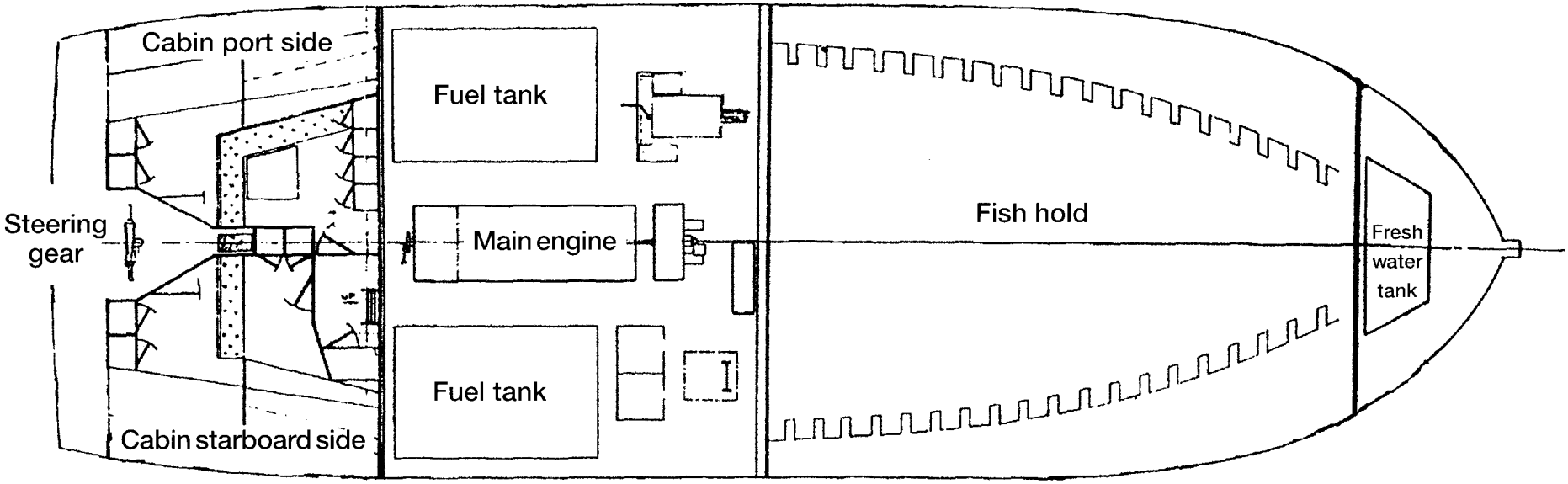
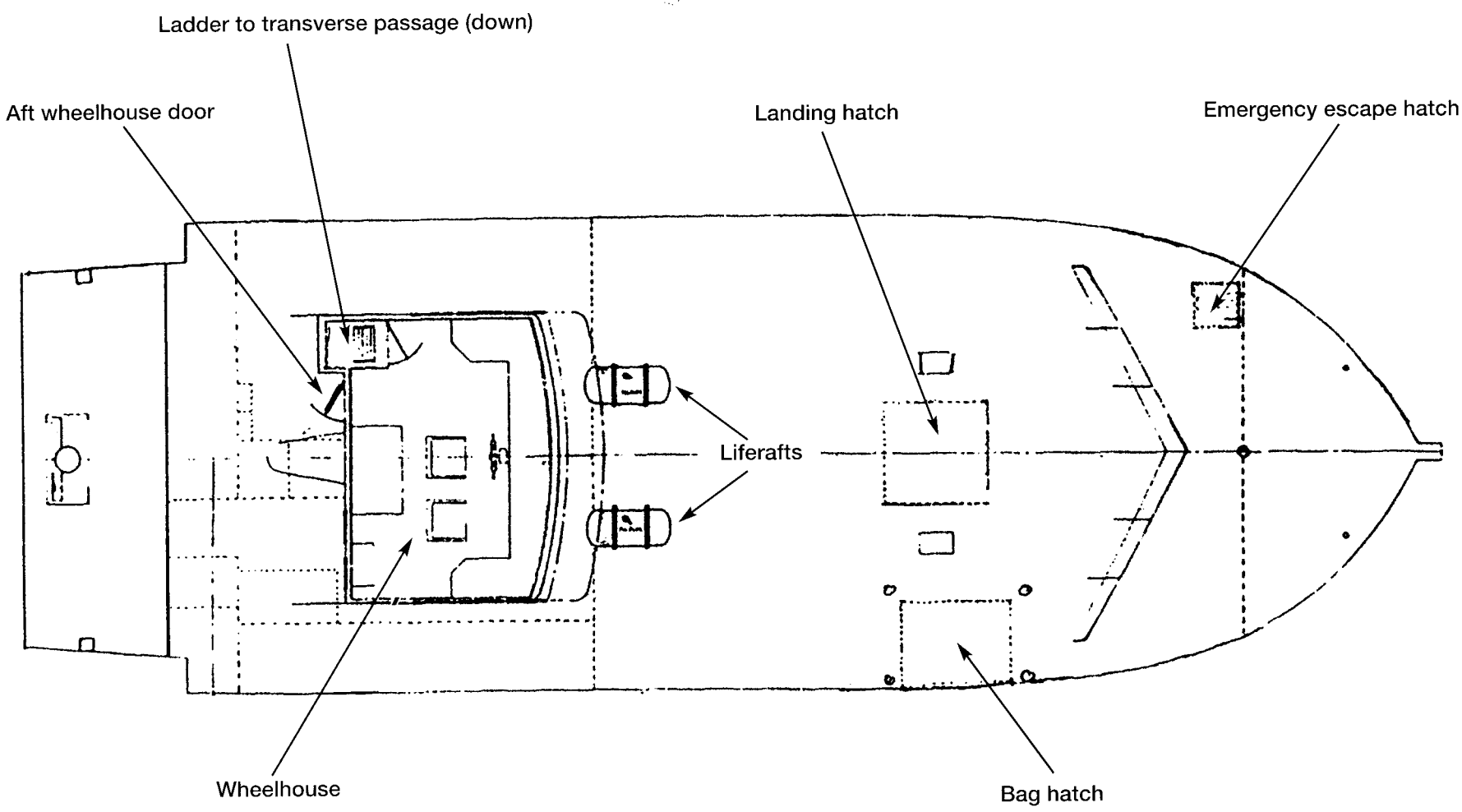


Figure 5: **Arrangement of Shelter Top**



The watch alarm was defective at the time of *Sapphire*'s loss. Although the length of time this alarm had not functioned has not been established, it was in the order of several weeks and, possibly, months. There is no MCA requirement for a watch alarm to be fitted to fishing vessels.

Behind the two chairs and at the aft end of the wheelhouse was a chart table, above which were a battery-powered, quartz, analogue clock of a domestic type and style, radios, telephones and a portable VHF radio. The table housed a set of integral chart drawers.

1.6 DECKHOUSE ARRANGEMENT

At main deck level, the deckhouse was divided into a galley/mess, shower, toilet, a single cabin designated for the skipper and a transverse passage.

The galley/mess was on the port side of the deckhouse forward. The forward bulkhead of this space, separating it from the working deck, had two vertically sliding windows. The single access door into the galley was at the port end of the transverse passage and adjacent to the vertical ladder leading up to the port side of the wheelhouse.

The door to the skipper's cabin opened on to the port extremity of the transverse passage with the shower space immediately next door, against the aft bulkhead of the deckhouse.

The starboard forward corner of the deckhouse formed the toilet space, with an access door leading from the starboard end of the transverse passage.

Almost opposite the toilet space, leading from the aft side of the passage, was the vertical ladder leading down to the main cabin.

1.7 HULL INSPECTION

Shortly before her loss, *Sapphire* was inspected out of the water in Peterhead, during September 1997. Work was performed on the propeller and stern gear and short lengths of caulking were renewed but no major structural or hull planking work was performed or considered necessary by the attending professional boat repairer.

1.8 CREW OF SAPPHIRE

The skipper of *Sapphire*, Victor Robertson, age 27, held a Deck Officer Certificate of Competency (Fishing Vessel) Class 2.

Other crew members were as follows:

Victor Podlesny, age 45 with 30 years fishing experience;

Bruce Cameron, age 32 with 16 years fishing experience;

Adam Stephen, age 29 with 13 years fishing experience;

Robert Stephen, age 25 with 9 years fishing experience.

1.9 GENERAL ARRANGEMENT OF ELEGANCE, PD33

Elegance is a 18.98m registered length wooden fishing vessel, constructed in 1989/90. In general arrangement she is similar to, but slightly shorter than, the 20.56m registered length of *Sapphire*. In particular, *Elegance* also has a non-weathertight shelter and a weathertight passage at the starboard side of her deckhouse. This passage is slightly further inboard than that on *Sapphire*.

Although similar in many other respects, the forward hull form of *Elegance* is slightly more full than that of *Sapphire*.

1.10 WEATHER CONDITIONS

At 1000 on 1 October *Sapphire* and *Elegance* were experiencing a westerly wind of force 4 to 5.

By 1400 the wind had increased to force 7 to 8.

At 1600 on 1 October the weather conditions reported to the MRCC Aberdeen by *Elegance* were wind force 7 to gale force 8, 4m high seas and good visibility. The wind was recorded separately as from the NW.

The time of sunset on 1 October was 1832.

1.11 SEARCH FOR THE WRECK

In order to progress the investigation into the sinking, an operation to search for the wreck of *Sapphire* was commissioned by the MAIB on 14 October 1997. The surface vessel employed for this operation left Aberdeen at 1615 on 16 October, arriving in the search area at 2000 when she commenced the search using side scan sonar equipment.

The sonar was towed astern of the surface vessel, at speeds of 4½-5 knots, for a series of parallel runs. The distance between each run was 200 metres with the sonar covering a distance of 150 metres either side of the run path to ensure a generous overlap.

The initial search area was based on the position of the sole survivor's liferaft at the time of his recovery by helicopter at 1746 on 1 October, with an allowance for drift being made. This area extended 3 miles NW and 1 mile SE of the survivor's position with a width of 1½ miles either side of the centre line.

By 1300 on 17 October this search area had been covered but nothing had been identified as a contact representing a vessel the size of *Sapphire*.

The search of a second area, based on *Elegance*'s initial report of the position of the flares and the reported heading of the two vessels at that time, commenced at 1334. A sea bed contact, thought to be an object the size of *Sapphire*, was located by the sonar at 2051, 2127 and 2212 on 17 October. To view it, a remotely operated vehicle (ROV) fitted with closed circuit TV cameras was put into the water at 2315. The contact was located visually by the ROV at 2339 and found to be a wreck heavily encrusted with marine growth. It was not *Sapphire*.

The search of this area recommenced and continued until 0630, 18 October. Nothing more was found.

The decision was then taken to return to the initial search area which was extended to the NW and SW. The search continued until 1307 on 19 October without success. Although the search operation was considered to be complete at this stage, a review of the sonar data held onboard identified a further possibility. It was a small contact, considered to be too small to represent a vessel the size of *Sapphire* but nonetheless situated in the vicinity of an oil slick and debris observed and reported during the original SAR operation.

Before finally concluding the survey and returning to port, the ROV was put back into the water at 1408 to examine this contact. At 1430 it was located and identified as a wreck. It was *Sapphire*, lying in position 57°36'16"N 01°23'25"W at a depth of 90m.

The ROV surveyed the wreck until 1730 and ensured that all accessible external parts were surveyed and recorded.

1.12 UNDERWATER SURVEY

The underwater survey established the following:

the wreck was lying on its starboard side in a shallow depression of the sea bed in 90m of water;

the sea bed was sand;

all the port side of the hull was visible, as was the stern, keel and stem; some limited area of the hull to starboard of the keel was visible; there was no damage to any visible part of the hull below main deck level;

the propeller and rudder showed no signs of damage; the rudder was approximately 25° to starboard;

the propeller was slightly fouled by netting;

the stern frame was free of damage but a net was around the skeg;

freeing ports in the port side bulwarks forward of the wheelhouse were as follows:

aft	open
centre	closed
forward	closed

freeing ports in port side bulwarks aft of wheelhouse were open;

one short plank was missing from the bulwarks, over two frame spaces, on the port side forward in way of the store space;

the port forward shelter emergency escape hatch was secured in the open position;

the bag hatch cover was in the closed position but not secured;

the fish or landing hatch in the shelter was secured closed;

the liferaft cradles were empty;

the wheelhouse windows were intact; the aft port window was open but all others were closed (all windows were obscured by a thin layer of sand);

the EPIRB was still in position on the aft mast;

the aft deck and aft end of shelter were covered and obscured by netting;

all visible surfaces of the hull, wheelhouse and shelter were seen to be in good condition with no signs of damage.

During the early part of the ROV operations, the strength of the tidal stream was noticeable. For a short period, the ROV pilot was forced to position the vehicle downstream of the wreck using it as a form of shelter. The tidal stream was capable of generating a drag greater than the thrust produced by the ROV's propulsion system. This not only made it difficult to control the vehicle but had the potential to force it off station.

1.13 RECOVERY OF THE WRECK

Subsequent to the MAIB underwater survey, the decision to lift *Sapphire* was made by the families of the missing crew and funded by voluntary contributions. The purpose of the recovery operation was to search for and recover bodies.

The heavy lift barge *Tak Lift IV*, and her accompanying tug *Vikingbank*, arrived in Peterhead at 1500 on 13 November 1997 to prepare for the salvage operation. Weather conditions prevented *Tak Lift IV* from going to sea until 22 November and forced her to return to Peterhead on 23 November. *Tak Lift IV* was able to go to sea again on 30 November but returned on 1 December, partly due to commercial commitments of her owners. No lifting operations were possible during either of these two excursions due to weather and sea conditions. However, *Sapphire*'s wreck was located and a preliminary ROV survey performed, which confirmed that the wreck was lying as first seen during the MAIB ROV survey on 19 October.

On 2 December, all necessary equipment and personnel were transferred from *Tak Lift IV* to *Tak Lift VII*, another heavy lift barge owned by Smit Tak International. *Tak Lift VII* went to sea on 3 December and anchored over the wreck of *Sapphire*. Efforts to rig lifting wires around the hull using a ROV fitted with manipulator arms were partially successful. The wreck was raised slightly but the wires slipped and caused *Sapphire* to sink again to the sea bed in, this time, an upright position. Forecasts of unfavourable weather and sea conditions then forced the operation to be halted and *Tak Lift VII* returned to Peterhead on 4 December.

Weather conditions prevented *Tak Lift VII* from returning to sea until 9 December. Efforts to rig wires around the hull of *Sapphire*, again using the ROV, continued until the evening of 13 December, when both wires were satisfactorily in place. The process of lifting the wreck recommenced the following morning.

The major problems encountered during the attempts to lift Sapphire were caused by adverse weather conditions. In particular, surface swell generated a vertical motion of the lifting barge which created a corresponding motion of the lifting wires and other wires positioned around Sapphire's hull. With these in position and Sapphire clear of the sea bed, the vertical motion generated by the swell caused the wires around the wreck to slacken during the downward component of the oscillation cycle.

Apart from causing difficulties for the salvors in their efforts to maintain the correct position of the wires, such as were encountered on 3 and 4 December, the vertical oscillations of the wreck generated complex water flow patterns. The most obvious manifestation was the cyclic opening and closing of the bag hatch cover on the shelter top. Apart from confirming that this hatch cover was not secured, several empty fish boxes escaped through this hatch during the many periods when it was open. Ten fish boxes were seen to float free, but others may have escaped during those periods when the ROV was employed elsewhere.

The problems caused by the swell had been anticipated by the salvors and were major factors that led to the operation being postponed on many occasions over an extended period.

As with the earlier MAIB survey, the ROV was affected by the strong tidal streams. The effects of drag on the ROV were significant despite the deployment of a more powerful vehicle.

Because the ROV was used to handle and monitor the wires employed in the lifting operation, it was essential it remained in attendance at the wreck throughout all underwater operations. The ability to view and record all movements of the ROV via its on board camera linked to the surface, had the consequential advantage of allowing all surfaces of the wreck to be inspected at some stage. No damage or defect was seen on any underwater surface of the hull.

Figure 6: *SAPPHIRE* breaking surface

During the salvage some minor damage to the wreck occurred as follows: loss of foremast; damage to guard rails on the shelter; a puncture to the shelter on the starboard side; scarring to the starboard side of the wheelhouse top; loss of the starboard navigation light and the loss of several planks in the starboard bulwark. Apart from cosmetic damage to paint caused by wires during the salvage, there were no adverse effects to any part of the hull below main deck level.

Sapphire broke surface at 1100 on 14 December. (Figure 6).

The body of one member of the crew floated free from the salvaged hull and was promptly recovered.

For passage to Peterhead, *Sapphire* was secured at the bows of *Tak Lift VII* with her weight taken by the lifting wires. The wreck was not lifted clear of the water and remained with its main deck close to sea level for the complete passage to Peterhead, an operation of about 7 hours, with *Tak Lift VII* travelling stern-first throughout.

Once *Tak Lift VII* had berthed in Peterhead at 2015 on 14 December, an inspection of *Sapphire* was started while police officers recovered the bodies of the remaining three crew members from the accommodation/wheelhouse spaces. The inspection was completed the following morning.

At about 1200 on 15 December *Tak Lift VII* sailed from Peterhead to return *Sapphire* to the sea bed.

1.14 INSPECTION OF THE WRECK

The task of recovering the bodies of the crew was completed without having to enter any spaces below the main deck. Consequently the fish hold, engine room and cabin were not pumped free of water and were not inspected.

Throughout the period spent in Peterhead, *Sapphire* remained suspended from *Tak Lift VII* by lifting wires with the lowest part of her main deck about 200mm above sea level. During the 12 hours spent under observation in this state, the level of water within the cabin, engine room and fish hold remained unchanged. The levels within the engine room and cabin were common. The level within the fish hold remained at the bottom edge of the hatch coaming at a height estimated to be about 600mm above that in the engine room and cabin.

Inspection of accessible spaces and items disclosed the following:

(a) **EPIRB** (Figure 7)

The EPIRB was still in its mounting on the starboard side of the aft mast. Its Hydrostatic Release Unit (HRU) had activated but had not cut the plastic retaining bolt of the EPIRB's securing strap. The HRU's expiry date was marked as March 1997. The HRU was covered in white spray paint which obliterated the expiry date label and an instruction not to paint the unit.

The lens of the EPIRB's strobe light was also obliterated with white spray paint, as was much of the EPIRB's casing, including the label carrying details of the unit's battery replacement date (12/97).

The HRU and its fixings were retained for further examination.

Figure 7: EPIRB and HRU on aft mast

(b) **Liferaft Mountings**

The canister retaining straps were in place together with the eyelets and remainder of the weak links from the HRUs.

(c) **Shelter Deck**

The shelter escape hatch at the forward port side of the shelter was hooked open and free on its hinges. The hook was a loose fit in the hatch cover's eye and the hinges were free. The bag hatch on the starboard side was closed but not secured. The centre, or landing hatch, had been removed by the salvage divers earlier and had been found by them to be secured closed. The forward mast was missing and its mounting arrangements fractured. Various lengths of guard rail around the shelter's edge were damaged.

(d) **Wheelhouse**

Any electronic equipment containing a cathode ray tube such as the radar and plotter had suffered damage to such a degree that some items could not be readily identified.

VHF and MF radios remained in place with no obvious mechanical damage. The printer unit was also in place but the telex had broken free.

Engine/gearbox control levers, at the starboard side of the control console were upright, in their idle/stop settings.

The analogue quartz clock above the chart table had stopped and indicated a time of *3.33* (Figure 8).

Figure 8: Chart table with clock left of centre

Two portable telephone handsets remained in their retaining brackets above the chart table.

The portable VHF unit at the starboard side of the chart table was in its stowage bracket.

The fire extinguisher by the port aft wheelhouse door was in its stowage bracket.

All windows of the wheelhouse were intact and all the sliding windows were closed, except the aft port window which was fully open.

The aft door of the wheelhouse was found open. This had been seen to be closed by the salvors when the wreck was being lifted from the sea bed. It was opened on arrival in Peterhead.

A diary for 1997 was found on the wheelhouse floor, to starboard of the chart table. It recorded approximate figures for the total boxes of fish caught by Sapphire and Elegance, together with notes on the movements of the two vessels. It was badly water damaged and soiled. Pages for 21 to 30 September and 1 October were recovered and found to be legible.

Recorded boxes filled were as follows:

21 to 23 September 750 boxes

24 to 25 September 800 boxes

26 to 28 September none recorded (vessels in harbour)

29 to 30 September 480 boxes

1 October no entry

Other items of debris and damaged, but unidentified, equipment were concentrated on the starboard side of the wheelhouse.

(e) Aft Deck

The emergency escape hatch from the cabin was open. This had been opened by salvor's staff on arrival at Peterhead. It moved easily on its hinges and its catches were found to operate freely.

The emergency escape hatch from the engine room was open. This had not been moved by salvors. The hinges were very stiff, as was the lower catch. There was corrosion and absence of paint on a small area of the hatch's upper edge where it made contact with an adjacent flexible hydraulic pipe. This contact was only possible with the door in the open position (Figure 9).

All freeing ports on the aft deck were open.

The weathertight door from the aft deck to the starboard passage was found secured in the open position. This door had not been moved by salvors (Figure 10).

(f) Deckhouse

The weathertight door from the starboard passage into the cross passageway was found closed. Of wood construction, it had swollen, and was seriously damaged during efforts to open it.

FIGURE 9: Engine room emergency escape hatch

FIGURE 10: Aft starboard weathertight door

The cross passageway contained one empty fish box but no other significant items.

The door from the cross passageway to the galley/mess was found open.

The galley/mess contained approximately 30 empty fish boxes (Figure 11).

The two vertically sliding windows in the forward bulkhead of the galley/mess had dropped into the open position.

(g) Working Deck

The weathertight door from the forward working deck to the starboard passage was found secured open. This had not been disturbed during recovery.

The weathertight door from the starboard passage to the engine room was found secured open. This had not been disturbed during recovery.

Evenly distributed throughout the working deck and forward of the accommodation were an estimated 80 fish boxes. They were empty. A small number were within the box pound and fish hopper.

The box pound at the port side was intact, as was the small rope pound at the forward end.

The small pound at the aft end of the box pound, used for stowing the flexible tubular fish chute, was found displaced while the chute itself extended across the aft end of the deck with its end passing through the starboard aft freeing port.

FIGURE 11: Fish boxes in galley

The large cover to the main fish hatch was found displaced to starboard of its coaming by a distance approximately equal to the cover's width, about 1200mm. Securing toggles were in place on the coaming but were swung down. Neither cover nor toggles showed any signs of damage or distortion. This cover had not been intentionally disturbed during recovery (Figure 12).

The small hinged hatch cover, set within the main fish hold hatch cover, was in place and in the closed position. One toggle was in place securing this cover closed. The butterfly nut on the second toggle screw was missing.

The fish hopper and gutting table to the starboard side were in place.

The fishing winch was in place at the forward end of the deck.

FIGURE 12: Main fish hatch cover (displaced)

1.15 DRESS OF CREW

During the final stages of bringing *Sapphire* to the surface on 14 December 1997, the body of one crewman floated clear. He was promptly recovered and taken on board *Tak Lift VII*. He was wearing lightweight clothing.

During the search of the wreck in Peterhead, between 2015 and 2400 on 14 December, Grampian Police recovered the bodies of the remaining three crewmen. Two were discovered in the wheelhouse and the third in the transverse passage of the deckhouse. Each was wearing lightweight clothing.

The surviving skipper, Victor Robertson, wore a tee shirt and jeans.

1.16 RECENT FLOODING INCIDENTS

Sapphire experienced two flooding incidents during the year before her loss. The first was the result of a problem with the bilge system and thought to have been caused by plastic fish packing material choking the fish hold's bilge suction. This resulted in water accumulating to a depth of about 300mm within the fish hold.

The second was the result of hull damage from an impact with a fixed structure when leaving Fraserburgh for passage to Peterhead. The consequences were not found until the vessel next arrived in Peterhead. The depth of flooding in this instance, which was also in the fish hold, was not quantified but considered greater than in the first incident.

In both these incidents the flooding was detected by the crew when they next entered the fish hold, and not by the bilge alarm.

1.17 HIGH-LEVEL BILGE ALARM

Sapphire had been equipped with high-level bilge and fire alarm systems which shared a common control and indicator panel positioned in the wheelhouse.

The bilge alarm system served both the engine room and the fish hold, with float switches in each. Regulations required only that it served the engine room. This system had had a recent history of problems, extending intermittently over several months, and had required the services of electrical contractors.

Following the earlier on-board repair work, the control panel for these systems had, just prior to the vessel's loss, been removed by these contractors for repair in a workshop ashore. This unit had not been replaced, nor had a substitute system been fitted before Sapphire left Pkterhead on 29 September (Figure 13).

FIGURE 13: High-level bilge/fire alarm panel

1.18 BILGE PUMPING ARRANGEMENTS

Sapphire was equipped with a total of five non-portable bilge pumps; two driven by the main engine, one by the auxiliary engine and the remaining two hand-powered. Although the capacity of these pumps is unknown, the capacity of each is described in the vessel's Record of Particulars as 'Adequate for rules'.

A petrol-engined portable pump was purchased as a new item in 1996 and was normally stowed in the skipper's cabin. This pump had replaced an older portable pump which had been causing difficulties due to the poor availability of spares. This older pump was stowed in the forward store, at main deck level, and secured in place by brackets. There is no record of either of these pumps having been used during the preceding year, either for pumping bilges or for other duties.

There was no practicable method of visually assessing the quantity of bilge water within the fish hold, particularly when filled fish boxes were stowed at the aft end of the space over the bilge well. The vessel's crew overcame this difficulty by pumping the space and monitoring the noise made by the bilge line's non-return valve, a common method used by fishermen.

During periods at sea it had become the crew's practice to pump bilges each time the fishing gear was hauled: usually every four hours. Although the amount of water ingress due to hull leakage, as opposed to ice melting, cannot be quantified, it was recognised that greater amounts of bilge water needed to be pumped overboard during periods of poor weather than otherwise.

1.19 FISH STOWAGE ARRANGEMENTS (FIGURE 14)

Once filled, fish boxes were stowed in the fish hold according to an established pattern. The fish hold was considered to be in two parts for stowage: forward and aft of the hatch and ice lockers. Gutted fish were normally stowed forward, ungutted fish aft.

During stacking of the filled fish boxes, wedges were inserted between the ends of various rows and the vessel's side. Securing boxes in this way eased the stacking in poor weather, and prevented shifting of the stow on passage.

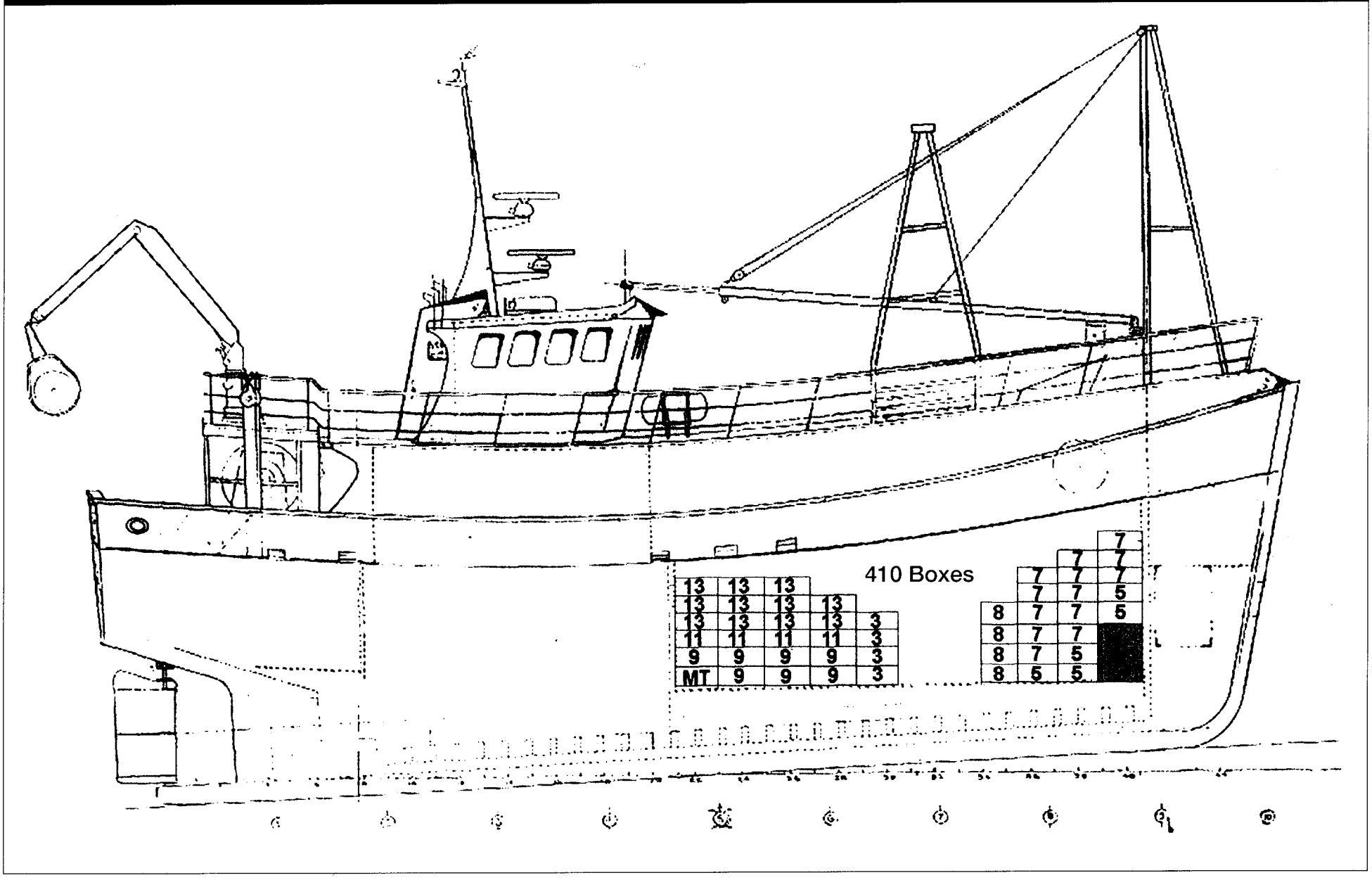
The established stowage pattern accommodated 410 fish boxes.

1.20 FISH BOX HIRE

Sapphire and *Elegance*, in common with many fishing vessels, hired all fish boxes from a local leasing company. The basis of the hire arrangement was for a weekly charge to be made for each fish box booked to the vessel and for a single penalty charge to be made for each box not accounted for. The hire charge was based on the maximum number of boxes recorded against each vessel's name during each weekly period of hire.

The leasing company performed audits on each participating vessel which, together with a record of the number supplied and landed, allowed a running total of boxes to be maintained against the name of the vessel. Where two vessels operated as a pair, as with *Sapphire* and *Elegance*, the running total was normally the combined total for both vessels.

Figure 14: **Stowage Arrangement of Fish Boxes**



Records of the number of boxes held by the *Sapphire/Elegance* partnership during the two weeks before the loss of *Sapphire* were as follows:

17/9/97 780 boxes supplied	running total of 818 on board both vessels
24/9/97 746 boxes landed	running total of 72 on board both vessels
24/9/97 785 boxes supplied	running total of 857 on board both vessels
26/9/97 775 boxes landed	running total of 82 on board both vessels
26/9/97 780 boxes supplied	running total of 862 on board both vessels

All boxes supplied by this company were the product of a single manufacturer and were purchased in one size only. Standard dimensions were: 813mm × 483mm × 220mm each of 4.6kg when empty. Nominal capacity of each box was 8 stone (50kg).

The above records of the numbers of boxes supplied suggests that each vessel carried between 400 and 440 boxes each. The number of boxes recorded as being allocated to each vessel on 1 October 1997 was *Sapphire* 424, *Elegance* 438, giving the total of 862.

1.21 VESSEL'S STABILITY

Sapphire had had full stability data prepared in accordance with *The Fishing Vessels (Safety Provisions) Rules 1975*, which had been approved by the MSA.

The vessel underwent a preliminary inclining test on 7 September 1987, at Appledore, Devon, in a state where her construction was nearing completion but with a number of major items of equipment not on board. A roll period test was performed on completion of the inclining. The period of roll was found from this test, but no unique factor calculated.

The vessel underwent an inclining test on 13 May 1988 at Peterhead, in the fully completed state and normal operating condition. The results of this test were used to compile a stability booklet which was approved by the MSA on 9 November 1988. On completion of the test and while weights on the vessel remained unchanged, a roll period test was performed and the unique factor calculated. Using this unique factor, a value for GM(actual) was calculated as 0.958m.

A roll period test was performed on 17 August 1992 in Peterhead, as part of the vessel's survey for renewal of her United Kingdom Fishing Vessel (UKFV) Certificate. Using the vessel's unique factor, the value of GM(actual) calculated from the results of this test was 0.91m.

On 8 September 1995 a roll period test was performed in Peterhead, again as part of the vessel's survey for renewal of her UKFV Certificate. The value of GM(actual), calculated from the results of this test and the vessel's unique factor, was 0.955m.

The shelter forward of the wheelhouse was of non-weathertight construction and made no contribution to the vessel's stability characteristics. The small forward store space, at main deck level beneath the shelter, was considered as weathertight for stability assessment purposes. The galley/wheelhouse deckhouse extended to the port side of the vessel as a

weathertight structure. The passage on the starboard side of this deckhouse was also of weathertight construction, having weathertight doors at forward and aft ends. The buoyancy properties of this deckhouse/enclosed passage were included in the vessel's stability assessment.

1.22 HATCHES, SCUTTLES AND FREEING PORTS

In the shelter's top, forward of the wheelhouse, were three hatches: escape hatch, bag hatch and landing hatch. As this part of the shelter was not a weathertight structure, none of the hatch covers fitted to these openings was required to be weathertight, although each was hinged and capable of being secured closed. Each hatch cover was constructed of aluminium.

Other openings in the shelter top and sides were for towing warps and mooring lines.

The weathertight passageway, to the starboard side of the deckhouse, was fitted with a weathertight door at the forward and aft ends.

The door leading from the starboard working passageway into the engine room was weathertight and constructed of steel. The adjacent door from this passageway into the transverse passageway of the deckhouse was also weathertight but was constructed of wood.

Two vertically sliding windows were positioned in the forward bulkhead of the galley, looking over the working deck beneath the shelter. The dimensions of these windows were 620mm high by 480mm wide.

Two further hatches, each fitted with weathertight hatch covers, opened on to the aft deck and served the emergency escape routes from the engine room and main cabin.

Beneath the shelter forward, set in the main deck, was a hatch measuring 1300mm by 1240mm, giving access to the fish room. The hatch cover serving this access, constructed of galvanised steel, was capable of being secured closed by four toggles on a coaming 500mm high. Set into this hatch cover was a smaller hinged hatch cover, 625mm by 625mm, also made of galvanised steel. Both hatches were of weathertight construction.

At the extreme forward end of the main working deck, beneath the shelter and forward of a steel bulkhead, was a hatch leading below to the forward peak/fresh water tank space. This hatch was fitted with a hinged weathertight hatch cover of steel. No door was fitted to the access opening in this bulkhead at main deck level.

The bulwarks enclosing the working deck forward and beneath the shelter, were fitted each side with a slot 9m long × 30mm high and three ports 250mm × 400mm high for the purpose of clearing deck water.

The bulwarks enclosing the aft working deck were fitted with a slot 4.8m long × 30mm high and two ports 255mm × 395mm high on each side for the purpose of clearing deck water.

Each freeing port was fitted with a vertical sliding shutter.

1.23 HATCHES AND FREEING PORTS (OPERATIONS)

The engine room door, engine room emergency escape, shelter escape hatch and the forward and aft weathertight doors of the starboard passageway were habitually left open when the vessel was at sea.

At sea, only the smaller of the hatches to the fish hold was used for transferring fish to the hold, usually via a tubular chute arrangement. The larger hatch cover was opened only in port, usually for landing purposes and, once its toggles had been released, it would be lifted off the coaming due to the absence of hinges.

Similarly, it had become standard practice for the forward two freeing ports in the port side bulwarks, beneath the shelter, to have their sliding shutters in the closed position. The forward starboard freeing port was also kept in the closed position. Although maintained with its shutter in the open position, the centre starboard freeing port was employed to discharge offal from the gutting table via a chute, with a resultant reduction in effective area. The aft starboard freeing port under the shelter was kept open.

The freeing ports serving the aft working deck were normally kept in the open position.

1.24 WORKING DECK ARRANGEMENTS

Fish was brought on board the vessel with the aid of a Gilson block at the head of the 'A' frame gantry over the bag hatch.

Located beneath the bag hatch, at the starboard side of the working deck, was a fish hopper from which fish were transferred to the gutting table situated at the aft starboard area of this deck. Crew working at the gutting table faced inboard, with their backs to the starboard bulwarks, and often found it necessary to stand on a low bench to keep their feet clear of deck water.

Pound boards enclosed the major part of the port side of this deck, forming an area for the stowage of empty fish boxes. The boards of this pound were retained in place, even when all fish boxes had been filled and stowed in the fish hold. A smaller triangular pound was at the forward end of this area and used for the stowage of ropes. Another small pound, at the aft end of the box pound, was used to stow the large diameter flexible hose used as a chute to pass fish into the fish hold.

Slightly inboard of the gutting table, and aft of the main fish hatch, was another small area surrounded on three sides by a single row of pound boards. To assist whoever was required to stand there as he transferred fish into the hold, the deck within this pound was covered with non-slip rubber matting.

Set out along the inboard edge of the gutting table was a row of fish boxes into which the gutted fish were placed. The contents of these boxes were then transferred to the fish hold via the chute or, under certain circumstances, by basket.

Waste from the gutting process was passed overboard via a chute which led from the gutting table through the centre freeing port in the starboard bulwark.

1.25 LIFE SAVING APPARATUS

The EPIRB carried by *Sapphire* was not registered on the Coastguard's database. Its battery was due for replacement in December 1997.

The EPIRB did not float free as *Sapphire* sank. Later inspection established that the EPIRB's HRU had not functioned correctly. The HRU was six months overdue for replacement and was found to have a coating of white paint as a result of spraying the mast on which it was mounted.

The number of the EPIRB's HRU was B069725 and its manufacturer's records show that it was made in March 1994 and had been despatched to their UK agent on 13 December 1994. The unit was installed in *Sapphire* during March 1995.

The EPIRB's float-free arrangement required the HRU to cut an 8mm diameter non-metallic bolt securing the EPIRB to the vessel's aft mast. These bolts are normally supplied with the HRUs by their manufacturer. The bolt used to secure this EPIRB was not of the type supplied by the HRU's manufacturer. It was incorrect both as regard material and dimensions.

Two six-person inflatable liferafts, housed in cylindrical GRP containers, were carried on cradles situated on the shelter top just forward of the wheelhouse. The securing arrangement for each liferaft included the fitting of an HRU.

A portable, hand-held VHF radio was carried in the wheelhouse.

Seven lifejackets were stowed in the cabin.

Other lifesaving apparatus recorded as being carried by the vessel were in accordance with the requirements of *The Fishing Vessels (Safety Provisions) Regulations 1975*, as amended.

SECTION 2
Analysis

2.1 GENERAL CIRCUMSTANCES

A number of fishing vessels have capsized with a resultant loss of lives in recent years while towing or attempting to recover fishing gear. Many of these sinkings have been caused by the forces generated by fishing gear overcoming reserves of stability. Most fishermen understand the potential dangers to which they expose their vessels during these operations but often regard these hazards as the normal risks of their profession.

From the earliest stages of this investigation, it was apparent that a major feature of the accident was the dramatic capsize and sinking of *Sapphire* while on passage, rather than during a fishing operation. For this reason no further consideration will be given to fishing gear and the forces which it might generate on a vessel. Without the effects of fishing gear-induced forces to consider, the incident became one which involved the loss of a vessel which coincidentally happened to be a fishing vessel. This suggests that the fundamental causes of the sinking and any lessons which may be learned from it, could be applicable to other vessels of any type or size.

2.2 TIME OF SINKING

After recovery, the vessel's wheelhouse clock displayed a time of 3.33. Although of a style normally found in domestic use, and thus having no water resisting properties, this clock was known to be reliable and accurate. Assuming it stopped at or very shortly after immersion, it is concluded that the vessel sank shortly after 1530 on 1 October 1997. This time is consistent with other times recorded in the incident.

2.3 SEARCH AND RESCUE

The initial reports of anything untoward were made by *Elegance* when she reported sighting flares to MRCC Aberdeen. Although *Elegance* had made several unsuccessful attempts to contact *Sapphire* by VHF, MF and telephone, these failed attempts were not included in the initial report to the MRCC. Indeed, *Elegance* did not mention any concern for the safety of *Sapphire* during her first communication with the MRCC.

The mention by *Elegance* of the flares being to the south, and a shadow about 4 miles away, also to the south, suggested that any casualty was in that direction. It was to the south of *Elegance* that the MRCC requested her to begin a search.

Once helicopters were airborne they were able to quickly identify the scene of the casualty

from debris and the liferafts. This position was very little removed from *Elegance*'s position at the time she observed the flares. Once debris had been identified, *Elegance* found herself several miles to the south of the datum and the survivor's liferaft. This resulted in her having to return north, after informing the MRCC of her intention.

Elegance's ability to spot the survivor's liferaft, a comparatively low target in the water, was hindered by the 4m seas. It was daylight and visibility was generally good but poor when looking into the weather. Had *Elegance* carried out a comprehensive 360° scan of the waters in her immediate vicinity before she headed south, she may have saved herself this unnecessary excursion and ensured an earlier recovery of the sole survivor. Although *Elegance*'s departure from the scene probably slightly delayed the survivor's recovery, it was not ultimately significant.

One mandatory item of *Sapphire*'s equipment intended to alert SAR units was her EPIRB, but it failed to float free as designed, and played no part in the incident.

Before examining the reasons for the EPIRB's failure to deploy, it is necessary to recognise that even when an EPIRB functions correctly and transmits as intended, a satellite may not be in a position to intercept the signal immediately. Once the distress signal has been received, further time is required to process the data and alert the necessary SAR units. The total time which might elapse between an EPIRB activating and the first SAR units being alerted, once a reliable position and details of the vessel in distress have been established, is typically 1-1½ hours. It will be an even longer period if the EPIRB is not registered on the Coastguard's database. *Sapphire*'s EPIRB was not registered.

In the event *Elegance* was able to alert the Coastguard to the presence of flares about 30 minutes after *Sapphire* sank and SAR units were mobilised well within the period typically required for the EPIRB system to function. Although the 2 hours which the surviving skipper spent in the liferaft will have seemed endless to him, it would not have been significantly shorter had the EPIRB released and functioned as intended.

2.4 CREW

All five crew members had substantial experience as fishermen. Together they formed a hard-working and commercially very successful crew, which is usually a prime reason for a crew to remain unchanged. This level of experience also emphasises that the lessons learned from this accident must be noted by all seafarers, not just fishermen, regardless of their experience.

The only member of the crew required by regulation to hold a certificate of competency was the skipper. He holds a Deck Officer Certificate of Competency (Fishing Vessel) Class 2, which satisfied requirements for a vessel of *Sapphire*'s registered length and area of operation.

2.5 SEA AND WEATHER CONDITIONS

During the late morning and early afternoon of 1 October, *Sapphire* and *Elegance* experienced gradually deteriorating weather conditions. From the start of the passage to Fraserburgh at around 1000, the wind increased from about W force 4 to NW force 7 or 8, with rough seas, at 1400.

Neither vessel should have experienced any difficulties in these conditions, although the speed of *Elegance* was very slightly reduced part way through this period. The time taken for *Elegance* to reach the approximate position of *Sapphire*'s sinking was little more than 20 minutes. Assuming a speed of 5-6 knots by *Elegance* during this time indicates that the distance between the two vessels was in the order of 1¼-2 miles at the time of the sinking.

As the vessels commenced the passage an estimated 2 miles apart, the difference in their average speeds over the subsequent 4-5 hours was negligible. Fishermen with experience of both *Sapphire* and *Elegance* suggested that *Sapphire* would have been able to maintain a greater speed in the prevailing conditions due to her finer hull form forward. The similarity in speed of the two vessels suggests that any inherent speed advantage *Sapphire* might have had in these conditions was not used to the full, or was reduced by some other cause as yet unconsidered.

The similarity in size, type, course and speed of the two vessels over these 5 hours suggests that any weather-induced difficulties experienced by the two vessels would have been very similar. *Elegance* experienced little problem due to the weather and, when only the influence of weather is considered as a possible primary cause of the sinking, it is concluded that *Sapphire* would have been no worse affected.

Some differences in the speeds of the two vessels appear, however, to have taken place after 1400.

At 1400 *Sapphire* was observed 4 miles ahead of *Elegance*, visually and by radar, having gained 2 miles on *Elegance* since 1000. At the time of *Sapphire*'s sinking the distance between the two vessels had lessened to 1¼-2 miles. While these changes are not large, they suggest that *Sapphire* reduced speed after 1400.

Sapphire's speed may have been reduced intentionally by her crew as a consequence of the deteriorating weather conditions or it may even have been caused directly by the weather. However, a reduction of this magnitude is not consistent with the vessel's superior performance over *Elegance*. There remains, however, the possibility that *Sapphire*'s progress was being affected by factors or events which were not applicable to *Elegance*: events which were unique to *Sapphire* after 1400.

A characteristic of *Sapphire*'s behaviour was the way water accumulated on the working deck in deteriorating weather conditions. This feature was identified by crewmen with working experience in both *Sapphire* and other fishing vessels of similar type and size. Such experience allows direct comparisons to be made and clearly indicates that the quantity of deck water increased with the onset of just moderate weather conditions. These observations have been supported by the practice of *Sapphire*'s crew standing on a wooden platform to keep their feet clear of deck water when working at the gutting table.

2.6 ESCAPE OF SAPPHIRE'S CREW

At the time of the accident no member of *Sapphire*'s crew was wearing working clothing or foul-weather gear. This suggests that none of them had been involved in any task outside the accommodation or wheelhouse area. This observation is consistent with the skipper's recollection of events and the likely crew duties during the passage to Fraserburgh.

The position from which each crewman's body was recovered lends further support to this

conclusion. As all four were recovered from the wheelhouse, main deck accommodation or immediate area, this indicates that all were within the cabin or adjacent spaces at the time of capsize. The one exception was the body of the crewman which floated free from the vessel as the wreck was brought to the surface. His lightweight dress suggests however, that, like the others, he was not involved in operational duties. It is possible that he had left the wheelhouse during, or shortly after, the capsize, but became fouled in nets or some other obstruction which prevented him from breaking free.

Whatever the precise position of each crewman at the time of capsize, none had sufficient time to make his escape and clear the vessel. This points to the speed of capsize and sinking being very rapid.

It is concluded that an earlier warning of the vessel's difficulties would have given the four men who lost their lives more time to make their escape from the vessel. Their chances of survival might have been correspondingly increased.

2.7 ACTIONS OF CREW

Before commencing *Sapphire*'s last voyage, her crew had the opportunity to rest between Friday, 26 September, when the vessel last landed fish, and her departure from Peterhead on Monday, 29 September.

This period of rest was followed by about 48 hours of fairly intense fishing activity which resulted in a full catch of fish being hauled on board and stowed.

During these 48 hours each member of the crew took some rest but any rest period taken would have been comparatively brief. Following a weekend of rest, serious fatigue is unlikely to have occurred in an experienced crew used to such work patterns.

Although not seriously exhausted by 1000 on 1 October, it would have been remarkable had the crew not welcomed the chance to relax and rest a little once all the fish had been stowed. The attraction of remaining within the cabin, galley/mess or even wheelhouse is understandable, particularly if there was no obvious or operational reason for doing otherwise.

Once all crew members had cleared the working deck on completion of stowing operations at 1000, the only likely excursions outside the accommodation area would have been those by the skipper, at 1030, and Robert Stephen, at 1300, to check the engine room. As part of his engine room inspection at 1000, the skipper did not visit the working deck. Its inspection by anyone else after 1030 was unlikely.

Between 1000 and the time of *Sapphire*'s loss at about 1530 it is probable that any developments on the working deck went unnoticed. A commendable routine had been established in *Sapphire* for the regular inspections of the engine room but this did not extend to the working deck. The importance of regular inspections or monitoring of all major spaces in a vessel, whatever its size and type, should be recognised by all masters, skippers and crews.

During the final moments of the vessel's capsize, the only known actions of *Sapphire*'s crew were to alert all on board of the need to get up, the attempt to broadcast a distress message and the attempts to escape from the stricken vessel.

Only the skipper successfully cleared the vessel but the positions of the remaining crew indicate that any who might have been asleep had, at the very least, been able to leave the cabin.

Neither the skipper's efforts to transmit a distress alert via the telex, nor his attempt to make contact with *Elegance*, using the MF radio, were successful. The causes of these failures cannot be established with certainty, but the great urgency of the situation, the shortage of time and the failure of the electrical power supply are likely to have been contributory factors.

The main engine/gearbox control levers in the wheelhouse were both found in the upright position, corresponding to idle/stop. It is considered most unlikely that both these levers were moved accidentally to identical positions during the capsize. Action by the watchkeeper, during or shortly before the capsize, to intentionally bring the engine to idle and stop the propeller is therefore probable. The watchkeeper's reasons for this action cannot be known, but it would have been a reasonable and understandable action if he had cause to believe there were serious problems in either the engine room or another part of the vessel.

There were no known movements of the engine/gearbox controls while the skipper was in the wheelhouse during the final stages of the capsize. The angle of heel was so great that the watchkeeper, who was immediately adjacent to the controls, apparently needed both hands to retain his position in his chair. This suggests the possibility that the engine and gearbox were put to their idle/stop positions at an earlier stage.

2.8 LIFEJACKETS

The seven lifejackets carried in *Sapphire* were stowed in the cabin. None of the crew was able to collect one, almost certainly because the speed of the capsize prevented it. It is unlikely that any of the crew would have had time to collect a lifejacket, no matter where they were stowed. In any event the lifejacket only becomes effective once a survivor has cleared the sinking vessel.

The availability of lifejackets and their stowage is considered to have been of little significance to the outcome of the incident.

2.9 THE EPIRB AND ITS HRU

Although it has been concluded that the failure of the EPIRB to float free did not play a significant part in the incident; this failure is important and warrants detailed consideration.

Sapphire was carrying an EPIRB having a HRU which was six months overdue for replacement. This HRU did not function as intended to release the EPIRB. Inspection showed that the hydrostatic pressure sensing component of the unit did operate and released the spring-loaded knife mechanism. This knife is intended to cut a plastic bolt which secures the EPIRB in its stowage bracket, so allowing the beacon to float clear and to the surface. On this occasion the knife did not completely cut through the plastic retaining bolt and the EPIRB was not released.

The specified service life of this type of disposable HRU is two years. The manufacturer's safety margins indicate that these units might not always experience a rapid and dramatic reduction in effectiveness once their service life has expired. Although a number of reasons can be given for the failure of the HRU to cut through the bolt, the expiry of its recommended service life is seen as a factor which could have been easily avoided. In spite of having a safety margin on their service life, it is imperative that units are replaced *before* their expiry date, and the industry has been reminded of the importance of this simple precaution in MAIB's Safety Bulletin 1/98 (Annex 2).

Carriage of an EPIRB, mounted with a float-free arrangement, is a requirement of *The Fishing Vessels (Life Saving Appliances) Regulations 1988* for all fishing vessels over 12m registered length. These regulations contain no explicit requirement that the float-free arrangements fitted to EPIRBs should be routinely replaced or serviced, nor are performance standards specified. This is in contrast to clear requirements, contained in the same regulations, that the HRUs fitted to inflatable liferafts should be capable of performing within given limits and be marked with servicing or replacement dates. As the type of HRUs employed in these two applications are often similar, there is no clear reason for these differences. In order to highlight the importance of proper servicing or replacement of these units, Merchant Shipping Regulations should be amended to make the requirements for maintenance explicit.

A factor which may have contributed to the failure to replace the HRU by the recommended date, was the obliteration of its expiry date label by paint. A coating of paint existed on all external surfaces of the HRU and masked the label showing the expiry date. This masking made easy checking of the unit's replacement date impossible and, consequently, it was never done and the unit remained in service.

It is conceivable that paint, particularly that applied by spraying as in this case, could enter the casing of an HRU and affect the freedom of movement of internal parts, particularly the spring-loaded knife. The potential dangers of paint affecting the internal mechanisms of HRUs are obvious and can only be hinted at by the manufacturer's necessarily brief warning label on the units; this problem has been brought to the attention of the industry by MAIB Safety Bulletin 1/98.

Another feature of the EPIRB's HRU was its installation using a bolt which was not of a material or dimensions specified by the HRU's manufacturer. The bolt was not supplied by the HRU's manufacturer. Its origin is uncertain, but it was most probably fitted as a substitute, with the best of intentions, when the original bolt became unserviceable. The diameter of the substitute bolt was 8mm with a metric thread similar to specification. Bolt specification required a bolt cross-sectional area of 37mm^2 which, using a standard 8mm thread, was achieved by machining two grooves along the length of the thread, 2mm wide by 2mm deep. Having no grooves along its threaded portion, the actual bolt employed had a cross-sectional area greater than specification.

Correct cross-sectional area of the securing bolt alone may not be sufficient to ensure that it is cut by the HRU's spring-loaded knife. The plastic material specified has been selected because of its brittle behaviour over a wide range of ambient temperatures. Fracture of the bolt, on activation of the HRU's knife, is intended to be achieved largely by shock failure of the material. A non-brittle material has the ability to absorb this shock without fracturing. A bolt with material having non-brittle properties had been fitted to *Sapphire*'s EPIRB float-free arrangement.

A number of factors may be cited as having the potential to cause the failure of the HRU fitted to *Sapphire*'s EPIRB. The true cause of failure may well be a combination of all three mentioned above. It is apparent that the periodical replacement and avoidance of painting HRUs is within the control of the users of the units, skippers, owners and crews. MAIB issued Safety Bulletin No 1/98 to draw attention to the dangers of time-expired and painted HRUs.

At the time of issuing this bulletin, information on the retaining bolt specification and the incorrect substitute which was used was not available for inclusion. A further Safety Bulletin 4/98 was issued to cover this aspect (Annex 4).

More detailed instructions supplied with replacement HRUs and publicity, will assist in making end users of these units aware of the problem at the time of purchase. However, before any action is taken, it is considered prudent to establish whether the use of incorrect bolts for this application is a widespread problem. MCA should ensure their surveyors, or others to which the task may be delegated, inspect these securing bolts during survey. Should these inspections show that the problem encountered in *Sapphire* was not an isolated incident, then appropriate steps must be taken to prevent a repetition.

2.10 VESSEL'S OTHER SAFETY SYSTEMS

High-level bilge alarms which function correctly are important items of safety equipment and have a proven record of alerting crews to problems at an early stage of a flooding incident.

A fire detection system and a high-level bilge alarm were both required to be fitted in the engine room of *Sapphire* by *The Fishing Vessels (Safety Provisions) Rules 1975*. The high-level bilge alarm on *Sapphire*, when fully operational, also served the fish hold. This feature was in excess of MSA requirements.

Sapphire sailed on her last voyage with no properly functioning high-level bilge or fire alarm systems.

The control panel for the high-level bilge and fire alarm systems had been removed from *Sapphire* for repair by an electronics contractor on the morning she sailed from Peterhead on her last voyage. Without this panel, neither system was able to function. The system had been malfunctioning for several months but, in common with too many other fishing vessels, insufficient priority had been given to its repair. The loss of *Sapphire* might have been prevented if flooding had been detected at an early stage. It follows that a properly functioning high-level bilge alarm would have served this purpose.

The two inflatable liferafts, which the vessel was required to carry by *The Fishing Vessels (Safety Provisions) Rules 1975*, were equipped with HRUs, as required by *The Fishing Vessels (Life Saving Appliances) Regulations 1988*. Both HRUs and liferafts functioned as intended.

2.11 FISH BOX NUMBERS

Following *Sapphire*'s recovery, an inspection of the wreck established the presence of a substantial number of fish boxes beneath the shelter and inside the galley. This discovery was at variance with the information available from other sources and created uncertainty

about the number of fish boxes carried and their stowage arrangements. Owing to the possible implications that additional boxes were being carried, efforts have been made to reconcile the seemingly conflicting data.

By far the most straightforward way of resolving this matter would have been to count the number of fish boxes on the vessel following its recovery. This meant that the complete vessel would have had to be pumped out, ventilated and made safe for entry and inspection; a substantial operation. During the period the vessel lay in Peterhead following recovery and prior to her return to the sea bed, the decision was made not to pump out the vessel for this purpose. It is proper that the reasoning behind this decision is discussed.

The main fish hatch cover was found displaced. Had *Sapphire* been recovered with its main fish hatch securely in place it would have been impossible for any fish boxes in the fish hold to escape through the fish hatch, at any time after the sinking. In the absence of any hull damage no other route for their escape existed. In these circumstances an inspection of the fish hold would have enabled an accurate count of fish boxes to be taken.

By the same token an accurate count of fish boxes stowed beneath the shelter would have been possible had that space remained closed following the sinking.

In the event, several boxes were seen to escape through the bag hatch during the salvage operation but it proved impossible to count the total number of boxes that floated out. As the main fish hatch was also open it is not known how many boxes emerged from the hold during the salvage. This inability to keep track of all the boxes that moved from the hold to the shelter or from the bag hatch to the sea made an accurate count impossible.

Owing to the unreliable nature of the likely data, it was concluded that there was no value in obtaining an accurate fish box count on the recovered vessel, and other sources of information would have to be relied on. It was further concluded that the mechanism which caused fish boxes to escape via the bag hatch could also offer an explanation for the significant numbers of boxes found in spaces other than the fish hold.

From the earliest stages of this investigation, figures had been available for the number of fish boxes on board *Sapphire* at the time of her loss. These figures were supplied by various sources including *Sapphire*'s skipper, *Elegance*, *Sapphire*'s agents and the fish box leasing company. None of these sources suggest that more than 430 boxes were carried on board *Sapphire*. Furthermore, several valid operational reasons have been offered to suggest that there was no reason for *Sapphire* to have had a greater number of fish boxes on board than was reported.

It is concluded that no more than 430 fish boxes were on board, of which 410 were filled with ice and fish, and that they were stowed in the fish hold. The vessel was therefore not overloaded. It follows that an alternative explanation is required to account for the significant numbers of fish boxes which were found in spaces other than the fish hold.

2.12 MIGRATION OF FISH BOXES

Following her sinking on 1 October 1997, *Sapphire* lay on the sea bed for over ten weeks before she was recovered and brought into Peterhead on 14 December. During this period the main fish hatch was open to the sea, as also was the working area beneath the shelter. In turn, the galley was connected to the space beneath the shelter by the open windows at the aft end of the working area.

The currents around the wreck were strong on various occasions during the initial survey and the later recovery and caused the ROV some difficulty in maintaining station. These currents would have ensured a flow through the space beneath the shelter for several substantial periods each day. Large openings to this space, namely, the emergency escape at the forward end and the doors at the aft end of the starboard passage, would have provided suitable paths for water movement into and out of this space. These would have been in addition to the freeing ports, slots in the bulwarks and ports for the towing and mooring lines.

The influence of both current-induced and buoyancy forces on fish boxes was observed on several occasions during the latter stages of the vessel's recovery. The manifestation of these influences was the passage of fish boxes from the space beneath the shelter through the unsecured bag hatch to the sea. The cyclic nature of the flow of sea water through the under-shelter space would have induced corresponding movement of any fish boxes within, so ensuring that fish boxes continually contacted the internal surfaces of the surrounding structure.

Openings of adequate dimensions existed in the structure offering the boxes an escape route: either to the sea or, as in the case of the galley, to another space within the vessel.

Box migration into the galley occurred while the vessel was resting on the sea bed. With the vessel resting on her starboard side, the two open galley windows, which communicated with the under-shelter space, would have been towards the upper or mid-height region of that space. Buoyancy forces acting on fish boxes under the shelter would have ensured that they tended to migrate towards the upper part of the space. The effects of currents would have provided the horizontal motion necessary to move boxes through either of the windows and into the galley. Once within the relatively still water of the galley, the lack of any positive current effects would have discouraged further motion of boxes through the doorway and into the transverse passage. A similar mechanism would also have been present once the vessel was moved to the near upright position during the recovery operation. However, it is likely that the galley was effectively full of boxes by that stage and further box migration would have been prevented.

For this account of fish box migration to be valid, there has to be an explanation to account for a significant number of fish boxes being present in the shelter having moved from the fish hold. Unlike the space within the shelter, the fish hold would not have experienced any significant current-induced flow of water because it had only a single opening: the main fish hatch.

Buoyancy forces acting on the fish boxes inside the hold would have been present continuously. It is reasonable to suggest that most of the fish boxes within the fish hold would, in spite of some being wedged in place, have been disturbed during the sinking. They were free to float to the higher regions of the fish hold which were, eventually, the port side and upper part. Any fish boxes adjacent to the main hatch would then have come within the influence of local turbulence generated by the previously mentioned flow of water through the under-shelter space and around the hatch coaming. The intensity of this turbulence might not have been great but owing to the large area to mass ratio of the boxes, its effect on them would have been significant. Any boxes lying in the vicinity of the open hatch were then disturbed and induced through the hatch by random local motions of the water.

Buoyancy and water motion then distributed the boxes within the under-shelter space.

2.13 HULL DAMAGE

During the initial underwater survey of the wreck and the subsequent salvage operation, no damage was found on any part of the hull below main deck level. The watertight integrity of the hull was also confirmed during the wreck's short stay in Peterhead following her recovery. Floodwater levels within the cabin, engine room and fish hold remained constant, and slightly higher than the surrounding sea, while the wreck was suspended from lifting wires during its stay in Peterhead.

Although constant, the water level within the fish hold was higher than in the engine room and cabin, due to the wreck's trim and shear of the hull placing the fish hatch on a higher horizontal plane. This small difference in hydrostatic head between the sea and the three compartments, and between the fish hold and engine room/cabin, not only confirmed the hull's integrity, but also indicated that the bulkhead between the engine room and fish hold was intact.

One length of planking, extending over two frame spaces, was found missing on the port side of the bulwark forward. Slightly above this was a second, very small, area of missing bulwark.

No parts of the bulwarks, except those adjacent to the deckhouse, were intended to be, or were, constructed as weathertight. The bulwark planking was therefore not caulked. The lack of weathertightness of the bulwarks was in accordance with general non-weathertightness of the shelter over the working deck.

Because of the non-weathertightness of the shelter and bulwarks, it can reasonably be expected that maintenance and repair of the bulwarks was to a less rigorous standard than that applied to the hull below main deck level. Cracked or split planking in the bulwarks was therefore unlikely to have been repaired with the same urgency or to the same standard as the hull planking.

Largely because of the likely repair and maintenance regime, minor bulwark damage of this nature is considered to be of little significance in establishing the cause of the vessel's sinking. It is considered most likely that this short length of planking was damaged at some earlier time and was swept from its position by the inrush of floodwater as the vessel sank.

2.14 CAUSE OF CAPSIZE

The term 'capsize' has been applied to the basic mechanism of *Sapphire*'s loss. It will continue to be. However, there is evidence which indicates that the vessel did not fully invert as she sank. In particular, loose wheelhouse equipment, such as the fire extinguisher, portable VHF radio and portable telephones, were all retained within their respective stowage brackets. Not all of these items would have been easily displaced from their stowage arrangements, but it is thought that complete inversion would have dislodged at least some. While continuing to use the term 'capsize', it is concluded that the vessel was caused to move beyond its range of stability, was unable to recover and started to sink.

Because *Sapphire* was on passage at the time of her capsize, the effect of snagged fishing gear has already been dismissed as a potential cause. The effects of weather being the primary cause of the accident have also been considered and disregarded. Other potential causes now need to be considered.

2.14.1 Collision

Sapphire's skipper has been unable to offer any recollection of seeing other vessels in the area at the time of *Sapphire*'s sinking. Notwithstanding this report, the possibility of collision has been considered, largely because of *Elegance*'s report that there might have been another, unidentified, vessel in the area at the time of her sighting the flares.

Collisions at sea have, in some cases, resulted in the catastrophic capsize and sinking of fishing vessels. Investigation has invariably identified damage to the vessel, the extent and characteristics of which are largely dependent on the material of the vessel's construction and the nature of the collision.

Nowhere on *Sapphire* was any evidence found to suggest any type of contact with another vessel or floating object. All underwater surfaces of the hull were found free of scars or scuff marks and, prior to recovery, there were no signs of damage to the shelter, guard rails or deckhouse which might have been consistent with a collision. The possibility of collision has therefore been dismissed.

With the possibility of external forces from fishing gear, weather or collision having been disregarded as primary causes of the capsize, only the effects of depleted stability remain.

2.14.2 Fish Box Stowage

Notwithstanding the conclusion reached earlier on the number of fish boxes carried and their stowage arrangements, consideration has been given to the effect of stowing filled fish boxes on the working deck beneath the shelter. The primary effect of this stowage arrangement is to reduce the vessel's stability.

An assessment of *Sapphire*'s stability with 100 filled fish boxes stowed beneath the shelter shows that the vessel falls well within all mandatory stability requirements, in many areas quite handsomely (Annex 1). Even if it were possible for all these boxes to shift transversely by 3m in the limited space available, an angle of heel of no more than 6° results. This angle is considered not large enough to cause the vessel any difficulties. This conclusion allows this stowage method to be dismissed as a possible primary cause of capsize.

It must be emphasised that these stability results apply only to *Sapphire*. Skippers and owners of other fishing vessels should be aware that their vessels may not have sufficient reserves of stability to adopt such a practice safely. In addition, such configurations may not have been taken into account when the stability of their vessels was considered and approved.

2.14.3 Deck Water

The primary function of freeing ports in a vessel's bulwarks is to clear deck water rapidly. Large quantities of water on the deck of a vessel reduce its stability due to the commonly known 'free surface effect'.

If no non-return arrangement is fitted to these ports it is possible for water to pass inboard onto the deck as well as outboard from the deck to the sea, particularly when freeboard is limited. The working deck of *Sapphire* was reported to be 'rather wet' due to this effect, particularly when operating with the weather on the beam.

To allow freeing ports to function as intended, it is necessary for the deck to be kept free from obstructions so that the flow of deck water to the ports is unimpeded.

The working deck of *Sapphire* contained a number of features and equipment, common to many fishing vessels, which obstructed the free flow of deck water.

At the starboard side was the fish hopper and gutting table. However, these two items were supported clear of the deck by slender legs which offered no significant obstruction to the free movement of deck water.

To port was a substantial fish box pound, with small pounds attached forward and aft of it. Although the lower boards of these pounds had some inverted 'vee' cut outs in their lower edges, the complete pound structure would have constituted an obstruction to water attempting to clear the deck from the port side; particularly via the two forward freeing ports on the port side. The operational practice of the vessel ensured that these two freeing ports remained closed. This was confirmed during the underwater survey of the wreck. Any attempt to aid the flow of water towards these ports, by way of the cutouts in the lower boards of the box pound, was therefore of limited value.

Deck water was a common feature on the vessel's working deck, even in modest weather conditions. *Sapphire* had a history of safe operation, during which no significant changes had been made which would have altered the quantity of water likely to be on deck in any particular conditions of wind, sea, draught, etc. The detrimental effect of deck water on the stability of a vessel is commonly recognised, and *Sapphire*'s stability would certainly have been affected to some degree in this way.

An assessment has been made of *Sapphire*'s stability with the effects of 100mm of water on the working deck included (Annex 1). This indicates that, without also considering the effects of flooding and with the exception of the vessel's GM, all criteria specified by Regulation would have been exceeded.

A vessel having a standard of stability significantly less than *Sapphire*'s could have been dramatically affected by water distributed over the complete working deck. However, *Sapphire* had a comfortable and substantial reserve of stability and there is no reason for suggesting that the quantity of water on her deck, at least until after 1300 on 1 October, was any greater, or its effect any more damaging to her stability, than at any other time during the vessel's operational history. Certainly *Sapphire*'s stability was affected by deck water, whatever the quantity present, and during any later references to stability of the vessel on the day of her loss, it will be necessary to be aware of free surface effects. It was not, however, a fundamental mechanism of her loss.

Although it had become the practice to maintain some freeing ports closed, which is poor seamanship, the introduction of this practice did not coincide with the loss of the vessel. Further, comparing the effects of this practice against statutory requirements, with four of the six freeing ports completely closed, as found post sinking, the combined areas of the two remaining freeing ports and the freeing slots gives 92.5% of Rule requirement. This figure, together with the unknown area available via the centre starboard freeing port, used by the gutting chute, suggests that the reduction in freeing arrangements was not so dramatic as might be suggested by the number of freeing ports which were closed.

In the absence of any other factor which might have caused an unusual quantity of water to be on deck, for the prevailing weather conditions, the effect of deck water on stability is not

considered to have been the primary or initiating cause of *Sapphire*'s capsize. However, there are other potential effects of water on the working deck in poor weather, particularly if equipment and fittings are not properly secured.

Having considered and disregarded the above loss mechanisms, there remains only the effects of flooding to consider.

2.15 WATER INGRESS

Provided bilge pumping could be completed within a fixed but unspecified period, and at standard intervals, the crew had no reason to be concerned by water in the bilges. Bilge pumping procedures of this type are common among fishing vessel crews.

No inspection of *Sapphire*'s bilge system was made following recovery. Again, the unchanging water levels within the hull while *Sapphire* lay in Peterhead following her salvage, indicates that there was probably no major fault in the bilge system, such as faulty non-return valves, which could have caused the flooding. Although this observation cannot be conclusive due to the unknown status of the bilge valves following the last bilge pumping operation, it does suggest that the system was correctly shut down after use.

A similar conclusion can be applied, with greater confidence, to other sea water systems, such as the engine cooling system.

Information supplied to the Inquiry suggests that *Sapphire*, during normal operations, might have suffered from water ingress through her hull at a rate significantly greater than is typical for a vessel of her type. It has not, however, been possible to obtain sufficient reliable information to confirm this. The post-sinking surveys revealed nothing to support this possibility.

Rather more reliable evidence indicates that the vessel suffered hull leakage proportionate to hull movement, noticeable in heavy weather. This ingress was controlled, without apparent difficulty, by routine bilge pumping and there is no indication that it caused any alarm or that it contributed to the sinking.

2.16 PREVIOUS FLOODING INCIDENTS

Sapphire experienced two comparatively recent flooding incidents before her loss. Each incident, when considered alone, was unremarkable and typical of the type of problem experienced by many fishing vessels of similar size and construction.

Both incidents involved flooding of the fish hold which, because the high-level bilge alarm was not functioning correctly, were discovered when crew entered the space for purposes other than inspection. The significant feature of each incident was the minimal effect which the flooding had on the vessel's behaviour. It was insufficient to alert the crew to anything untoward.

The vessel's behaviour during these incidents suggests a significant amount of flooding of the fish hold could occur without the crew being alerted by any change in the vessel's 'feel' or response to the sea. Assessments of the vessel's stability with the fish hold loaded, as on 1 October, and subject to a substantial degree of flooding, show that the value for GM

obtained is still in excess of requirements. Any change in behaviour of the vessel, in the near upright condition, could therefore have passed unnoticed, particularly if deteriorating weather and sea conditions were masking the effects.

However, a vessel's GM is not the only criterion against which a vessel's stability should be assessed. Flooding of the fish hold, due to the effect of the floodwater's weight, also increases the vessel's draught, with a corresponding reduction in freeboard. In turn, reduced freeboard results in smaller angles of heel before immersion of deck edge, doors and hatches occurs.

2.17 SEQUENCE OF FLOODING

On the morning of her sinking, *Sapphire*'s bilges had been checked and pumped out at about 1030 when the skipper handed the watch to Robert Stephen. Bilges were again expected to be checked and pumped out at about 1300, when Robert Stephen handed over the watch to Bruce Cameron. It is expected that, following established routine, this check would have included the fish hold bilges. As no report of excessive bilge water levels was made to the skipper following that operation, it is assumed that no excessive quantity of bilge water was noticed, either in the engine room or fish hold.

Between the last likely pumping of the bilges and the vessel's loss, 2½ hours elapsed during which time, in the absence of a high-level bilge alarm, any flooding of the fish hold or engine room could have occurred unnoticed.

Data from numerous incidents involving flooding of engine rooms in fishing vessels shows that, without a warning from a high-level bilge alarm, flooding often continues until the level reaches approximately the height of the main engine's centre line. Typically, the electrical system is then affected by water thrown about by the flywheel and belt-driven auxiliaries, the belts of which often slip. The main engine usually continues to function but the watchkeeper only becomes aware of a problem in the engine room when lights begin to flicker or wheelhouse equipment fails.

The degree of progressive flooding within the engine room which could have occurred before the watchkeeper was made aware of the problem would have been rather limited. It is most unlikely that floodwater could have reached a level much above the centre line of the main engine before the problem was noticed by an alert watchkeeper.

Calculations show that *Sapphire*'s stability would not be significantly affected by this degree of flooding in the engine room (Annex 1). The engine room certainly flooded at some stage of the incident, but the degree of flooding before symptoms were apparent, and the limited effect on the vessel's stability, indicates that such flooding did not initiate the capsize of the vessel, although it probably contributed in the extreme latter stages. It was one of a chain of events which occurred as a consequence of earlier happenings.

The only remaining large uninhabited space which could have initiated a capsize by flooding, was the fish hold.

2.18 THE MAIN FISH HATCH

The main hatch cover to the fish hold had a smaller hinged cover set within it. The larger cover normally was opened only when in port and fish were being landed. Owing to the absence of hinges on the large hatch cover it was necessary to lift it to one side and place it on deck whenever it was opened. Once the catch had been landed, the hatch cover was replaced on the hatch coaming and secured by its four butterfly toggles.

The last occasion on which this large cover was removed was for the landing of fish on Friday, 26 September. There is nothing to indicate it was not replaced. It is almost inconceivable that the vessel would have gone to sea without it being in place. There is, however, evidence to indicate it was not properly secured.

Following the vessel's recovery, the main hatch cover was found unsecured and displaced to the starboard side of the hatch coaming, with the securing toggles on the coaming swung down in the released position. The absence of visible damage or straining on the securing toggles and hatch cover indicates that a large force had not been necessary to displace the cover.

Inspections of a number of foundered vessels, including fishing vessels of similar size to *Sapphire* and with decks of wooden construction, have been undertaken in recent years. In several instances vessels have sunk with the main hatch covers securely in place. In each case the deck structure, or hatch cover and/or its coaming, has suffered severe damage due to forces generated by hydrostatic pressure. In particular, deck damage of this type has been dramatic and has occurred where vessels have sunk in depths of less than 30m. Similarly, where hatch cover or coaming damage has been found it has been substantial and centred on the flat surfaces. There was no such damage found on *Sapphire* which sank in 90m of water, nor was any damage found on the main working deck, the main hatch cover or the coaming which formed the upper boundary of the fish hold. The absence of such damage indicates that, during her sinking, the fish hold was open to the sea shortly after the vessel left the surface.

In the absence of any damage to the remaining boundaries of the fish hold, either in the hull or bulkheads, the main fish hatch alone provides the means by which the fish hold could flood sufficiently rapidly to prevent hydrostatic damage to the vessel's deck, hatch cover and its coaming. These observations suggest that the main fish hatch cover was not in place shortly after the vessel left the surface.

There was no reason for the crew to have opened the main hatch cover during the voyage for any of the tasks they were expected to perform. The possibility that the vessel's crew left this hatch cover off, after completing their task of stowing fish at 1000 on 1 October, is therefore dismissed. There remains the period of about 5½ hours between the crew finishing this task and the vessel's loss, a period during which none of the crew would have had any operational reason to visit the working deck and during which this hatch cover would, because of the shelter top, have been invisible to the watchkeeper in the wheelhouse.

The mechanism which caused the main hatch cover to move without being damaged cannot be known precisely, but a pre-condition would be that the securing toggles were either not in place, or had not been tightened.

2.19 POSSIBLE CAUSES OF FLOODING

In the absence of any hull damage or sprung planking below main deck level, neither of which was found during post-sinking surveys, there is no route by which significant and rapid flooding could have occurred; other than via the normal openings and hatches on the vessel.

Procedures on *Sapphire* allowed many hatch covers and doors to be left open or unsecured when at sea. This practice was confirmed during the underwater surveys and the post-recovery inspection. It is significant that a number of the openings found open were situated on the starboard side of the vessel, or on her longitudinal centreline and included the fish hatch, the bag hatch, the forward and aft weathertight doors at either end of the starboard passage, the engine room door and the emergency escape hatches from both the shelter and the engine room.

Although considered to be poor practice, analysis of the vessel's stability shows that maintaining these hatches and doors open would have been insufficient to diminish the vessel's stability below that required by regulation. It follows that other factors are likely to have had a major influence on the vessel to produce the conditions necessary for the vessel's loss.

The conclusion has already been reached that the engine room flooded as a consequence of, rather than being the cause of, other events. The rate at which it flooded was inextricably linked to the door from the starboard passage and/or the engine room emergency escape hatch being open. In the final stages of the incident, the rate of flooding through these openings would have been dramatic. Even in the earlier stages, where progressive flooding from the starboard passage was probable, this would have been totally prevented had the door been secured closed.

It is an unavoidable conclusion that the engine room would not have flooded at such an early stage in the incident, nor at such a dramatic rate in the latter stages, had the door to the engine room from the starboard passage been closed and/or had the forward and aft weathertight doors in the starboard passage been shut. Had the engine room not flooded so quickly, the rate of flooding of the accommodation and wheelhouse is likely to have been less rapid.

2.20 FLOODING OF THE FISH HOLD

The only remaining large space in the vessel which could have flooded and affected the vessel's stability sufficiently to cause her to capsize, was the fish hold. In the absence of hull or other structural damage, or evidence to suggest serious problems with the bilge pumping system, the only downflooding path remaining is the main fish hatch. It follows that the main fish hatch cover was probably already displaced from its coaming before the vessel capsized.

Stability calculations show that the vessel's stability would not have been dramatically diminished unless serious flooding of the fish hold had occurred (Annex I). As well as providing a route for rapid downflooding during the capsize, the displaced hatch cover would also have provided a route for progressive flooding of the fish hold while on passage. To enable this to happen the main fish hatch cover needed to have been displaced. The evidence strongly suggests that at some time shortly after 1400, the fish hatch, without any

means of keeping it in place in the prevailing conditions, became detached from its coaming.

Water on the working deck, known to be a common feature on the vessel, particularly in anything worse than very moderate sea conditions, was normally expected to clear via the freeing ports and slots in the bulwarks. These freeing arrangements become less effective as freeboard is reduced and are of limited value once the deck edge is immersed.

Deck water would attempt to follow the pitching and rolling motion of the vessel. Given the longer distances involved when pitching, this water would have acquired added momentum before striking a surface such as the hatch coaming. On impact with the coaming a wedge of water would have formed and, unless the hatch cover was in place, any water higher than the coaming would have spilled into the fish hold.

Initially this ingress would have been at a modest rate. However, as the weather conditions deteriorated and the vessel's freeboard reduced with the accumulated weight of the water in the fish hold, there would have been an increase in the amount of water remaining on deck. It follows that, in turn, the rate of flooding over the coaming would have increased.

This mechanism would have continued until the vessel's freeboard and stability were reduced sufficiently for other spaces to be affected by flooding: first the starboard passage and then the engine room.

2.21 SHELTERS ON FISHING VESSELS

The primary function of a fishing vessel's shelter is normally to protect the crew and equipment from the weather while processing and handling fish. To some degree this will be met whatever the designation of the shelter's structure; weathertight or non-weathertight.

Owing to its buoyancy, a weathertight shelter may contribute something to a vessel's stability. Of greater relevance to those working in it is the facility to secure its hatch covers and doors to fully protect them from the elements. Providing the shelter and its hatch covers remain weathertight, any opening in the working deck is then protected against the possibility of water ingress. Given this protection, a practice of leaving open internal doors often develops. Standards of maintenance for the doors, hatches and hatch covers in these spaces can also slip, due to the rather less critical nature of their function.

The working deck beneath a non-weathertight shelter has no similar level of protection. Indeed, features such as freeing ports should have characteristics identical to those in a similar sized vessels not equipped with any type of shelter and with a working deck completely exposed to the elements. It follows that hatches and hatch covers set in the working deck beneath a non-weathertight shelter need to be of a weathertight standard, not only in design and construction but, of equal importance, in the way they are used.

Because owners, skippers and crews of fishing vessels change from time to time, the procedures adopted in one vessel with a weathertight shelter will understandably translate to others, perhaps to those fitted with a non-weathertight shelter. Crews familiar with one routine may find it difficult to alter their working habits when they change vessels, particularly if the need is not immediately obvious. Procedures for keeping weathertight doors shut will vary from vessel to vessel, but clear identification of those doors and hatch

covers which should be secured closed at sea to ensure a vessel's safety would be an aid to new crew members. It would also be a constant reminder to those already familiar with a particular vessel.

Most of the crew of *Sapphire* had sailed in her for several months, even years, and so the suggested transfer of practices from other vessels did not arise in this instance. Nevertheless the existence of a 'permanent' crew highlights the need for all crews, including those familiar with their vessels, to be reminded about the importance of keeping certain doors and hatches shut to ensure their vessel's safety. It is considered that a policy of clearly labelling these doors and hatches, with instructions to keep them closed at sea, will enhance the safety of a number of fishing vessels.

2.22 WATERTIGHT AND WEATHERTIGHT OPENINGS

Concern over the practice of operating with weathertight doors and hatches open while at sea was expressed in the publication of the MAIB's Safety Bulletin 2/98 in January 1998 (Annex 3). Responses to this bulletin, from some parts of the industry, suggested that there is some confusion over the terminology employed to describe weathertight and watertight doors and hatch covers. This confusion is sometimes compounded by the frequent use of the term watertight to describe either watertight or weathertight structures. This has been seen in official documents produced by professional naval architects. As this terminology is extensively employed within this report, and is critical to the interpretation of the message contained within Safety Bulletin 2/98, a brief discussion of these terms is worthwhile.

The term 'watertight' is applied to hatches, doors and bulkheads of a vessel if they are intended, and designed, to prevent the passage of water in either direction. The bulkhead between an engine room and a fish hold may be considered watertight if it is capable of preventing the passage of water from the engine room to the fish hold, and vice versa. Similarly, a door in a watertight bulkhead must have characteristics to ensure that it, too, is watertight.

The essential intended function of hatches and doors on the outer boundaries of a vessel is to prevent the ingress of water and it follows they must be capable of achieving this. However, there is little merit in containing water within the spaces which these hatches and doors serve. For example, there would be no point in containing floodwater within a galley or mess. Any such water should be allowed to flow onto the open deck and overboard. As the intended function of a door fitted to such a space is to prevent the passage of water in one direction only, that is inboard, it is considered to be 'weathertight'.

In addition to several weathertight hatches and doors, *Sapphire* also had a number of other hatch covers, and structures, which are not covered by either the 'weathertight' or 'watertight' definitions. The vessel's shelter, forward of the wheelhouse, was neither constructed nor intended to be watertight or weathertight. This is most clearly shown by the presence of the freeing ports and slots in the bulwarks which were capable of allowing water to pass inboard or outboard. It follows, therefore, that the hatches in the upper part of the shelter had no need to be weathertight.

The function of the shelter on *Sapphire* was that of a true shelter for the personnel and equipment beneath. It protected crew and gear from the worst of the wind, spray and breaking seas. Hatch covers in the shelter's top, when closed, served the purpose of improving the level of shelter to whatever was below. Having any of these hatch covers

open at sea diminished the level of shelter over the working area but did not, in itself, expose any important compartment of the vessel to the possibility of flooding.

The covers to the emergency escape hatch and the bag hatch on *Sapphire* were not secured closed at the time of her sinking. Indeed, the emergency escape hatch was hooked open. Although it is always a sensible and seamanlike precaution to secure closed all hatches on a vessel in poor weather conditions, the failure to secure closed these two hatches is not considered significant to the sinking of *Sapphire*. Of much greater significance to *Sapphire*'s loss was the failure to close and secure several weathertight hatches.

2.23 SAPPHIRE'S STABILITY BOOKLET

Sapphire's stability booklet was prepared in order to satisfy statutory requirements before she was issued with her UKFV Certificate. This booklet was approved by the then Marine Safety Agency (MSA), now the MCA, for this purpose.

Stability calculations made during the compilation of her stability booklet, and separately following the accident, show that *Sapphire* satisfied the statutory stability requirements whether or not the starboard passage was treated as a weathertight space.

Notwithstanding this compliance, the vessel's approved stability booklet gives no clear indication as to which spaces were required to be maintained weathertight in order to achieve the stated standard of stability. In this context, the only reference to the spaces considered to be watertight, or weathertight, is a reference in the tables of KN values to the fact that, '*computation includes hull, fo'c'sle and watertight deckhouse and is on free trim basis.*' This was normal practice at the time *Sapphire*'s stability book was approved.

Sapphire's stability booklet received MSA approval in November 1988. Following normal practice at that time, no warnings about closure of openings in heavy weather, or the importance of maintaining watertight integrity of the hull and superstructure were given. Since then, developments in the format of approved stability booklets have taken place, including Notices to Skippers, advising them, in general terms, of the importance of maintaining watertight integrity but without specifically identifying the critical openings. No retrospective insertion of such warnings in previously approved stability booklets has been implemented. It is recommended that, in future, clearer identification of weathertight doors and hatches is given in any stability booklet approved by the MCA.

These developments are positive steps in assisting skippers to operate their vessels in a safe manner. However, the way this information is presented is not conducive to careful study and consideration, and could lead to important messages being missed. There is no clear indication which openings are being referred to and no clear indication as to which spaces are required to be weathertight in order to maintain the vessel's stability to the standards calculated. It follows that there can be no certainty that the inclusion of this type of warning in *Sapphire*'s stability booklet would have had any influence on the operational procedures adopted on board. Effective warnings, followed by suitable action, would have had a significant influence on this accident and might have prevented it.

Improved presentation, and a refinement of the information contained in stability booklets, could contribute to preventing future incidents of this type. The graphic identification of weathertight openings, which should be closed to achieve calculated standards of stability, may allow this important information to be more readily digested by skippers and crew. In

order not to unnecessarily increase the size of stability booklets there may be some advantage in omitting the tables of KN levers and hydrostatic properties, if these can be shown to be of limited value to skippers.

Rather than embark on an ad hoc set of modifications to the information which might be contained in stability booklets, MCA is recommended to undertake a study of the value of stability booklets for fishing vessels, in the format presently accepted. This study should be extended to consider major modifications to the type and presentation of the information contained, so that skippers and crews can more readily understand and appreciate the value of that information. Consultation with skippers, owners, naval architects, fishermen's training colleges, Fishing Industry Safety Group (FISG), fishermen's federations and other parties able to make a contribution is considered important to this study.

2.24 IDENTIFICATION OF WEATHERTIGHT OPENINGS

During the routine operation of a fishing vessel, reference to the stability booklet may not be made very frequently, even when presented in the form which could be the result of the study proposed above. In order to serve as a constant reminder, those doors and hatches which are critical to a vessel's safety should have a written warning on both sides. These warnings should set out the need to maintain the respective hatch or door securely closed, unless immediate access is necessary. The important requirements of these warnings are clarity, accuracy and permanence. These can be achieved at minimal cost without the need to employ a professional signwriter.

An alternative to textual warnings would be to mark all weathertight doors and hatches with some easily recognisable sign or symbol to indicate that it should be shut and secured at sea. A coloured flash painted on one corner of the door or hatch would suffice.

Previous MAIB investigations have identified unsecured weathertight openings as being a fundamental factor in the loss of many fishing vessels. Notable among these are the *Majestic*, which sank with the loss of five lives in 1989, and *Green Valley* which sank in 1995, fortunately with no loss of life. There have been other losses due to this cause, one involving one of the largest ships of its type in the UK Merchant Navy.

One recommendation made following the investigation into the loss of *Majestic*, which was addressed to the MSA, suggested the posting of safety labels in various parts of fishing vessels. The report, which was published, contained an example of one proposed label: '*these WT doors are to be kept closed at sea and opened for access only.*' This recommendation was fully accepted by the MSA.

A rather more specific recommendation, again addressed to the MSA, was made following the investigation into the loss of *Green Valley*. The report, which was not published, contained the following recommendation: '*... for any fishing vessel which requires any superstructure to be weathertight to achieve the standards of stability set out in its Stability Booklet, require labels or notices to be attached to both sides of closures for openings (in that superstructure), indicating that such openings are to be secured closed at sea, except for absolute minimum periods for purposes of access essential to the operation of the vessel.*' The same recommendation continued, '*a clear diagram to be included in the Stability Booklet showing those openings which are to be secured closed to achieve the standard of stability indicated.*' This recommendation was also fully accepted by the MSA.

Warnings on this subject have previously been publicised in Merchant Shipping Notices, the most recent being M.1657. However, as observed before by the MAIB, the M Notice system is largely ineffective as far as the fishing industry is concerned. A more practical and immediate approach is required and the method of labelling doors and hatches, together with a graphical representation set out in the stability booklet, should be pursued by the MCA.

2.25 OPERATIONAL PRACTICES ON SAPPHIRE

Practices had evolved on *Sapphire* which resulted in important weathertight doors being left open while the vessel was at sea. The clear ease with which the main fish hatch cover became displaced is also indicative of procedures which were not conducive to maintaining the weathertight integrity of the vessel and is indicative of a lack of appreciation of their importance.

During the normal working patterns of any vessel, particularly a fishing vessel when fishing, it is clearly essential for crew to use many doorways and hatches for access and egress. However, once these operations have been completed there is no reason why these doors and hatch covers should not be closed and secured.

Only skippers and their crews have direct control over these matters. The skipper and crew of *Sapphire* were experienced fishermen, with a reputation for running their vessel hard but successfully. Other vessels are also operated without proper recognition being given to the function of weathertight doors and hatches and some have been lost as a result. Those in *Sapphire* paid a high price for their oversight and it is proper that other seafarers are made aware of the potential consequences.

2.26 RECONSTRUCTION OF THE ACCIDENT

The events which occurred prior to 1030 and after 1530 on 1 October 1997 have been sufficiently well documented, or sufficient witness evidence is available, to enable a sequence of events to be established.

Between these two times, however, certain critical events occurred on *Sapphire* which have been impossible to set out with certainty. With the tragic loss of the four crew, and the surviving skipper being off watch and asleep in the main cabin throughout this period, witness evidence alone has not been sufficient to reconstruct the circumstances leading up to the accident.

It is therefore necessary to combine the material collected from many sources, which has been reviewed and analysed under various categories in earlier sections of this report, to construct a likely sequence of events.

2.26.1 Circumstances leading to the Loss

At about 1000 on 1 October *Sapphire*'s last haul of fish had been stowed in the fish hold and the small fish hatch was secured closed.

The main hatch cover to the fish hold was in place but not properly secured. The doors at

the forward and aft end of the starboard passageway and to the engine room were secured open. The emergency escape hatch from the engine room was partially open.

On completing his watch, the skipper made his checks of the engine, prior to making his way to the cabin to sleep at 1030. The other non-watchkeeping crew members rested or relaxed in the cabin or galley/mess area.

Weather conditions progressively deteriorated.

Watchkeepers changed again at 1300. The relieved watchkeeper carried out an inspection of the engine room and probably pumped the fish hold and the engine room bilges. Neither this inspection nor the amount of bilge water pumped out gave cause for concern. There was no operational reason for this crewman to enter the working area beneath the shelter.

Weather conditions were continuing to gradually deteriorate and the motion of the vessel progressively increased. As the vessel pitched and rolled the sea passed on to the working deck, through the open freeing ports and slots, in increasing quantities.

2.26.2 Commencement of Flooding

Shortly after the last inspection of the engine room, the large unsecured hatch cover to the fish hold was displaced, probably by the effects of a heavy roll or the combined effects of a roll and slamming. Deck water, which was increasing in quantity because of the deteriorating weather and increased vessel motion, sloshed forward and aft, port and starboard along and across the deck as the vessel pitched and rolled. By 1400 the wind had increased to force 7 to 8.

The free flow of water on deck was restricted by the box pound on the port side and the hatch coaming in the centre of the deck. As this coaming was a flat surface, the stream of deck water impacted with it and generated a wedge of water, or wave, leading to water sporadically spilling over the coaming of the main fish hatch and into the fish hold.

With no functioning high-level bilge alarm to alert the crew, this gradual flooding mechanism continued at a progressively increasing rate as the weather worsened, for up to 2½ hours between 1300 and 1530. The vessel suffered a reduction in freeboard corresponding to the degree of flooding.

As the fish hold flooded, initially at a modest rate, the vessel's GM gradually reduced, but in the early stages not catastrophically so. From an initial value of 1.06m, GM progressively diminished to 0.91m, when the fish hold was flooded to a depth of 600mm; a value of GM still substantially in excess of mandatory requirements. Deck water to a depth of 100mm would have reduced GM to 0.18m but values of righting levers, or GZs, suggest the vessel would still have been capable of resisting capsize The vessel's change in behaviour was insufficient to alert the crew to the problem, which may have been masked to an extent by the worsening weather conditions. The deck water flooding through the fish hatch could not be seen by the watchkeeper in the wheelhouse, and the remainder of the crew were within the accommodation spaces.

Progressive flooding of the fish hold resulted in continued reduction in the vessel's freeboard. Consequently the deck edge became immersed at smaller angles of heel, so increasing the quantity of water on deck. The increase in draught also resulted in the

vessel's speed reducing, which was also masked from the crew by the effects of the deteriorating weather.

2.26.3 Flooding of Starboard Passage and Engine Room

The vessel rolling to port presented little immediate danger. Although the deck edge was immersed allowing water to pass on to the deck, the deckhouse on that side provided a small reserve of stability and its intact nature prevented any downflooding.

Rolling to starboard not only immersed the deck edge, at angles as little as 8° with the fish hold flooded to 1800mm, but the starboard passage began to take in water through the open doors with each roll. Flooding of this passage was not noticed by the crew as the weathertight door from this passage to the accommodation's transverse passage, was closed. At this stage a substantial quantity of water was on deck and the rate of flooding via the fish hatch was high, although still intermittent, owing to the vessel's motion and the corresponding movement of deck water. There was no reason for any of the crew to leave the accommodation during this time; the problem would have been discovered had they done so. Similarly, had a properly functioning high-level bilge alarm been onboard they would have been alerted.

Subsequent rolling then caused water to spill from the starboard passage over the sill of the engine room door opening. As the fish hold continued to fill, the angle of heel at which water entered the starboard passage and engine room progressively reduced as the vessel's freeboard decreased. Very few rolling cycles were required to flood the engine to the level of the floor plates.

At this stage the fish hold was partly flooded, the engine room partly flooded, the starboard passage flooded and significant quantities of water were swilling around the working deck. None of these problems were obvious to the crew.

2.26.4 Final Flooding

In this condition the vessel's stability was seriously reduced, in particular the range of stability and GZ for a roll to starboard. The reduction in stability was particularly marked as the fish hold flooded from 1200mm to 1800mm depth, producing corresponding maximum GZs of 0.272m and 0.0995m due to that effect alone. When the effects of a modest amount of deck water are included, the corresponding GZs are 0.239m and 0.065m.

The vessel then experienced a sea which caused her to roll to starboard, probably only slightly greater than any earlier roll. This roll, from which she was unable to recover, took the vessel beyond the range of her much depleted stability, probably to an angle of less than 25° at this stage, allowing the engine room to fill at a dramatic rate.

It was at this stage that the skipper awoke and became aware that a serious problem existed. The watchkeeper was alerted only a little sooner and had no opportunity to take positive action. In any case, little could be done to save the vessel. The engine room was flooding rapidly through the open door. Shortly afterwards the fish hold started flooding through the open hatch, at an angle of heel less than 50° which was well beyond the limit of the vessel's much reduced range of stability. This stage had probably been reached before the skipper reached the wheelhouse.

The wheelhouse filled rapidly with water and allowed flooding via the open port window through which the skipper made his escape. Flooding of the galley/mess, and consequently the transverse passage and cabin, probably began shortly before this through the forward windows. At this stage the vessel had heeled to at least 90° with flooding of the fish hold, engine room, accommodation and wheelhouse taking place at a catastrophic rate.

The vessel briefly lingered on the surface on her starboard beam, as the final stages of flooding proceeded. She then sank below the surface, allowing the liferafts to float free, and rotated back to the near upright state before hitting the sea bed and rolling onto her starboard side.

SECTION 3
Conclusions

3.1 FINDINGS

The Capsize and Crew

1. The FV *Sapphire*, PD285, capsized and sank in 90m of water, in position 57°36'16"N 001°23'25"W, shortly after 1530 on 1 October 1997. [1.3, 1.11, 1.12, 1.13, 1.14, 2.2]

2. The vessel did not fully invert during the capsize.[2.14]

3. The vessel was on passage to Fraserburgh at the time of sinking. [1.3, 2.1]

4. The vessel was operating with a skipper and four other crew. [1.8]

5. The crew were experienced fishermen and the skipper had the required certificate of competency. [1.8, 2.4]

6. The capsize to starboard and sinking occurred rapidly giving four of the crew insufficient time to escape. [1.3, 2.6]

7. The weather and sea condition deteriorated between 1000 and 1400. [2.5]

Weathertight Integrity

8. The vessel was operating with:

   (i) the engine room's weathertight emergency escape hatch open. [1.14, 1.23]

   (ii) the cabin's weathertight emergency escape hatch closed. [1.14]

   (iii) the forward and aft weathertight doors on the starboard passage open [1.14, 1.23]

   (iv) the weathertight door from the starboard passage to the engine room open. [1.14, 1.23]

   (v) the weathertight door between the transverse passage and the starboard passage securely closed. [1.14]

   (vi) the weathertight main fish hatch not securely closed. [1.14]

9. There is no requirement for weathertight doors and hatches to be identified. [2.23]

Flooding and Stability

10. The vessel had approved stability data. [1.21]

11. The frequency of pumping bilges had to be doubled due to hull leakage during periods of poor weather, but this is not considered to have been a significant factor in *Sapphire*'s loss. [2.15]

12. The vessel was carrying about 410 boxes of fish and up to 20 empty boxes at the time of sinking. [1.3, 1.19, 1.20, 2.11]

13. The vessel was not overloaded. [2.11]

14. The fish boxes were stowed in the fish hold. [1.19, 2.11]

15. The failure to close and properly secure weathertight doors and hatches was the major factor in the sinking of the vessel. [2.19, 2.25]

16. The main fish hatch cover was displaced from its coaming before the vessel capsized. [2.19, 2.20]

17. The quantity of water on deck increased as the weather conditions deteriorated. [2.5]

18. Deck water was able to enter the fish hold with the hatch cover displaced. [2.20]

19. The vessel's fish hold would have been able to progressively flood after the hatch cover became displaced. [2.20]

20. The flooding affected the vessel's behaviour insufficiently to alert the crew. [1.16, 2.26]

21. Between 1400 and 1530 the vessel's speed was reduced, most probably by the effects of flooding. [2.5, 2.26]

22. The rate at which water was able to enter the fish hold increased as the freeboard decreased and the weather deteriorated. [2.20]

23. The flooding of the fish hold reduced the vessel's range of stability, freeboard and the downflooding angle of the engine room door. [2.20]

24. The most probable cause of the capsize was the low stability level generated by the flooded fish hold. [2.17, 2.20]

25. The engine room flooded after the fish hold had flooded. [2.17]

26. The vessel's stability booklet assumed that the starboard passage was weathertight. [1.21]

27. The vessel was operating with only two of the six freeing ports serving the forward working deck open. [1.23]

28. The failure to secure closed the emergency escape hatch and the bag hatch in the shelter top was not a significant factor in the sinking of the vessel. [2.22]

29. The damage to the port forward part of the bulwarks was not a significant factor in the cause of the vessel's sinking. [2.13]

30. The vessel suffered no major structural failure of the hull which could have contributed to its sinking. [1.12, 1.13, 1.14, 2.13]

Safety Equipment

31. The vessel's EPIRB:

    (i) did not float free during the sinking. [1.12, 1.14]

    (ii) was installed with an HRU which was six months overdue for replacement. [1.14, 1.25, 2.9]

    (iii) was installed with an HRU which had been covered with paint. [1.25, 2.9]

    (iv) was installed with a HRU which had been fitted with a securing bolt of the wrong specification as regards to material and dimensions and which had not been supplied by the HRU's manufacturer. [1.25, 2.9]

    (v) had been covered with sufficient paint to mask the lens of its strobe light.[1.14]

    (vi) was within its recommended service life. [1.25]

32. The hydrostatic element of the HRU fitted to the vessel's EPIRB had activated during the sinking. [2.9]

33. The failure of the EPIRB to float free and transmit did not delay the commencement of the SAR operations. [2.3]

34. The vessel's high-level bilge alarm and fire alarm systems were not operational. [1.17, 2.10]

35. A functioning high-level bilge alarm in the fish hold would have alerted the crew to the flooding at an earlier stage. [2.6, 2.10]

36. The control panel for the high-level bilge alarm and fire alarm systems had been removed for repair. [2.10]

37. The vessel's two inflatable liferafts floated free as the vessel sank. [1.3, 1.12, 1.14]

38. The availability and location of the lifejackets did not influence the outcome of the accident. [2.8]

3.2 Causal Factors

1. The fundamental cause of the sinking of the FV *Sapphire* was the downflooding of major spaces through weathertight doorways and hatches which were open or inadequately secured while at sea.

2. A major contributory factor was the crew's lack of understanding of the function and importance of the weathertight hatch covers and doors.

3. A lesser contributory factor was the absence of a fully functioning high-level bilge alarm.

SECTION 4

Recommendations

4. THE MARITIME AND COASTGUARD AGENCY is recommended to:

1. Instruct their surveyors, or others to which the task may be delegated, to inspect, during survey, the securing bolts fitted to HRUs of EPIRBs installed on fishing vessels. Should these inspections show the problem of incorrect bolt material specification is not isolated, the Agency should take suitable steps to prevent repetition of this problem. [2.9]

2. Amend The Fishing Vessels (Life Saving Appliances) Regulations 1988 explicitly to require that float free arrangements fitted to EPIRBs are routinely replaced or serviced. [2.9]

3. Undertake a study of the contents of approved stability booklets for fishing vessels and their value to skippers. This study should consult with individuals and organisations within the fishing industry. The objective should be to establish the optimum format for satisfying the needs of skippers and crews, with a view to encouraging their more regular reference to stability booklets. Once agreement is reached, the content and format of stability booklets should be made a statutory requirement. [2.23]

4. Require, on any fishing vessel on which it is necessary for any enclosed space to be weathertight to achieve the standards of stability set out in her stability booklet, that labels, symbols, markings or notices are attached or painted on both sides of doors and hatches to such spaces. These notices should indicate that such openings are to be secured closed at sea, except for absolute minimum periods when access is essential to the operation of the vessel. [2.21, 2.24]

5. Require, for inclusion in the stability booklets of fishing vessels, a graphical indication of those hatches and doors which should be secured closed in order to provide the level of weathertight integrity necessary to achieve the standards of stability set out within the booklets. [2.23]

ANNEX 1

Stability Assessment (Figure A1)

Assessments of the vessel's stability in various conditions have been made following her loss. The conditions considered were as follows:

(1) the vessel loaded with 410 fish boxes in fish hold, ice, water, fuel and gear as on 1 October 1997 but with all weathertight doors and hatches secured closed;

(1a) the vessel as in (1) above but with 100mm of water on the forward working deck;

(2) the vessel as in (1) above but with forward and aft weathertight doors on starboard passage open;

(3) the vessel as in (2) above but also with engine room door to starboard passage open;

(4) the vessel as in (3) above but with engine room flooded to centre line of main engine;

(5a) the vessel as in (3) but with fish hold flooded to 600mm;

(5b) the vessel as in (3) but with fish hold flooded to 600mm and with 100mm of water on the forward working deck;

(6a) the vessel as in (3) but with the fish hold flooded to 1200mm;

(6b) the vessel as in (3) but with fish hold flooded to 1200mm and with 100mm of water on the forward working deck;

(7a) the vessel as in (3) but with fish hold flooded to 1800mm;

(7b) the vessel as in (3) but with fish hold flooded to 1800 mm and 100mm of water on the forward working deck;

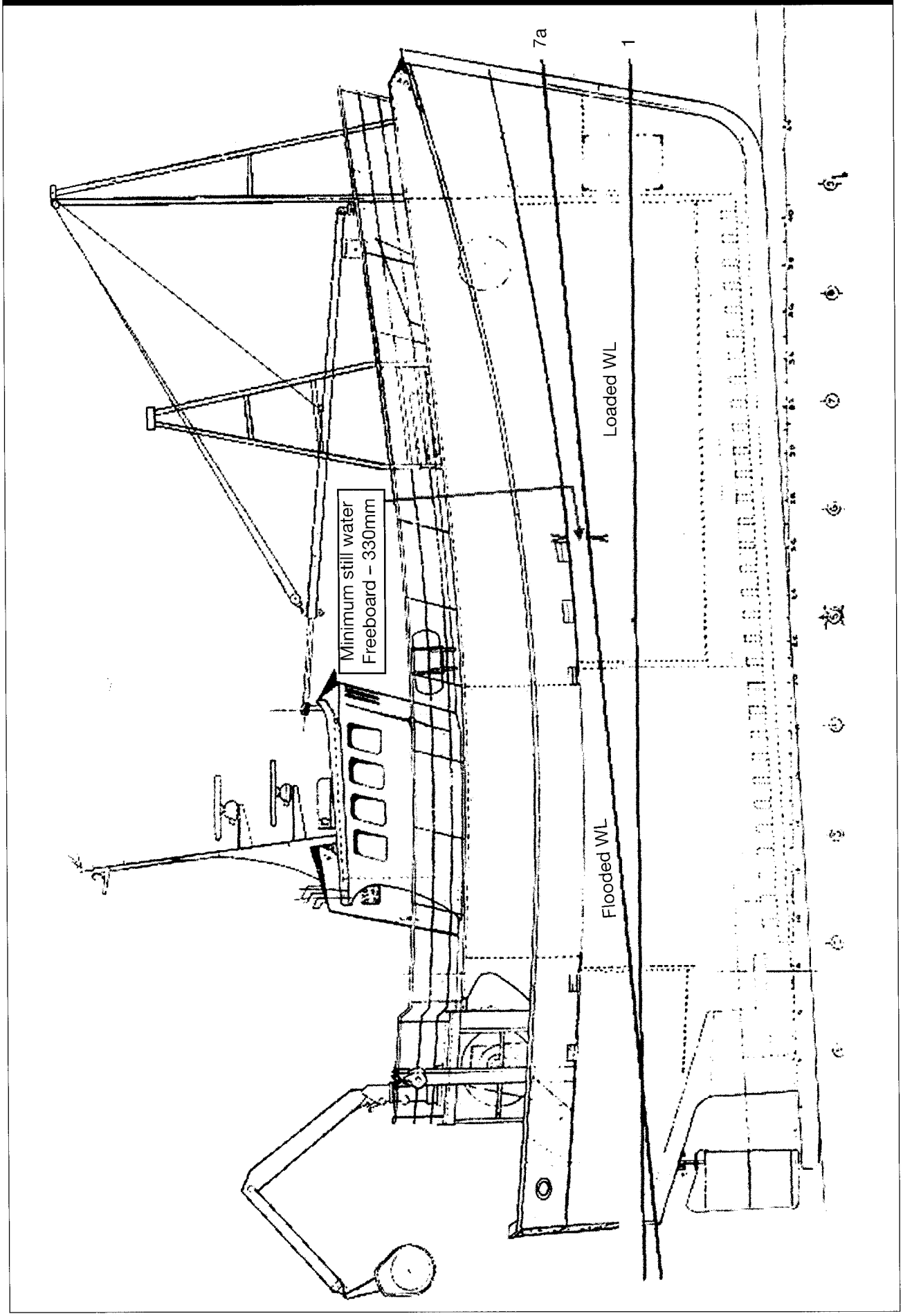
(8) the vessel as in (3) above but with engine room flooded to centre line of main engine and fish hold flooded to 600mm;

(9) the vessel with fuel, ice, water and gear as in (1) above but with 319 filled fish boxes in the fish hold and 100 on the working deck;

(10) the vessel as in (9) above but with the fish boxes on deck shifting transversely by 3m.

The results of the above assessments are compared to the requirement of Rule 16 of The Fishing Vessels(Safety Provisions) Regulations 1975. Non-compliance with the Regulations is indicated by ***.

Figure A1


7a
1
Loaded WL
Minimum still water
Freeboard – 330mm
Flooded WL

Condition (1): the vessel loaded with 410 fish boxes in fish hold, ice, water, fuel and gear as on 1 October 1997 but with all weathertight doors and hatches secured closed.

GM (fluid) = 1.06m (Rule minimum 0.35m)

Area under GZ curve to 30° = 0.133m.rads (Rule minimum 0.055)

Area under GZ curve to 40° = 0.212m.rads (Rule minimum 0.09)

Area under GZ curve between 30° and 40° = 0.079m.rads (Rule minimum 0.03)

Maximum GZ = 0.456m and occurs at 36° (Rule minimum 25°)

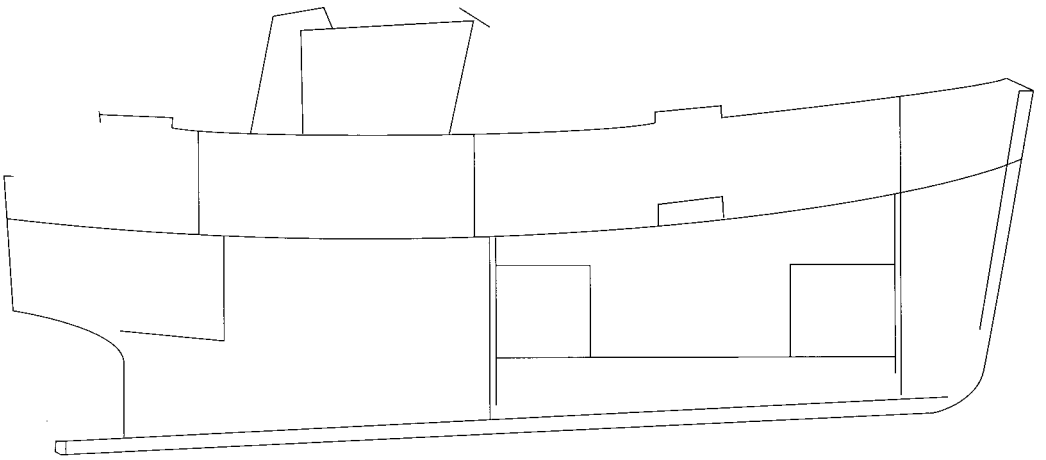
Deck edge immersion at 18.1°

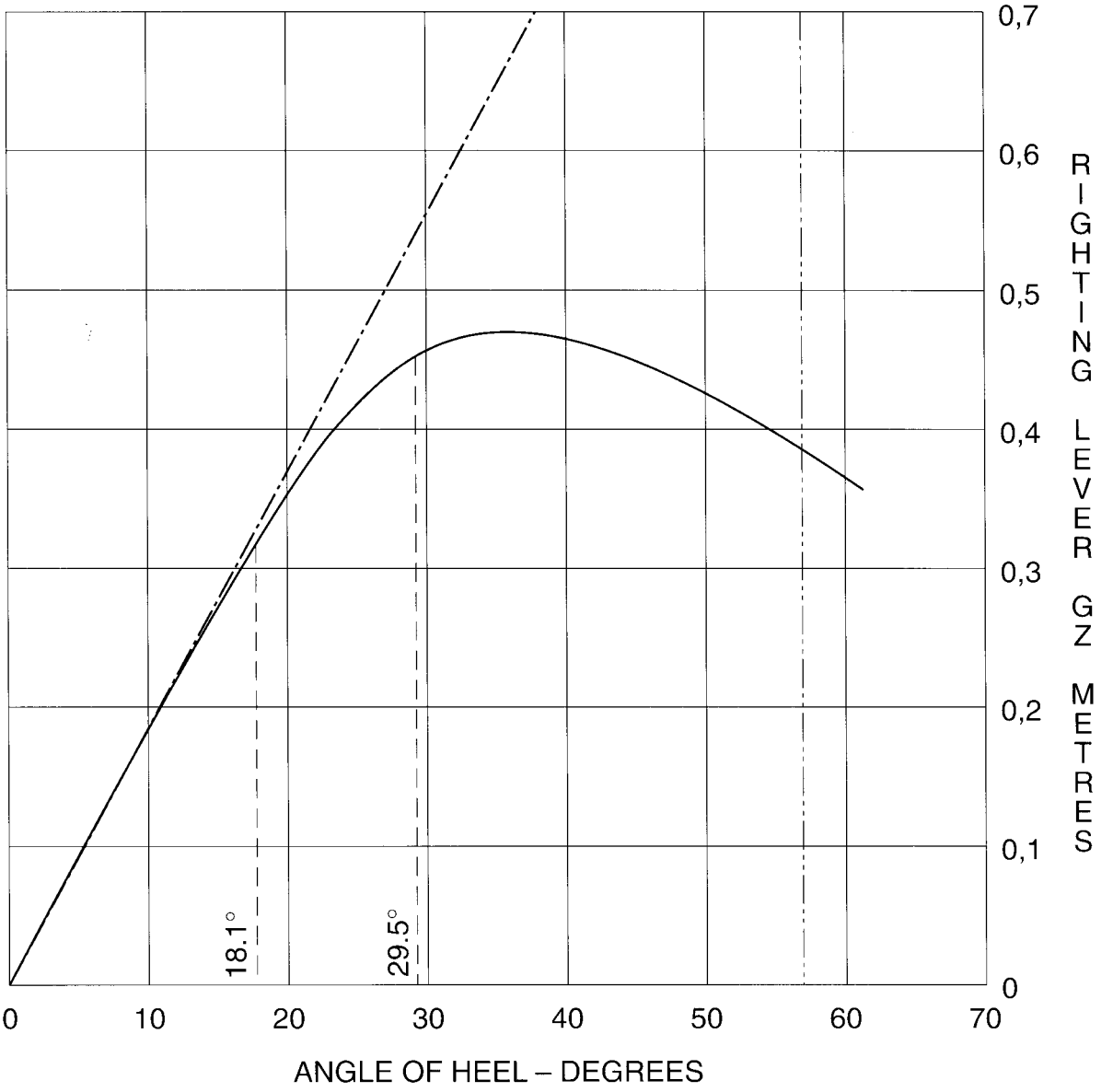
Draught at aft marks = 3.41m

Draught at forward marks = 2.38m

Sill of forward door on starboard passage immersed at 29.5°

Condition 1: **GZ Curve for Condition 1**





Condition (1a): the vessel as in (1) above but with 100mm of water on the forward working deck

GM (fluid) = 0.25m ***

Area under GZ curve to 30° = 0.124m.rads

Area under GZ curve to 40° = 0.197m.rads

Area under GZ curve between 30° and 40° = 0.073m.rads

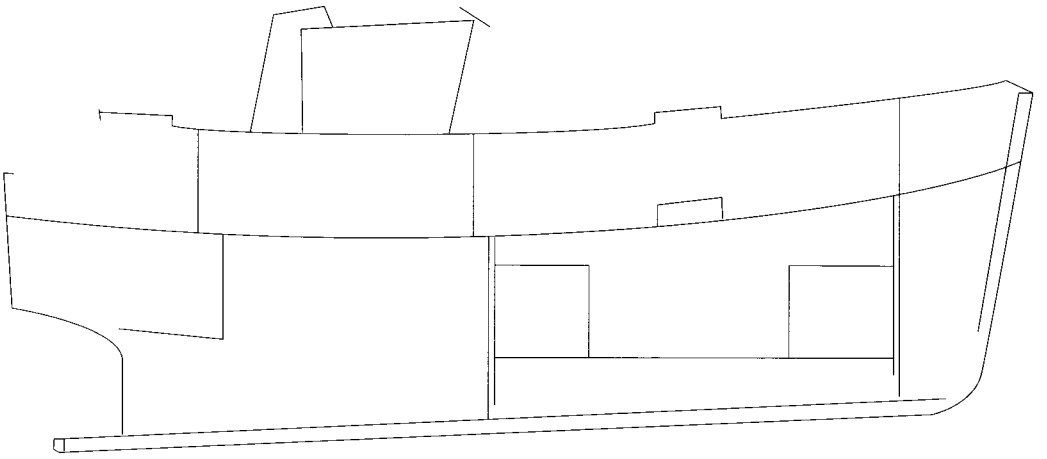
Maximum GZ = 0.423m and occurs at 36°

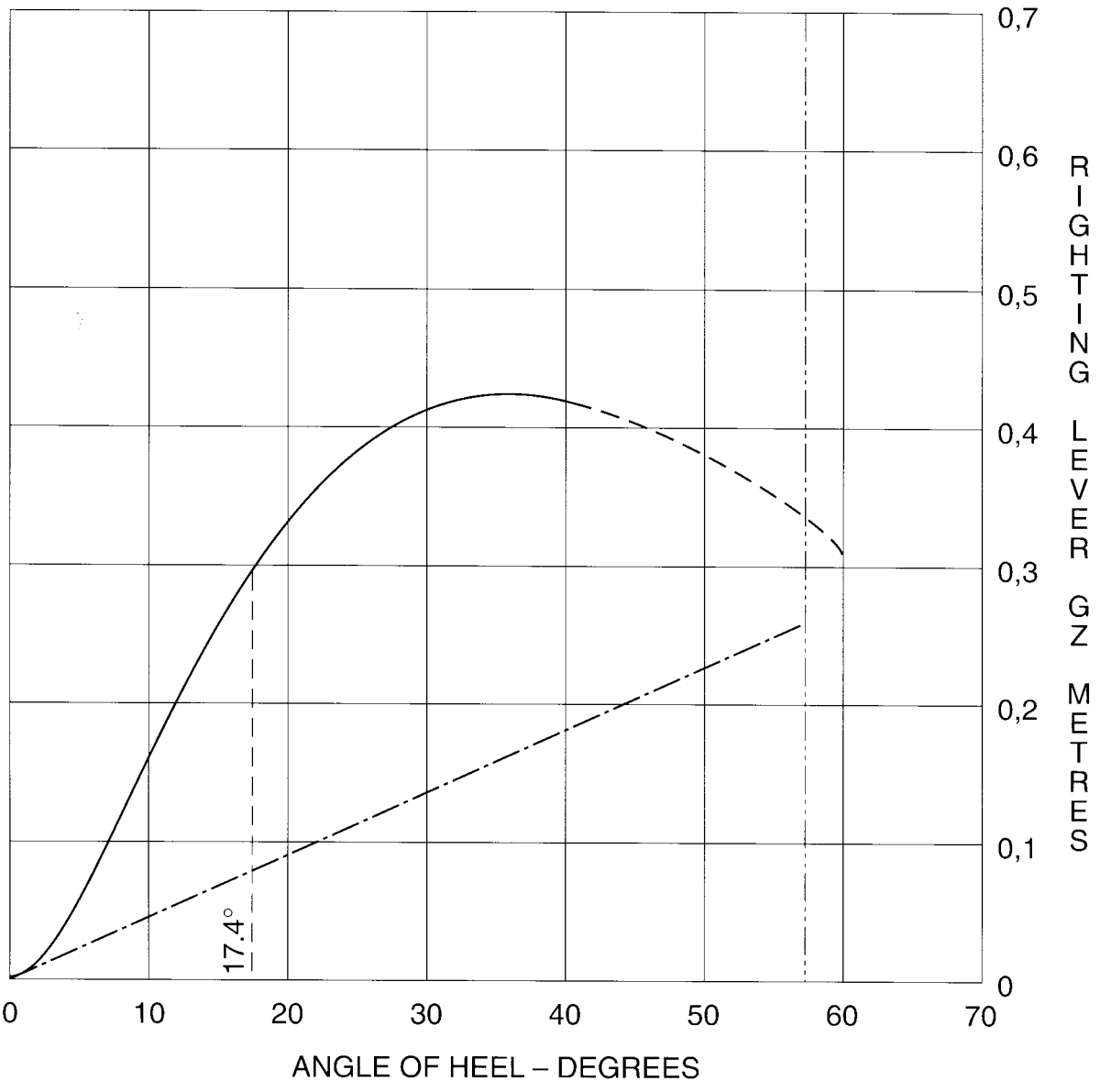
Deck edge immersion at 17.4°

Draught at aft marks = 3.39m

Draught at forward marks = 2.5m

Condition 1a: **GZ Curve for Condition 1a**





Condition (2): the vessel as in (1) above but with forward and aft weathertight doors on starboard passage open.

GM (fluid) = 1.06m

Area under GZ curve to 30° = 0.13m.rads

Area under GZ curve to 40° = 0.197m.rads

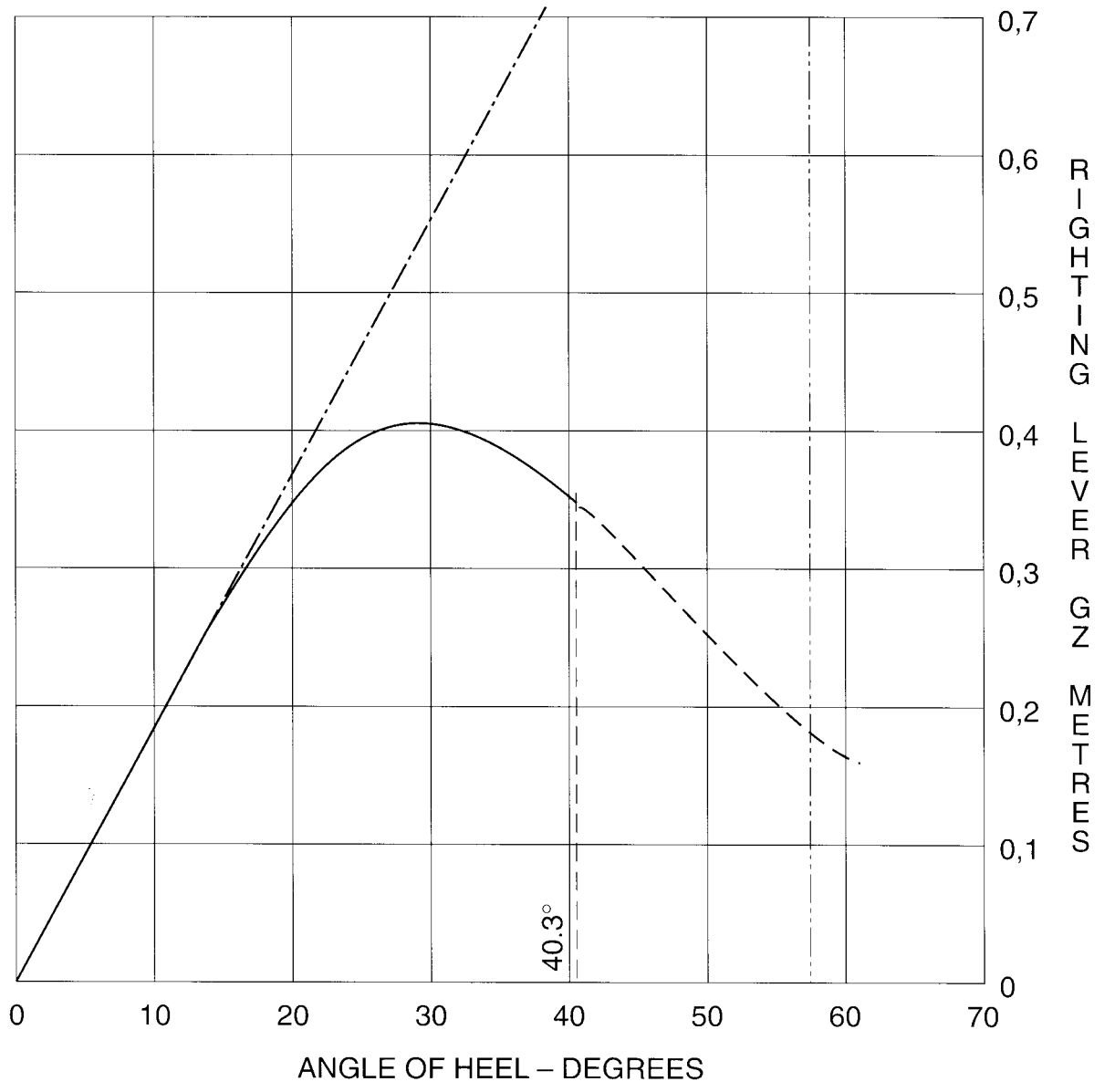
Area under GZ curve between 30° and 40° = 0.067m.rads

Maximum GZ = 0.403m and occurs at 29°

Condition (3): the vessel as in (2) above but also with engine room door to starboard passage open.

Downflooding through engine room door begins at 40.3°

Conditions 2 and 3: **GZ Curve for Conditions 2 and 3**



Condition (4): the vessel as in (3) above but with engine room flooded to centre line of main engine.

GM (fluid) = 0.9m

Area under GZ curve to 30° = 0.105m.rads

Area under GZ curve to 36.9° = 0.138m.rads

Area under GZ curve to 40° = 0.151m.rads

Area under GZ curve between 30° and 36.9° = 0.033m.rads

Maximum GZ = 0.303m and occurs at 26°

Deck edge immersion at 16.1°

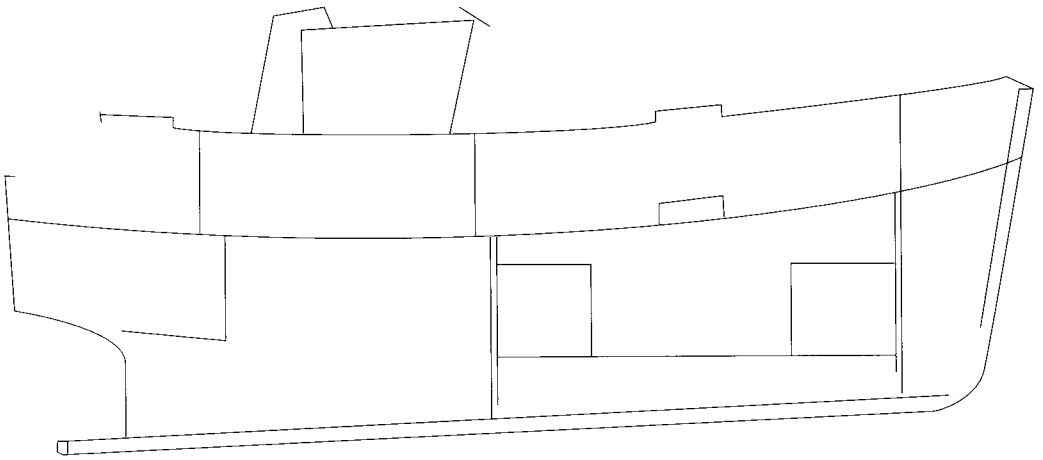
Flooding of starboard passage at 27.1°

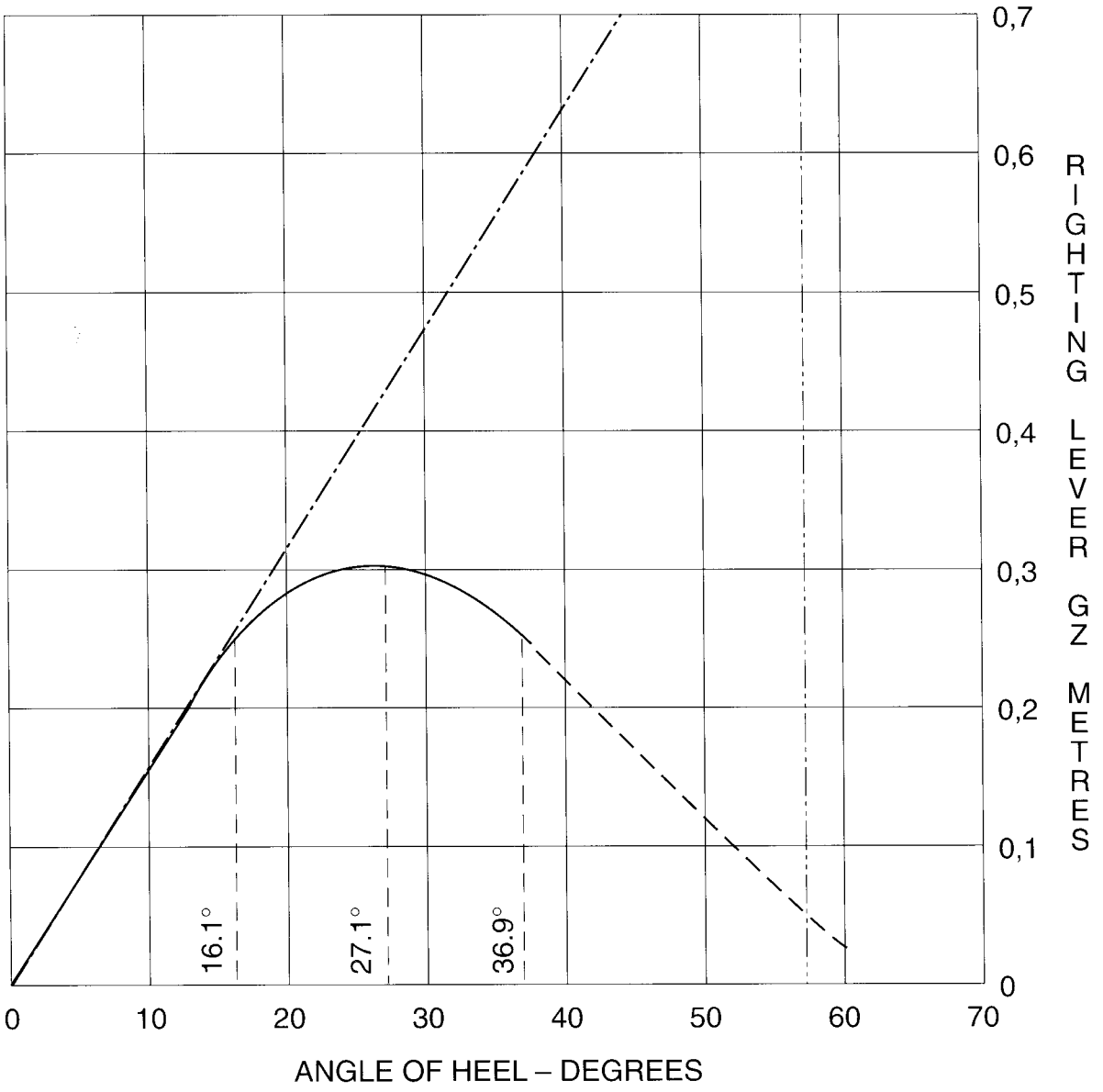
Downflooding through engine room door begins at 36.9°

Draught at aft marks = 3.6m

Draught at forward marks = 2.41m

Condition 4: **GZ Curve for Condition 4**





Condition (5a): the vessel as in (3) but with fish hold flooded to 600mm.

GM (fluid) = 0.91m

Area under GZ curve to 30° = 0.109m.rads

Area under GZ curve to 33.8° = 0.129m.rads

Area under GZ curve between 30° and 33.8° = 0.02m.rads ***

Area under GZ curve between 30° and 40° = 0.051m.rads

Maximum GZ = 0.322m and occurs at 27°

Deck edge immersion at 14.3°

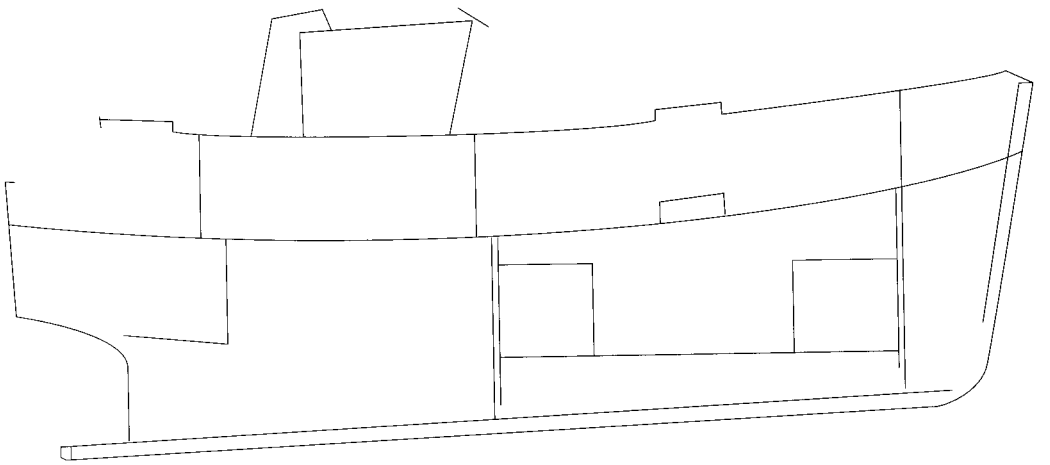
Flooding of starboard passage begins at 24.9°

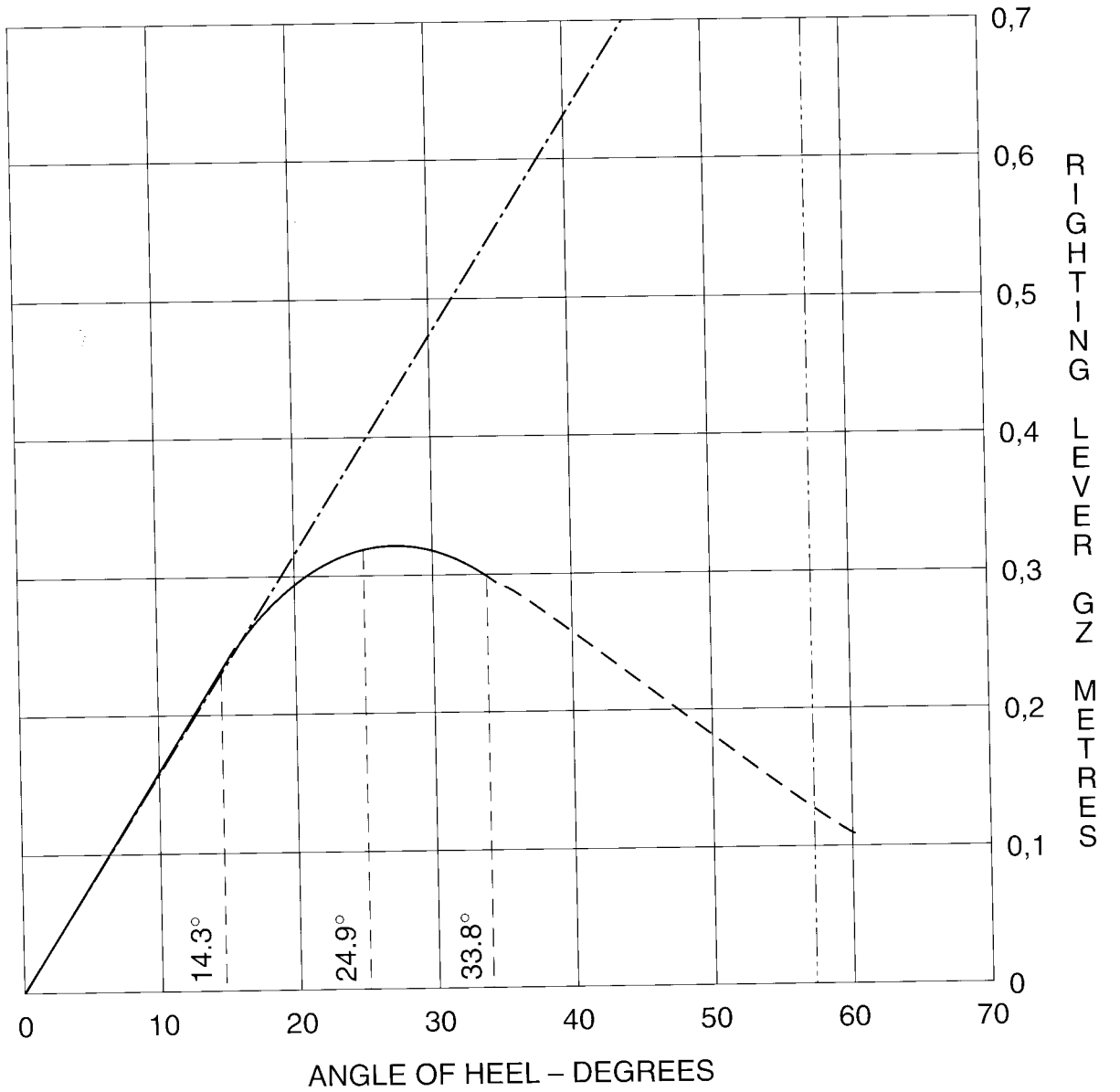
Downflooding through engine room door begins at 33.8°

Draught at aft marks = 3.34m

Draught at forward marks = 2.99m

Condition 5a: **GZ Curve for Condition 5a**





Condition (5b): the vessel as in (3) but with fish hold flooded to 600mm and 100mm of water on the forward working deck.

GM (fluid) = 0.18m ***

Area under GZ curve to 30° = 0.097m.rads

Area under GZ curve to 32.7° = 0.11m.rads

Area under GZ curve between 30° and 32.7° = 0.017m.rads ***

Maximum GZ = 0.284m and occurs at 26°

Deck edge immersion at 14.3°

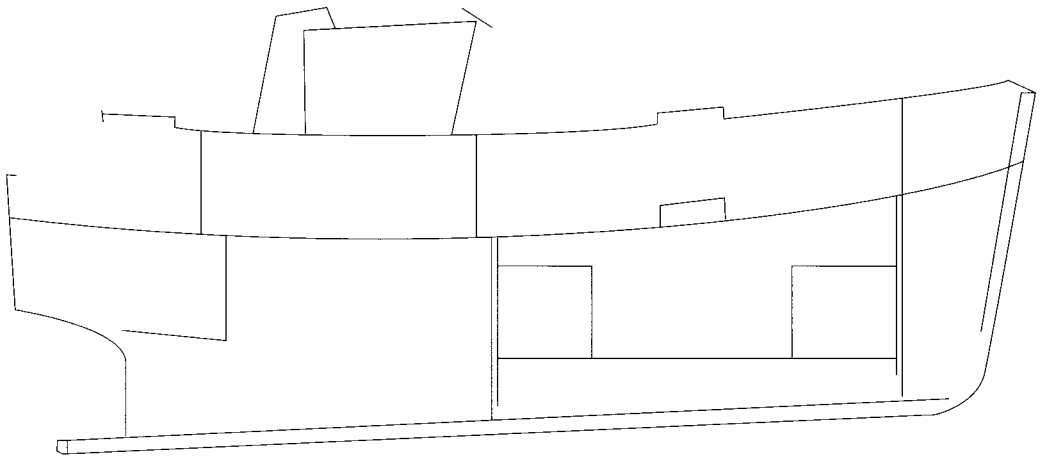
Flooding of starboard passage begins at 24.9°

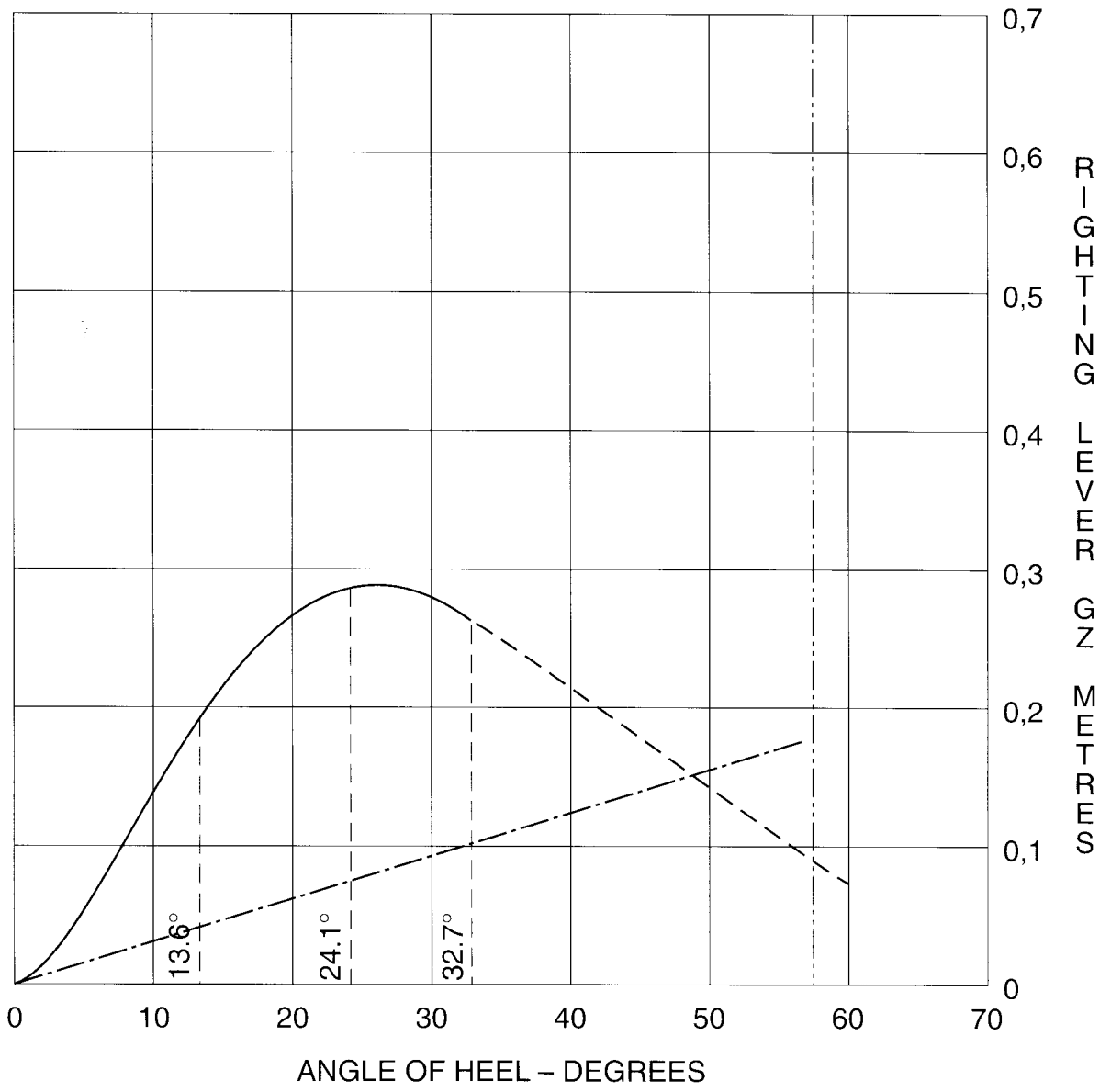
Downflooding through engine room door begins at 32.7°

Draught at aft marks = 3.32m

Draught at forward marks = 3.1m

Condition 5b: **GZ Curve for Condition 5b**





Condition (6a): the vessel as in (3) but with fish hold flooded to 1200mm.

GM (fluid) = 0.83m

Area under GZ curve to 30° = 0.096m.rads

Area under curve to 30.1°.= 0.096m.rads

Area under GZ curve between 30° and 30.1° = 0m.rads ***

Maximum GZ = 0.272m and occurs at 25°

Deck edge immersion at 12°

Flooding of starboard passage begins at 22.3°

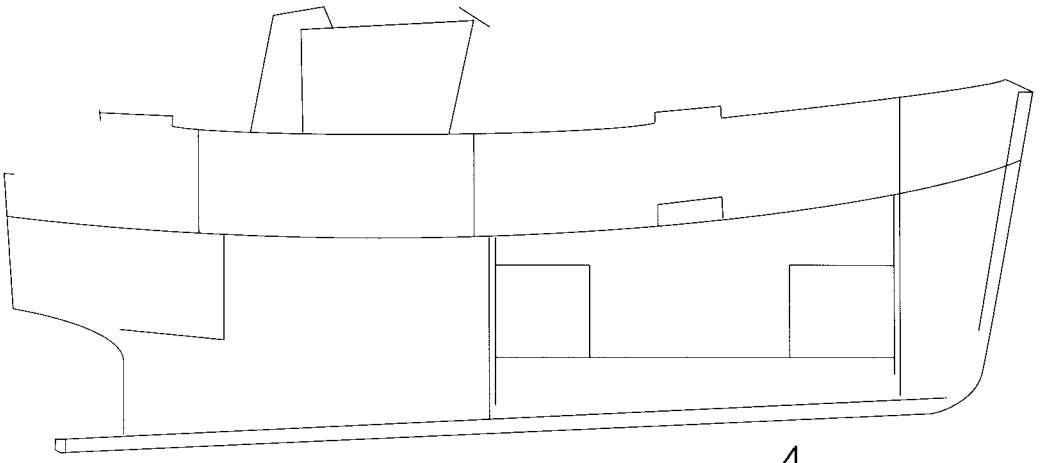
Downflooding through engine room door at 30.1°

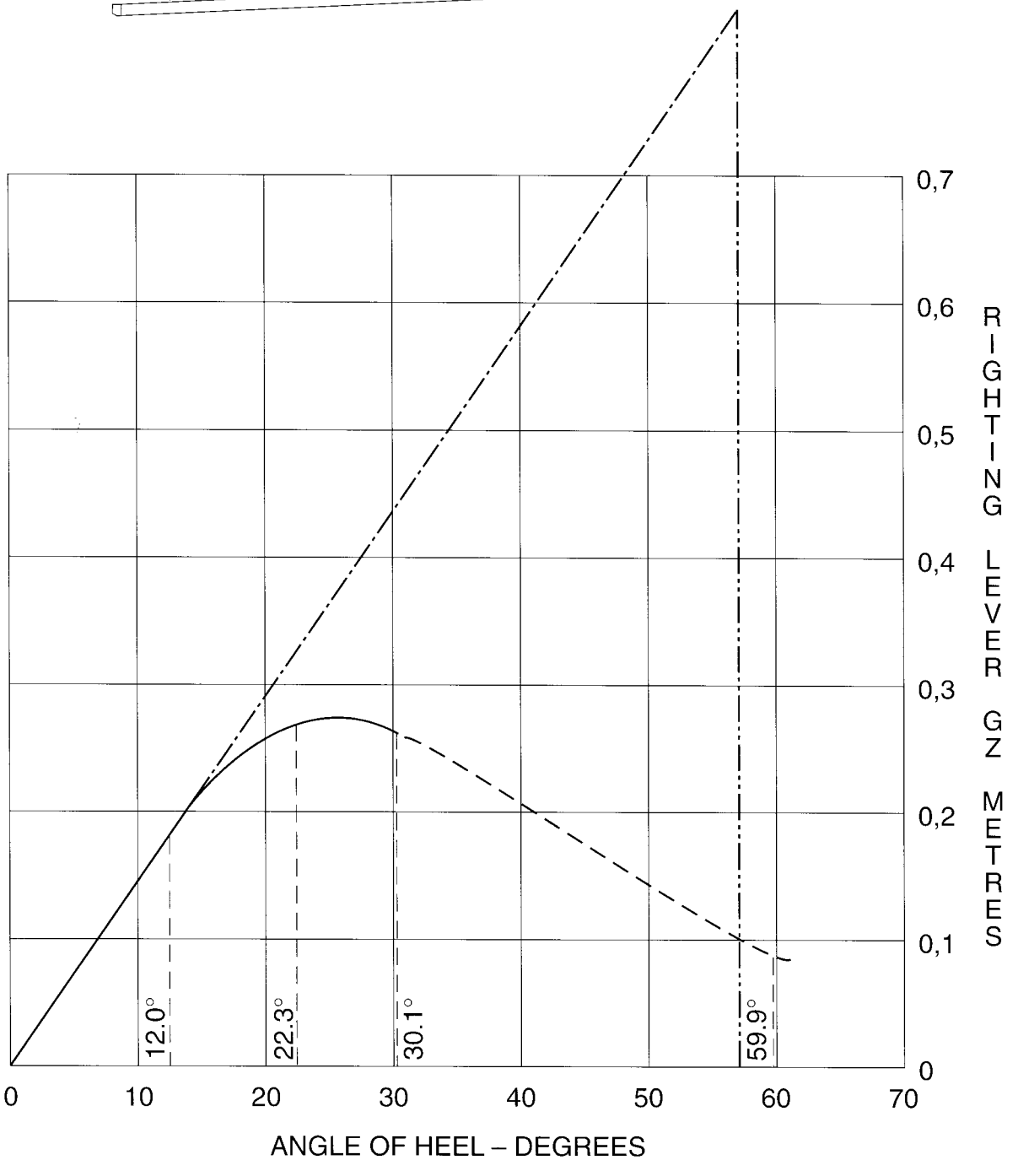
Downflooding through main fish hatch at 59.9°

Draught at aft marks = 3.27m

Draught at forward marks = 3.38m

Condition 6a: **GZ Curve for Condition 6a**





Condition (6b): the vessel as in (3) but with fish hold flooded to 1200mm and 100mm of water on the forward working deck

GM (fluid) = 0.19m ***

Area under GZ curve to 29.2° = 0.085m.rads ***

Maximum GZ = 0.239m and occurs at 25°

Deck edge immersion at 11.4°

Flooding of starboard passage begins at 21.5°

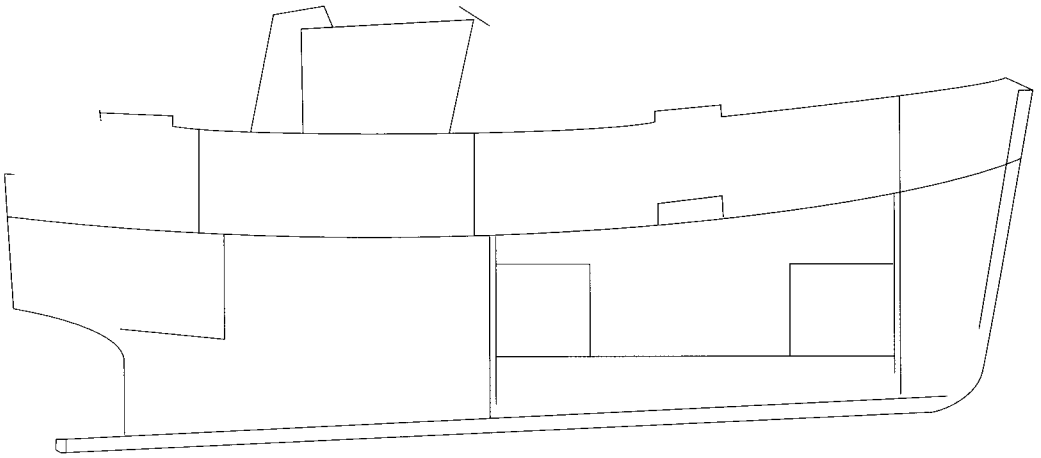
Downflooding through engine room door at 29.2°

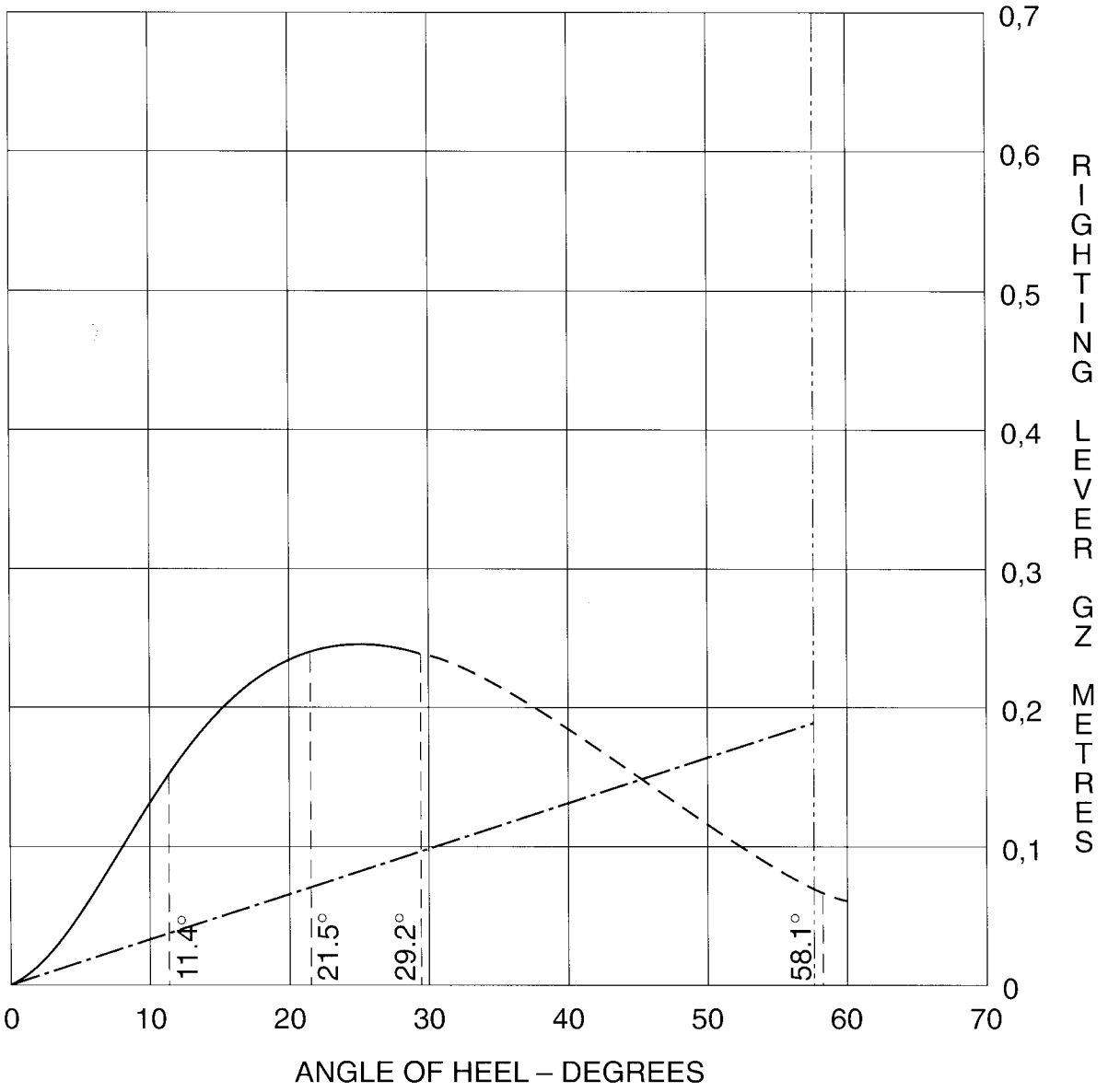
Downflooding through main fish hatch at 58.1°

Draught at aft marks = 3.25m

Draught at forward marks = 3.49m

Condition 6b: **GZ Curve for Condition 6b**





Condition (7a): the vessel as in (3) but with fish hold flooded to 1800mm.

GM (fluid) = 0.43m

Area under GZ curve to 24.2° = 0.027m.rads ***

Maximum GZ = 0.095m and occurs at 15° ***

Deck edge immersion at 8°

Flooding of starboard passage begins at 17.8°

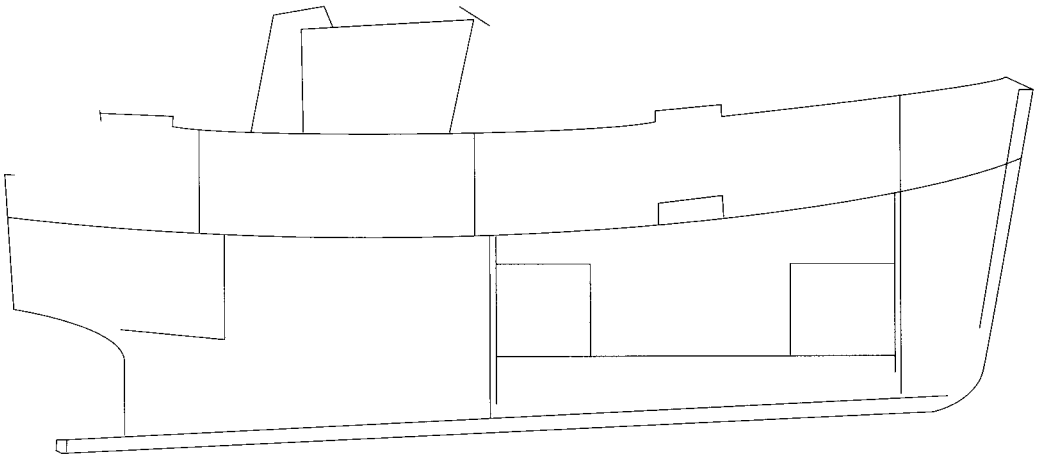
Downflooding through engine room door at 24.2°

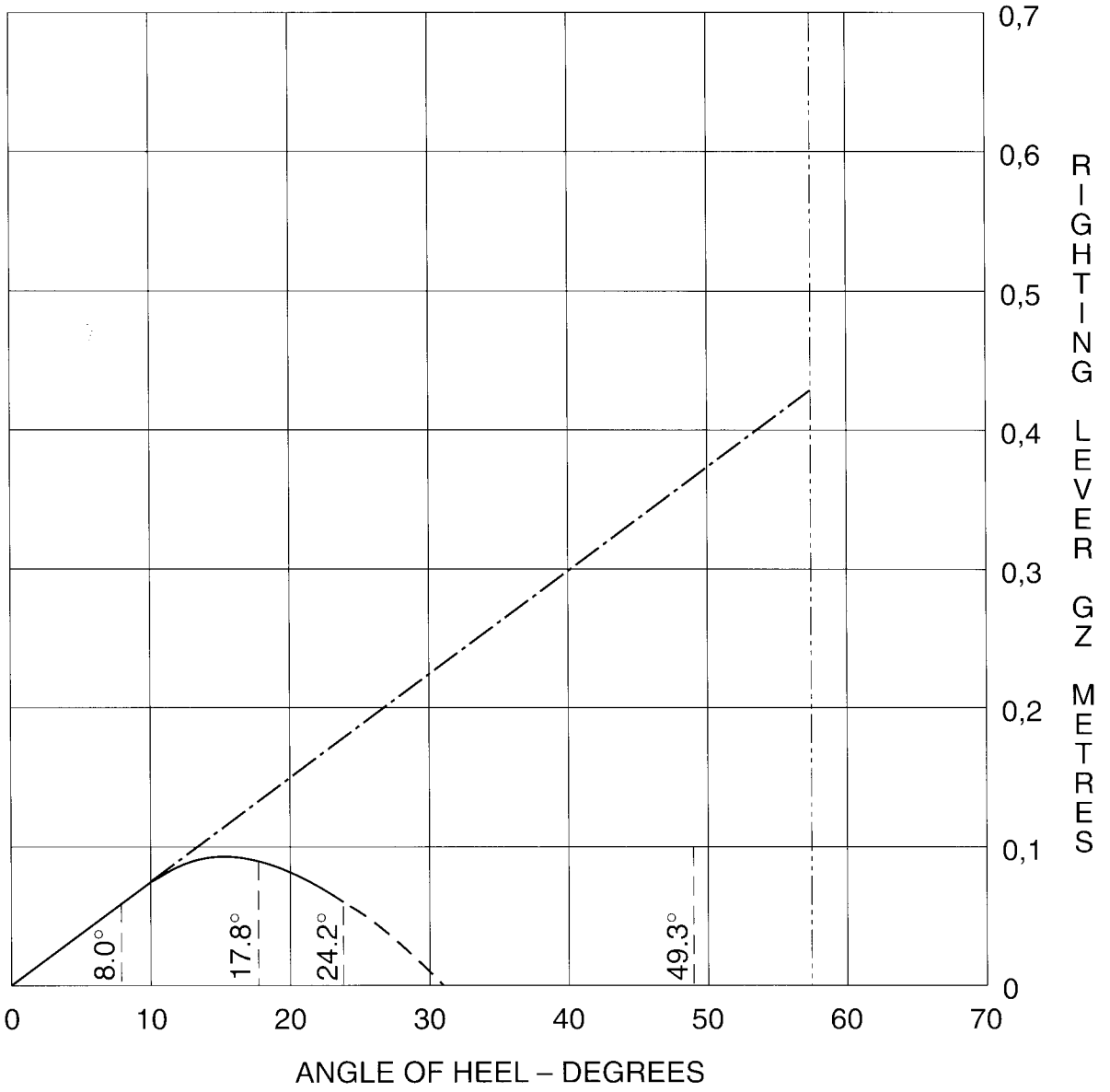
Downflooding through main fish hatch at 49.3°

Draught at aft marks = 3.22m

Draught at forward marks = 3.91m

Condition 7a: **GZ Curve for Condition 7a**





Condition (7b): the vessel as in (3) above but with fish hold flooded to 1800mm and with 100mm of water on the forward working deck.

GM (fluid) = –0.14m ***

Area under GZ curve to 23.4° = 0.022m.rads ***

Maximum GZ = 0.065m and occurs at 16° ***

Deck edge immersion at 7.5°

Flooding of starboard passage begins at 17.2°

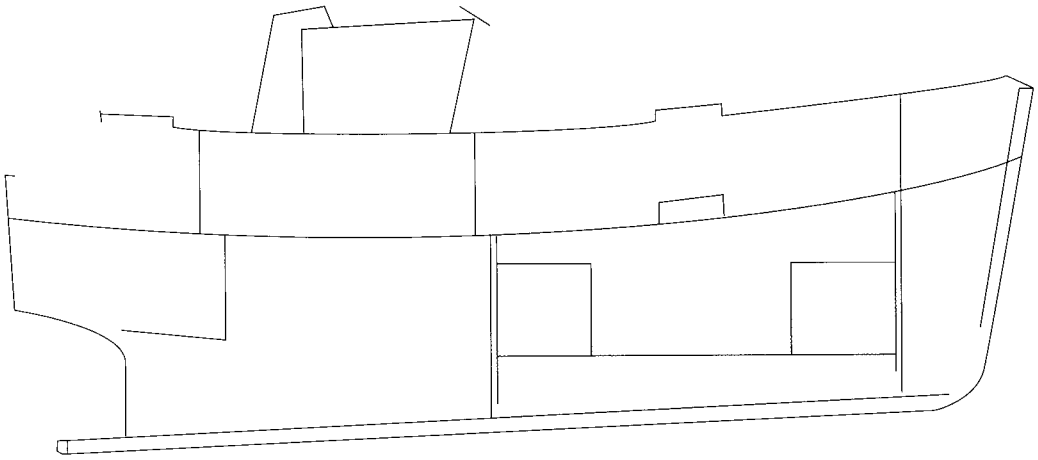
Downflooding through engine room door at 23.4°

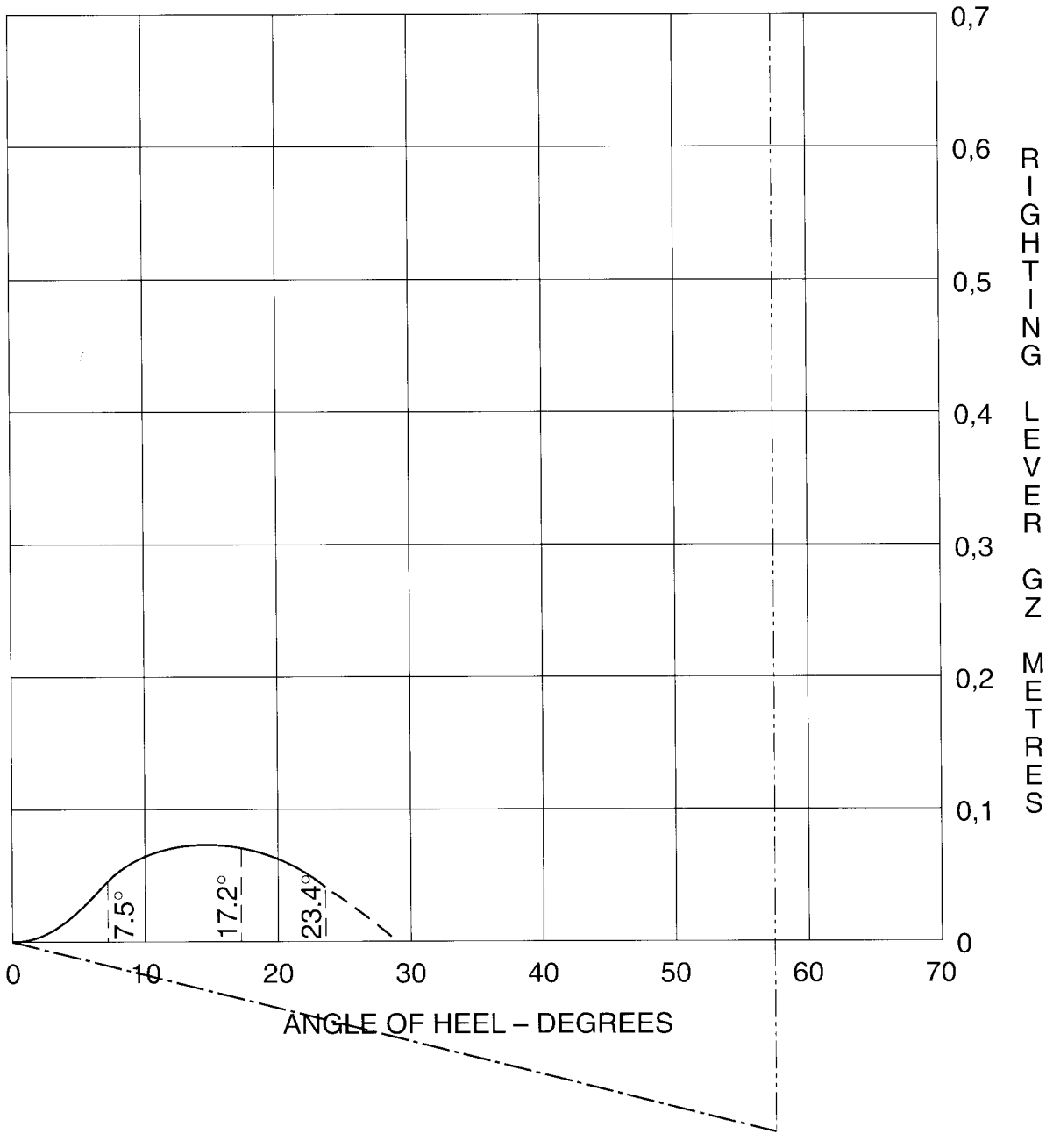
Downflooding through main fish hatch at 47.9°

Draught at aft marks = 3.21m

Draught at forward marks = 4.01m

Condition 7b: **GZ Curve for Condition 7b**





Condition (8): the vessel as in (3) above but with engine room flooded to centre line of main engine and fish hold flooded to 600mm.

GM (fluid) = 0.76m

Area under GZ curve to 30° = 0.085m.rads

Area under GZ curve to 30.7° = 0.088m.rads ***

Area under GZ curve between 30° and 30.7° = 0.003m.rads ***

Maximum GZ = 0.238m and occurs at 24° ***

Deck edge immersion at 12.4°

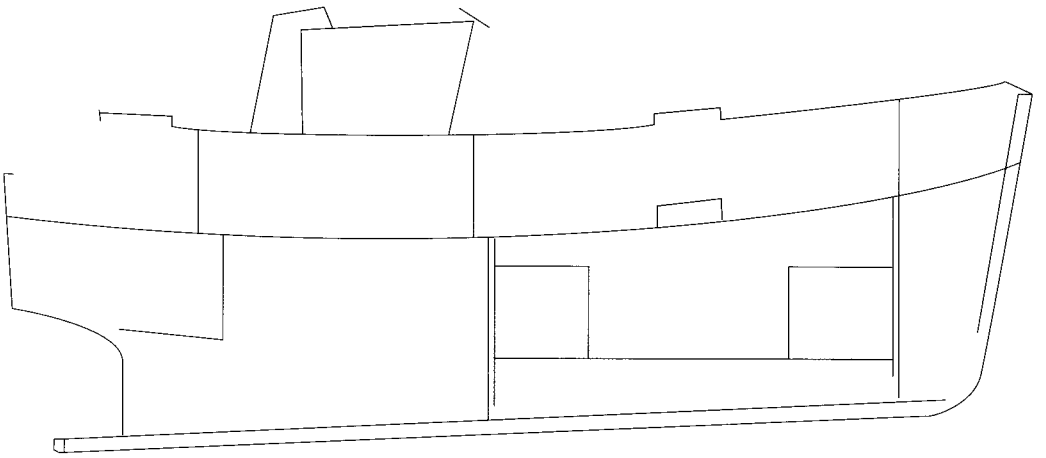
Flooding of starboard passage begins at 22.7°

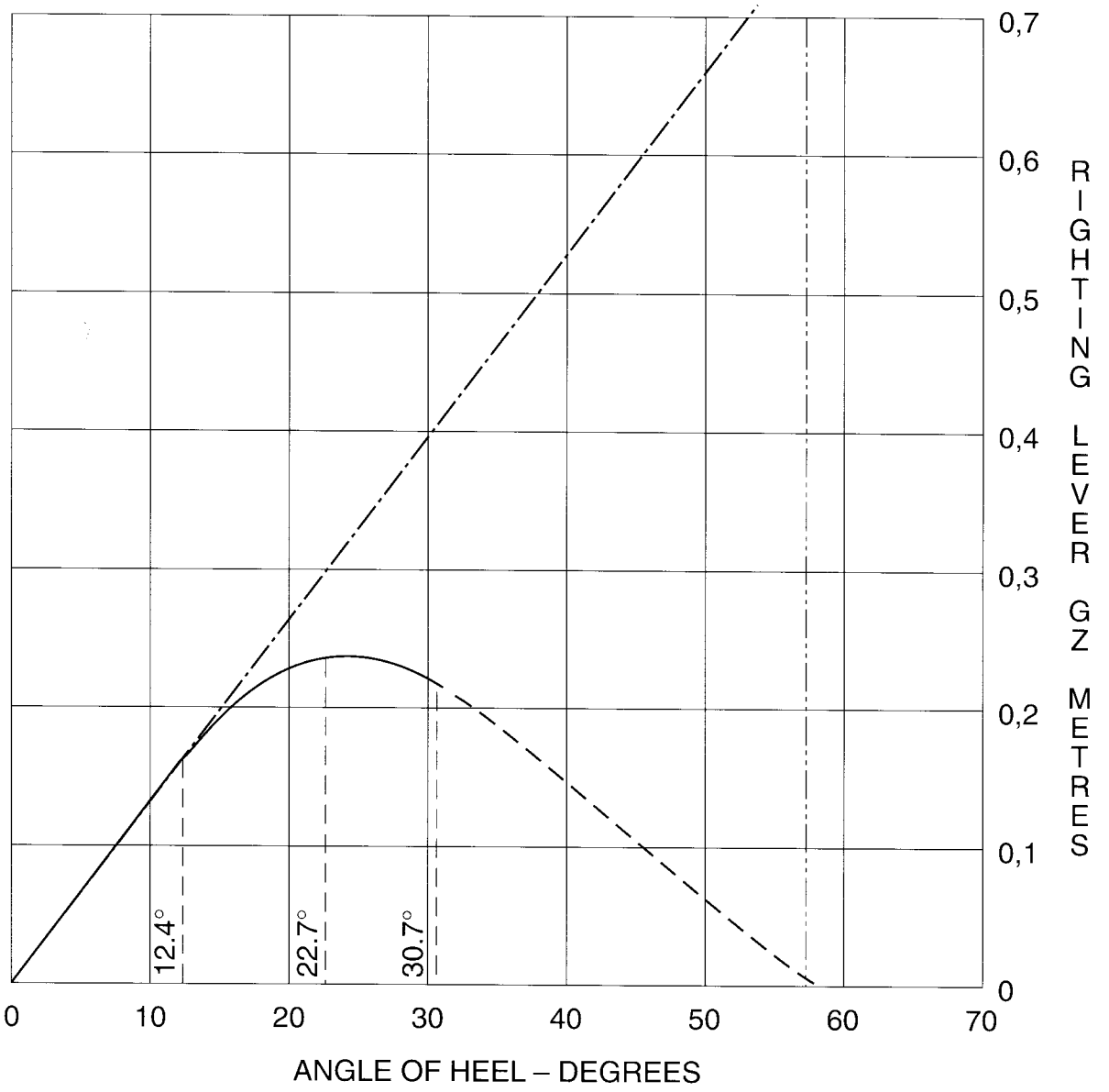
Downflooding through engine room door begins at 30.7°

Draught at aft marks = 3.53m

Draught at forward marks = 3.01m

Condition 8: **GZ Curve for Condition 8**





Condition (9): the vessel with fuel, ice, water and gear as in (1) above but with 319 filled fish boxes in the fish hold and 100 on the working deck.

GM (fluid) = 0.97m

Area under GZ curve to 30° = 0.117m.rads

Area under GZ curve to 40° = 0.175m.rads

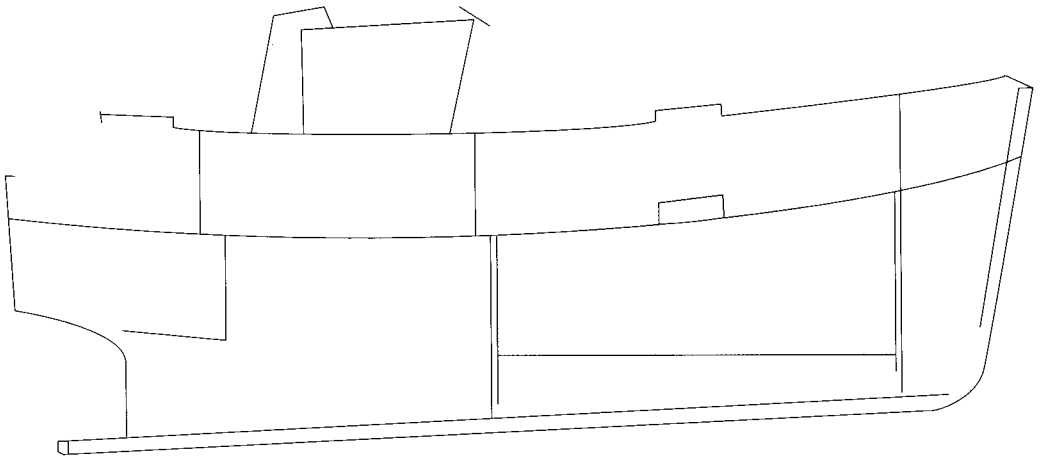
Area under GZ between 30° and 40° = 0.058m.rads

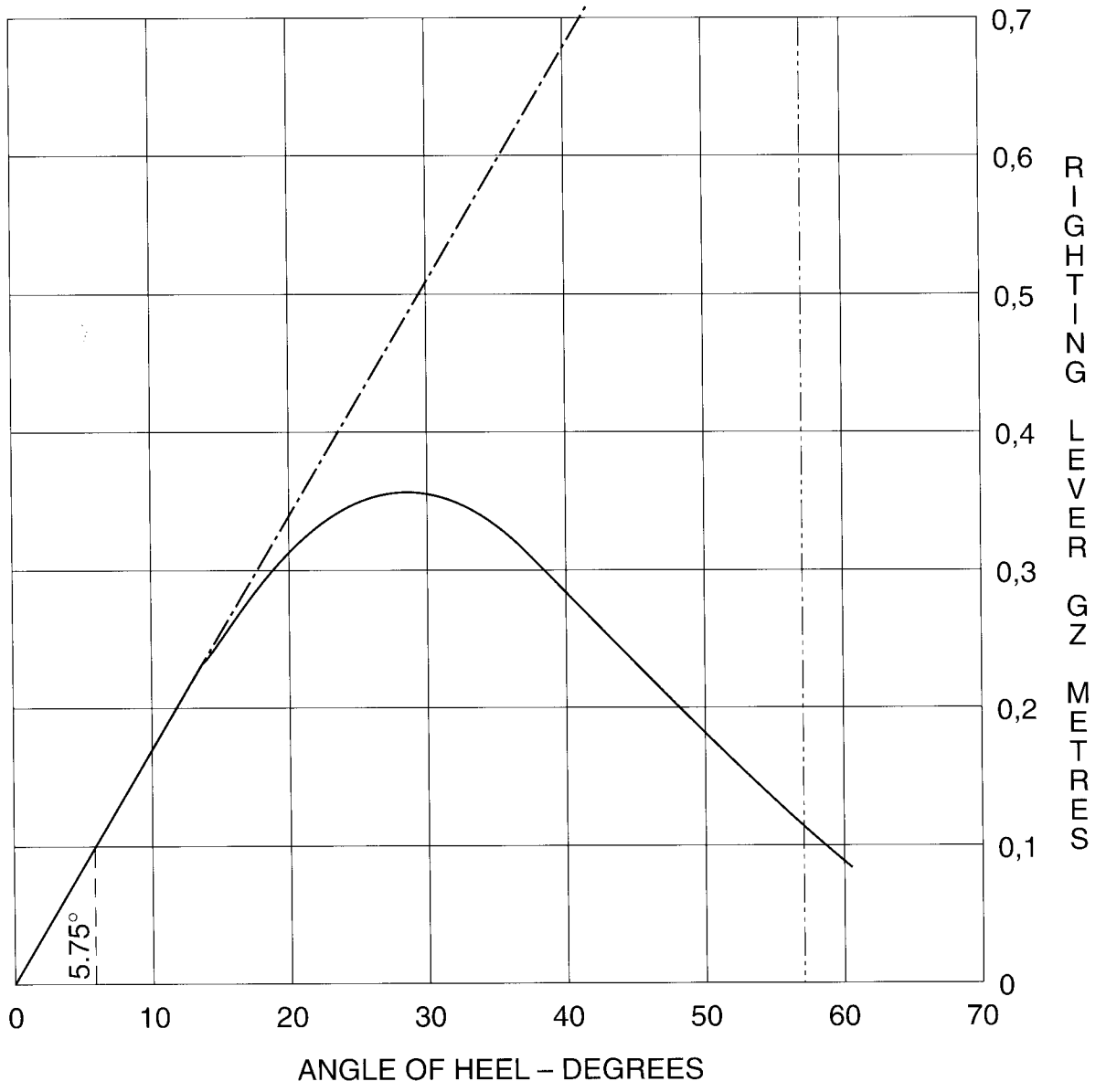
Maximum GZ = 0.358m and occurs at 28°

Condition (10): the vessel as in (9) above but with the fish boxes on deck shifting transversely by 3m.

Angle of heel = 5.75°

Conditions 9 and 10: **GZ Curve for Conditions 9 and 10**





Where relevant, the implications of the above conditions have been addressed within the body of the report.

All conditions have been judged against statutory requirements for the non-flooded condition. Several are identified as 'not-complying'. There can be no suggestion that non-compliance with the standard contained within the regulations, which do not require any flooded condition to be assessed, is likely to offer an explanation for the cause of *Sapphire's* loss. Comparison has been made only to offer a standard against which the effects of flooding can be measured.

These stability analyses have identified two characteristics possessed by *Sapphire* which are worthy of note.

The vessel's GM exceeded statutory requirements in most of the flooded conditions considered. This feature has been mentioned within the report, but the result does identify the possibility that a vessel may experience a substantial degree of flooding without sustaining an angle of loll; a condition which would probably have caused the crew to be alerted to the problem of flooding.

The reduction in *Sapphire's* range of stability, and general depletion of its GZ curve, was dramatic as the flood level in the fish hold increased from 1200mm to 1800mm. This was a most unexpected feature and one which, common to all other flooded conditions considered, was not required to be assessed before the issue of a UKFV Certificate.

Annex 2

DETR Environment Transport Regions **News Release**

MAIB SAFETY BULLETIN 1/98
Date: 13 January 1998

FV SAPPHIRE - FOUNDERED WITH LOSS OF FOUR LIVES - 1 OCTOBER 1997

Failure of Hydrostatic Release Units on the Emergency Position Indicating Radio Beacons

This document, containing a Safety Recommendation, has been produced to enable the appropriate organisation to take urgent and necessary action. It has been produced for marine safety purposes only on the basis of information available to date. The information must necessarily be regarded as tentative and subject to alteration or correction if additional evidence becomes available.

MAIB SAFETY BULLETIN 1/98
(containing interim safety recommendations)

Inspector's Inquiry into the sinking of the Fishing Vessel SAPPHIRE with the loss of four lives - 1 October 1997

The Merchant Shipping (Accident Reporting and Investigation) Regulations 1994 provide for the Chief Inspector of Marine Accidents to release information as to material facts at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so. Similarly, recommendations may also be made at any time during the course of an investigation. The main cause of the loss has not yet been determined.

The Peterhead registered fishing vessel SAPPHIRE was returning to harbour during the afternoon of 1 October 1997. Although the conditions were rough they were not excessively so. At about 1530 she capsized and sank very rapidly with the loss of four lives.

The skipper survived by escaping through one of the wheelhouse windows and swimming to a liferaft. The Marine Accident Investigation Branch (MAIB) is carrying out an Inspector's Inquiry into the loss and will report its findings to the Secretary of State within twelve months. Although the investigation is still underway, an early study has been made to establish why the vessel's Emergency Position Indicating Radio Beacon (EPIRB) failed to operate when she sank. The MAIB has found that the hydrostatic release unit (HRU) was six months overdue for replacement and had been covered in paint which not only prevented it from functioning but also covered a clear DO NOT PAINT label.

This Safety Bulletin is issued to:

-- draw the attention of Owners, Skippers, Masters and crews to the need to ensure EPIRB HRUs are in date

-- highlight the potential consequences of painting over HRUs

-- recommend that checks on all such devices in seagoing vessels, particularly fishing vessels, are carried out as a matter of urgency

J S Lang
Rear Admiral
Chief Inspector of Marine Accidents
Marine Accident Investigation Branch

MAIB 1/98

Interim Safety Recommendations

Arising from the loss of the SAPPHIRE on 1 October 1997, The Marine Accident Investigation Branch (MAIB) has established that her Emergency Position Indicating Radio Beacon (EPIRB) failed to release as the vessel sank. This was because the Hydrostatic Release Unit (HRU) was both out of date for replacement and had been painted over. In order to prevent similar failures of EPIRBs occurring in any vessel so fitted, the following recommendations are made.

1. All Masters and Skippers of vessels fitted with an EPIRB are advised to:

(i) check that the HRUs for all EPIRBs onboard are in date, and if not, either replace them or ensure that the annual service is carried out at the earliest opportunity. If the vessel is in harbour this must be done before next proceeding to sea.

(ii) ensure that the HRUs for all EPIRBs are capable of functioning as designed. A particular check must be made to ensure that no paint or other substance has been applied to the release mechanism which could affect its correct operation;

(iii) that the HRUs are protected whenever painting takes place in their vicinity. Paint spray applied some distance away from the HRU can seriously interfere with the correct operation of the release units;

(iv) ensure that EPIRBs (and other safety equipment) are regularly checked so that nothing will interfere with their correct operation.

2. All Owners, Managers and Officers responsible for safety are recommended to:

(i) ensure that Masters, Skippers and Crews undertake regular safety checks on EPIRBs and are trained to do so;

(ii) replace, or service, HRUs before they reach their renewal date;

(iii) replace, or service, any HRU immediately it is found to be out of date;

(iv) that clear instructions are given to crews to ensure that appropriate measures are taken to protect HRUs when painting in their vicinity.

DETR

Annex 3

Press Notice MAIB2

DETR Environment Transport Regions **News Release**

MAIB SAFETY BULLETIN 2/98
Date: 13 January 1998

FV SAPPHIRE - Foundered with loss of four lives 1 October 1997

Weathertight Hatchcovers And Doors

This document, containing a Safety Recommendation, has been produced to enable the appropriate organisation to take urgent and necessary action. It has been produced for marine safety purposes only on the basis of information available to date. The information must necessarily be regarded as tentative and subject to alteration or correction if additional evidence becomes available.

MAIB SAFETY BULLETIN 2/98
(containing interim safety recommendations)

Inspector's Inquiry into the sinking of the Fishing Vessel SAPPHIRE with the loss of four lives - 1 October 1997

The Merchant Shipping (Accident Reporting and Investigation) Regulations 1994 provide for the Chief Inspector of Marine Accidents to release information as to material facts at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so. Similarly, recommendations may also be made at any time during the course of an investigation. The main cause of the loss has not yet been determined.

The Peterhead registered fishing vessel SAPPHIRE was returning to harbour during the afternoon of 1 October 1997. Although the conditions were rough they were not excessively so. At about 1530 she capsized and sank very rapidly with the loss of four lives. The skipper survived by escaping through one of the wheelhouse windows and swimming to one of the liferafts. The Marine Accident Investigation Branch (MAIB) is carrying out an Inspector's Inquiry into the loss and will report its findings to the Secretary of State within twelve months. Although the investigation is still underway it has been established that several weathertight hatches and doors were open at the time she foundered and almost certainly contributed to the rapid and catastrophic flooding of all the main compartments. Escape from a vessel in such a situation is extremely difficult.

This Safety Bulletin is issued to:

- draw the attention of Owners, Skippers, Mates and crews of the need to ensure that except when in use or when access is required, all weathertight hatchcovers and doors are properly shut and secured while the vessel is at sea.

J S Lang
Rear Admiral
Chief Inspector of Marine Accidents
Marine Accident Investigation Branch

MAIB 2/98

Interim Safety Recommendations

Arising from the loss of the SAPPHIRE on 1 October 1997, The Marine Accident Investigation Branch (MAIB) has established that several weathertight doors and hatches were open at the time she capsized. This almost certainly contributed to the vessel sinking more rapidly than she might have.

Skippers of fishing vessels are reminded that even in calm conditions a vessel may heel suddenly. Weights can shift, fishing gear can snag or the wash of another vessel can cause heavy rolling. In rough weather the circumstances are more obvious. The importance of maintaining weathertight integrity cannot be stressed too strongly. Many vessels have their stability properties calculated on the assumption that their deckhouses and shelters, or parts of shelters, are enclosed and weathertight. Open doors and hatches in these structures may reduce the stability below that calculated. This could result in the failure of a vessel to right itself should she heel heavily and take water.

Owners, Skippers, Mates and all Fishermen should ensure that all weathertight hatchcovers and doors are secured while a vessel is at sea and access is not required.

Annex 4

DETR News Release

MAIB SAFETY BULLETIN 4/98
Date: 28 August 1998

FV SAPPHIRE foundered with the loss of four lives 1 October 1997

Failure of Hydrostatic Release Units on the Emergency Position Indicating Radio Beacon.

This document, containing a Safety Recommendation, has been produced to enable the appropriate organisations to take urgent and necessary action. It has been produced for marine safety purposes only on the basis of information available to date.

MAIB SAFETY BULLETIN 4/98 (containing interim safety recommendations)

Inspector's Inquiry into the foundering of FV SAPPHIRE - with the loss of four lives 1 October 1997

The Merchant Shipping (Accident Reporting and Investigation) Regulations 1994 provide for the Chief Inspector of Marine Accidents to release information as to material facts at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so. Similarly, recommendations may also be made at any time during the course of an investigation.

The Peterhead registered fishing vessel SAPPHIRE was returning to harbour during the afternoon of 1 October 1997. Although the conditions were rough they were not excessively so. At about 1530 she capsized and sank very rapidly with the loss of four lives.

The skipper survived by escaping through one of the wheelhouse windows and swimming to a liferaft. The Marine Accident Investigation Branch (MAIB) is carrying out an Inspector's Inquiry into the loss and will report its findings to the Secretary of State within twelve months of the accident.

Two Safety Bulletins were released during January 1998, covering failure of Hydrostatic Release Units (HRUs) to release the Emergency Position Indicating Radio Beacons (EPIRBs) and securing of weathertight hatches and doors. The investigation is still continuing and studies have been made to establish why the vessel's EPIRB failed to float free when she sank.

The results of these studies show that the HRU's release bolt was incorrect both as regards material and dimensions.

This Safety Bulletin is issued to:

- draw the attention of Owners, Skippers, Masters and crews to the need to ensure that the release bolts fitted to EPIRB HRUs are those supplied by the manufacturer for the purpose;
- recommend that checks on all such devices in seagoing vessels, particularly fishing vessels, are carried out as a matter of urgency. Should any doubt exist as to the suitability of the release bolts then they should be replaced and/or the manufacturers consulted.

J S Lang
Rear Admiral
Chief Inspector of Marine Accidents
Marine Accident Investigation Branch

MAIB 4/98

Annex 4

Interim Safety Recommendations

Arising from the loss of the SAPPHIRE on 1 October 1997, The Marine Accident Investigation Branch (MAIB) has established that her Emergency Position Indicating Radio Beacon (EPIRB) failed to float free as she sank. A contributory factor in the EPIRB's failure to float free was that the bolt fitted to the HRU was the incorrect size and made from the wrong material.

So that the EPIRB's float free arrangement functions correctly, the HRU is required to cut the bolt holding/attaching it to a secure part of the vessel. Great care is therefore required to ensure that the bolt is made from the correct material.

1. All Masters and Skippers of vessels fitted with a float free EPIRB are advised to:

i) check that only the bolts supplied with HRUs are used for the installation of EPIRBs;
ii) check that the bolt is the correct length as supplied by the manufacturers and is suitable for the make and model of EPIRB;
iii) seek advice from manufacturers, or their agents, if there is any doubt as to the suitability of any bolts already in service.

DETR

APPENDIX
Alternative Text

Regulations 9 (4) and 9 (6) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 1994 provide that any person whose reputation is likely to be adversely affected by the Report shall have the opportunity to comment on that part of the Report before it is submitted to the Secretary of State. If, following representations, there are passages in theReport which remain in issue and are critical of the person, alternative text can be provided by the person for the part which is in issue. Such alternative text must be included with the Report as an appendix.

A number of persons and organisations have exercised their rights in this respect. The alternative texts, which have been incorporated into the relevant numbered paragraphs from the Report, are given below, together with the person, company or organisation who provided the text.

The Napier Company (Arbroath) Ltd. (Naval Architects/Marine Consultants and designers of Sapphire)

> *"Paragraph 2 of the causal factors on page 73 should be expanded, adding "Especially the fishroom hatch cover and Engine Room door, plus possibly the Engine Room escape." The stability characteristics of the vessel are such that leaving open the weathertight doors at each end of the passage did not affect stability to any significant degree,and their being open would have caused no problems if the openings which lead below deck had been secured weathertight.*
>
> *The stability data excludes the effect of water in the side passage. If this was full up to the door coaming height, it would hold about 2.5 tonnes which would make freeboard and stability worse in each condition.*
>
> *A dramatic reduction in stability as the fishroom flood level increased from 1200mm to 1800mm is not "A most unexpected feature" (as stated in the last paragraph of annex page 26). The only reason for it is that her stability was so good until then, despite major flooding which on most fishing vessels would be expected to create a dramatic and catastrophic reduction in stability much earlier."*

Alternative text for Victor Robertson, Skipper of "Sapphire" and V Robertson, W Robertson, Mrs R M Robertson and Mrs L Melville, as owners of "Sapphire".

> *Paragraph 1.23, paragraph 2.19 and paragraph 2.25:*
>
> *"When the vessel was at sea it was normal practice for the main fish hatch to be in place and secured. When the vessel left Peterhead on her last voyage the hatch and its fastenings were in good and working order. It was normal practice for the forward door on the starboard alleyway to be closed and secured other than as required during fishing operations or for access and for the after door on the starboard alleyway to be closed and secured while the*

vessel was underway during poor weather. When "Sapphire's" Skipper, Victor Robertson, last visited the engine room when coming off watch at around 1030 hours, the forward door on the starboard alleyway was shut.

The main fish hold hatch cover was heavy and made of steel. It required two or three men to lift it off. The owners of "Sapphire" are unaware of any occasion when this hatch cover has been displaced unintentionally by the force of water or otherwise."

Paragraph 1.24:

"The crew on deck stood on a low wooden platform to keep their feet clear of deck water, a normal practice on fishing vessels like "Sapphire".

Paragraph 1.25, paragraph 2.9 and section 3.1, conclusion 31 (iv):

"To the best of the knowledge of the Skipper and owners of "Sapphire", the EPIRB in place when the vessel was lost was as fitted by the original contractor who installed it."

Paragraph 2.7, paragraph 2.26.1:

"It was normal practice on "Sapphire" for the bilges to be pumped overboard by way of the deck wash hose. To check that the pumps were operating and that the bilge had been cleared, the crew member doing the job would most probably have visited the working deck during the operation. Accordingly, it is likely that while visiting the engine room at 1300, Robert Stephen would have visited the working deck as well."

Paragraph 2.10:

"The owners of "Sapphire" do not accept that they gave insufficient priority to the repair of the bilge alarm. The vessel's maintenance records show that this was not the case. It is by no means uncommon for bilge alarms on fishing vessels to be temperamental and to malfunction intermittently. The owners of "Sapphire" had already exceeded the statutory requirement for such alarms by installing systems in the fish room and engine room and when any problems were experienced they called in reputable marine and electrical contractors to repair the system. The alarm panel was only removed when a repair with the panel in place could not be made and no replacement panel was available before the vessel sailed."