Report on the investigation of

the capsize and foundering of the

fv *Harvest Hope* PD120

40 miles north-east of Peterhead

on 28 August 2005

Marine Accident Investigation Branch
Carlton House
Carlton Place
Southampton
United Kingdom
SO15 2DZ

Report No 21/2006
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Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

3D	-	3-Dimensional
BGS	-	British Geological Survey
BP	-	British Petroleum
BS	-	British Standard
BSI	-	British Standards Institution
BST	-	British Summer Time
BV	-	Bureau Veritas
CCTV	-	Closed Circuit Television
CG	-	Coastguard
CM	-	Consultative Maritime
CPSO	-	Counter Pollution & Salvage Officer
DEAL	-	Digital Energy Atlas and Library
Defra	-	Department for Environment, Food and Rural Affairs
DfT	-	Department for Transport
DNV	-	Det Norske Veritas
DSC	-	Digital Selective Calling
DTI	-	Department of Trade & Industry
EPIRB	-	Emergency Position Indicating Radio Beacon
FISG	-	Fishing Industry Safety Group
FOIA	-	Freedom of Information Act
fv	-	fishing vessel
GMDSS	-	Global Maritime Distress and Safety Systems
HRU	-	Hydrostatic Release Unit
HSE	-	Health & Safety Executive
IP	-	Ingress Protection
ISO	-	International Organization for Standardization
ITC	-	International Tonnage Convention
km	-	kilometre

KN tables	-	Stability cross curve tables, generated from a vessel's hydrostatic particulars; KN is the righting lever measured at the vessel's keel.
kW	-	kiloWatt
LOA	-	Length Overall
m	-	metre
Marine Office	-	A regional MCA office responsible for vessels' survey and certification.
MCA	-	Maritime and Coastguard Agency (formerly MSA)[1]
MEG	-	Mono-ethylene Glycol
MFA	-	Marine Fisheries Agency, an executive agency of Defra
MGN	-	Marine Guidance Notice
MGS	-	Miller Gas System
MRCC	-	Maritime Rescue Co-ordination Centre
MS	-	Marine Safety
MSA	-	Marine Safety Agency (precursor to the MCA)[1]
NAO	-	National Audit Office
NM	-	Notice to Mariners
OAN	-	Operations Advice Notice
OIM	-	Offshore Installation Manager
PC	-	Personal Computer
PD	-	Published Document
POLREP	-	Pollution Report
PTO	-	Power Take Off
QA	-	Quality Assurance
QA&D	-	Quality Assurance & Development (branch, within the MCA)
RAF	-	Royal Air Force
ROV	-	Remotely Operated Vehicle
ROVSV	-	Remotely Operated Vehicle Survey Vessel
RSS	-	Registry of Shipping and Seamen

[1] In April 1998, the Marine Safety Agency (MSA) and The Coastguard Agency merged to form the Maritime and Coastguard Agency (MCA).

RSS	-	Research Survey Ship
SAGE	-	Scottish Area Gas Evacuation
SAR	-	Search and Rescue
SAROPs	-	Search and Rescue Operations
SCMS	-	Survey & Certification Management System
SFF	-	Scottish Fishermen's Federation
SFIA	-	Sea Fish Industry Authority
SI	-	Statutory Instrument
SIAS	-	Ship Inspection And Survey
SOLAS	-	Safety of Life at Sea
SoSRep	-	Secretary of State Representative
SPOC	-	Single Point of Contact
STC	-	Short Term Certificate
tph	-	tonnes per hour
TSG	-	Technical Sub-Group
UK	-	United Kingdom
UKCS	-	United Kingdom Continental Shelf
UK FVC	-	United Kingdom Fishing Vessel Certificate
UKHO	-	United Kingdom Hydrographic Office
UKOOA	-	United Kingdom Offshore Operators Association
UTC	-	Universal Co-ordinated Time
V	-	Volts
VDR	-	Voyage Data Recorder

SYNOPSIS

At around 1630 on 28 August 2005, the UK-registered trawler, *Harvest Hope* came fast while trawling in the vicinity of seabed pipelines, approximately 40 miles north-east of Peterhead. The aft net drum space immediately began to flood through the port transom door, which had been inadvertently left open from the previous voyage.

A port list quickly developed, which worsened as more water poured in through the transom door. The crew immediately tried to close the open door using the hydraulic ram, but this became damaged by a green sea, and the door could not be closed.

An electric submersible pump, located at the forward end of the net drum space, on the port side began to drain the water. However, the pump stopped immediately after a flash was observed from the area of the pump and its junction box. There were six non-return freeing ports, commonly known as tonnage valves, in the net drum space. These had been welded up by the owners several years before the sinking, due to practical concerns about back-flooding. There was no other means of clearing the rising flood water in the net drum space.

The crew witnessed water pouring into the galley through open windows in the watertight bulkhead at the forward end of the net drum space. Water was also latterly seen flowing into the forward cabins. A window in one of these cabins, leading forward into the fish processing space, was also known to be open, and would have allowed progressive flooding into this space.

As the port list increased, main hydraulic power was lost, resulting in the brakes on the vessel's automatic trawl winch system activating. With no safe and easy means of releasing these brakes, the vessel was effectively anchored to the seabed on the port side. Although the trawl warps were cut with an electric grinder, the vessel's condition failed to improve.

Despite some difficulties, the crew managed to deploy the starboard liferaft, and as the list critically increased, the crew abandoned into the liferaft, around 15 minutes after first coming fast. Shortly afterwards, the vessel capsized, and sank by the stern. Not all of the crew had been able to put on their lifejackets. A nearby fishing vessel, *Fruitful Bough* had responded to the earlier "Mayday" issued by *Harvest Hope*, and safely recovered the crew at about 1700, returning to Peterhead later that day.`

Following the sinking, the MRCC immediately informed Mobil, one of the three operators of the four subsea pipelines in the vicinity of the sinking of the incident. The MRCC did not inform BP of the incident, and were also not aware of the presence of the two Shell pipelines in the area, as the Admiralty chart being used did not depict the latter pipelines.

BP and Shell subsequently arranged underwater ROV surveys to inspect their pipeline integrity. These surveys also briefly inspected the wreck, which was found lying intact in about 99m of water. The port liferaft canister was discovered a short distance from the wreck on the seabed, intact and not inflated. The painter had been partially deployed, but was apparently not attached to the wreck. Subsequent analysis of the video footage and side scan sonar data of the area was conducted by consultants tasked by Shell. This concluded that the bridle and

tickler chains on the vessel's trawl gear had snagged large mounds of boulder clay, probably created when a plough had either stalled or jumped during the trenching back-fill process to cover a pipeline. The remaining trawl gear was considered to represent a further snagging hazard, and the consultants made proposals to Shell regarding solutions for removing the trawl gear, and the promulgation to the offshore industry of the hazards potentially caused by back-fill ploughs.

The vessel's as-built displacement was greater than originally designed, due to the addition of large amounts of solid ballast for stability purposes. This resulted in minimal aft freeboard which did not comply with the relevant regulations. A dispensation had therefore been granted by the MCA, based on obsolete and uncontrolled guidance.

During the investigation, a number of issues were identified regarding the vessel's stability approval and regulation. Consequently, the MAIB wrote to the MCA to highlight the issues identified during its investigation. In response, the MCA set up an internal inquiry to investigate and, where appropriate, address the issues raised.

Recommendations have been made to RAPP Hydema, manufacturers of the automatic trawl winch system fitted on *Harvest Hope.* These relate to the development of a quick release mechanism for the "fail safe brake" mechanism, in an emergency, and the review of information, training and guidance provided to fishermen, on the system.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *HARVEST HOPE* AND ACCIDENT

Vessel details

Registered owner	:	Harvest Fishing Company Limited, Peterhead
Port of registry	:	Peterhead – PD120
Flag	:	UK
Type	:	Fishing Vessel (trawler)
Built	:	1996 at Parnica Shiprepair Yard, Szczecin, Poland
Classification society	:	None
Construction	:	Steel
Length overall	:	28.23m
Registered length	:	24.37m or 25.68m
Beam	:	8.7m
Depth	:	7.4m
Gross tonnage	:	356.00
Engine type and power	:	742kW produced by a single Anglo Belgian Motor Company 6DZC-750 (S/N 12484)

Accident details

Time and date	:	1653 on 28 August 2005 (UTC +1)
Location of incident	:	57˚ 55.12´N, 000˚ 46.04´W, 40 miles NE of Peterhead
Persons on board	:	7
Injuries/fatalities	:	None
Damage	:	Vessel lost

Figure 1

Harvest Hope alongside in 2004

1.2 BACKGROUND

The trawler *Harvest Hope* was the first of a series of five similar fishing vessels designed in the UK for various UK-based owners and built in Szczecin, Poland during the late 1990s.

A copy of the latest Certificate of Registry for the vessel is at **Annex A**. Details of the vessel's design are described at section 1.8 below, with a photograph of the vessel at **Figure 1** and a general arrangement of the vessel provided at **Figures 2** and **3**.

Harvest Hope was built for and operated throughout her life by her owners, who had successfully operated the vessel out of her home port of Peterhead since 1996. She typically undertook 10-day fishing trips, bottom trawling for white fish, with a single turnaround day for unloading and storing between each trip. The two owners would operate the vessel as skipper on alternate trips, and they had a pool of eight other experienced crew from which five or six would be utilised to give a total crew of six or seven, for each trip.

In recent years she had also been contracted by oil companies for short periods to undertake offshore support work.

1.3 NARRATIVE OF ACCIDENT

All times are UTC+1 hour (BST) unless otherwise stated.

1.3.1 Environmental conditions

The conditions at the time of the accident were reported by the MRCC as south-easterly winds of Force 7 and speed 35 knots. The sea state was moderate, with a 3m high swell, and good visibility at 6 nautical miles.

This compares to *Harvest Hope*'s skipper's description of the wind as having a south-westerly component and in the region of Force 5 to 6. *Fruitful Bough*'s skipper, who ultimately went to the aid of *Harvest Hope*, likewise estimated south-south-westerly winds of Force 5 with speeds of 30 knots.

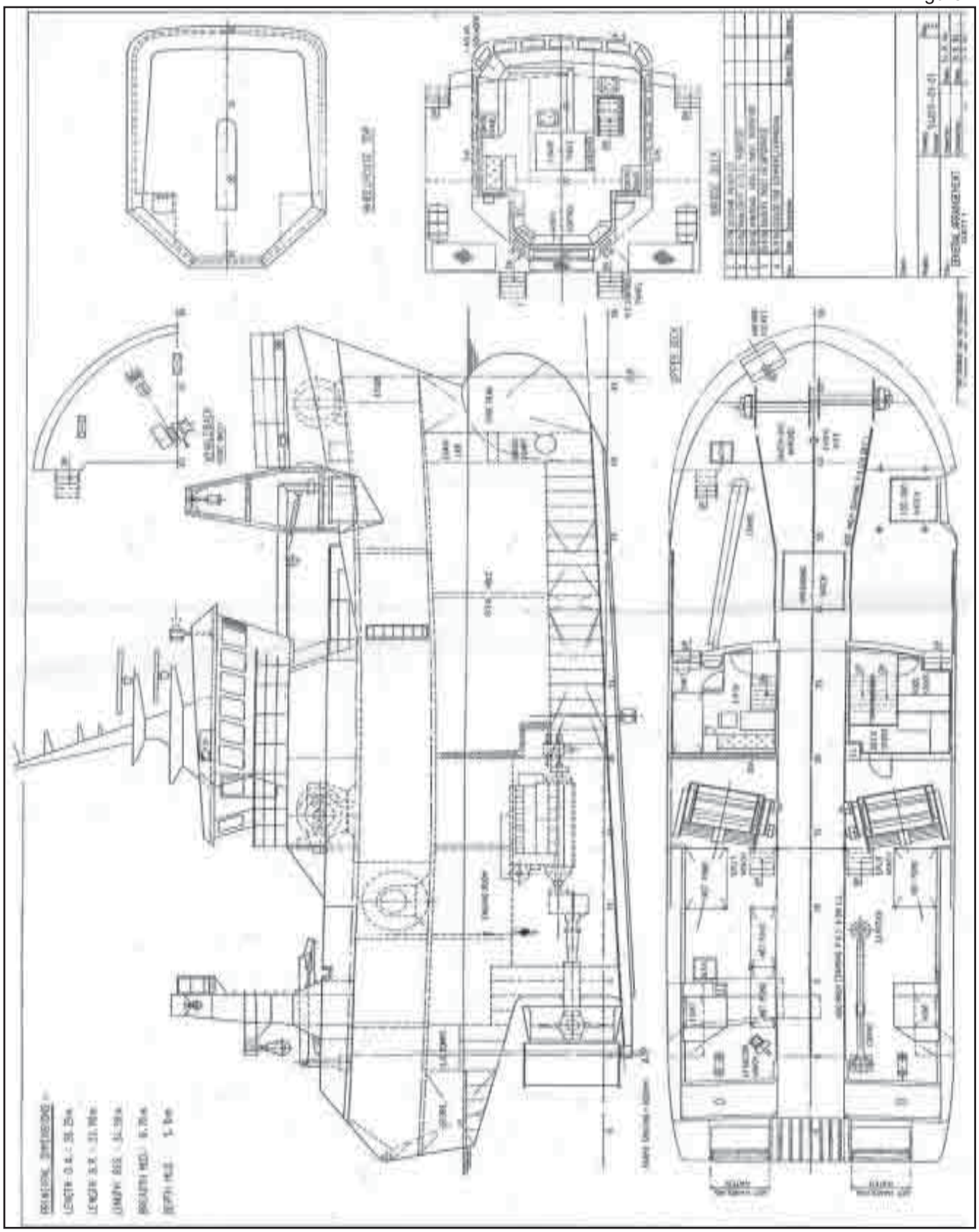
The tidal stream at the time of sinking was 0.2 knots to the north-east.

1.3.2 Details of final voyage

Harvest Hope departed from Peterhead between 0930 and 1000 on 28 August 2005. Onboard were the skipper and crew of six, comprising the mate, engineer, relief engineer/deckhand, fishroom deckhand, and two further deckhands. All were UK nationals, except the Polish deckhand. The vessel was fuelled, stored and iced, for her standard 10-day trip.

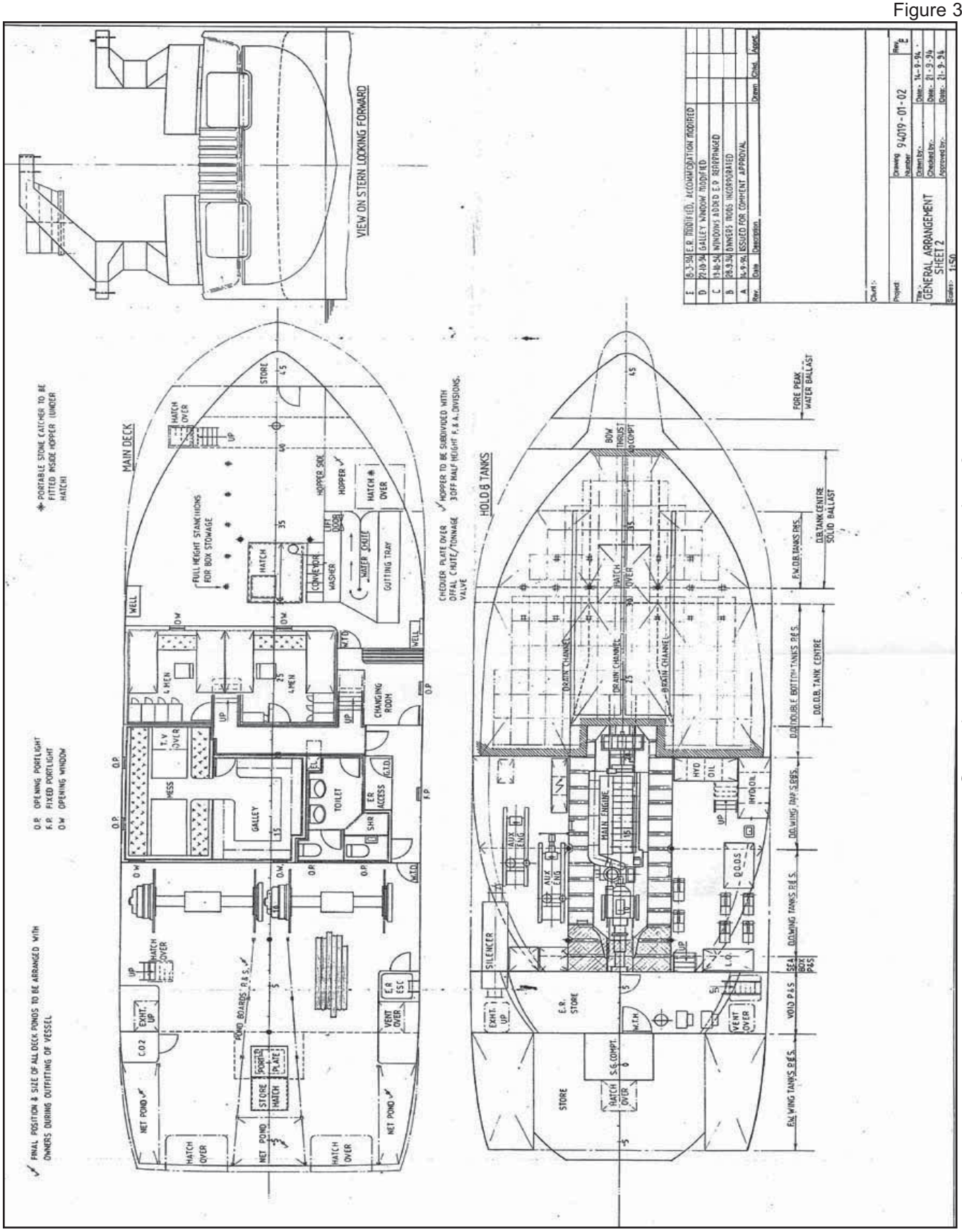
On departing, the vessel steamed at around 8.5 knots, and after a couple of course changes, the skipper shot their semi-clean single net, with a double bag, from the starboard side of the vessel's upper deck at about 1430, some 33 miles out. The intention was to tow for their standard duration of about 5 hours, at around 3.5 knots towards the north-east, in the vicinity of subsea pipelines. During the tow, the crew either relaxed in the galley/mess or their cabins, while the skipper remained on watch in the wheelhouse.

Figure 2



General arrangement drawing - sheet 1

Figure 3



General arrangement drawing - sheet 2

After approximately 2 hours, the vessel's speed started to reduce and the "auto-trawl" system on the port trawl winch began to pay out. The skipper immediately recognised that the trawl gear had become fast on the seabed, and stopped the vessel, while raising the alarm to the crew. He then moved aft in the wheelhouse from the forward console, as shown in **Figure 4**, which was used during towing operations, to the winch control console at the aft end of the wheelhouse, depicted in **Figure 5**.

On arriving at the aft console he immediately noticed daylight and water on the port side of the net drum space on the CCTV monitor adjacent to the console, and given the camera's position **(see Figure 6)**, concluded that the port transom door was open, allowing the following seas to enter the space. The vessel had two inward hinging doors on the transom, as shown in **Figures 6, 7** and **8**, which could be opened for transferring nets and trawl gear. The skipper was certain that the starboard door was closed, because at the time of the incident they were not carrying a working trawl net on the starboard net drum. However, the port transom door was regularly opened to deploy the rockhopper net, used for trawling harder ground, from the port net drum. The skipper realised this door must have been left open from the previous voyage. He had not visited the net drum space either before departure or during the current voyage, and only he would issue instructions to the crew to either close or open this door.

Given that they were towing before the wind and tide, the skipper immediately realised the danger and again called the crew on the intercom, this time asking for someone to close the door before he could commence hauling in.

Once stopped, the vessel began to fall astern with the weight of the wire and residual tension. As this was happening, the skipper observed further seas entering the net drum space, and he thus gave slight ahead pitch on the controllable pitch propeller to try and prevent the vessel falling further astern.

Within a minute of the skipper raising the crew, the relief engineer had entered the net drum space to try to close the transom door. The mate, who had been reading in the galley, immediately went to the top deck to haul in the side scan sonar which was connected to the port trawl warp, just above the trawl board. The engineer went down to the engine room to clutch in the hydraulics.

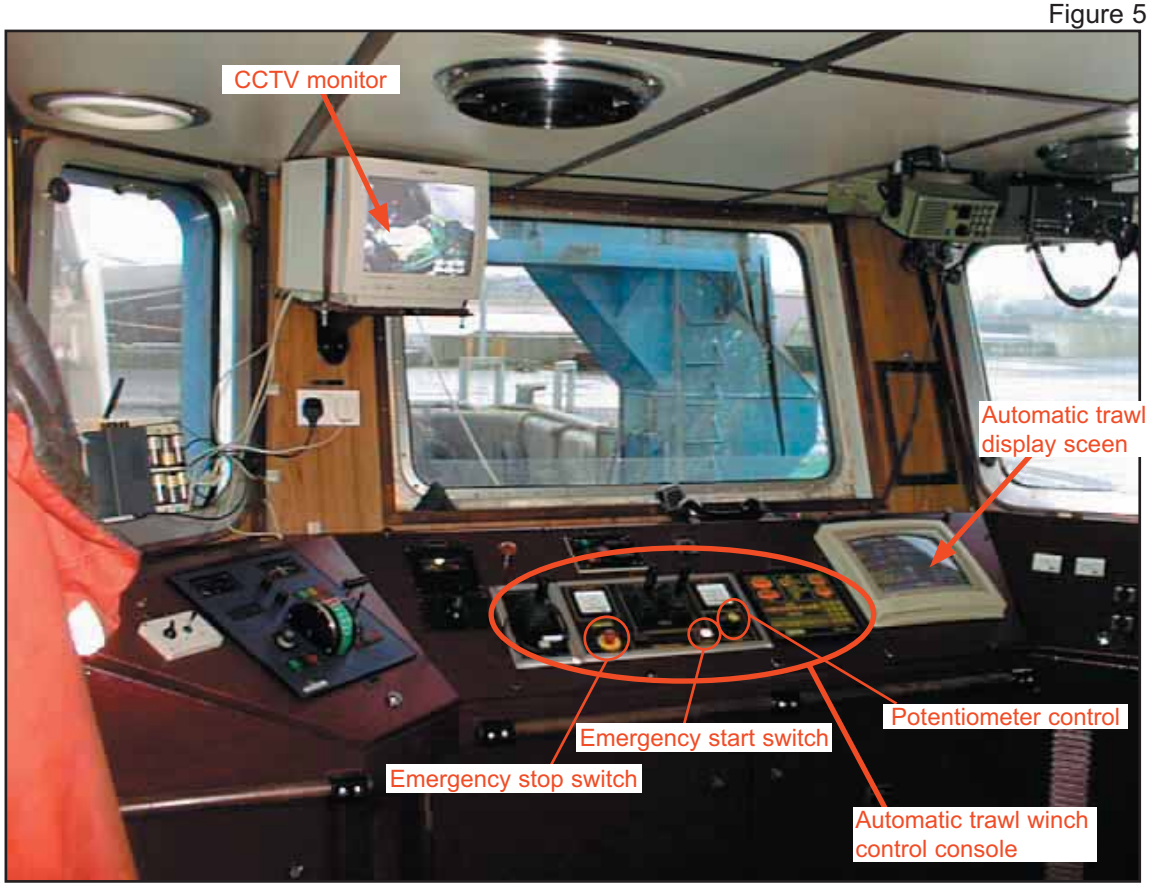
In the net drum space, the relief engineer unhooked the door from the deckhead, noting that the water was already about 3' deep, worsened by a slight port list. He was initially unconcerned, and returned to the central hydraulic control area, as shown in **Figure 9**, to commence closing the door. Each door had a single hydraulic ram fitted on the outboard edge of the door, which pushed the door down from the deckhead.

During this operation, the door caught on the hoppers and cod end of the net on the port drum, which were being lifted off the deck by the gathering water. Fortunately, a green sea poured through the door opening, moving the net sufficiently to allow the door closing to recommence. However, this was a slow process, and whilst still only partially closed, a further green sea struck the area, bending and breaking the ram free from the door, which was left loosely swinging from the deckhead.

Figure 4

Wheelhouse of *Harvest Hope*, looking forward, when built

Figure 5

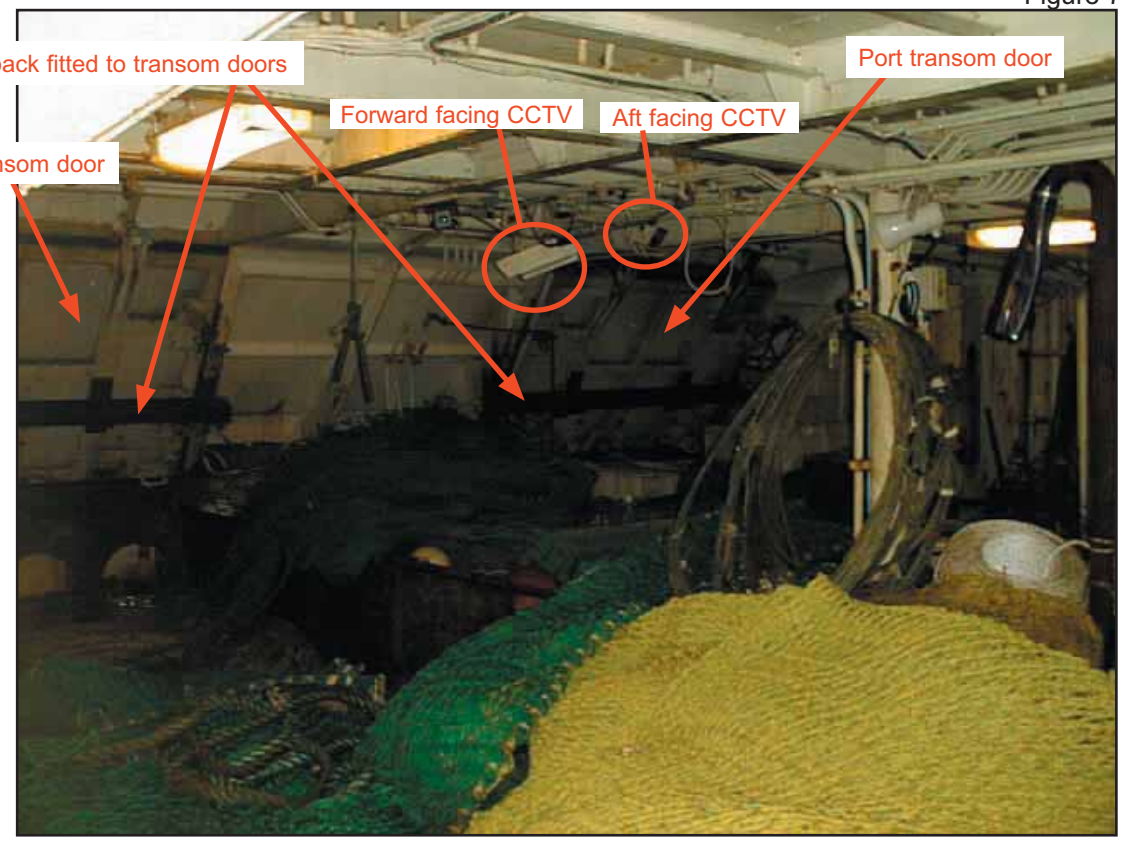


Wheelhouse of *Harvest Hope* looking aft (February 2003)

Figure 6

Net drum space on *Harvest Hope*, looking aft (when built)

Figure 7

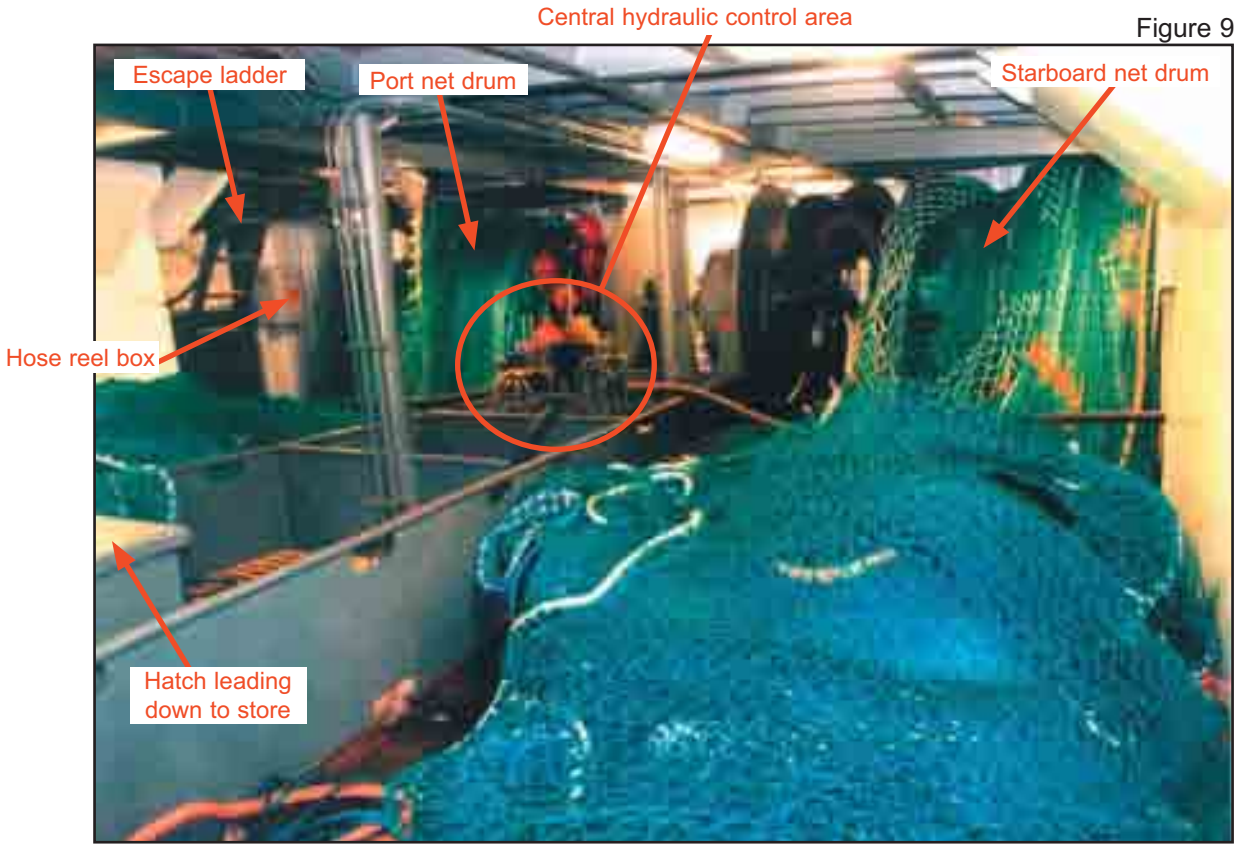


Net drum space on *Harvest Hope*, looking port aft (February 2003)

Figure 8

Stern view of *Harvest Hope*, when built

Figure 9

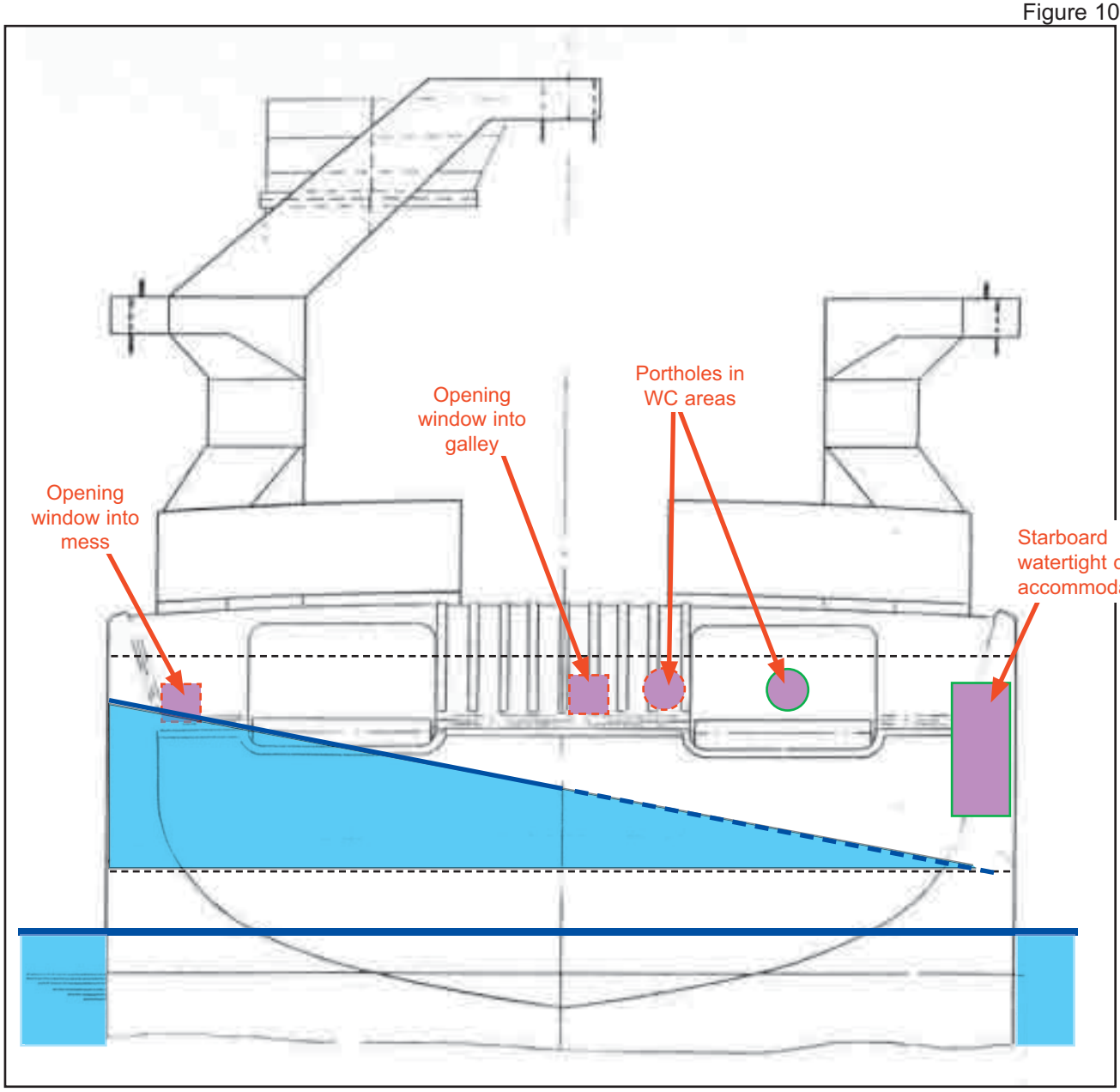


Net drum space of *Harvest Hope*, looking forward (when built)

By this stage, the vessel had started to adopt an increasingly large port list, and the relief engineer noted that the water had reached shoulder height (about 5') at the ship's side and was still about 3' deep, adjacent to the hydraulic control position at the centre of the net space. Based on these observations, the waterline at this stage has been depicted at **Figure 10**.

The only method of removing water from the net drum space was with two 80tph electric submersible pumps, immediately aft of the forward bulkhead, and automatically activated with float switches. There were also six non-return scuppers, or tonnage valves, in the ship's side, which could have been used to free water. None, however, were operational during *Harvest Hope*'s final voyage, having been previously welded shut.

Figure 10



View on stern looking forward
(on forward bulkhead in net drum space)

The starboard submersible pump was ineffective throughout due to the port list, but the port pump was confirmed to be initially working. Although there were no indicators in the wheelhouse for the pumps, the port pump was heard pumping, with a brown slick on the surface of the sea observed by the engineer at one point, indicating that water was being successfully removed from the deck below.

Just after the ram broke free, one of the deckhands arrived in the net drum space to assist with closing the door. On observing the situation, he immediately waded across to the port side, and climbed the ladder **(see Figure 9)** to the escape hatch to try to get a rope from the power block on the upper deck down onto the door. He found the mate was already up there.

Having observed the water ingress, the skipper had informed the mate, on his arrival up top, that the priority was to try to close the transom door. The mate therefore moved aft to the hydraulic power block, as depicted at **Figure 11**. When closing the transom door, it was normal practice to attach a rope between the power block and transom door, and use the former to close the door tight. This allowed the dogs to be secured, because the hydraulic ram below could only close the door so far. The mate readied the rope, and lowered it into position, waiting for whoever was below to attach the rope to the door.

Figure 11

Aft port quarter of *Harvest Hope* (February 2003)

As he waited, the mate looked down and saw the port door swing back on its hinges and out of sight. Shortly afterwards, he was joined by the deckhand, arriving from the net drum space, who informed him of the situation below. As they tried to think of another means of closing the door, they saw successive green seas shipping over the bulwark into the net drum space as the stern dipped into the sea. With no obvious solution, and an increasing port list, the mate went to the wheelhouse to offer assistance to the skipper.

Given that the depth of water was now above the height of the bulwarks at the port door opening, the relief engineer also left the net drum space. He headed straight up to the wheelhouse to inform the skipper of the broken door ram and the deteriorating situation.

When the skipper received confirmation of the problems with the transom door he issued a "Mayday" call on VHF channel 16, at 1637. This was immediately responded to by the fishing vessel *Fruitful Bough* and the offshore standby vessel *Dea Mariner.* They reported that they were 25 and 30 minutes away respectively, and both confirmed that they would steam directly to *Harvest Hope'*s position.

At 1644, the MRCC requested a rescue helicopter from RAF Lossiemouth be scrambled.

By the time the mate arrived at the wheelhouse, the skipper had already started to manoeuvre the vessel ahead and pay out warp on the "auto-trawl" system, while attempting to thrust *Harvest Hope'*s head round to starboard to clear herself aft.

However, during this manoeuvre, *Harvest Hope* took on a dramatic list and the skipper realised that if he gave her too much way, the water on deck could shift rapidly to the other side of the vessel and capsize her.

Realising the dangers of progressive flooding into the accommodation spaces, the skipper asked the engineer to go and close the galley and mess windows. By the time he arrived there, he found the mess full of water up to the level of the television set **(see Figure 12)** and water pouring in through the galley window **(see Figures 13 and 14)**. While in the galley area, the engineer also observed a flash outside the window, which he believed to be from the junction box for the submersible pump, installed just below deckhead level aft of the port net drum **(see Figure 15)**. Following this flash, there was no further confirmation of the port submersible pump operating.

About the same time, the "auto-trawl" winch system, and indeed all the vessel's hydraulics shut down. The skipper believed this to be due to the low level hydraulic oil cut-out activating in the engine room, although he could not recall hearing or seeing this alarm on the control console. The "auto-trawl" system has a fail safe device built into it to shut down and apply a brake to the winches, in the event of low oil level in the hydraulic tank.

With these brakes now on, the vessel was effectively fastened to the seabed from the towing block suspended from the port gallows **(see Figure 8)** and there was no easy means of releasing the trawl warp. The skipper therefore asked the mate to get the electric grinder and extension lead from the starboard alleyway on the main deck, and cut away the trawl gear, as the vessel's primary petrol-driven grinder was ashore being serviced.

On returning to the upper deck the mate plugged in the grinder, and handed it to the relief engineer. On the instruction of the skipper, he first cut the port warp easily, given the tension on the wire, and then started to cut the starboard warp. The skipper was going to tell him to hold off cutting the starboard warp, in the hope that they could get strain on the starboard side to assist righting the vessel. However, by the time the skipper moved outside the wheelhouse, both wires had been cut, and the vessel had not righted herself in the least. The skipper then put the vessel slow ahead into the wind, careful not to build up too much speed, given the large port list.

Meanwhile, the mate returned below a further three times to try to find lifejackets for himself and the crew. On his first visit, he observed water streaming out the galley door into the 4-man port cabin, which he was thus unable to enter. He instead went into the starboard cabin but, not being his own cabin, he couldn't find any jackets, and he therefore returned to the wheelhouse to ask the skipper where they were stowed. On his next visit below, he managed to locate a lifejacket in the starboard alleyway, near the changing room. By the third time, water was now pouring into the 4-man starboard cabin, and he abandoned his search.

At the same time as the trawl was being cut, three of the crew launched the vessel's starboard 10-man liferaft, with some difficulty given the port list.

After assisting in launching the liferaft, the fishroom hand went down below to close the galley door, which he did, noting that water continued to pour out from beneath it. He promptly returned to the upper deck.

As the vessel was coming up to wind, the crew were having difficulty holding on to the liferaft, despite having taken several turns on the painter. They therefore shouted to the skipper to slow the vessel down further, in case the painter snapped or the liferaft capsized.

The vessel continued to list, and with *Harvest Hope*'s starboard bilge keel now out of the water, the skipper decided to abandon, with the mate, followed by the skipper, last to board the liferaft. As the skipper was attempting to board the raft, a sudden swell took it away, and he became totally immersed, but the mate managed to haul him onboard the liferaft.

The skipper was cold from his immersion, so the Polish deckhand took off his jacket and gave it to him. They cut the painter and paddled away from the vessel, now resting on her side, then deployed the drogue.

The Polish deckhand had an inflatable lifejacket with him, which had automatically inflated, so he had struggled to put it on. The other deckhand had no lifejacket on, whilst the fishroom hand was wearing a survival flotation jacket. The engineer had a lifebelt on, and both the skipper and mate were wearing SOLAS lifejackets, retrieved from the wheelhouse.

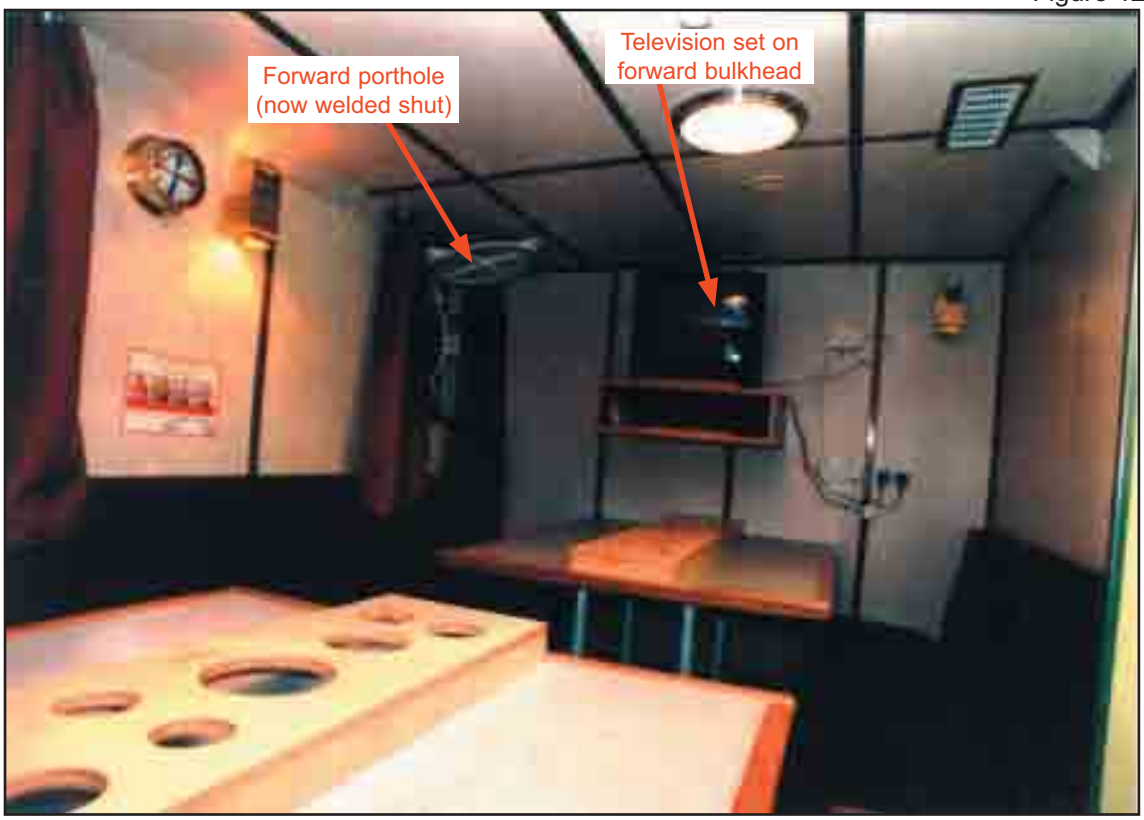
From within the liferaft, several of the crew noted that both the engine and radar of *Harvest Hope* were running, (the latter operated off the 24V batteries), until just before she sank. Some of the crew also observed steam emitting from the port engine exhaust **(see Figure 16)**, as water entered. Before they could paddle away, the starboard main engine overboard discharge was spurting out water, which started to enter the liferaft.

The skipper of *Fruitful Bough* observed the final moments of *Harvest Hope* as they approached the scene at their top speed of 8.5 knots. When about 1¾ miles away, he observed *Harvest Hope* on her port side. She subsequently sank by the stern at 1653, when *Fruitful Bough* was only about ½ – 1 mile away. The position of sinking, as reported by *Fruitful Bough* was 57° 55.13N 000° 45.96W. As they steamed towards the area, *Dea Mariner* had been monitoring *Harvest Hope*'s position on radar, and later called the MRCC to confirm that she had disappeared off the screen at position 57° 55.12N 000° 46.04W.

The port liferaft did not surface either during or following the sinking, and the crew had made no attempts to deploy this raft, given the port list.

Fruitful Bough arrived alongside the liferaft at 1658, and picked up the crew, who estimated they had been in the liferaft for between 10 and 15 minutes. All were physically well and uninjured.

Figure 12

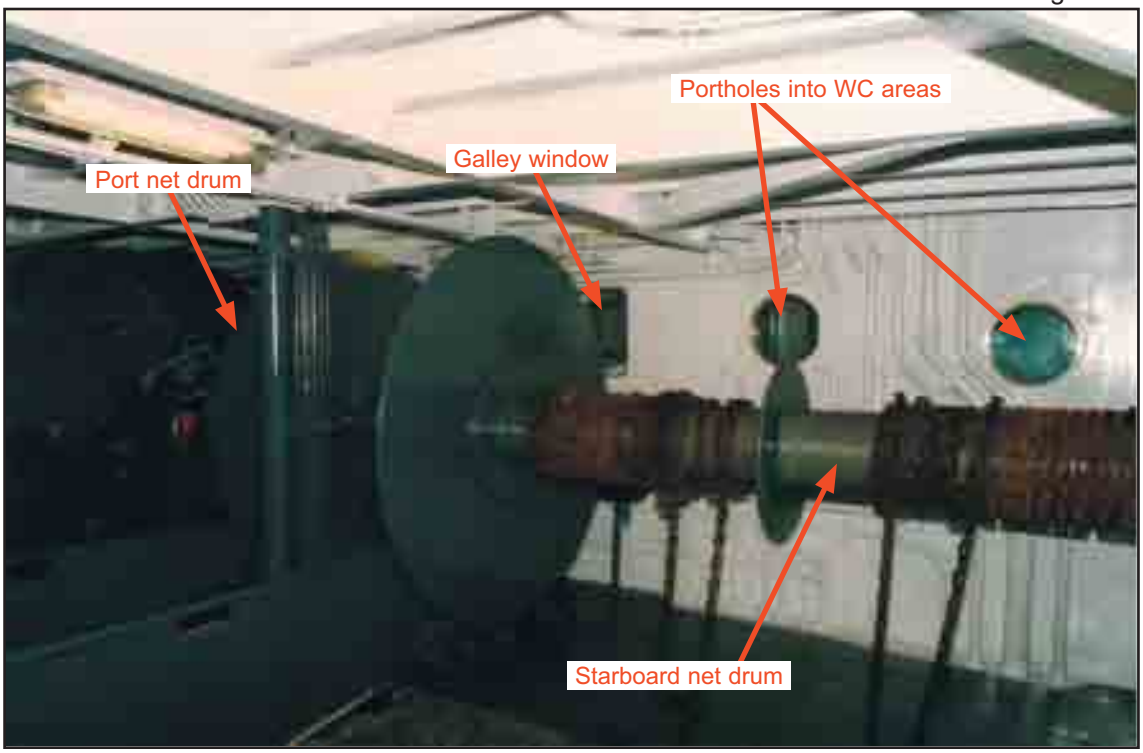


Mess on *Harvest Hope*, looking forward (when built)

Figure 13

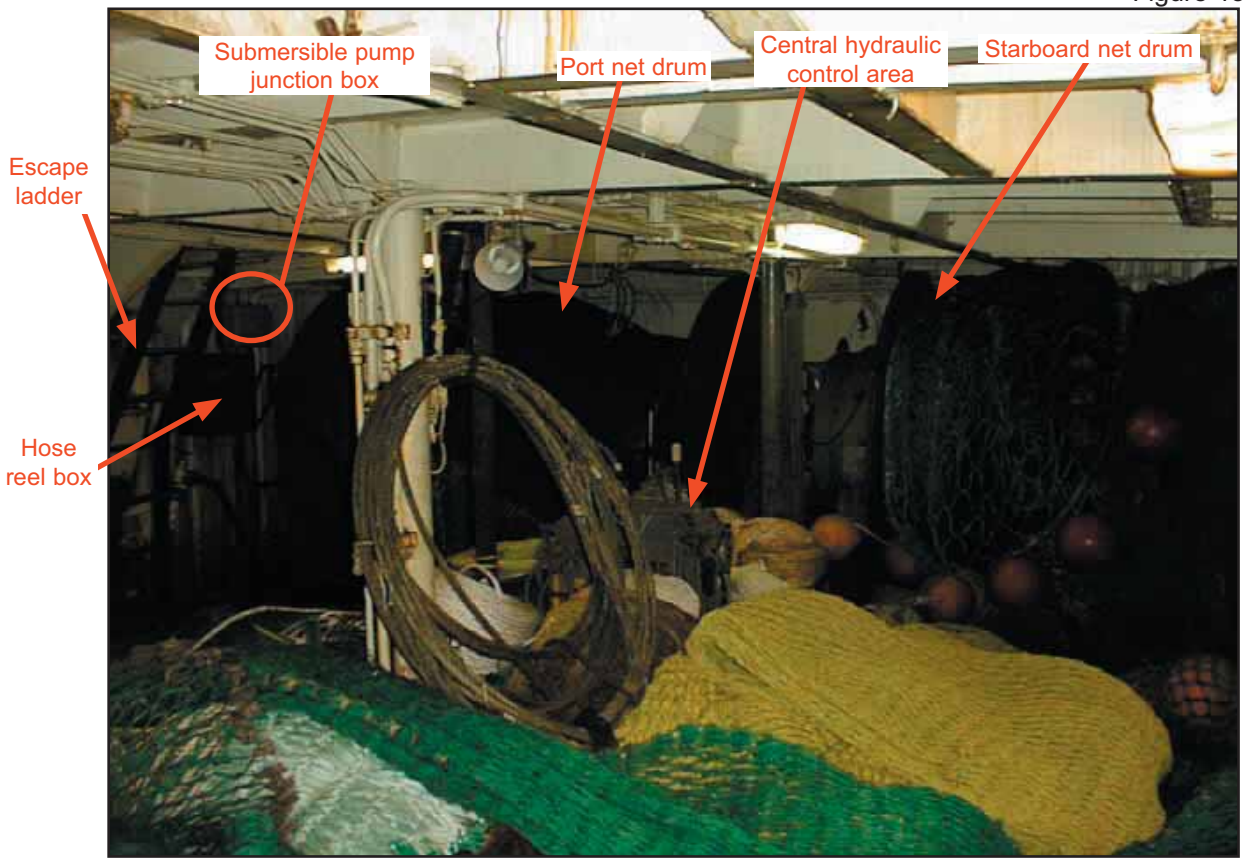
Galley looking aft on *Harvest Hope* (February 2003)

Figure 14



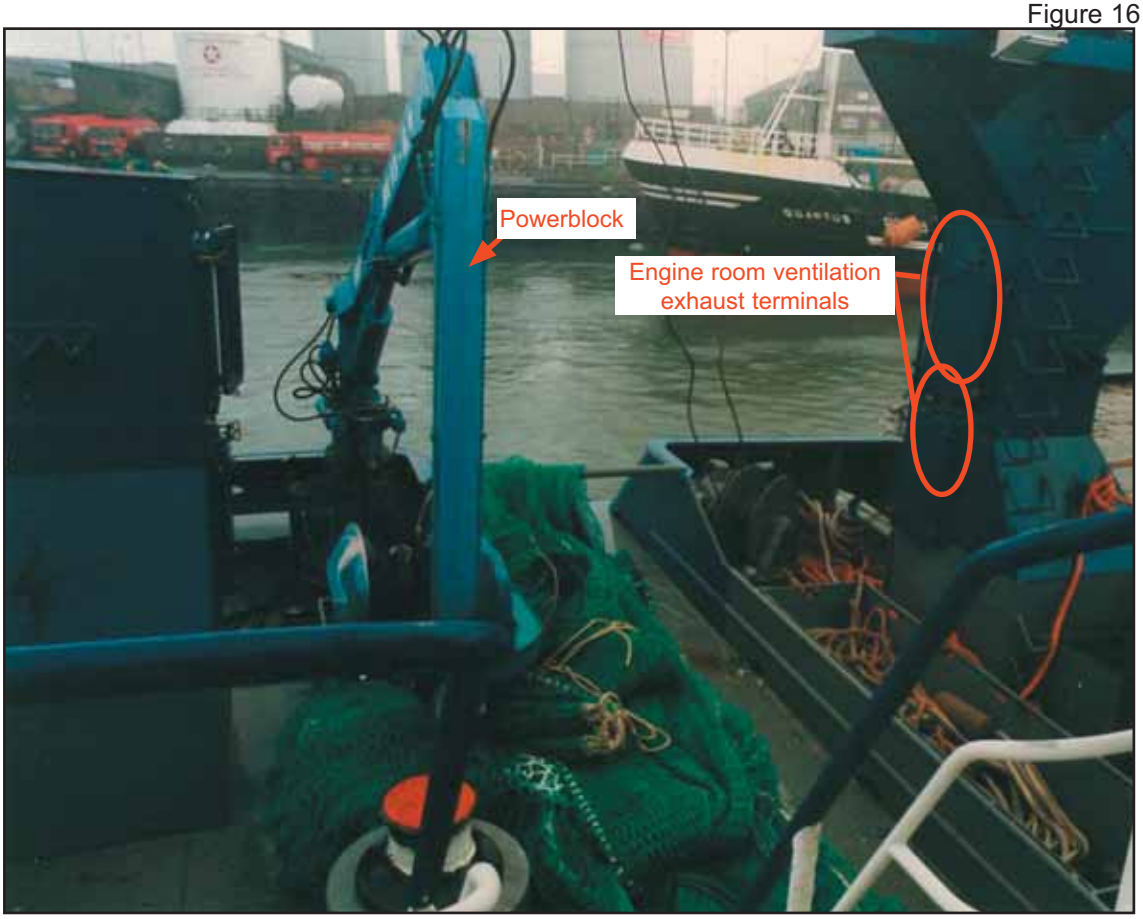
Forward bulkhead in net drum space of *Harvest Hope* (when built)

Figure 15



Net drum space on *Harvest Hope*, looking forward (February 2003)

Figure 16



Aft area of upper deck of *Harvest Hope* (when built)

1.3.3 Actions following the sinking

After *Fruitful Bough* confirmed at 1704 that all of *Harvest Hope*'s crew were safely on board, the MRCC asked her to search for *Harvest Hope'*s EPIRB. They did this for 15 minutes, before aborting the exercise due to concerns for their own safety in the midst of the surface debris, including ropes and trawl gear. They then steamed to Peterhead, arriving at 2255 the same day.

By 1659, the MRCC had plotted the foundering position, as initially reported by *Fruitful Bough*, on the latest version of the paper Admiralty Chart 278. An extract of this chart, updated to show the position of the wreck of *Harvest Hope* is included at **Figure 17**.

Noting that this position coincided with the Beryl gas 30" pipeline, the MRCC identified that the operators of this pipeline were Mobil and that this was a SAGE (Scottish Area Gas Evacuation) pipeline. A copy of the relevant MRCC information is included at **Annex B**. Although highlighting it to be a shared pipeline, later joined by spur lines from the Marathon Brae Field and Amerada Hess Scott Field, it notes three possible Single Points of Contact (SPOC) that can be contacted following any incidents. Also of note is the reference to the Miller pipeline, stated as independent of the Beryl pipeline.

Accordingly, the MRCC contacted the SAGE Pipeline Control Room at 1702 to inform them of the sinking of *Harvest Hope*, and SAGE acknowledged the information and agreed to pass it on.

At 1707, the MCA's on duty Regional Operations Manager for Counter Pollution & Salvage contacted the MRCC regarding the incident, asking for his mobile number to be given to the pipeline owners so they could discuss the incident with him.

By 1719, *Harvest Hope*'s sinking position had been updated by *Dea Mariner*, and this was again plotted on Chart 278, and no longer found to be on the pipeline. This was reported to SAGE at 1728, noting that the vessel's underwater trajectory from the surface to the seabed was unknown.

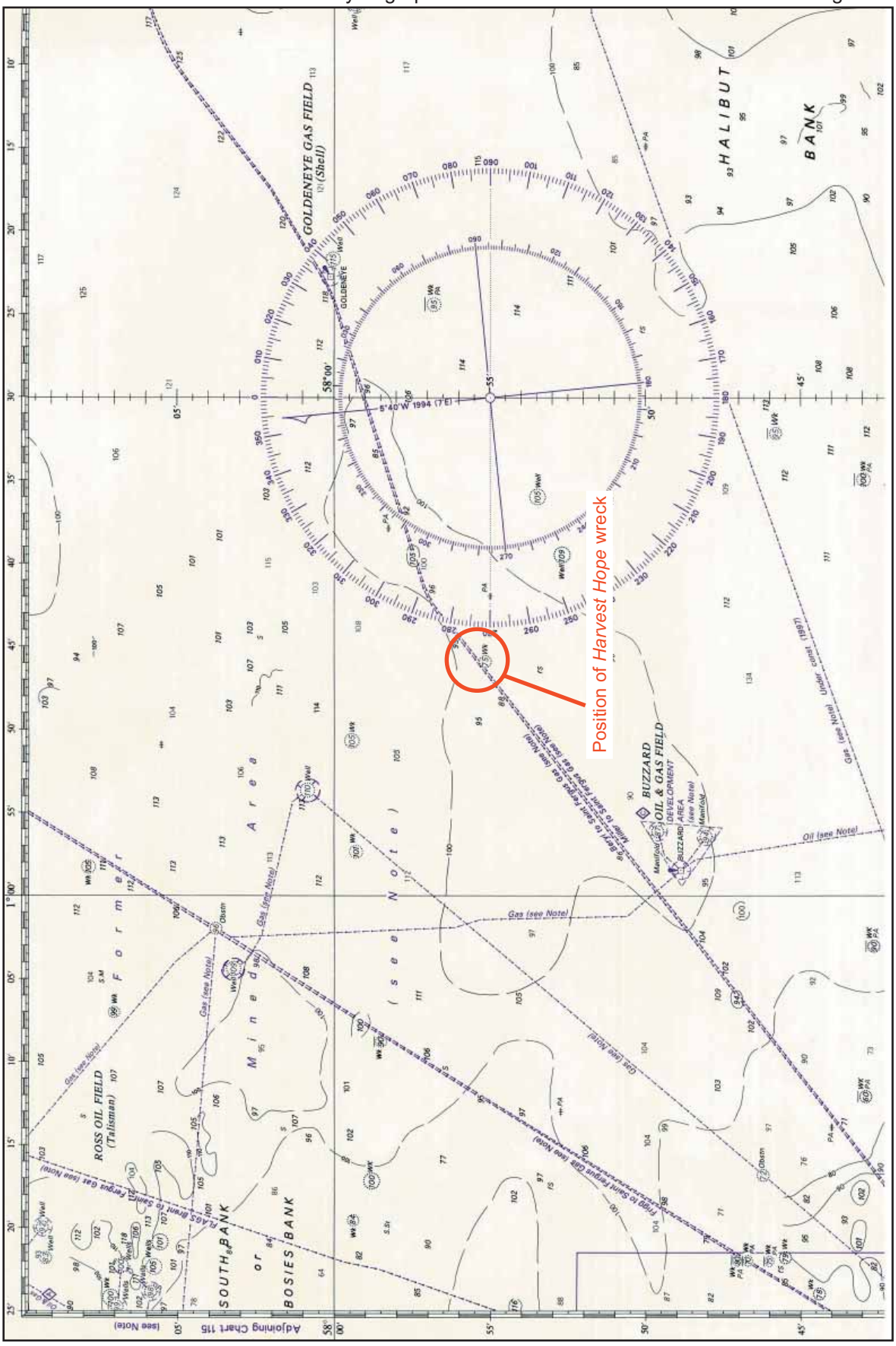
The MRCC had also previously contacted the SPOC at 1724, for an update, with the latter noting that their "Duty Man" had been advised, as had the Beryl, Brae and Scott Fields.

The MRCC next contacted the Beryl Offshore Installation Manager (OIM) at 1843 to confirm whether they had ceased production following the sinking. The Beryl OIM stated this was not the case, but confirmed that they were closely monitoring levels and pressure, and there had as yet been no change. Ten minutes later, an update was received from the Scott OIM.

At 1728 on 29 August 2005, the day after the sinking, BP contacted the MRCC in relation to a phone message received earlier that day from SAGE regarding a fishing vessel sinking near a pipeline. They noted that the BP Miller pipeline was also in the vicinity, and queried why they had not been informed by the MRCC. The latter noted that they had only contacted SAGE as both the SAGE and BP pipelines terminate at St Fergus, and they believed that they only needed to contact SAGE. BP subsequently noted they intended to investigate the procedures for contacting the appropriate authorities in such instances.

Reproduced from Admiralty Chart 278 by permission of
the Controller of HMSO and the UK Hydrographic Office

Figure 17



Extract from Admiralty Chart 278

At 1726 the following day, BP informed the MRCC that they had arranged for the vessel RSS *Ernest Shackleton* to undertake an ROV survey of the Miller pipeline between 6 September and 8 September.

On 2 September, Shell contacted the MRCC at 0935 requesting information on the sinking of *Harvest Hope*. It transpired that Shell also had two subsea pipelines in the vicinity of the vessel's sinking.

1.4 SUBSEA PIPELINES – CHARTING ISSUES

1.4.1 Details of subsea pipelines

As detailed above, there are four seabed pipelines in the immediate position of the foundering of *Harvest Hope,* operated by three different companies (as described below) but all coming ashore at the St Fergus terminal, north of Aberdeen.

- The 30-inch diameter Miller pipeline was installed on the seabed in 1991, and transports export gas from the Miller Field on behalf of British Petroleum (BP).
- The 30-inch diameter Beryl pipeline is part of the SAGE system, again lying on the seabed. Commissioned in 1992, equity ownership is held by a number of offshore operators, with ExxonMobil, holding the main stake.
- Two pipelines were installed between May and June 2003 for the Shell Goldeneye field. The 20-inch diameter main gas pipeline runs along the seabed, while a 4-inch diameter MEG (Mono-ethylene Glycol[2]) is trenched.

1.4.2 Charted pipelines in area of sinking

In the vicinity of the vessel's foundering, the four pipelines run parallel, with a SW to NE heading, as depicted in the Shell underwater survey plot at **Annex C**. The most northerly is the SAGE – Beryl pipeline, adjacent to which is the Miller pipeline, then the two Goldeneye pipelines offset again to the south-east.

Admiralty Chart 278 is the 1:200,000 scale chart covering the area, as depicted at **Figure 17**. Only the two earliest pipelines installed in the area are illustrated on this chart. No reference is made to the presence of the two newer Goldeneye pipelines. A generic reference to the presence of seabed cables and pipelines and the associated dangers of seabed activities in these areas, is made in a note at the bottom of the chart, which highlights that not all pipelines may be depicted.

In 2003, the United Kingdom Hydrographic Office (UKHO) issued a Notice to Mariners (NM) 2087(P)/03, advising of the presence of the two new Shell pipelines. A correction was not required to be made to the chart, and a copy of this document is placed at **Annex D**.

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[2] Mono-ethylene Glycol is a chemical used in production pipelines for the purposes of the prevention of internal corrosion and hydrates.

1.4.3 UKHO seabed pipeline charting policy

Information on all new seabed pipeline routes received by the UKHO is assessed according to the requirements of SOLAS (Safety of Life at Sea). An NM requesting a chart correction to highlight a new pipeline on the chart is then issued if either:

- the route of the new pipeline is considered to be "safety critical", either in a position removed from other seabed obstructions or in shallow waters;
- or, when the scale of the chart is large enough to show the gap between the new and existing pipelines;

For the 20-inch Goldeneye pipeline, the as-laid route, east of position 57° 39'N 001° 25'W was noted by the UKHO as closely following the route of the existing SAGE-Beryl and Miller to St Fergus pipelines. Therefore the UKHO considered that, given the scale at 1:200,000 of both chart 278 and another chart, 291, it did not consider the representation of this new pipeline to be "safety critical". The separation between the new and existing pipelines would have been depicted by just over half a millimetre on the chart. Consequently, the UKHO considered that the issue of an NM to insert the pipeline on these charts would have been an unnecessary burden on the mariner. However, as west of 57° 39'N 001° 25'W the pipeline deviated significantly from the existing pipelines, an NM was considered necessary to correct charts 213, with a scale of 1:75,000 and 115, with a scale of 1:200,000.

A copy of the Annual NM No.24 which refers to submarine pipeline and cables is at **Annex E**. Paragraph 4 of this notice specifically states that "*Where pipelines are close together, only one may be charted.*"

Following the MAIB's enquiries into the above matter, the UKHO have advised that due to their generalisation policy, they will probably not include the Goldeneye pipeline route on the next new edition of chart 278, which is due to be published in June 2006. However, they also noted that they may consider adding an additional legend referring to this pipeline.

1.4.4 Information regarding subsea pipelines

Information on the presence of seabed pipelines is currently available via a number of sources.

DEAL (Digital Energy Atlas and Library) is a free, public, web-based service located at www.ukdeal.co.uk, which aims to provide a full national catalogue of UKCS United Kingdom Continental Shelf) geoscience data, and points users to the source of data of interest, including pipeline alignments. It was developed by the British Geological Survey (BGS), and funded by UKOOA (United Kingdom Offshore Operators Association) and the Department of Trade & Industry (DTI).

Previously known as Kingfisher Charts, Kingfisher Information Services is now a self funding unit within The Sea Fish Industry Authority (Seafish). It provides seabed users, free of charge, with seabed obstruction information in a variety of formats, including fortnightly bulletin sheets, awareness charts, and electronic data, compatible with the majority of electronic fishing plotter systems.

Following the foundering of the trawler *Westhaven*, which snagged on a seabed pipeline in 1997 with the loss of four crew, an electronic warning device, FishSAFE, was developed in collaboration with fishermen's organisations and UKOOA. This system is fitted on board fishing vessels, and uses the vessel's GPS position to interrogate the Kingfisher Information Service – UKCS database of seabed obstructions, triggering an on board alarm if the vessel approaches any such hazard. The information for this database is provided by UKOOA, and is updated along with the FishSAFE systems, bi-annually.

In 2005, Seafish used this database to develop a restricted access website for use by MCA Coastguard (CG) stations at www.subseahazards.org.uk which provides information on all seabed obstructions. Screen captures at **Figures 18** and **19** depict the sinking position of *Harvest Hope* as well as all four pipelines in the vicinity. This information was available to the MRCC on the date *Harvest Hope* sank, but was not used following the accident.

Following the accident, the MRCC advised that they preferred to use Admiralty Charts in such situations, as these were perceived to be more accurate than www.subseahazards.org.uk, which is updated only bi-annually. It was also noted by the MRCC that even if they had been aware of multiple pipelines in the area of the vessel's sinking, their immediate priority following an accident is SAR, and that it might not be possible to contact all pipeline operators.

1.5 UNDERWATER SURVEYS OF WRECK

1.5.1 Background

Once they were aware of the location of the wreck, all three operators of subsea pipelines in the vicinity of the wreck considered their response.

As **Annex C** confirms, the SAGE – Beryl pipeline was furthest away from the sinking, so its operators, ExxonMobil, chose not to undertake an immediate underwater survey of the area. However, given the proximity of the vessel's sinking position to the Miller and Goldeneye pipelines, both BP and Shell respectively decided to commission underwater surveys to assess for any potential damage to their pipelines.

1.5.2 ROV survey conducted on behalf of BP

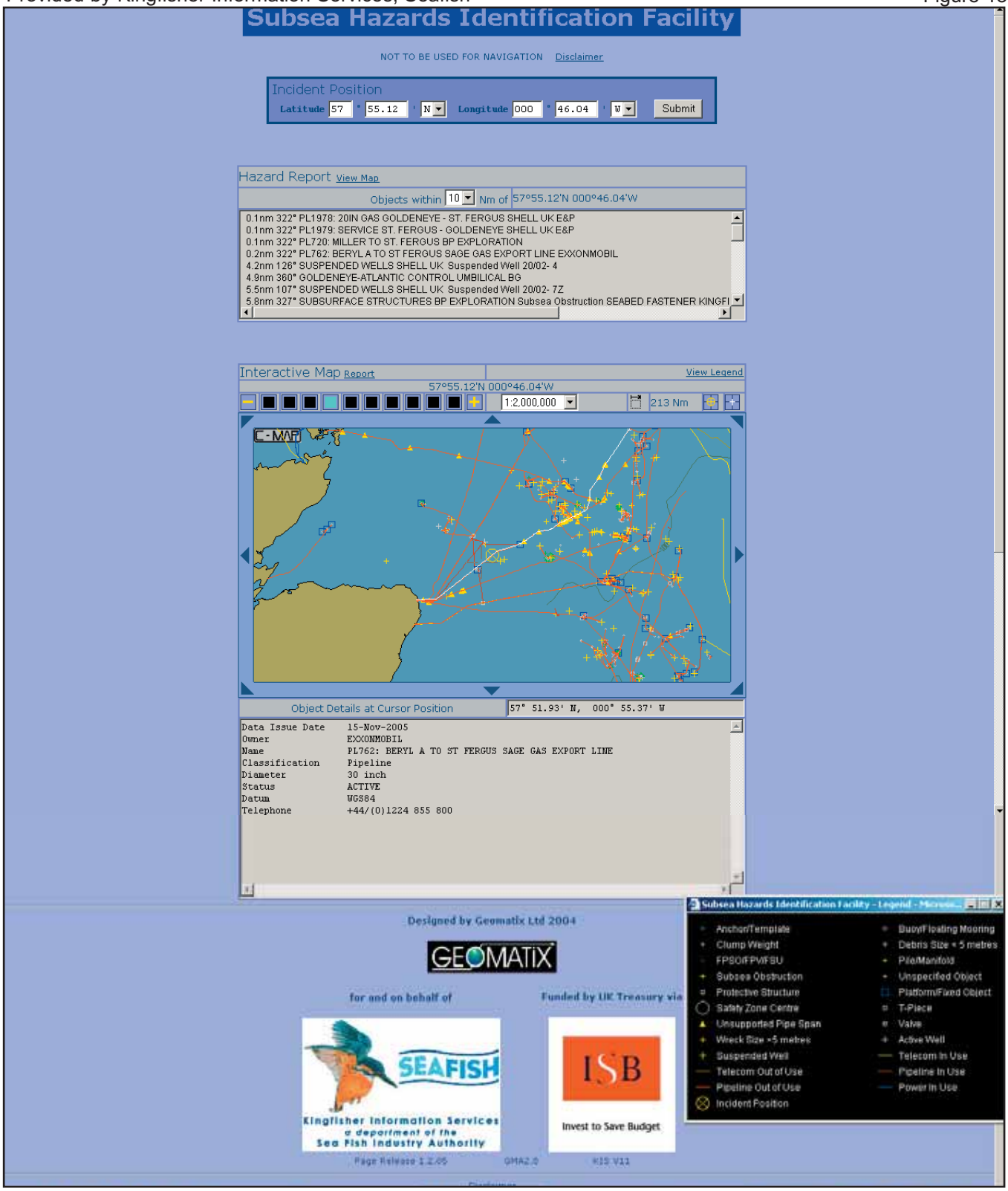
- Details of ROV survey

  BP tasked the offshore contractors Stolt Offshore with the British Antarctic Survey vessel RSS *Ernest Shackleton,* deployed between 6 and 9 September 2005 to conduct an underwater survey using a Solo 1 Workclass Remotely Operated Vehicle (ROV).

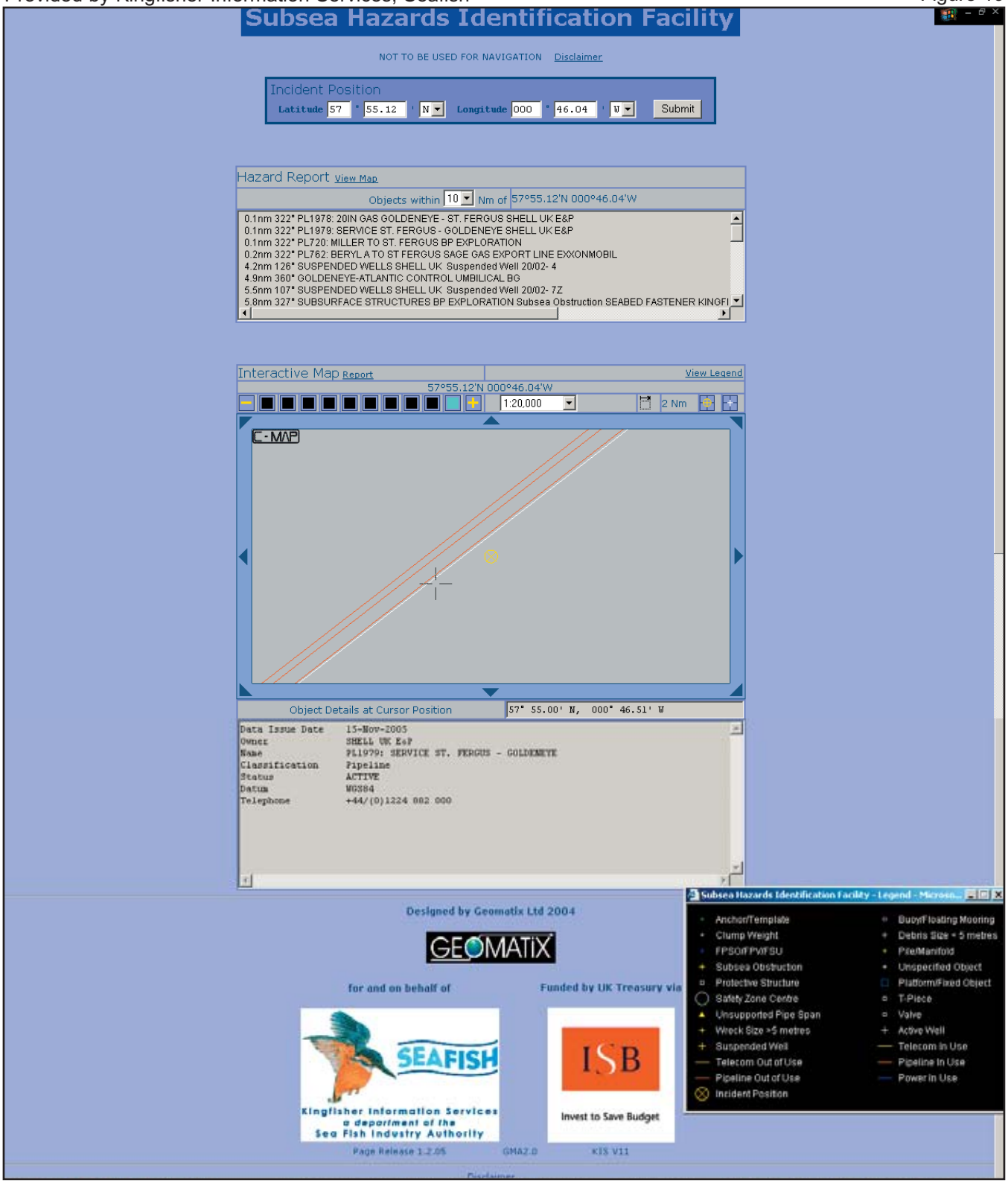
- Findings of ROV survey

The track of the ROV conducting the surveys is displayed on a chart of the area shown at **Annex F**.

The primary purpose of the ROV survey was the inspection of the BP Miller pipeline, and this was confirmed to be undamaged, with no debris in the immediate vicinity. The survey did however confirm that some of the trawl gear was resting either on or near to the Shell Goldeneye pipelines, to the south-east of the Miller pipeline.



Screen capture from website: www.subseahazards.org.uk



Screen capture from website: www.subseahazards.org.uk

Approximately 39 minutes of ROV footage was captured of the wreck of *Harvest Hope* itself. Although this footage only covers limited areas of the wreck, it was possible to determine that the wreck was intact resting on the seabed, inclined to port to about 25°. The footage also confirmed that the port transom door was open.

The port liferaft canister was identified on the seabed, approximately 10m off the port side of the wreck, as shown at **Figures 20** and **21**. The canister was still intact, with the painter attached and running fairly taut along the seabed away from the area of the wreck. It was, however, unfortunately not possible to determine from the survey footage what the painter was attached to or what length had been released from the canister.

1.5.3 ROV Survey conducted on behalf of Shell

- Details of ROV survey

  Shell contracted the offshore contractor, Subsea 7 to conduct their survey of the area. The ROVSV *Kommander Subsea* was therefore deployed to undertake a ROV survey in the vicinity of the Goldeneye pipelines between 30 and 31 October 2005.

- Findings of ROV survey

  Subsea 7 also produced a chart summarising the seabed positions collated during the ROV survey, and a copy of this is at **Annex C**. Extracts taken from the Subsea 7 survey report are placed at **Annex G**.

  About 27 minutes of ROV footage was captured of the wreck of *Harvest Hope* itself. Again, only certain areas of the wreck were inspected, with no images obtained to confirm the integrity of the tonnage valve openings. The port transom door was again observed to be open **(see Figure 22)**, and some slight damage was observed near the bow of the hull.

  More detailed footage was however obtained of the trawl gear in the area of the trenched 4-inch MEG pipeline, as depicted at **Figure 23** and summarised at **Annex G**.

- Post-survey actions

  Following the survey, Shell had a number of concerns regarding potential damage to the 4-inch MEG pipeline, the additional seabed hazard that the trawl gear posed and the possibility that attempts might be made to recover the expensive trawl gear on the seabed. Shell therefore arranged for a guard ship to be deployed to the area on 1 December 2005 to warn off other fishing vessels from the area.

  Shell also employed the services of the Aberdeen-based Boreas Consultants Ltd. to review the underwater data and footage. The purpose was to attempt to establish the likely scenario by which the trawl gear had become snagged in the area of the 4-inch MEG pipeline, and also a suggested strategy for the removal of the seabed hazard posed by the gear.

  Underwater footage of the snagging area was subsequently viewed during a meeting in December 2005 between Shell, Boreas and the vessel's owners. The latter felt that the footage confirmed that the tickler chain at the forward end of the trawl net had become fast in large mounds of boulder clay by the edge

Figure 20 and 21

Harvest Hope's port liferaft canister on seabed

Figure 22

Port transom door on *Harvest Hope* open

Figure 23

Harvest Hope's trawl gear embedded into large mounds of boulder clay

of the 4-inch MEG line trench. The owners also noted that their "auto-trawl" system had paid out slowly following the snagging, which is typically indicative of coming fast in mud, rather than a hard obstruction, such as a rock. They also confirmed that they had successfully trawled the area many times previously in both directions.

Following the meeting, Shell contracted Subsea 7 to return to the area with the ROVSV *Kommander Subsea* to obtain sonar and 3D swathe imagery of the seabed in the area of snagging. Boreas were subsequently tasked again to review this data and produce their final report.

A copy of the final Boreas report is placed at **Annex H**[3]. This concluded that part of *Harvest Hope's* trawl gear, the chain bridle and tickler chain had most probably come fast in a mound of compacted boulder clay in the vicinity of the 4-inch MEG line.

Side scan sonar imagery had also been used to suggest that this mound was probably created during the trenching process, when the backfill plough either stalled or jumped at this location. Another similar backfill feature was also identified in another section of the trench.

The Boreas report made various recommendations to Shell regarding the removal from the seabed of the trawl gear, which was considered to pose a significant hazard to other deep sea users, and the promulgation of the lessons learnt regarding trenching procedures.

1.6 SUBSEA PIPELINES – TRENCHING STANDARDS

The Health & Safety Executive (HSE) issues Regulatory Trenching Criteria, which stipulate that pipelines of diameter greater than or equal to 16 inches can be left untrenched, provided they will not be damaged by a fishing vessel's trawl board, and fishing organisations have been advised of the pipeline.

For the trenching of the Goldeneye 4-inch MEG line, Shell would have used Standard BS 8010 Part 3 Pipe Subsea: Design, Construction and Installation (now known as PD 8010 Part 2, where PD denotes "Published Document") as the basis for the design, supplemented by Shell's own standards. Neither standard is however prescriptive in terms of specifying the protection requirements for a trenched pipeline, and it would have been the responsibility of the Shell project team to establish the actual requirements.

The trench for the Goldeneye 4-inch MEG line was therefore backfilled, with the design basis being for burial to provide coverage of 0.5m to the top of the pipe. No rock-filling or dumping was undertaken for this trench. Shell also confirmed that they were not aware of any previous trawler snagging incidents in the vicinity of the Goldeneye 4-inch MEG line.

[3] It should be noted that *Harvest Hope* was actually trawling with a double bag trawl net when she came fast, and not the single bag arrangement depicted in the Boreas report.

1.7 CREW DETAILS

1.7.1 Skipper/owner

The skipper of *Harvest Hope* was one of the joint owners of the vessel, who skippered the vessel one trip in every three. He had been at sea for 21 years since leaving school, and had skippered the vessel since she had entered service. He had obtained his Class 1 Deck Officer (Fishing Vessel) certificate in 1992. Like all of the crew on board, he had completed all of the mandatory training courses for fishermen.

1.7.2 Mate

The mate had been at sea for about 30 years, the last 18 of which he had spent on board *Harvest Hope*, and her earlier namesake. He had a Second Hand Full certificate.

1.7.3 Crew members

All of the crew were experienced fishermen, with many years of experience on board *Harvest Hope*. The engineer had been at sea for 27 years, and had been the vessel's engineer since she was built, as had the relief engineer who had been at sea for around 18 years. The fishroom hand, who also acted as the vessel's cook, had worked on board *Harvest Hope* for 6 years, with 27 years of fishing experience, while the UK deckhand had worked on board for the last 3 years. The Polish deckhand had only been with the vessel since February 2005, and had Polish equivalent certificates for the required training courses. His English was described as "improving", but he could understand simple instructions.

1.8 GENERAL DESCRIPTION OF VESSEL

The vessel was a steel construction trawler with an overall length of 28.23m and moulded breadth of 8.70m. She was fitted with bilge keels, and had Tenfjord steering gear and a fixed Kort nozzle propulsion system, and was capable of a top speed of 10.5 knots, her service speed being about 9.5 knots.

The design incorporated an external working through deck, at upper deck level, running beneath the bridge deck, which was supported by split deck houses. The two main split winches were situated immediately beneath the aft end of the wheelhouse, while two further sweep-line winches were located forward on this deck, housed within the whaleback.

Aft on the main deck aft was a net drum space, described in more detail at 1.9. Forward of this bulkhead was the main accommodation block, comprising the mess and galley, toilets, changing room and two 4-man cabins, port and starboard. A longitudinal alleyway on the starboard side led to a gas tight door providing the main access to the engine room, and an aft watertight door to the net drum space. A further watertight door led forward through a watertight bulkhead to the fish processing space, detailed at 1.10.

The engine room and fish hold were located below the main deck, along with the chain locker, thruster compartment and various tanks. The vessel's steering flat was accessed from the net drum space, via a bolted portable plate, and through a watertight door from the engine room. Furthest aft was the vessel's store, accessed from the net drum space above by a watertight hatch **(see Figure 6)**.

1.8.1 Vessel alterations since completion

The as-built general arrangement drawings for the vessel are included at **Figures 2** and **3**. However, a number of alterations had been made to the depicted layout of the vessel since she was completed in Poland, and which are therefore not incorporated in these drawings, as detailed below.

- A new, larger hydraulic power block was fitted on the upper deck to assist with trawl gear handling and general deck operations.
- In the net drum space on the main deck, the CO_2 store on the port side was moved to the starboard side, with an aft door to this compartment. The former CO_2 store became a storage area, again with the door re-located to the aft bulkhead.
- In the accommodation area on the main deck, the door to the galley was positioned on the centreline when built.
- The original layout of machinery in the fish processing space was changed significantly once the vessel had been operating for a period.

1.9 NET DRUM SPACE

1.9.1 General description

The internal net drum space aft on the main deck, provided an additional area for storing and deploying trawl gear, with two large net drums located forward in this space. On the vessel's final voyage, the port net drum housed the vessel's rockhopper net for working hard ground, whilst two clean ground nets were stored on the upper deck. There were also about 160 fish boxes stowed on the starboard side of the space during the voyage.

The forward watertight bulkhead in the net drum space included five openings leading into the accommodation block. On the starboard side was an alarmed watertight door, and there were also two opening watertight windows and two opening watertight portholes. The dimensions of these openings were recorded in the original Record of Particulars at **Annex I**, whilst their estimated positions are depicted at **Figure 10**.

The windows leading from the mess and galley were intended to act as secondary escape routes to comply with Regulation 60 (2) of the Fishing Vessel (Safety Provisions) Rules 1975 requiring at least two means of escape from accommodation areas within watertight boundaries. The exception to this rule was at 60 (2) (a) :

> *"in vessels less than 24.4 metres in length this provision shall apply to the compartments situated beneath the freeboard deck other than fish-holds;"*

SI 2002 No. 2201 however omitted this subparagraph (a) from the Rules.

Figures 13 and **14** offer views of the galley window externally and internally, however none of the available construction drawings for the vessel confirm a vertical position for any of these windows. Based on the photos and comments made by the crew, it is estimated that the height of the base of these windows was approximately 1.5m off the deck, as shown at **Figure 10**.

The original designed position for the opening window from the mess area, was further inboard. However, it was moved outboard as shown in **Figure 2**, due to likely blockage of the escape route when a net was on the drum.

Additional egress points from the net drum space were via a ladder and hatch **(see Figures 9 and 15)** leading to the upper deck, on the port side, and an alarmed watertight starboard door used as the engine room escape route on the starboard side. Further aft in the space, a portable deck plate led down to the steering gear flat, whilst a watertight hatch, as visible in **Figure 6**, accessed the store below. There were no vent openings located in the net drum space.

1.9.2 Transom doors

The transom incorporated two inward hinging hatch doors for deploying and recovering the gear from this space. These were constructed from 8mm thick aluminium with overall dimensions 1340mm x 1300mm. Photographs of the doors are at **Figures 6**, **7** and **8**.

Following a period in service, the owners had a 4" x 3" box section fitted to the internal face of the door. This was to assist with closing the doors, which were secured closed using dogs. Although the doors were initially fitted with rubber seals, the condition of these seals was uncertain by the time of the vessel's final voyage.

Each door had a single hydraulic ram, controlled from a central control position in the net drum space, as shown at **Figure 9**. This ram was on the outboard edge of each door, and was used to open and close the doors, with the assistance of the hydraulic power block on the upper deck.

Varying opinions on the watertight integrity of these doors have been expressed. The Bureau Veritas surveyor conducting the original survey of the vessel described them as "watertight" in his handwritten version of the vessel's Record of Particulars (see **Annex I**). This view was also shared by the consultant in his letter to the MSA in May 1995. This view was not shared by the MSA, who considered the doors to be, at best, weathertight.

The owners of the vessel noted that, while they were at sea, there was often seepage through the doors, even when closed.

1.9.3 Weathertight or watertight?

Part 1 of The Fishing Vessel (Safety Provisions) Rules 1975 provides definitions for watertight and weathertight. The former relates to structure that is capable of preventing the passage of water in any direction, while the latter is capable of preventing passage of sea water in "*ordinary sea conditions*."

Section 3.1 of the Survey of Fishing Vessels – Instructions for the Guidance of Surveyors, also notes that *"Weathertight doors should normally open outwards so as to bear the door frame under the impact of the sea."*

1.9.4 Tonnage valves

- Background

  When *Harvest Hope* was completed, four non-return valve scuppers, or tonnage valves, were fitted in the side shell of the net drum space. Their purpose was to allow the removal of any accumulated water in this space, along with the option of closing the valves, if required. The original Record of Particulars at **Annex I** records the dimensions of the four tonnage valves.

  No drawings are available, either of the valves fitted on board *Harvest Hope* or of their locations, but **Figure 24** indicates a similar arrangement installed on another fishing vessel. **Figure 25** shows one of the tonnage valves in *Harvest Hope*'s fish processing space, while under construction, and therefore unpainted. A completed tonnage valve, in the fish processing space of *Harvest Hope'*s sister vessel *Kinnaird* is depicted at **Figure 26**. Of note in this latter photograph is the inclusion of an adjacent warning notice. It is understood that there were no such notices on *Harvest Hope*.

  It is also of note in **Figures 24**, **25** and **26**, that unlike a conventional scupper or freeing port, the base of the valve opening is between 30-75mm above deck. The reason for this was apparently to allow the continuous welding of the valve box to the ship's side.

- Installation of additional tonnage valves

  As part of the remedial action required to allow an MCA dispensation on the vessel's aft freeboard (as described at Section 1.19), an additional tonnage valve, port and starboard was required to be fitted in the net drum space.

  It is understood that this work was conducted in Denmark during June-July 1999. A photograph of the vessel in 1999 at **Figures 27** and **28**, is the only confirmation that this work was completed, with a third opening now apparently evident in the side shell in way of the net drum space.

- Alterations to tonnage valves

  The net drum space had previously filled with water on *Harvest Hope*'s second voyage, when the vessel came fast before the seas. The transom doors were being held closed only by the hydraulic rams, and both burst open, flooding the net drum space. On this occasion, the skipper managed to pay out wire and bring the vessel's head to wind, allowing a combination of the bilge suctions and tonnage valves to safely clear the water. After this encounter, the owners removed a hook from the starboard watertight door leading forward to the accommodation block so that this door could never be left open.

  Sometime shortly after the third pair of tonnage valves was installed, the net drum space again flooded. The vessel had started to list to starboard, and when the skipper went down to investigate, he observed 300mm-600mm of water swilling around and streaming through one of the starboard tonnage valves. This flooding was later attributed to the flap in this valve coming adrift. On this occasion, water flooded into the alleyway of the accommodation block past the seal of the starboard watertight door.

  Prior to this event, the owners had encountered regular instances of the tonnage valves allowing water ingress, and given the low freeboard aft, the valve openings were frequently underwater whilst at sea.

The owners therefore attempted to seal up the flaps in the closed position using silicon. However, after several months, the valves were again allowing water into the space. The owners finally arranged for the six valve openings to be blanked off and welded at the outer shell, leaving the valve housings in situ. When this occurred is uncertain, but is believed to be in early 2001.

Photographs taken of the vessel in 2003 and 2005 at **Figures 29** to **32** appear to confirm that the relevant openings are no longer present.

The owners confirmed that the valves remained welded up until she sank.

1.9.5 Pumping arrangement

The vessel's original pumping arrangement in the net drum space included two 50mm suctions, one port, one starboard, to the vessel's bilge system, in the area aft of the watertight bulkhead. The vessel's bilge pump is recorded as a DESMI pump, capable of discharging 25m^3/hour.

Having experienced previous problems with stones impairing the bilge pump performance, the owners blanked off the net drum space suctions, and voluntarily installed two 80tph electric submersible Flygt pumps. Again, despite extensive enquiries, it has not been possible to determine the exact date of fitting these pumps, but it is likely to have been prior to February 2001.

The "Working Instructions" for the stability booklet, copied at **Annex J**, suggest that the pumps were installed, along with the two additional tonnage valves and door alarm sensors in June 2000. (It is however noted that these working instructions are identical to those in the stability booklet for *Harvest Hope's* sister vessel, *Kinnaird*, where this date is not believed applicable.)

Driven off the vessel's auxiliary system, one of these pumps was situated either side of the vessel, immediately aft of the watertight bulkhead, in 2' deep wells. Automatically activated by float switches, the pumps had a 6" bore discharge overboard, the external position of which can be identified in **Figures 29** and **31**. The owners confirmed that there had been no instances of the pumps choking, and the crew had been instructed to clean up any dirt, and not to allow the gratings to clog up.

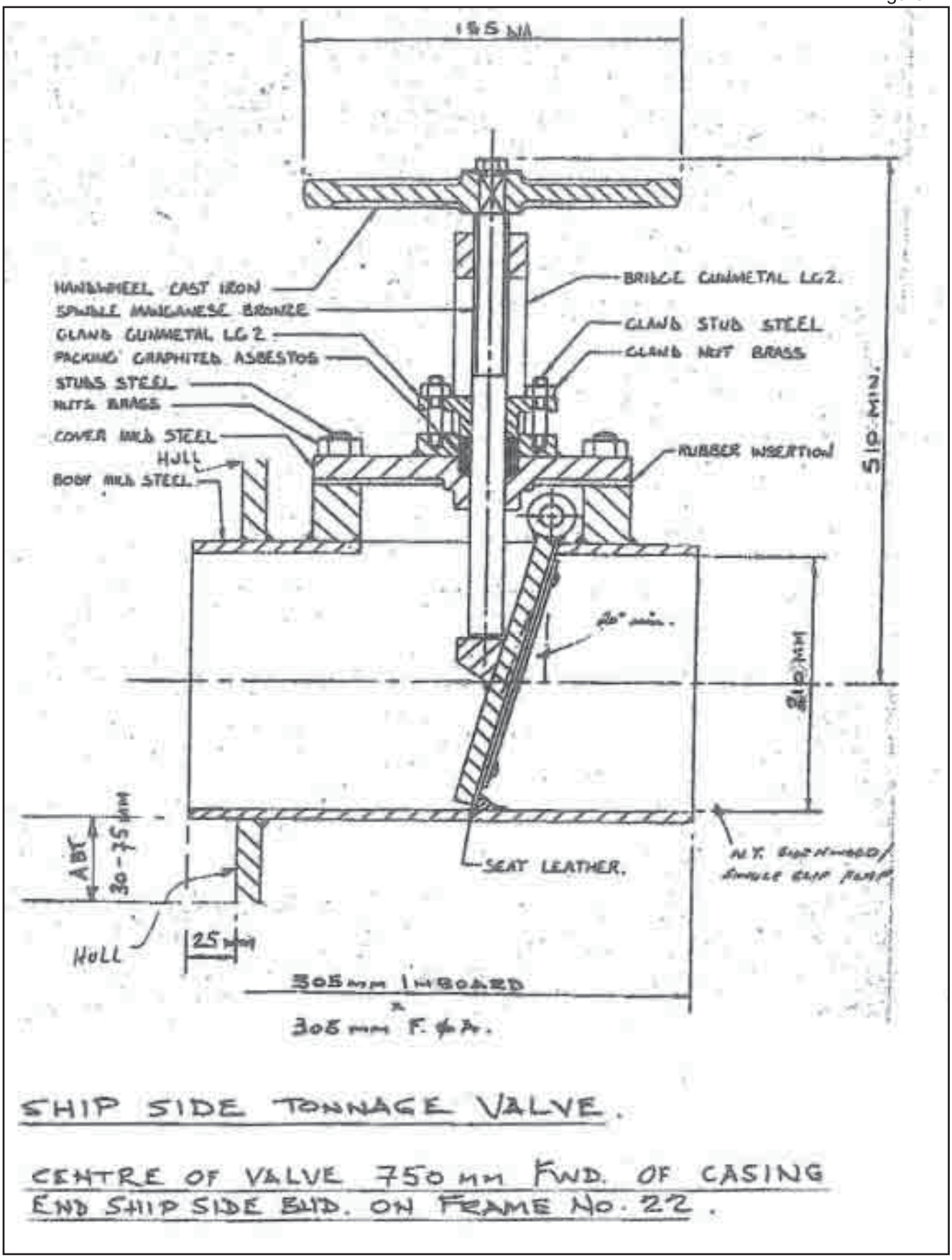
The electric junction box for the pumps was located on the port side, aft of the port net drum, on the side shell just below deckhead level. The junction box can be identified in **Figure 15**. The watertight integrity of this box at the time of the incident is unconfirmed.

1.9.6 Electrical installations in weathertight spaces

The Fishing Vessels (Safety Provisions) Rules 1975 contain no specific requirements for the location and protection of electrical equipment.

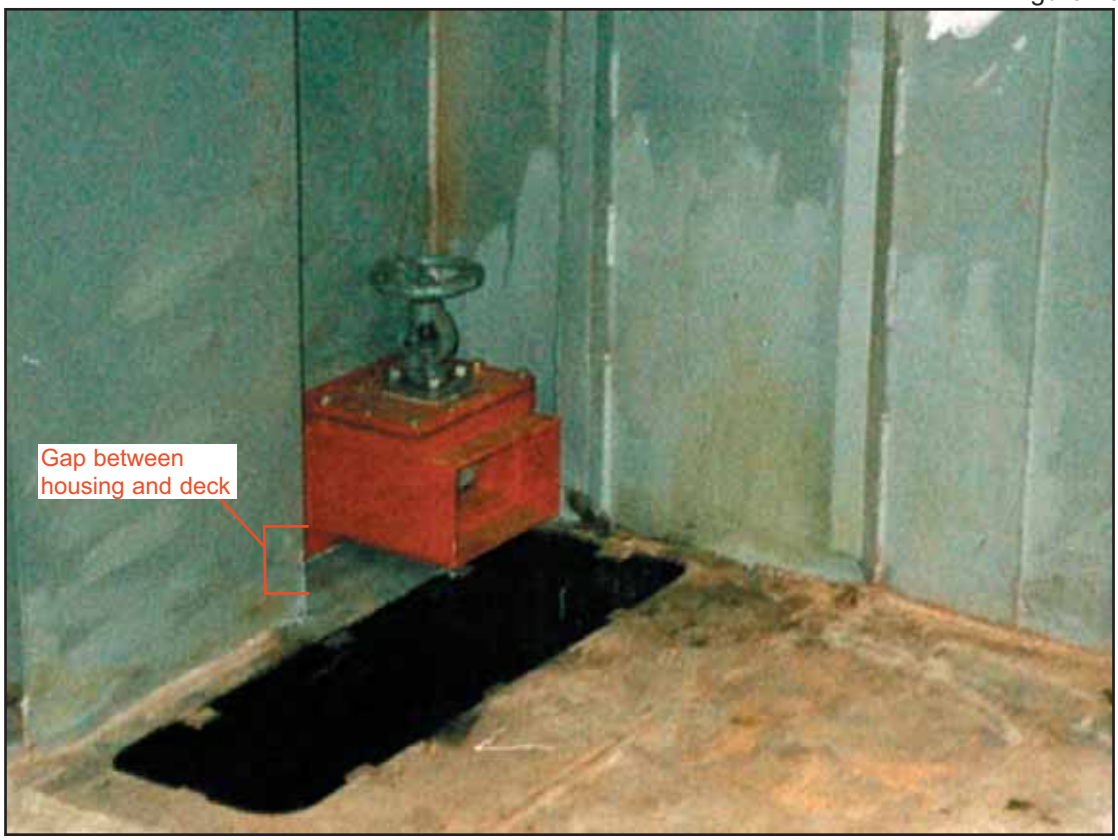
MCA surveyors generally refer to the Institution of Electrical Engineers Regulations for the Electrical and Electronic Equipment of Ships with Recommended Practice for their Implementation (commonly referred to as the "Blue Book") as an appropriate standard.

Figure 24



Typical tonnage valve arrangement

Figure 25



Unpainted tonnage valve in *Harvest Hope*'s fish processing space during build

Figure 26

Kinnaird's fish processing space looking forward (when built)

Figure 27

Harvest Hope in 1999

Figure 28

Close-up of hull in way of net drum space on *Harvest Hope* in 1999

Figure 29

Harvest Hope at sea in 2003

Figure 30

Close-up of hull in way of net drum space on *Harvest Hope* in 2003

Figure 31

Harvest Hope leaving Peterhead in 2005

Figure 32

Close-up of hull in way of net drum space on *Harvest Hope* in 2005

1.10 FISH PROCESSING SPACE

Two watertight windows, again acting as escape routes from the two 4-man cabins, were fitted in the aft watertight bulkhead in this space. It was normal for the port window to be closed and the middle cabin window to be always open.

A watertight door led into the space from the forward end of the accommodation block. Unlike the aft door from the accommodation, this door was not alarmed, as this had not been stipulated by the MCA. However, the crew were all adamant that this door would have been closed during the incident.

Three watertight hatches on the upper deck led down into this space, all of which would have been closed.

There were originally three tonnage valves in the side shell, as detailed in the Record of Particulars at **Annex I**. The owners confirmed that, latterly, one of the starboard tonnage valves had been removed, but with two additional valves installed on the port side. All of the crew confirmed that these tonnage valves would have been open at the time of the incident.

There were two submersible pumps in this space, supplemented by emergency fire hand pumps. It was noted that this space was generally fairly dry, with only the "occasional splash".

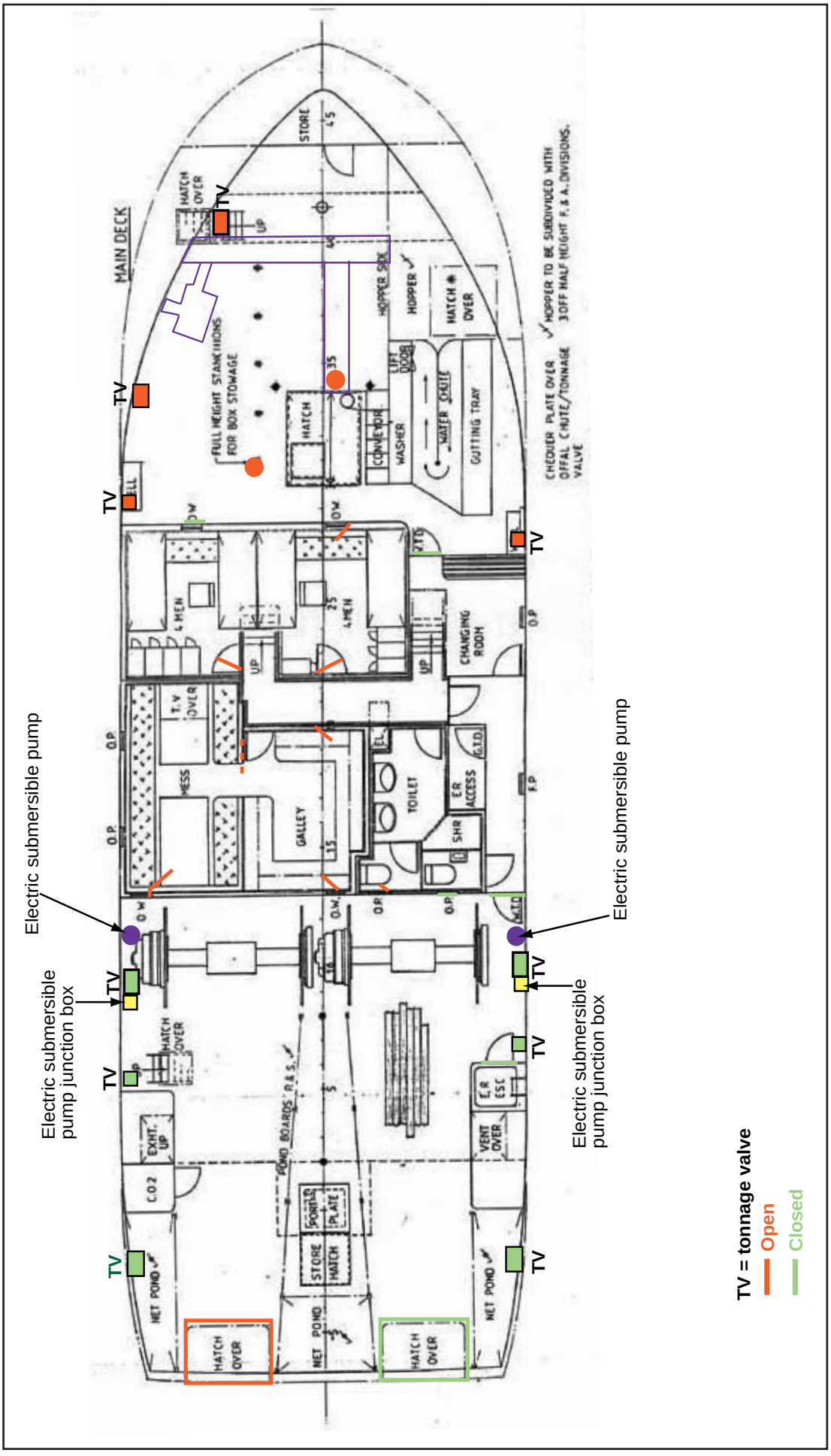
Along with the tonnage valves, overboard discharges were integrated into the port side shell for the gutting machine and athwartships conveyor. Both of these discharges were screwed shut at the time of the incident.

The central watertight hatch was always shut and dogged, and the smaller hatch built into the cover of the former hatch would also have been shut. Forward of this hatch and aft of the longitudinal conveyor was a 457mm square fish feed scuttle with coaming height of about 610mm, and no cover. Fresh water ice making machinery was situated on the port side of the space. This machinery fed into open funnels, between 610mm and 760mm above deck, leading down into the fish room through pipes.

Extreme forward in this space was a small store, with a door, believed to be watertight. During the final voyage, this space contained only empty boxes.

1.11 MAIN DECK OPENING STATUS

Figure 33 depicts the status of the openings based on the recollections of the crew. A "green" opening indicates that the door or window was closed and secured, "red" indicating that they were open at the time of the foundering.



Harvest Hope's main deck layout showing status of openings

1.12 MACHINERY

The vessel's original main engine was a Stork-Wartsila 6FHD 240G delimited from 1105kW to produce 742kW of power. However, during the vessel's refit in Denmark in 1999, her engine room flooded, causing damage to the engine. Although subsequently overhauled, ongoing problems led to the owners' decision to replace the engine in 2001 with an Anglo Belgian Motor Company 6DZC-750, again capable of producing 742kW.

Harvest Hope had two auxiliary engines, a 3306 CAT 175kW and a 3306 CAT 150kW, both driving one of two Stamford 108kW generators.

1.13 LIFESAVING EQUIPMENT

1.13.1 Details of liferafts

During her final voyage, *Harvest Hope* had two 10-man RFD Surviva liferafts, embarked. Manufactured in 1995, they were fitted with SOLAS A survival packs, and the intact weight of the liferafts in their canisters was 95kg. The stipulated maximum weight for a liferaft canister in The Fishing Vessel (Safety Provisions) 1975 Rules is 185kg

The liferafts had last been inspected and certified in February 2005 by Cosalt International Ltd. New HRUs were fitted following the vessel's MCA Loadline survey in February 2005.

1.13.2 Liferaft stowage

The liferafts were stowed in their cradles, port and starboard, alongside the wheelhouse. **Figure 31** confirms that these had recently been moved slightly forward of the original position shown in **Figures 2** and **27**. The final stowage positions and original location for the starboard liferaft were behind 1.0m high non-collapsible railings. The original port stowage location was, however, behind a section of folding railing used for gangway access to the vessel, as shown at **Figure 34**.

Rule 98(1) of The Fishing Vessels (Safety Provisions) Rules 1975 specifies:

> *"liferafts shall be so stowed so that they can be put into the water safely even under unfavourable conditions of trim and up to 15 degrees of list either way."*

1.13.3 On board lifejackets

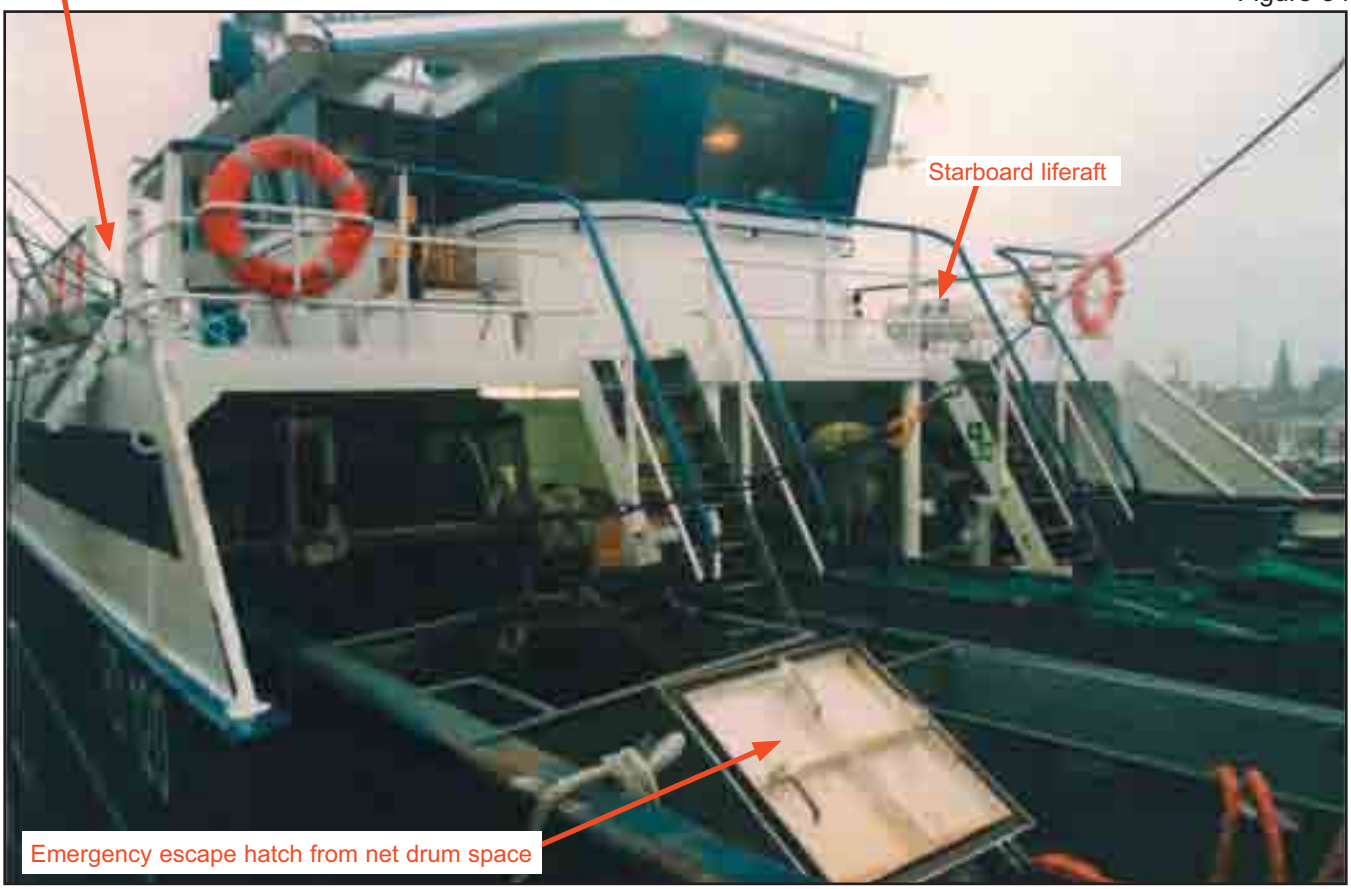
All of the crew were responsible for their own lifejackets, and these were therefore stowed either in personal lockers or bunks.

Rule 98(6) of The Fishing Vessels (Safety Provisions) Rules 1975 states that:

> *"lifejackets shall be so stowed as to be readily accessible to all persons on board. Their position shall be clearly and permanently indicated."*

It was noted that the abandon ship drills were rarely conducted, although comprehensive inductions were carried out for new crew members, and all the crew knew where their muster points were.

Figure 34



View of *Harvest Hope*'s upper deck and wheelhouse looking forward (when built)

1.14 DESIGN AND OPERATION OF WINCH CONTROL SYSTEM

1.14.1 General description of system

The vessel's two main split winches each had a 23.5t core pull, and were angled slightly outboard to provide a good lead to the towing blocks on the outrigger gallows. They were controlled by a PTS 3000 programmable trawl winch system, supplied by RAPP Ecosse in Peterhead, a subsidiary of the Norwegian company, RAPP Hydema A/S.

Utilising a standard programmable controller, the system offers four main modes of usage for trawl winches: Manual, Automatic Pay out, Automatic Towing and Automatic Haul in.

In the Automatic Towing mode, often referred to as "auto-trawl", a hydraulic pressure equaliser between the port and starboard winches automatically adjusts the tension of the warps while trawling. This can be particularly advantageous, for example, when fishing in adverse weather or over rough grounds, leading to more efficient trawl gear usage and improved catches.

On *Harvest Hope*, the system was operated from the aft control console in the wheelhouse **(see Figure 5)**, with a further display and controls integrated into the forward main control console **(see Figure 4)**.

The PTS 3000 control system was electrically-powered: the trawl winches were hydraulically-driven, integrated into a single hydraulic system also powering the vessel's other hydraulic equipment, such as the bow thrusters and power block.

A "Hytec" gearbox was connected to the forward end of the main engine, driving two double "main" hydraulic pumps, and a "towing" pump. The "main" pumps operated off a single, but different, clutch to that used by the "towing" pump, and were activated by depressing a button on the control console. An "auxiliary" pump, running off the PTO (Power Take Off) from one of the auxiliary engines, was normally used for landing fish while in harbour. The system also featured an electrically-powered hydraulic servo-pump, which not only fed the hydraulic control system, but also produced a 45 bar pilot pressure to release the brakes on the winches.

1.14.2 Fail safe brakes

These brakes are termed the "fail safe brakes" and are a safety feature of RAPP "auto-trawl" systems, engaging a band brake to each winch if there is a loss of hydraulic power to the system. This is intended to avoid potentially dangerous situations involving uncontrolled activation of the winches while crew are working on deck, as the gear is being deployed or recovered. A hydraulically-controlled valve is fitted to ensure that both "main" hydraulic pressure and servo-pressure are required to lift and keep the "fail safe brakes" off.

The hydraulic oil tank was located at the forward end of the engine room, on the starboard side. Positioned transversely, the tank contained horizontal and vertical baffles, and a level alarm/cut out switch. This was referred to as a "Murphy switch", and was fitted on the tank's starboard side about 350mm below the top of the tank. During the vessel's final voyage, the tank was reported as being full to the top of the sight glass, about 100mm below the tank top.

If the hydraulic oil in this tank fell below the level of this switch, for example due to a system leak or angle of heel, the "main" hydraulic pumps would be declutched, and therefore disengage and switch off. This protected the pumps from operating without hydraulic oil, thus reducing the risk of high pressure leakage or pump burn out. However, a low level alarm would not have de-activated either the servo-pump or the "auxiliary" pump. Nevertheless, with no "main" hydraulic power, not only would the trawl winches have stopped, but the "fail safe brakes" would also have activated.

When the "Murphy switch" opened for a low oil level, an audible and visual alarm would activate on the PTS 3000 control console in the wheelhouse. Described as a low "background buzzing noise", the audible alarm could be cancelled by depressing a button. This would, however, not cancel the flashing red light alarm, nor would it re-activate the "main" pumps.

An "emergency start" switch **(Figure 5)** is integrated in to the PTS 3000 system. If there was a PTS controller failure, this switch would have engaged the clutch on the Hytec gearbox and started the "main" pumps, but it would have had no effect until the low level alarm had been reset. The "emergency start" switch was not activated by the skipper during the incident.

There were therefore three possible options available to the crew to release the fail safe brakes:

- Following the accident to *Heather Bloom* (as described below), the owners of *Harvest Hope* had arranged for RAPP to install a local changeover valve in way of the auxiliary engine. A crew member could therefore manually activate this valve in the engine room to divert hydraulic pressure from the "auxiliary" pump to the "fail safe brake" control valve to lift the brakes;
- Alternatively, a crew member could locally reset the "Murphy switch" to the "closed" position in the engine room, by filling the hydraulic tank or manually by-passing the switch;
- Finally, a spanner or socket could be used to turn the brake cylinder adjustment screw at the winches to gradually release the brake band off the winch drums. However, given the high tension on the warps, this would have proved extremely difficult and dangerous.

Given the risks and time required to pursue any of the above options, the skipper chose to have the trawl warp cut to release the tension.

1.14.3 Potentiometer

The system also incorporates a Potentiometer, referred to as the "Pot. Meter", used to manually adjust the tension acting on the trawl winches whilst the system is being operated in one of the three "Automatic" modes.

On *Harvest Hope*, the "Pot. Meter" was normally set to about 60% and used only during hauling in; its use during towing was considered by the owners to be problematic. While in pay out mode, if the "Pot. Meter" was set to 0%, this would allow the wires to free-run out. However, this was of course subject to the "fail safe brakes" not being engaged, as well as there being hydraulic pressure to allow the winches to turn.

1.14.4 System knowledge

The owner/skippers of *Harvest Hope* received training from RAPP on the system's features, both during an initial session and the vessel's sea trials. Further training was also subsequently received while using the system, and during visits to the vessel by RAPP representatives.

Neither of the skippers was aware of the potential use of the "Pot. Meter" to quickly release the trawl warps by reducing the setting to 0%. After coming fast, the skipper began to pay out the warps at the 45%-50% setting. Nor was the true functionality of the "emergency start" switch known to them. Following the incident, the skipper was of the impression that he could have used this switch to start the "main" pumps after a hydraulic shut down, and was unaware that the "Murphy switch" would also need to have been reset.

A copy of the Trouble Shooting diagram supplied as part of the system Instruction Manual is provided at **Annex K**. No documented emergency safety procedures had been supplied by the winch manufacturers, and the manual offers no specific coverage of the use of the "Pot. Meter" to release the trawl warps. It also does not highlight that the trawl warp, when under tension, can not be released quickly in an emergency without hydraulic power.

1.14.5 PTS Pentagon system

The PTS Pentagon system is a later version of the PTS 3000, and is generally more sophisticated, being a PC-based system.

The system incorporates a “safety brake” feature, which allows the “fail safe brake” to be overridden once 25 fathoms of warp have been deployed. A much louder low level oil alarm has also been introduced.

1.14.6 Previous vessel losses involving RAPP “auto-trawl” systems

- fv *Heather Bloom* (INS 110)

In December 1994, *Heather Bloom* with a crew of six, snagged her fishing gear on an underwater obstruction whilst bottom trawling. The snagging caused the vessel to heel heavily to port and take on water, and she subsequently sank in a position 69 miles north of Cape Wrath in heavy seas and gale force winds. Five of the crew were rescued from the liferaft by another fishing vessel, but the skipper tragically drowned.

The cause of the accident was an uncontrolled ingress of sea water into the vessel. The main onboard electrical system subsequently failed, preventing release of the hydraulically-operated brakes on the trawl winches and release of the tension in the warps. There was no safe operational procedure for manually releasing the winch after hydraulic power was lost.

The manufacturers of the “auto-trawl” system, Fishing Hydraulics Ltd, (later becoming RAPP Ecosse U.K.), were recommended by the MAIB to advise all system users that it was not possible to manually release the winch brakes quickly when hydraulic power is unavailable and the trawl is in heavy tension. This warning was also to be clearly marked on each system control panel.

No response was received from Fishing Hydraulics Ltd regarding the implementation of this recommendation. However, following the accident, a number of fishing vessel owners approached them requesting the development of an emergency brake release system. Fishing Hydraulics Ltd subsequently designed such a system, incorporating an accumulator and appropriate valves, but the proposal was not pursued by any of the owners.

- fv *Radiant* (PD 298)

In April 2002, the trawler *Radiant* was fishing about 45 miles north-west of the Isle of Lewis, when her trawl gear came fast on the seabed. As the vessel rolled, the engine room air intakes began to downflood, flooding the engine room. The vessel subsequently capsized and sank. Although five of the crew were rescued, one of the crew was tragically lost during the abandonment of the vessel.

Radiant had become effectively anchored to the seabed after her port net snagged on a seabed obstruction. While hauling back to try to release the fastener, power was lost to the winches, which stopped, with the winch brakes then activating.

The MAIB investigation report recommended that Rapp Ecosse, the suppliers of the PTS Pentagon winch control system, should put greater emphasis on the emergency start facility when training fishermen in its use and also to enable the safety brake when configuring PTS Pentagon systems.

Rapp Ecosse responded to these recommendations by agreeing to issue a memo to all system users, emphasising both the emergency start and safety brake features, and advising users of earlier systems that the latter feature may be retro-fitted. Notwithstanding the enhancements in the Pentagon system compared to the PTS 3000 system, no changes were made to the Pentagon system as a result of the *Radiant* accident.

1.15 DESIGN AND CONSTRUCTION OF VESSEL

1.15.1 Design of *Harvest Hope*

The owners of *Harvest Hope* approached a local marine consultant to take on the development and build supervision of the vessel. An outline design had already been developed, and a contract had been signed for the vessel to be constructed in Poland. The marine consultant duly agreed, and employed the services of a firm of naval architects, to undertake the detailed design and stability calculations. The resultant layout of the vessel remained largely the same as the original design, and a hullform was subsequently developed.

1.15.2 Construction of *Harvest Hope*

Harvest Hope was constructed in the Stocznia Remontowa "Parnica" Ltd. Shiprepair Yard (commonly referred to as the Parnica Yard) in Szczecin, Poland. As its name suggested, this yard conducted mainly repair work, and the build of *Harvest Hope* and her sisters represented the yard's first major construction contract with a foreign customer. The yard went into receivership in June 1999.

The vessel's keel was laid in January 1995, with the vessel being launched in early summer 1995.

1.15.3 Increased displacement of *Harvest Hope*

It has become apparent that the vessel's design displacement increased during the construction, for various reasons.

It is understood that a number of unrecorded inclining experiments were carried out on the vessel before the final test, witnessed and approved by the MCA in January 1996. Following these tests, additional ballast was required to be added to the vessel to improve her stability. This included 37 tonnes in the double bottom and bow thruster compartment, and 19 tonnes of cement installed in the fish room. An additional 10 tonnes ballast keel was also fitted after the January 1996 inclining experiment.

No other records exist to confirm whether this was all of the ballast fitted to the vessel. Shipyard records do however exist for *Harvest Hope*'s sister vessel *Elegance*, confirming that 122 tonnes of ballast was installed.

It has also been reported that heavier steel plating was used during the vessel's construction. A copy of the vessel's Shell Expansion drawing is included at **Annex L**, and can be compared with reports of the Ultrasonic Testing conducted as part of the surveys in 2000 and 2004 at **Annexes M** and **N**. The 2004 report, if accurate, indicates heavier grade steel to have been used in the hull construction.

Finite element modelling was conducted on behalf of the yard for the five vessels, after reports of a winch being ripped off the deck of a similar vessel undergoing bollard tests whilst being built in a Spanish shipyard. This modelling identified that *Harvest Hope*'s structure should be reinforced in certain areas, and additional stiffening was therefore fitted beneath the deck plating in way of the trawl winches and net drums.

The original design of the vessel's bulbous bow required 7-8mm thick plating, but 11-12mm plating was actually used.

1.15.4 Survey regime during construction

The Fishing Vessel (Safety Provisions) Rules 1975 allows for a classification society surveyor to assess the vessel's compliance with certain requirements of the 1975 Rules. The areas covered were the vessel's structural strength, watertight integrity, and various machinery aspects, including bilge pumping arrangements. All other aspects of a vessel's design, such as structural fire protection, navigational equipment, lifesaving appliances, and freeboard and stability remained the responsibility of the MSA under this arrangement. The surveys undertaken by the classification society and MSA for fishing vessels are commonly referred to as Category A and B surveys respectively.

For *Harvest Hop*e, the classification society Bureau Veritas (BV) was contracted by the owners via the consultant to conduct the Category A survey. This was acceptable to the MSA, and a local BV surveyor was duly appointed.

Harvest Hope was built to the BV "Black Spot" notation. This meant that although designed and constructed to the classification society's standards, her material and equipment used for the construction were not surveyed at works by BV prior to their delivery to the shipyard. The vessel was not issued with a classification certificate at the end of the construction but with the attestation of survey which is at **Annex O**. Accordingly she was not subsequently surveyed by the society after completion, nor "maintained in class".

At various stages of the vessel's construction, there would therefore have been a number of visits made to the Parnica Yard by the various interested parties, including on at least two occasions, an MSA surveyor from the Marine Office.

1.16 REGISTERED LENGTH OF VESSEL

1.16.1 Fishing Vessel Tonnage Regulations

A copy of The Merchant Shipping (Fishing Vessels – Tonnage) Regulations 1988 is at **Annex P**. Also included is a diagram interpreting these requirements, forwarded by the MSA in January 1995 to the naval architects developing the detailed design of *Harvest Hope*.

1.16.2 Record of vessel's registered length

Harvest Hope's registered length is varyingly documented as 24.33m to 24.38m or 25.68m. The vessel's United Kingdom Fishing Vessel Certificates (UK FVCs), for example, record a registered length of 24.33m and overall length of 25.63m, while the Certificate of British Registry quotes lengths of 25.68m and 28.23m respectively.

The draft Certificate of Survey for the vessel **(see Annex Q)**, prepared by BV in December 1995, denoted a registered length of 25.68m. However, later in the same month, BV forwarded an Attestation to the vessel's naval architects declaring that the registered length was 24.37m **(see Annex R)**.

A further fax on the matter from BV to the consultant in January 1996 advised that the vessel's registered length was considered to be 25.68m, and that *"strictly speaking the length of 24.37m at the present moment has no statutary (sic) application, therefore if the builder wishes to state this length on the builders certificate they are perfectly entitled to do so."*

This ambiguity is confirmed in an MSA letter in January 1996, noting that the registered length was over 24.4m using the "ITC". This also suggested that the consultant formally request exemption from the regulations applying to vessels over 24.4m registered length, as it would probably not be possible to alter the registered length at this stage. No further correspondence on this matter is contained in the vessel's CM files held by the MCA.

1.16.3 Significance of vessel's registered length > 24.4m

In The Fishing Vessels (Safety Provisions) Rules 1975, a registered length of 24.4m is used as a cut-off for various design features. Vessels longer than 24.4m generally require higher standards for various systems such as cooling water, bilge pumping, fire-fighting, steering gear and electrical equipment. Additionally, such vessels with fewer than 16 crew members, are required to carry either:

- a lifeboat (capable of being launched from a davit) and at least one inflatable liferaft, both capable of accommodating the entire crew; or
- a lifeboat or inflatable boat, capable of being launched on one side of the vessel, and at least two inflatable liferafts with an aggregate capacity to accommodate twice the number of persons on board.

For vessels less than 24.4m, the requirement is to carry at least two inflatable liferafts with an aggregate capacity of twice the number of persons on board, which *Harvest Hope* complied with.

1.17 CERTIFICATION OF VESSEL

1.17.1 Background

Part V of The Fishing Vessel (Safety Provisions) Rules 1975, requires that fishing vessels such as *Harvest Hope* be surveyed in accordance with the provisions of these Rules, prior to the issue of a United Kingdom Fishing Vessel Certificate (UK FVC).

The duration of these safety certificates is stated as "*…48 months from the date of its issue or such shorter period as may be specified in the certificate."*

1.17.2 Certification issued

A summary of the Fishing Vessel Certificates issued to *Harvest Hope* is detailed at **Annex S**, while copies of all of the available certificates are included at **Annex T**. These identify a number of apparent anomalies:

- There is no record of a UK FVC having been issued to *Harvest Hope* until September 1997, despite her entering service in January 1996;
- The vessel was issued with Short Term Certificates (STCs) until June 2002;
- The duration of the STCs varied from 1.7 months to 7.4 months;
- There were numerous gaps between certificates expiring and being re-issued, the longest such gap appearing to be 19 months.

1.17.3 *Harvest Hope* service periods

The owners of the vessel confirmed that there had been only two significant periods of lay-up, between June and August 1999, following the flooding in Denmark, and during the vessel's engine replacement, in March to July 2001.

1.17.4 Issue of Short Term Certificates (STCs)

Following the foundering of *Harvest Hope's* sister vessel *Elegance* in 2004, the MCA issued Operations Advice Note (OAN) 343 in June 2004, a copy of which is at **Annex U**. Entitled "Survey and Certification Policy (including issue of Short Term Certificates)" and expiring 6 months after its publication, this document notes that STCs, with a maximum validity of 3 months, (unless agreed otherwise), may be issued by a surveyor if:

- A renewal survey has been completed, but there is insufficient time to have the full certificate signed by the authorised person (normally a principal surveyor);
- there are outstanding defects, needing rectification by a specified date;
- stability has not been approved.

In the latter instance, a provisional stability booklet must be available to demonstrate that the vessel is safe and complies with the required standards, and copies must have been both submitted to the MCA and placed on board.

1.17.5 UK FVC Exemptions

The reverse side of the standard UK FVC form includes a table which is used to record any exemptions from the relevant regulations. As **Annex T** denotes, all of *Harvest Hope*'s certificates recorded an exemption from Rule 78 (3) (A) of The Fishing Vessel (Safety Provisions) Rules 1975 regarding the carriage of portable radio equipment. The vessel instead carried a suitably water protected portable VHF Transceiver.

The only other exemption recorded on these certificates was on the STC issued on 24 August 2001 and expiring on 31 January 2002, which granted an exemption from Rules 15 and 16 of the 1975 Rules until 30 November 2001:

"Stability and aft freeboard data to exclude aft net handling area is resubmitted."

The covering letter to this, or any of the other STCs, makes no further reference to the reasons for the certificate being "Short Term", nor does it explain why the exemption expiry date on 30 November 2001 is some 2 months earlier than the certificate's expiry date.

1.17.6 UK FVC lapse procedures

The MCA's Fishing Safety Branch currently sends a reminder letter to owners 6 months before the expiry of a UK FVC to allow them time to apply to the MCA for the required renewal survey. Should the certificate be allowed to expire, the owners are then allowed 1 month's "grace" to initiate the renewal process. If no contact has been made after this period, the Marine Office informs the Fishing Safety Branch and the Registry of Shipping and Seamen (RSS) with a request that vessel de-registration commences.

It is also noted that following the publication of the MAIB's Trilogy report investigating the losses of the fishing vessels *Kathryn Jane*, *Jann Denise II*, and *Emerald Dawn*, DfT has been working with MFA to link fishing vessel licences to the vessel's safety certification.

1.17.7 Revocation of a UK FVC

OAN 343 defines the scenarios when a surveyor may consider detaining a vessel, including when a:

- certificate has expired, and the survey has not been completed; or
- STC has expired, and the consultant or owners are not progressing the necessary stability calculations or other rectification work.

However, OAN 343 also states that if detention is considered too onerous or unnecessary, alternatives are to cancel the relevant certificate and request it be surrendered[4], or temporarily remove the certificate. Without a valid certificate, it is then an offence for a vessel to proceed to sea. This OAN also suggests that "it is better to err on the side of caution than to take unnecessary risk."

1.18 CERTIFICATE OF BRITISH REGISTRY

1.18.1 Background

The Merchant Shipping (Registration of Ships) Regulations 1993, with various amendments between 1994 and 1999 outline the process for the registration of a United Kingdom fishing vessel by RSS. This process requires a valid UK FVC to allow registration, and the issue of a Certificate of British Registry.

Based on information provided by the Marine Offices, the MCA's Fishing Safety Branch maintains a database of vessel certification status, with monthly reports issued to the Marine Offices and RSS. RSS then use this information to ensure that all vessels on their register hold safety certificates.

A copy of the vessel's latest Certificate of British Registry is at **Annex A**, which records the date of entry into service as 24 January 1996.

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[4] This is based on powers granted in Regulation 19 of the Merchant Shipping (Survey and Certification) Regulations 1995 or Regulation 11 of the Fishing Vessels (EC Directive on Harmonised Safety Regime) Regulations 1999.

1.19 RECORD OF PARTICULARS (FV2)

1.19.1 Requirement for Record of Particulars (FV2)

Rule 125(2) of The Fishing Vessels (Safety Provisions) Rules 1975 requires that when a fishing vessel has been surveyed, a record of particulars should be completed and appended to the declaration of survey. The 1975 Instructions for the Guidance of Surveyors also notes that the FV2 will be the determining factor in deciding whether a vessel complies with the Rules.

1.19.2 Record of Particulars for *Harvest Hope*

The original Record of Particulars for the vessel was recorded by the Polish BV surveyor attending the vessel during her construction. This was produced as part of the agreed package of work being prepared for the vessel by BV, and is a handwritten document using a generic FV2 template. This document was dated 3 January 1996, and a copy is at **Annex I**. On the reverse of some of the pages of this form the surveyor included additional details of the vessel's construction not corresponding with the form's standard sections, including details of the windows fitted in the net drum space bulkhead.

The original and only copy of this document was placed on the MCA's "Rough Office" file for the vessel, held in the Marine Office.

Further typed copies of the vessel's FV2 are contained both in this "Rough Office" file and the registered CM "Construction" file for the vessel. The latter file also referred to an FV2 at document number 33, resulting from the original survey of the vessel in January 1996 in Poland. This document was missing.

None of the later versions of the FV2 record details of the:

- internal opening windows in the net drum and fish processing spaces;
- survey upon which that version of the FV2 was based;
- surveyor conducting the survey, (all FV2s are unsigned).

A copy of the latest FV2, prepared following the 2005 Loadline survey, is at **Annex V**. The reverse of the final page of this form is understood to be the MCA surveyor's defect observations during this survey, but there is, however, no other reference to the conduct of this survey on either of the official CM files for the vessel.

1.19.3 Updating of *Harvest Hope*'s Record of Particulars (FV2)

The latter FV2s do not refer to various alterations to the vessel, including:

- two additional tonnage valves fitted in the net drum space in the summer of 1999, as requested by the MCA;
- changes to the fish processing space tonnage valve arrangement;
- replacement of the original bilge suction pumping arrangement in the net drum space with the two electric submersible pumps;
- details of the vessel's new main engine, following its replacement in 2001, despite the MCA being aware of this change.

1.19.4 Notes on *Harvest Hope*'s Record of Particulars (FV2)

The FV2s contain only one drawing of the vessel's Main Deck, although reference is made throughout to other features of the vessel, including, for example, a numbering scheme for hatches.

No positional details for any of the vessel's tonnage valves were included on the Record of Particulars forms.

1.19.5 New version of Record of Particulars (MSF 1301)

A new format for the Record of Particulars was introduced by the MCA in December 1998 for vessels over 24m in length, entitled MSF 1301. This is currently only used for vessels entering service after this date, with existing vessels continuing to use the earlier FV2 form. A copy of extracts from the blank template for MSF 1301 is at **Annex W**, with the front sheet containing sections for referencing the survey(s) used to update the form.

1.19.6 General format of Record of Particulars (FV2)

As indicated at **Annexes V** and **W**, the content of both the FV2 and later MSF 1301 is based on a standardised format, using a number of distinct headings. There is however no specific section in the forms for recording details of internal watertight windows.

1.20 INSPECTIONS/SURVEYS OF VESSEL

1.20.1 Background

The survey regime for a UK fishing vessel with a Registered Length greater than 24m corresponds with the certification cycle denoted in The Fishing Vessel (Safety Provisions) Rules 1975. Vessels are therefore surveyed every 48 months for the issue and renewal of UK FVCs.

These Rules also require that vessels are periodically inspected every 2 years, plus or minus 3 months, from the UK FVC's issue date. Annual surveys of radio equipment will also be conducted, along with a further survey following any major repairs.

On 1 December 1999, the Fishing Vessels (EC Directive on Harmonised Safety Regime) Regulations 1999, came into force, implementing the Torremolinos Convention requirements. These regulations primarily affect "new" fishing vessels, with contracts placed after 1 January 1999. Existing vessels, such as *Harvest Hope,* were therefore still required to comply with the original 1975 Rules. However from 1 January 2000, International Fishing Vessel Certificates were to be issued to all UK fishing vessels of 24m and over, still based on 4-year renewal surveys and bi-annual inspections.

1.20.2 Surveys and inspections conducted

In accordance with the above regime, a number of surveys and inspections were conducted on board *Harvest Hope*, as summarised below at **Table 1**.

Table 1

Date of Survey/ Inspection	Type of Survey/ Inspection	Location
10/01/96	Cat. B Survey (New building)	Szczecin, Poland
18/09/97	Random	Peterhead
02/09/99	Targeted	Peterhead
11/07/00	Cat. A Survey (UK FVC Renewal)	Fraserburgh
13/02/02	Food & Hygiene	Peterhead
01/11/02	Targeted	Peterhead
09/02/04	Cat. A Survey (UK FVC Renewal)	Peterhead
02/02/05	Loadline Survey	Peterhead

1.20.3 MCA SIAS database

The MCA's Fishing Safety Branch maintain a computerised database, entitled Ship Inspection And Survey, or SIAS, that contains a record of all the surveys and inspections conducted on a vessel.

1.20.4 *Harvest Hope* SIAS records

A copy from the SIAS database for the vessel is included at **Figure 35**. It should be noted that the first record at **Figure 35** is for a different vessel called *Harvest Hope*. Comparison with **Table 1** above, highlights the omission of any record on SIAS for the 11 July 2000 survey. The SIAS records for the other seven surveys or inspections are at **Annex X**.

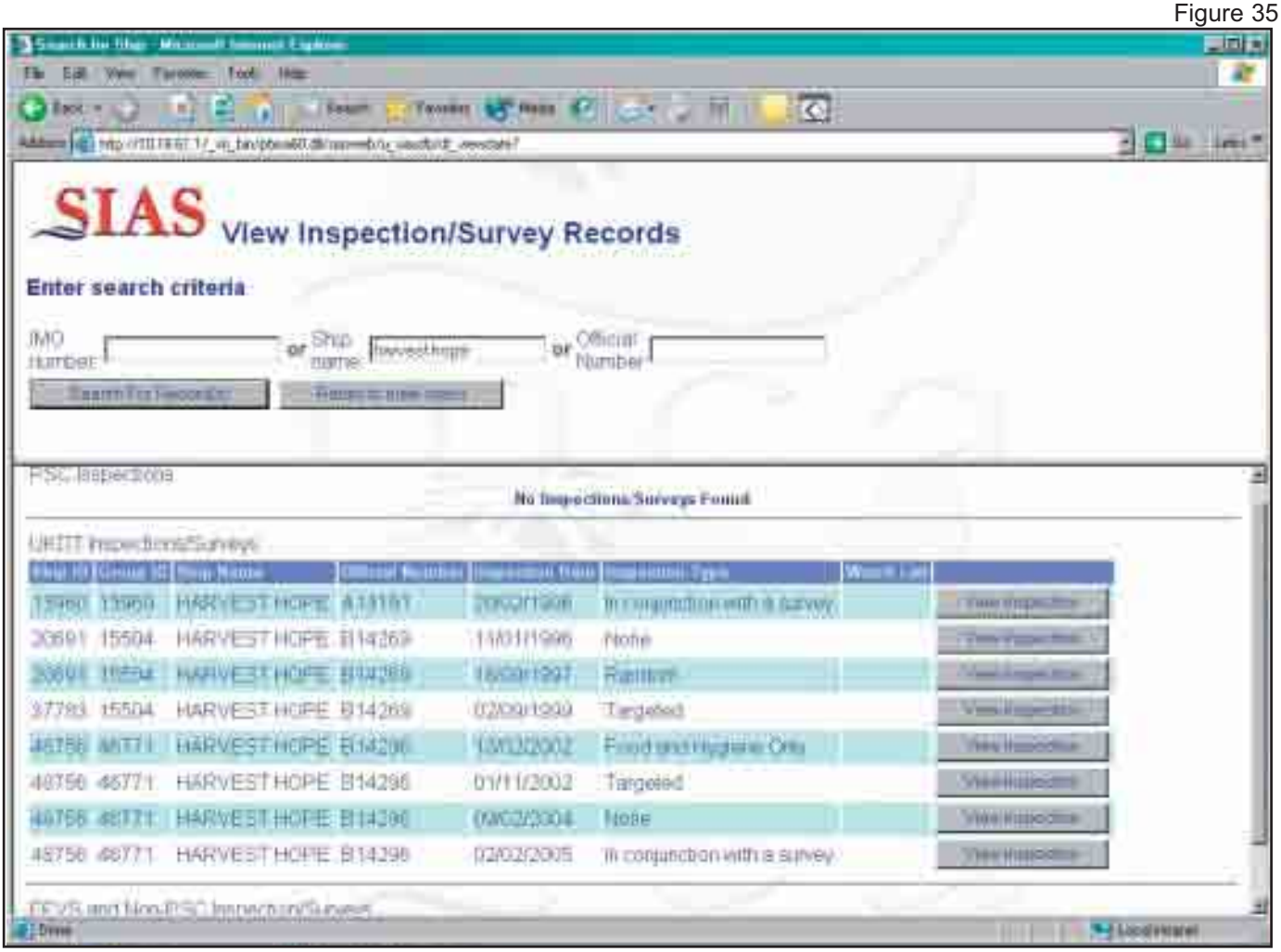
According to SIAS, the very first survey in the yard in Poland in January 1996 recorded no deficiencies, yet the "Report of Inspection And/Or *Survey" in the CM "Construction" file for the corresponding survey contains five pages of very detailed deficiencies recorded by the MSA surveyor.

The only record in the CM files of the 2000 survey is a copy of the typed "Report on Condition of a Steel Fishing Vessel", Form FV6, a copy of which is at **Annex Y**. No other SIAS records are on file.

1.20.5 SIAS references to tonnage valves on board *Harvest Hope*

Only the SIAS record for the Targeted Survey carried out in Peterhead on 1 November 2002 makes any reference to tonnage valves, with the entry *"Tonnage valves"* and a requirement to rectify the deficiency within 14 days.

Figure 35



Screen capture from MCA's SIAS database

None of the MCA files contained a handwritten “Report of Inspection And/Or *Survey” for this or other surveys and inspections. The data from the original forms are entered onto the SIAS database by Marine Office administrative staff, and it was hoped that the form might establish further details about this defect.

Although all other forms prior to 2002 were no longer available, the 2002 form was still retained by the Marine Office. However, it recorded no further information about the defect, but did identify the surveyor conducting the inspection, a detail which is not recorded on SIAS. It is understood that this deficiency referred to the requirement for maintenance of the tonnage valves within the fish processing space.

1.20.6 Current Guidance to MCA Fishing Vessel Surveyors

The 1975 document *Survey of fishing vessels – Instructions for the guidance of surveyors*, currently remains the only specific guidance to MCA fishing vessel surveyors. Over 350 pages long, this extremely comprehensive document is designed to provide guidance on the practical interpretation of The Fishing Vessels (Safety Provisions) 1975 Rules. This document is currently being reviewed and updated, intended for publication in early 2007.

More generic guidance is offered to MCA surveyors in the document Survey & Inspection Policy, dated 2002, and which is also currently under revision.

1.20.7 Checklists and aide-mémoires

There are currently no available checklists or aide-mémoires available to MCA surveyors conducting fishing vessel surveys, other than a checklist entitled *GUARDSHIP DUTY NOTES*, dating from 1994 **(see Annex Z)**. This is intended to assist surveyors conducting Load Line Exemption surveys of fishing vessels, a prerequisite for such vessels undertaking offshore support work.

In 2001, the National Audit Office (NAO) published the findings of its audit of the MCA's Survey & Inspections branches. A copy of the Executive Summary of the final report is at **Annex AA**. A recommendation was made to the MCA to develop appropriate checklists for use during surveys. This has been initiated for other types of vessels, but not as yet fishing vessels.

1.20.8 Survey policy

UK FVC renewal surveys are conducted in two parts, "in water" and "out of water". From the inspection of records, it is evident that these inspections are carried out by different surveyors. It was also noted that although surveyors are issued with cameras for use during surveys and inspections, there currently exists no guidance for their use in recording the vessel's features.

There is also no specific written guidance regarding how the integrity of a feature, such as a tonnage valve should be verified. The 1975 Instructions for the guidance of surveyors note that for openings in the vessel's sides below the freeboard deck, and in the sides and ends of enclosed superstructures:

"Means of closing these openings are to be examined carefully in place and hose tested if considered necessary to ensure watertightness or weathertightness as appropriate."

1.21 OTHER INSPECTIONS/SURVEYS OF VESSEL

1.21.1 Surveys conducted on behalf of the Insurance Company

Bi-annual condition & valuation surveys of *Harvest Hope* were also conducted on behalf of the vessel's insurance company by its marine-survey division. These were to check the vessel's general condition and review her insured value. If the survey identified items needing attention, the surveyor and/or insurance company would instruct the owners to rectify them.

The last such survey was conducted in February 2003, and prior to that in December 2001. It is understood that neither survey identified any problems in the net drum space regarding the tonnage valves or submersible pumps and their electrical installations. The photographs at **Figures 5**, **7**, **11**, **13** and **15** are part of a series of 39 photos taken during the 2003 survey.

1.22 FREEBOARD AND STABILITY

1.22.1 Background

The freeboard requirements for a fishing vessel are covered by Rule 15 of The Fishing Vessel (Safety Provisions) Rules 1975, stating that the freeboard should be "*adequate*" in all foreseeable operating conditions.

In May 1981, Merchant Shipping Notice No. M975 was introduced in order to provide guidance as to the interpretation of "adequate". A copy of this document at **Annex BB**, paragraph 6 of which stipulates that:

> *"It is possible that failure to demonstrate that Rule 15(1) can be complied with in all foreseeable working conditions will preclude the issue of a United Kingdom Fishing Vessel Certificate or require considerable alteration to structure or fishing capacity to enable the certificate to be issued."*

1.22.2 Freeboard and stability approval for *Harvest Hope*

In May 1995, during the early stages of the vessel's construction, the consultant wrote to the local Marine Office to outline particular aspects of the design affecting the freeboard and stability.

This letter noted that although the vessel had been designed to meet the relevant statutory stability criteria, without including the net drum space on the main deck as part of the intact watertight envelope, measurement of the aft freeboard from the upper deck was being requested. The letter also noted that there were various "safety features" in the net drum space, including transom "watertight hatches", which would only be opened briefly at sea and tonnage valves, for use if "*a substantial quantity of water is shipped*".

Handwritten annotations to this letter in the MSA file commented that the hatches were considered "weathertight", and were "hinging inboard". Concerns were also expressed regarding access to the tonnage valves if there was substantial flooding in the area.

MSA headquarters wrote to the consultant in early June 1995, stating that as the aft freeboard was "*not currently a problem*", it "*should be measured form* (sic) *the main deck and not the shelter deck.*" When interviewed by the MAIB, the consultant could not recall details of this letter.

The approval of this stability booklet was conducted by a surveyor at another Marine Office, and in March 1996, he wrote to the consultant to clarify whether the net drum space had been included in the stability calculations.

The response from the consultant confirmed this was the case, and that:

> *"…the upper deck and complete stern area of the vessel with M.S.A. and B.V. Class approval at time of build and outfit is maintained fully watertight..."*

No documentary evidence of whether this approval was given is available. The MSA surveyor attending the vessel in Poland could not recall giving any such approval, and despite extensive enquiries in Poland, the MAIB was unable to obtain either contact details for the BV surveyor, or any records.

The stability booklet also referred to the inclusion of the net drum space, both in the "Working Instructions" (copied at **Annex J**), and the KN Tables notes. Despite the above, the stability booklet was approved and stamped on 10 April 1996, and forward to the consultant on 8 May 1996.

Following queries from various designers regarding *Harvest Hope*'s aft arrangement, the Marine Office wrote to the Fishing Vessel Section at MSA headquarters in March 1997 seeking technical assistance. This memo highlighted that *Harvest Hope*'s net drum space had been accepted as intact for stability purposes, and expressed concern about the vessel's safety in this area, particularly given the *Heather Bloom* foundering (see Section 1.14.6).

Despite a further email from the Marine Office in July 1998, no response was received until October 1998, with a memo from headquarters. This agreed that it was not MSA policy "*to consider after net drum spaces fitted with transom doors as being capable of weathertight closure*", and that "*this space cannot be considered to contribute to the stability envelope*." The memo ultimately noted that "*in view of the effect this has on the safety of the vessel…*", the matters should be brought "*to the attention of the owner and his consultant as a matter of urgency to seek remedial action.*"

There is no subsequent record of any further correspondence on the matter between the Marine Office and MSA headquarters. Although the Marine Office immediately wrote to inform the consultant of the decision, the immediate actions thereafter are unclear. It is however understood that a number of meetings were held between the consultant and the MSA, although there are no records of these meetings in the CM files.

It is understood that during one such meeting, agreement on a way ahead was reached. As the vessel would no longer comply with the aft freeboard requirement of M975, a dispensation was to be granted, based on information contained in an MSA document entitled Survey Memorandum (SM) 55.

A copy of SM 55 is at **Figure 36,** which although undated, was issued subsequent to the publication of M975 in May 1981, and was intended to offer dispensations on its requirements, only for vessels built prior to issuance of M975.

Applying SM 55, freeboard deficiencies of up to 5% forward and 20% aft could be accepted for such vessels. For greater freeboard deficiencies, consideration should be given to freeboard compliance by attempting to vary the vessel's trim. If these measures proved impracticable, then:

"…consideration should be given to constructional modifications eg raising coamings, creating a secondary internal watertight barrier with additional drainage."

Based on the latter, the MCA therefore requested that two additional tonnage valves be fitted in the net drum space, and "Door Open" alarm sensors fitted to the Engine Room Escape and Accommodation Access watertight doors.

There is no reference to this dispensation or the use of SM 55 in the vessel's CM files, nor is there evidence that consideration was given to varying the trim.

The consultant wrote to the Marine Office in August 1999 confirming that the required net drum space modifications had been carried out on *Harvest Hope*, *Kinnaird* and *Vandal*. This letter also referred to the likely aft freeboard dispensations on two other vessels, including *Victoria May* (PD239), a vessel of similar design to that of *Harvest Hope*.

The consultant confirmed to the Marine Office in February 2001 that following "exhaustive discussions", a new stability booklet had been prepared and forwarded, "*…using with some reluctance the main deck aft as the freeboard deck*." The postscript to this letter noted that *"…in addition to your requirements on non return freeing ports and door sensors within the Net Drum space, the owners, on their own accord, have fitted two (2) heavy duty submersible pumps within this space.*"

Further correspondence in August 2001 noted possible delays in the final stability booklet approval, while awaiting the outcome of the vessel's re-engining.

Figure 36

SURVEY MEMORANDUM NO 55

To: All Fishing Vessel Surveyors

cc Surveyor General
Deputy Surveyor General (D)
Chief Surveyors
SFIA
UNV
BV ICM

FREEBOARD -
APPLICATION OF MS NOTICE NO M 975

The above Notice was produced in May 1981 and provides guidance as to the interpretation of 'adequate' freeboard in Rule 15(1) of the Fishing Vessel (Safety Provisions) Rules 1975. The recommended freeboard standard has been applied subsequently without modification in respect of new construction. When considering for stability approval purposes, the loading conditions of existing ships - in this context ships built prior to circulation of the Notice - reasonable compliance only with the standard is sought having regard to the merits of each case and the approach as follows has been adopted:-

1 (i) Freeboard deficiency of up to 5% forward and 20% aft may be accepted.

(ii)(a) Where the deficiencies are greater that those indicated in 1(i), consideration should be given to obtaining freeboards within those limits by variation in loading eg utilising balance of trim forward to achieve acceptable freeboard aft, limiting use of certain tanks or by the re-distribution/addition of permanent ballast etc.

or (b) If trim variation is not practicable, depending on the arrangements, consideration should be given to constructional modifications eg raising coamings, creating a secondary internal weathertight barrier with additional drainage.

(iii) The arrangements considered at (ii)(b) designed to compensate for freeboard deficiency may only be acceptable up to 50% deficiency aft. Thereafter catch and/or fuel limitations would be necessary.

(iv) In the case of vessels with weather tight shelters extending from forward for at least 85% of the length L, - as defined in the Notice - provided the after bulkhead is intact and not pierced by entrance doors, the freeboard aft may be measured from the line of the shelter deck extended aft parallel to freeboard deck. This treatment does not affect definition of freeboard deck which remains at level of exposed deck aft and the overall principle applies that the freeboard deck must not be submerged at any point in any condition. Escapes from the aft end of the shelter should be arranged direct to deck over and special attention should be given to internal drainage of the enclosed shelter space and to air pipes in vicinity of exposed deck aft.

PRINCIPAL SHIP SURVEYOR FVSS

Survey Memorandum No. 55

1.22.3 Final approved stability booklet

The revised stability booklet was finally approved, with three copies forwarded to the consultant, on 28 May 2002.

A copy of the "Working Instructions" for this booklet is at **Annex J**. The section dealing with Maximum Draught Aft states that a reduction of 27% in this freeboard had been granted, based on:

"…The additional measures included added non-return freeing port area, w.t. door alarms and secondary bilge pumping arrangements…."

The required freeboards were also listed, based on positions evaluated by the requirements of M975, but were not referenced to the draught mark locations.

The "Working Instructions" did not contain any specific reference to the opening watertight windows in the net drum space, nor of the necessity for them to be closed. The booklet also did not contain a list of unprotected or protected openings that could potentially act as downflooding points.

1.22.4 Changes to MCA stability approval process

In September 2003, the MCA introduced a centralised Stability Unit, which has established itself as the centre for the computer-based stability approval for all vessel types. This unit now undertakes all stability approvals requiring computer modelling for new build vessels and major conversion work completed since the inception of the unit. As part of this process, it will also check for compliance with the relevant freeboard requirements.

It is noted that the local Marine Offices currently still deal with the stability approval for vessels built prior to September 2003, as well as instances of minor lightship changes, which require a simple manual stability calculation.

1.22.5 Inclining experiments and displacement checks

The first formal inclining experiment of *Harvest Hope*, was carried out at the shipyard in Poland on 9 January 1996, in the presence of the MSA's fishing vessel surveyor. A further inclining experiment was conducted in 2000 at the time of the vessel's scheduled four-yearly UK FVC renewal. Displacement checks were also conducted in December 1999 and February 2004.

1.22.6 Draught marks

The first reference to a problem with *Harvest Hope*'s aft draught marks was identified on 12 January 1996 by the MSA surveyor attending the vessel in Poland, in his "Report of Inspection And/Or *Survey".

During the vessel's 2000 survey, ongoing doubt over the positioning of the aft marks was noted. The survey report stated that the port and starboard aft marks were "*totally awry*" and transom marks 70mm too low, and that: "*The side marks are removed and transom marks rewelded* (sic) *in correct position.*".

The consultant, who conducted all of the vessel's inclining experiments and displacement checks, confirmed that the aft side marks were indeed removed following the 2000 survey. He also noted that the transom centreline mark had generally been considered to represent the most accurate of the three aft marks, and was used for taking the aft draught reading.

Rule 15(2) of the 1975 Rules states that draught marks complying with Section 7 of the Merchant Shipping Act 1894, amended by the Merchant Shipping (Metrication) Regulations 1973, should be fitted on each side of a vessel.

Schedule 3 of The Merchant Shipping (Registration of Ships) Regulations 1993 details the requirements for draught marks, which are required to be fitted "*…on each side of its stem and its stern post…"*.

It is noted that Schedule 3 of The Fishing Vessels (EC Directive on Harmonised Safety Regime) Regulations 1999, also stipulates that draught marks should be provided at the stem and stern on both sides.

1.23 SURVEY MEMORANDA

1.23.1 Scope of Fishing Vessel Memoranda

During the 1980s, the MSA introduced a series of Management and Survey Memoranda, which were intended to interpret and clarify both the Fishing Vessel (Safety Provisions) Rules 1975 and Instructions to Surveyors.

The MCA's Fishing Safety Branch no longer holds a consolidated list of these Memoranda, as they view them obsolete. The MAIB was, however, able to locate a copy within its own archive material, which was issued in April 1995 to all MSA chief surveyors and surveyors as an attachment to an MSA Memorandum, a copy of which is at **Annex CC**. This indicates that 103 such fishing vessel survey memoranda were issued prior to April 1995, along with 96 fishing vessel management memoranda.

As part of the introduction of the MCA's current Quality System in 1996-1997, all regulatory documents are now electronically stored on an internal database, entitled Survey & Certification Management System (SCMS).

Survey Memoranda are not recorded on SCMS, as they are uncontrolled documents, and it is understood that they were intended to be replaced by Operational Advice Notices (OANs) in 1998 to 1999.

During the MAIB's investigation into this accident it became evident that survey memoranda were still being used in some of the regional offices during the certification process for fishing vessels.

1.23.2 Survey Memoranda 54

The MAIB was able to obtain a copy of memorandum 54, a copy of which is at **Annex DD**, entitled "Openings in Weathertight (WT) Shelters". Again undated, this memorandum notes that:

> *"When a WT shelter is fitted, the Department is concerned to ensure that the shelter remains intact at all times such as to provide the assumed contribution to the stability of the vessel…"*

1.24 AUDIT REGIME FOR MCA

1.24.1 Background

The Maritime & Coastguard Agency (MCA) currently complies with the requirements of ISO 9001 (2000) standard for quality assurance of its processes and procedures. In order to maintain this certification, a program of internal and external Quality Assurance (QA) audits are conducted.

1.24.2 Internal audits

The MCA's own Quality Assurance & Development branch (QA&D) carries out audits of all MCA departments and branches on an 18-month cycle. The QA&D branch currently has five full-time Lead Auditors, three of whom are ex-Coastguard employees, with the other two from an administrative background. There are also 30 Associate Auditors, working within various MCA areas, including 4 active surveyors.

The internal audits conducted by QA&D will generally review the application of the quality system, and the management and administrative processes. Such audits will undertake high level reviews of CM files, but not necessarily consider detailed technical aspects, such as the conduct of a vessel survey.

The last QA&D audit of the local marine office dealing with *Harvest Hope,* was carried out in October 2003.

1.24.3 External BSI audits

The British Standards Institution (BSI) conducts audits of all MCA departments on a 3-yearly cycle, as part of the process to verify the MCA's ongoing compliance with ISO 9000 (2000).

The scope of the BSI audits is to review the management system and relevant documents, rather than technical procedures. During a typical 2 to 4 day audit of a Marine Office, CM files would possibly be sampled, but the BSI auditors would generally rely on the local surveyor to confirm that the files were acceptable, and relevant procedures were being followed.

The last BSI audit of the local Marine Office dealing with *Harvest Hope,* lasted 4 days and was carried out in April 2005.

1.24.4 Peer Review system

Following the NAO audit of the MCA's Survey & Inspections functions in 2001, one of the recommendations accepted by the MCA was for the establishment of an internal "Peer Review" system. Developed by the QA&D branch, this system would, for example, involve two surveyors from different regions working together to review current operational practices and identify and share both good and weak processes.

1.25 MCA FILING SYSTEM

1.25.1 Filing procedures

For the maritime-related divisions and agencies of the Department for Transport (DfT), all registered files are sub-divided into "themes" and "sub-themes" used to categorise specific subject matters. Each file has a unique filing identifier, based on a lettered prefix, followed by a series of numbers. The prefix "CM" denotes "Consultative Maritime" and is used for recording vessels' operational details.

1.25.2 Existence of "Rough Office" files

It is understood that the Marine Offices often retained local files, commonly referred to as "Rough Office" files. These contain routine correspondence and documentation not perceived to form part of the formal audit trail for the vessel's survey and certification process. The intention was that these unregistered files could reduce both the size of the registered files, and the need to recall them from the MCA's Registry in Southampton.

The "Rough Office" file for *Harvest Hope,* however, contained not only a selection of routine correspondence for the vessel, but also unique copies of original documentation relating to the vessel's design and survey.

In late 2004, the MCA's Scotland and Northern Ireland Region, began to instigate a process of transferring the information recorded on the "Rough Office" files onto a new registered CM file for each fishing vessel.

1.26 SISTER VESSELS OF HARVEST HOPE

1.26.1 Background

Harvest Hope was the first of a series of five vessels built by the Parnica Shiprepair Yard in Szczecin, Poland. Details of her sister vessels are included below:

1.26.2 *Kinnaird* (FR377)

Based on the same hull form and layout as *Harvest Hope*, *Kinnaird* however had a bolted upper bow section, which could therefore be opened for the purposes of defining her registered length at 23.99m. This section was later welded in place.

Kinnaird de-registered as a fishing vessel in September 2003, having decommissioned.

1.26.3 *Vandal/Aalskere* (LK337 then K373)

Being slightly longer than the other vessels, at 30.6m registered length, *Vandal* was built with a different layout, including a third winch and the absence of opening windows in the forward watertight bulkhead of the net drum space. The only one of the five vessels still operating as a trawler, she was re-named *Aalskere*.

It is understood that *Vandal* experienced a similar net drum space flooding incident, following a "fastener" early in her career. All internal watertight openings had been closed, and with the winch brakes activated, the skipper gave the vessel full ahead to try to free the obstruction. Although the vessel reportedly started to sink by the stern, submersible pumps installed in the net drum space by the shipyard were able to clear the area.

1.26.4 *Harvest Reaper III* (PD142)

Completed in 1997, *Harvest Reaper III* was the fourth vessel of the class. Although the vessel's CM "Construction" file doesn't contain a full general arrangement of the vessel, a copy of a shipyard-produced layout indicates several differences to the net drum space, including the absence of an escape window in way of the mess room.

In January 2001, the vessel ran aground in Loch Roag, and subsequently sank alongside in April of the same year. The vessel was salvaged, and following failed repair attempts, her registration as a fishing vessel closed in November 2001. She was latterly bought by Macduff Shipyard, who converted her into the anchor handling/ mooring vessel *Intrepid B*.

1.26.5 *Elegance* (UL540)

In early 2004, the final vessel, *Elegance* suffered two serious engine room fires. Following the latter incident, in March 2004, she flooded then sank while under tow, west of Shapinsay. Like *Kinnaird* and *Harvest Reaper III*, *Elegance* had a slightly shorter registered length of 23.92m. At the time of her loss, the vessel was operating on a STC while her stability booklet was being developed.

Elegance had two siphon-type tonnage valves fitted in her net drum space, designed to evacuate water overboard by the action of an internal float creating a siphon. However, it was unclear how many of these valves were fitted in the vessel's net drum space when she sank.

Previously, in March 2002, *Elegance* had capsized at her moorings in Peterhead, having grounded at low water and then flooded on the rising tide. The cause of this flooding was thought to have been due to seized siphon-type tonnage valves permitting back-flooding to the net drum space, or improperly maintained siphon-type tonnage valves in the fish processing space.

1.26.6 SIAS records for the sister vessels

A number of the reports recorded on SIAS for the four sister vessels included references to identified defects involving the vessels' tonnage valves. A summary of the relevant SIAS records is at **Annex EE**. It is evident that there were ongoing problems with the vessels' tonnage valves, including in September 1999 on *Harvest Reaper III,* a requirement to re-instate the six net drum space tonnage valves. This inspection was conducted on the same day as a similar inspection on *Harvest Hope*, and a copy of the handwritten "Report of Inspection And/Or *Survey" for *Harvest Reaper III* was filed in *Harvest Hope*'s CM file. Neither the CM file nor SIAS recorded any deficiencies for the inspection of *Harvest Hope* at this time.

1.26.7 CM files for the sister vessels

As for *Harvest Hope*, the "Construction" and "Stability" files for each vessel were reviewed. A number of discrepancies were noted in the files, including:

- Gaps in the recorded certification records for the UK FVCs and International FVCs **(see Annex FF**).
- Missing copies of the UK FVCs and International FVCs in the files.
- Extended periods of Short Term Certificates (STCs), due generally to the ongoing, lengthy approval process for each vessel's stability booklet.
- The majority of the STCs and covering letters make no reference to the reasons for the short term certification. For some certificates, it is not clearly stated as to whether the certificate is a full or short term.
- The stability approval process for *Vandal/Aalskere* extended between August 1997 and October 2004. There were a number of versions of the stability booklet issued, due to ongoing problems in achieving stability criteria

compliance. The vessel ultimately required the fitting of an extended ballast keel, and her final approved stability booklet imposed a system of fluid restrictions. *Vandal/Aalskere* also appears to have been granted a 27% aft freeboard dispensation.

- *Vandal/Aalskere* was issued with a Full UK FVC in August 2002, although her provisional stability booklet was not approved until October 2004.
- None of the Record of Particulars for the vessels was updated to reflect the MCA requested changes to the net drum space.
- The "Working Instructions" in the approved stability booklet for *Harvest Reaper III* provided no details of the permitted operational draughts to ensure compliance with the freeboard criteria. It is not clear whether a freeboard dispensation was granted to this vessel.
- Although *Harvest Reaper III*'s stability booklet was approved in August 2000, there is no record of a Full UK FVC being issued to the vessel, either following this approval, when the STC expired in October 2000, or before her de-registration as a fishing vessel in November 2001.

1.26.8 Spanish vessels

It is understood that the fishing vessel *Fairway* was built in the Spanish shipyard Astilleros Armón S.A. to the same layout as *Harvest Hope*, using a copy of the latter's original plans, but with a different hull form. **Figure 37** shows the similarities between the vessels. *Fairway* sank in October 2003 following the vessel's engine room flooding, with no casualties.

Armon built a number of similar vessels to *Fairway*, including *Harvest Moon IV* (now operating as *Norlantean*, as shown at **Figure 38**), *Vela* and *Audacious II* (BF83), shown at **Figure 39**, all fitted with transom doors into an aft enclosed working area.

Audacious II sank in January 1998, while under tow by another fishing vessel, following a serious flooding incident. The vessel had snagged her fishing gear on a seabed obstruction, and heeled heavily to port while trying to retrieve her gear. Oncoming seas breached the transom doors, causing the net drum space to flood, and leading to downflooding of the engine room and fish room spaces through open weathertight doors. The vessel's winches were controlled by an "auto-trawl" system, but it is not clear whether this system hindered the crew's efforts to release the fastener. The port trawl wire was however ultimately cut using an electric grinder.

Fortunately all of the crew were able to abandon the vessel, into one of the liferafts. One of the crew later noted his opinion that the vessel's freeboard was too low, and that the aft main deck was always "wet".

The first of three recommendations to the MCA resulting from the MAIB's examination of this incident was:

> *"Consider requiring that on vessels with similar configurations to that of the AUDACIOUS II the forward bulkhead to the lower working deck is of a watertight construction with no through access way or ventilation intakes."*

The MCA's Survey Policy Section responded:

"*After much consideration it was concluded that the Fishing Industry would not accept this recommendation, however in the interests of safety, it was decided that an alternative would be discussed. After looking closely at the accident report and the vessel's latest FV2 it was decided that the Bilge Pump capabilities should be a more appropriate issue to discuss at the at the* (sic) *next TSG meeting."*

Figure 37

Fairway at sea

Figure 38

Norlantean II (formerly *Harvest Moon*)

Figure 39

Audacious II undertaking fishing operations

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 GENERAL OBSERVATIONS

As the foregoing sections indicate, there are many factors that have contributed to the loss of *Harvest Hope*. Although the dynamics and primary cause of the vessel's foundering can be easily identified, the events leading up to the loss cover over 10 years of actions and decisions.

Harvest Hope was a modern, well maintained and operated trawler. She was also one of the most profitable vessels operating out of Peterhead in recent years, and her owners and operators are highly regarded within the industry, as conscientious, industrious and extremely successful.

Her crew were also highly experienced fishermen, and unusually for the fishing industry in recent years, had nearly 50 years of combined service on the vessel, with the four senior crew having been on board since new.

Yet somewhat alarmingly, their vessel was able to quickly capsize and sink, and with slightly different circumstances, this report could have easily been describing the tragic and untimely deaths of seven hard-working crew members.

2.3 CIRCUMSTANCES OF THE LOSS

2.3.1 Initial flooding

During the first tow of her final voyage, *Harvest Hope'*s trawl gear came fast on a seabed obstruction; a common occurrence for a bottom trawler, but not one that should lead to a modern, well-equipped vessel sinking.

The port transom door had been left open since the last haul of the previous voyage, when the other skipper had been in command, and only the skippers were responsible for ordering the doors open or closed. Certainly this opening was the primary cause of flooding when the vessel came fast, and when trawling before wind and tide, this door should have been closed.

It is therefore likely that an improved routine of pre-departure checks, or perhaps the handover of responsibility for the closure of main deck openings, including the internal windows, to a greater proportion of the crew, would have prevented the flooding.

However, there was no statutory requirement to even have a door fitted to these transom openings. The net drum space was not considered to be watertight or weathertight, and wasn't included in the "intact" volume in the final approved stability booklet, (although its "Working Instructions", at **Annex J**, warned against the risks of allowing "free water" accumulation on the main deck). It is in fact noted, that many fishing vessels of similar design to *Harvest Hope*, including her crew's rescuers, *Fruitful Bough,* don't have transom doors fitted to aft enclosed main deck spaces.

2.3.2 Attempts to close the transom door

Despite their best efforts, the crew were unable to close the port transom door. Given the ingress of water, the only practical means of closing the door was to use the single hydraulic ram, fitted on the outboard edge of each door. However, a substantial green sea swamped the area, detaching the ram from the door, and leaving the door swinging from the deckhead.

It is probable that if two hydraulic rams had been fitted to each door, the closing-arrangement might not have been so susceptible to damage. Likewise, if a line had perhaps been permanently run from the door to the upper deck for use with the power block, then this could have been used to partially close the door to stem the ingress.

2.3.3 Progressive downflooding

With the water level rapidly rising on the port side of the net drum space, and the tension on the port trawl warp acting from the towing block suspended from the gallows, as shown at **Figure 8**, the vessel began to heel to port.

Figure 10 shows the last accurate description of the water level in the net drum space, only a few minutes after they came fast, and no more than 20 minutes before the vessel actually capsized and sank. By that point, the angle of heel was already about 12° and there would have been a wedge of water representing around 45 tonnes of water on the port side. Clearly, even at this relatively small angle of heel and list, this amount of water would have been moments away from starting to flow through the open mess window.

The status of the main deck openings is depicted at **Figure 33**. Apart from the open windows in the mess and galley areas, and the forward starboard 4-man cabin, no other watertight openings in the net drum space or accommodation area could have contributed to the progressive flooding of the vessel; all of the engine room exhaust and vent terminals were on the upper deck. During the latter stages of the flooding, the crew observed the water level rising in the galley and mess area, and flowing forward into the two 4-man cabins.

With the increasing port list, it is suggested that the side shell openings on the port side of the fish processing space would have eventually started to allow water ingress. With water now pouring into the fish processing space, various internal deck openings would have precipitated rapid downflooding into the fish room.

A watertight bulkhead subdivides the fish room from the engine room, so this latter space would have been one of the final areas to flood. Some of the crew recalled that, while they were in the liferaft, *Harvest Hope*'s engine was still running until just before she sank, and they had observed both water pouring into, and steam emitting from the engine room exhausts.

2.3.4 Net drum space drainage arrangements

The intended drainage arrangement for the net drum space was based on a combination of pumps and non-return tonnage valves, but these had been modified. The reasons for the alterations are discussed in more detail below, but the crew were solely reliant on two electric submersible pumps. The tonnage valve openings had previously been welded up at the side shell.

However, even if the tonnage valves had been operational, it is doubtful whether they would have assisted in freeing the water. With the minimal freeboard in the area diminished even further due to the port list, the valves would have been deeply immersed and more likely to exacerbate the flooding than mitigate it.

The two submersible pumps had always previously cleared minor build-ups of water, and the crew confirmed they were functioning during the early stages of this incident. However it is evident that the accumulation of water on the port side proved too much for the pump and its associated electrical installation. The port submersible pump stopped immediately after the engineer observed a flash outside the galley window.

Original speculation attributed this flash to the immersion and shorting of the pump's junction box, located, as shown at **Figure 15**. Unfortunately, despite extensive research, it has not been possible to locate any documentation relating to the electrical installation or performance of these pumps. It is noted that the Fishing Vessel (Safety Provisions) Rules 1975 contain no specific guidance on the location and watertight integrity of safety-critical electrical installations, but it is understood that MCA surveyors, and industry in general, refer to the IEEE "Blue Book" for guidance on appropriate electrical standards.

2.3.5 Capsize

The combined effect of the tension in the port trawl warp, and free-surface effect of the flood water progressively accumulating in various spaces, would all have eventually contributed to a sufficient reduction in transverse statical stability to induce capsize. The crew of both *Fruitful Bough* and *Harvest Hope* observed the vessel sink slowly by the stern following capsize.

2.3.6 Previous *Harvest Hope* flooding incidents

The owners of *Harvest Hope* had previously experienced several other unplanned net drum space floodings, resulting from "fasteners" and back-flooding through tonnage valves. During one such occasion, the space had been flooded up to the base of the transom door opening, after a tonnage valve flap had fallen off. What is clear, is that on these previous occasions, circumstances had permitted the skipper and crew to stabilise the vessel's list and trim sufficiently to allow the use of the pumps and/or tonnage valves to successfully drain the space.

2.3.7 Primary cause(s) of vessel loss

It is evident that *Harvest Hope* sank by the stern, having capsized to port. This followed a seabed "fastener", which not only pulled the vessel over to port, but also initiated the flooding of her net drum space via the open port transom door. The flooding progressed through open windows both into her accommodation block, and then forward into her fish processing space.

2.4 THE VESSEL

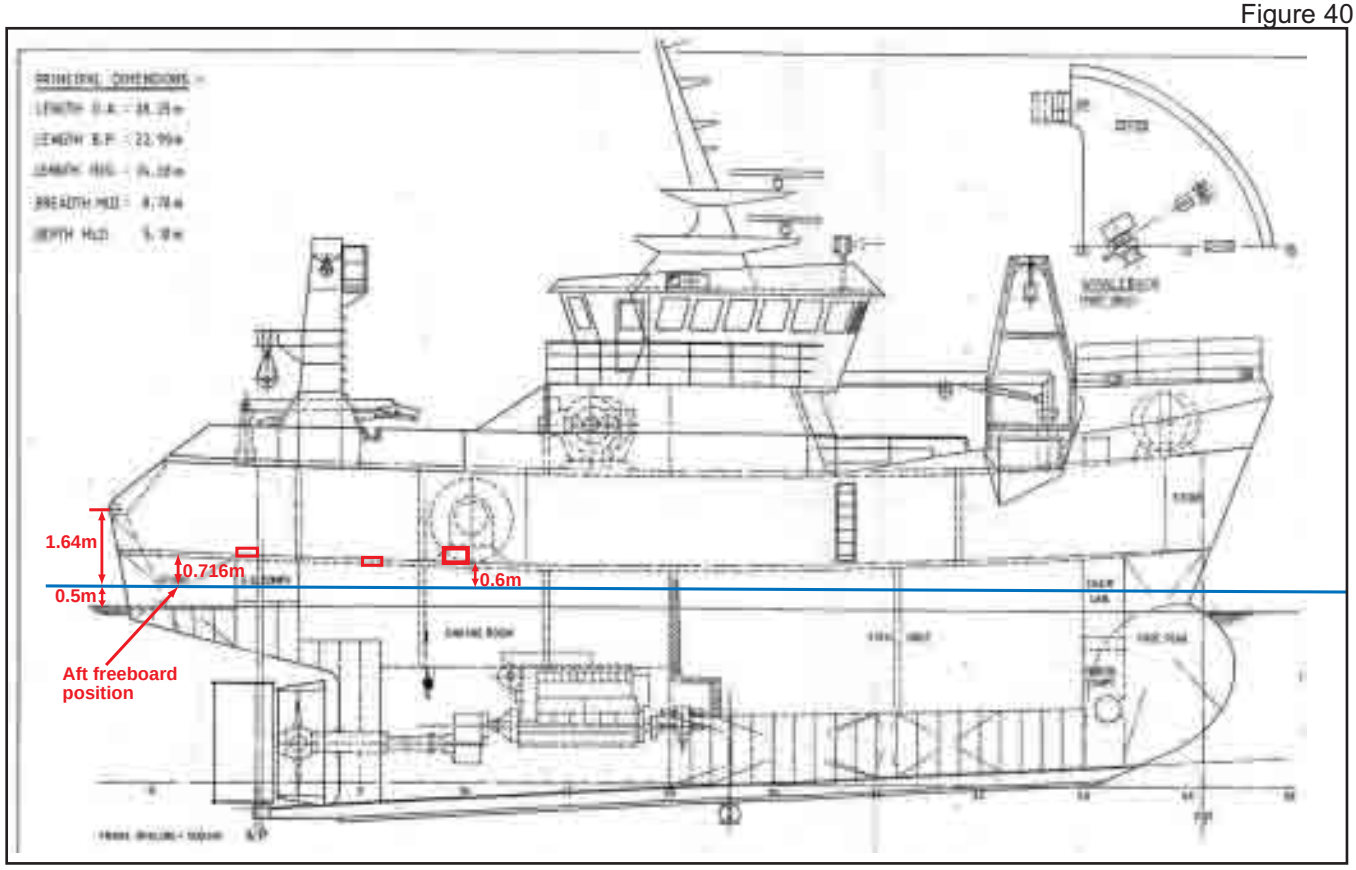
2.4.1 Increased displacement

The as-built displacement of *Harvest Hope* was greater than originally designed. During the MAIB's enquiries into this accident, there were various reports of the use of heavier than intended steel during construction. Despite a visit to the shipyard in Poland, and comparison of the ultrasonic test results conducted on behalf of the MCA in 2000 and 2004, these suggestions can not be confirmed. What is more certain is that large amounts of additional solid ballast were required to be installed in the vessel for stability purposes.

Figure 40 depicts the waterline corresponding to the vessel's loading condition[5] during her final voyage, fairly standard for the beginning of her normal 10-day trip. Also illustrated are the estimated positions and respective freeboards at the tonnage valves (neither the available drawings nor Record of Particulars refer to their locations), and the transom door openings.

It can be seen that this operational waterline exceeds what is presumably the vessel's intended design draught by about 0.5m and that the aft "rule" freeboard was 0.716m, which is less than the required value of 0.818m, stipulated in the stability booklet at **Annex J**. The freeboard in way of the forward tonnage valve in the net drum space would have been even less, due to main deck sheer.

Figure 40



Profile depicting estimated waterline during final voyage

[5] Based on Loading Condition 2 in the vessel's 2002 approved stability booklet, except that both the Fore Peak and No.11 Oil Fuel tank aft starboard were empty, as advised by the skipper. The latter tank was generally left empty to compensate for a natural starboard list.

2.4.2 Role of MCA and Classification Society during construction

The survey responsibilities for the construction of *Harvest Hope* were divided between the MSA and the classification society, Bureau Veritas (BV). Although this meant that the former was responsible for the vessel's freeboard and stability, many of the features of the design which would have been surveyed by BV, particularly those affecting the vessel's watertight integrity, would also have impacted upon the freeboard and stability aspects of the design. For example, the size, installation and positioning of the tonnage valves in the net drum space would have been approved by BV, yet have implications on the vessel's stability and freeboard.

The level of liaison between the MSA and BV surveyors is unknown, and neither of the CM files contain any relevant correspondence. It is clear however that overlapping areas of survey responsibility affecting safety-critical design features require close liaison to ensure relevant considerations are made by both parties. It is considered that the roles and demarcation of responsibility for the approval of the initial freeboard and stability of a fishing vessel, being built under class supervision, require review.

It is also possible that earlier and closer liaison between the MSA and the designer/ builder or classification society could have identified the signs of the later freeboard and stability problems early enough to incorporate appropriate design modifications. By the time the aft drainage and freeboard problems on *Harvest Hope* had been highlighted in 1997, it was too late to develop a practical solution, without recourse to radical, and possibly impractical, alterations to the vessel's operational arrangement.

2.5 FREEBOARD & STABILITY

2.5.1 Stability booklet approval process

The approval of *Harvest Hope*'s initial stability booklet was completed by a separate Marine Office, a standard MSA practice at the time, dependent on the workload and available resources in the various regional offices. There were a number of drawbacks to this approach, including the possibility that the surveyor validating the booklet might not be familiar with the particular vessel's design.

Irrespective of whether this may have affected the initial stability approval for *Harvest Hope*, what is evident is that the process went wrong. Early correspondence between the MSA and the consultant confirmed that the net drum space should not be included in the vessel's watertight envelope for stability purposes. Although it is not certain whether the consultant ever received the relevant letter, it is clear that the resultant stability booklet did not take this into account. The inclusion of the net drum space was confirmed both in the booklet itself, and later by the consultant, when the matter was queried by the surveyor undertaking the check. Yet the stability booklets for both *Harvest Hope*, and *Kinnaird*, were approved on this basis.

Some 12 months after the entry into service of *Harvest Hope*, the Marine Office received queries from certain fishing vessel designers regarding the approved aft arrangement on the vessel. This prompted the Marine Office to seek technical advice from the MSA headquarters in March 1997. However, a period of over 17 months passed before the Marine Office received a reply, which contained little guidance. The reasons for this are not known, although it is likely that the Fishing Vessel Section's workload was heavy at the time, given the many fishing vessel approvals being conducted by the regional offices. Since then, the Fishing Vessel Section has evolved

into the Fishing Safety Branch, based in Southampton, and from which the regional offices seek safety policy advice. In late 2005, this branch merged with the Code Vessel Branch, the latter containing a group of experienced surveyors, a re-structuring that should hopefully re-focus the policy support available to the regional fishing vessel surveyors.

It is also noted that since the above took place, the MCA has re-addressed the way in which stability approvals are conducted. The positive step of creating a centralised Stability Unit in 2003 should go a long way to ensuring that MCA stability approvals are standardised.

2.5.2 Freeboard dispensation

With limited support available from the policy section, the Marine Office therefore initiated the difficult process of trying to retrospectively resolve the freeboard and stability issues for both *Harvest Hope* and *Kinnaird*.

Yet, after the initial response informing the consultant of the decision made by headquarters, the Marine Office's actions are not documented. It is understood that a number of meetings were held to try to agree a way ahead, but the absence of any recorded notes of these meetings, or of the development and implication of the final solution, is not helpful.

Following one such meeting, a dispensation was granted for the vessel's aft freeboard, based on Survey Memorandum (SM) 55 **(see Figure 36)**, and modifications required to the net drum space in the form of two additional tonnage valves and "Door Open" sensors for the two watertight doors in the space.

It is however evident that the usage of SM 55 was flawed in that:

- SM 55[6] was developed to augment the freeboard criteria introduced in May 1981 by M975. However, the dispensations SM 55 offered were intended only for vessels built prior to the issue of M975;
- For aft freeboard dispensations greater than 20%, compliance should have initially been sought by attempting to vary the vessel's trim. There is no evidence to confirm whether this was considered;
- The modifications suggested by SM 55, namely *"…. raising coamings, creating a secondary internal watertight barrier with additional drainage"* were different in nature to those implemented on *Harvest Hope*. Although the fitting of the door sensor alarms seemed sensible and practical, the logic of fitting additional tonnage valves is debatable.
- As an uncontrolled document, SM 55 is not part of the MCA's registered document system;
- Survey Memoranda are considered obsolete by many areas of the MCA, including the Fishing Safety, Survey Policy and Quality Assurance & Development Branches. However, there appears to be continued use of SMs to supplement regulations in regional offices.

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[6] Although uncontrolled, and undated, SM 55 appears to have been issued sometime between May 1981, when M975 was issued, and March 1990, when another survey memorandum, with a higher number in the series, was withdrawn.

The “Working Instructions” **(see Annex J)** in the final approved stability booklet are the only formal confirmation that a 27% allowance on the aft freeboard was ultimately granted. There is no reference to either the consideration of using SM 55, or its application in the vessel’s CM files.

The Marine Office appears to have been faced with a dilemma. It could have cancelled *Harvest Hope’*s UK FVC, or allowed the continued operation of a vessel that had been in service for over 2 years, by pursuing a design alteration.

It is easy to say in hindsight that the former option should have been selected, and the vessel withdrawn from service until the problem had been appropriately resolved. However, it is noteworthy that this was not suggested in the memo sent from MSA headquarters to the Marine Office, which noted that “*remedial action*” should be sought as a “*matter of urgency*”.

It is, of course, not unreasonable to seek equivalency to regulations that can not be retrospectively complied with. However, *Harvest Hope* was built many years after the introduction of the relevant freeboard regulations.

Although not strictly applicable, SM 55 therefore undoubtedly appeared to offer a solution. However, its application and interpretation does appear to have been flawed, if not misguided. The solution of additional tonnage valves also appears to neither comply with the spirit of the modifications proposed by SM 55 or M975, nor be particularly ideal.

The physical and practical limitations of tonnage valves are widely known, and the requirement for additional openings, although supposedly non-return, in a space prone to flooding, together with minimal freeboard is questionable. There also appears to have been little or no consultation with the vessel’s owner-operators regarding this decision. If they had been involved, and had been able to recount their practical experiences of the existing valves being frequently immersed and regularly back-flooding, the solution might have been different. A photograph of the vessel at sea in 2001 **(Figure 41)** confirms the reality of the concerns the owners could have raised.

It is suggested that stronger measures could have been implemented, for example the enhancement of watertight subdivision in the net drum space as SM 55 suggested, or welding up of the transom doors. It might have been that both parties considered the potential operational and cost implications of such measures to be prohibitive.

There were in fact two different, but interlinked problems to solve. The net drum space was an enclosed area vulnerable both to flooding and subsequent entrapment of water, requiring adequate freeing arrangements. However, the vessel’s increased displacement had resulted in minimal aft freeboard, which rendered not only the space itself, but also its drainage arrangements, more susceptible to flooding.

The owners recognised this conflict, and latterly chose to weld up the tonnage valves, and enhance the pumping arrangement.

Figure 41

Harvest Hope at sea, possibly in 2001-2002

2.5.3 *Harvest Hope*'s final approved stability booklet

Regardless of the above, the requested alterations in the net drum space were implemented on *Harvest Hope* as early as June 1999. However the final stability booklet was not forwarded to the Marine Office until February 2001, incorporating, as the covering letter noted *"…with some reluctance the main deck as the freeboard deck*", and not approved until May 2002.

The final stability booklet was based on the results of the 2000 inclining experiment, and so the booklet's production would have been delayed until some time after that.

The Marine Office was experiencing a high workload at the time, with many stability approvals being conducted concurrently. Likewise, the requirement to re-engine *Harvest Hope* in the summer of 2001, could have potentially delayed the MCA's validation of the vessel's lightship details.

Obviously such an elongated stability booklet approval process is not ideal, given the safety-critical nature of the documentation. However, as stated earlier, the introduction of the MCA's Stability Unit should ensure that such unacceptable timescales will not reoccur.

2.5.4 General comments on stability booklet

Although *Harvest Hope*'s final approved stability booklet appears to be a comprehensive document, a number of observations can be made:

- The guidance on the maximum permissible draughts provided no easy practical means of confirming compliance with the required freeboards. The necessary freeboards and draughts were not quoted at known datum points, and therefore, in practical terms, were of little value.
- Although there is a warning of the dangers of allowing "free water" accumulation, there is no indication of the likely magnitude of this problem. There is also no record in the CM files of any calculation or check of the effects of "free water" during the stability approval for any of the vessels. If a graphical representation of the likely loss of transverse stability had been provided, it is possible that extra caution might have been taken to ensure that the openings were closed on *Harvest Hope*'s final voyage.
- Although the importance of ensuring that *"…all watertight accesses to and from the net drum space, are kept closed and clipped when the stern doors are open*" is emphasised, the previous reference is only to "*open doorways, hatchways etc…*" potentially breaching the vessel's watertight integrity. There is no specific reference to the watertight windows in this space, or the need to keep them closed.
- There was no diagram indicating which spaces had been included as intact for the purpose of the stability calculations. This would have provided a useful visual reminder to the crew of which spaces were essential to the vessel's intact stability, but this might have halted the approval of the initial booklet.
- There was no list of the key watertight and weathertight openings. Such a list is included in stability booklets for commercial vessels, along with a diagram indicating their locations.

It is noted that most of the above observations also applied to *Harvest Hope*'s sister vessels' stability booklets. For *Harvest Reaper III*, for example, there was no reference made to the required freeboard values.

However, since the approval of *Harvest Hope*'s stability booklet in 2002, MGN 281 (F) was issued in 2004. This provides a recommended format for fishing vessels' freeboard and stability information booklets. It was intended that the stability booklets for all new build vessels or, existing vessels requiring a new booklet after the date of issue of MGN 281 (F), should be based on this new format, which in fact requires the inclusion of many of the above omissions. However, there is no requirement in MGN 281 (F) for either a graphical representation of the effects on stability of "loose" water, nor a list and diagram of potential downflooding points, which may provide a useful reminder to designer, crew and MCA alike, of all such points.

2.6 NET DRUM SPACE

2.6.1 Watertight or weathertight?

It is evident that the categorisation of the net drum space on *Harvest Hope* proved to be a subject of some contention from the early stages of the vessel's design. The key question to be resolved initially was whether the space should be considered watertight, weathertight, or in fact, neither.

The correspondence in the CM files relating to the stability and freeboard approval for *Harvest Hope* highlights the confusion on the matter, with the consultant, Bureau Veritas and MCA seemingly holding differing opinions on the integrity of the net drum space.

It is suggested that the ambiguity regarding the watertight/weathertight debate has probably not been assisted by the original definitions of "watertight" and "weathertight" in the 1975 Rules, which are open to interpretation.

The 1975 MCA Instructions to fishing vessel surveyors, however, state that "weathertight" doors should normally open outwards to bear any impact against the frame. Likewise, the current issue of the Draft Code of Practice for over 24m Registered Length fishing vessels, has indeed provided some clarification on the matter by stating that watertight openings should be capable of preventing the passage of a "head" of water in any direction.

It is suggested that the arguments surrounding the integrity of *Harvest Hope*'s net drum space can be divided into two main interlinked factors:

- the physical integrity of the external openings in the net drum space;
- consideration would either be left open for sufficiently long durations to negate their presence, or could be closed quickly enough if required.of whether the transom doors, as operational openings

Considering the former, the transom doors incorporated dogs, and, at least initially, rubber seals, combined with enhanced internal strengthening, but were inward opening. This arrangement, it is argued, therefore precluded them from being watertight, and almost certainly from being weathertight. Indeed, the owners noted that when closed, the transom doors would generally allow some seepage.

The logic behind the second point is harder to substantiate. All openings, regardless of their watertight status, are of course designed to be opened. While at sea, it is however preferable to minimise the time that particularly exposed openings are unprotected, but the success of a fishing vessel is dependent on deploying and recovering her trawl gear, and embarking her catch. For *Harvest Hope*, it was a particularly slow process to close the transom doors, which would have been delayed further if a net was being moved through the opening at the same time.

Given the practical experiences of back-flooding through the tonnage valves, even when screwed closed, it can be argued that they were no more than weathertight. However, it is noted that the fish processing space, forward on the main deck, had been considered watertight from the outset, despite including three tonnage valves at deck level.

Despite the implied status of the forward tonnage valves, it is considered that the transom door openings were barely weathertight. Yet if this had been clearly advertised to the crew, either by warning signs in the space itself, or the stability booklet, it is questionable whether the internal watertight windows would ever have been left open. If, for example, the closed and clipped port transom door had been immersed for a prolonged period in rough weather after a "fastener", for how long would this inward hinging aluminium door really have withstood a significant head of water?

However, given that the net drum space had been excluded from the vessel's intact volume for stability purposes, there was arguably no need for transom doors at all. So, again, although the skipper should really, in hindsight, have had the door closed, there was no requirement to have a door there in the first place.

Indeed, the owners of many similar vessels choose not to have doors fitted to these openings, arguing that then at least everyone knows where they stand with the space. All ambiguity regarding the watertight status of the space is removed, and the risks of potential downflooding are clear.

2.6.2 Protection or exposure?

It is evident that this ambiguity significantly contributed to the losses of not only *Harvest Hope* but also other, similar vessels such as *Heather Bloom*, *Audacious II* and *Fairway.* All sank, either directly or subsequently, as a consequence of their aft enclosed spaces flooding.

Irrespective of whether or not the net drum space was designated as weathertight, or of any of the warnings provided in the stability booklet, the psychological containment offered by a substantial enclosed space is significant. Such spaces instil a sense of security that they form part of the vessel's intact volume, even when they don't. It must be easy for crew to assume that with the transom doors closed, internal openings, such as windows, are no longer a risk, and it soon becomes normal practice to leave them open.

Once water begins to gather, the mechanism for quickly and safely draining it is critical to the vessel's survival, particularly if the accumulation is on one side of the vessel, thereby halving the potential drainage and pumping capability. As *Harvest Hope* and other cases have shown, any internal flooding can potentially cause the vessel to sink, irrespective of the opening position or size.

It is appreciated that enclosed working spaces offer substantial operational benefits to fishing vessels, and well-deserved protection for fishermen, working in often miserable weather. But unless the design of these spaces is carefully considered, and monitored by the regulatory authorities, with tight on board operational procedures developed, it is likely that *Harvest Hope* will not be the last such vessel to be lost in this manner.

2.6.3 Windows in the watertight bulkhead

The crew regularly left the windows open at sea for ventilation purposes, and their safety-critical nature was not recognised, nor highlighted in the stability booklet. Likewise, although the starboard watertight door was alarmed as part of the freeboard dispensation process, the windows had been overlooked, with neither alarm sensors nor warning signs considered necessary. In hindsight, both should have been fitted, or the windows permanently closed.

Given their position and height above deck, it is likely that they were simply not perceived a risk. As an MCA surveyor noted, alarms had not been fitted in the same way as the watertight doors, because if the water reached that level, then the vessel would have been in serious difficulties anyway.

It is, however, possible that if the windows had been closed and progressive flooding prevented, the flood level in the net drum space might just have stabilised sufficiently to let the pumps cope, as had occurred previously. However, with ever increasing levels of entrapped water accumulating in the mess and galley, and no means of drainage from these spaces, the port list and draught would have increased even further, worsening the situation.

The original requirement for the windows in the mess and galley area was to provide secondary routes of escape, in accordance with the 1975 Rules. In fact, it would seem that these windows did not need to be fitted to *Harvest Hope*. The version of these rules at the time of *Harvest Hope*'s design and construction only required one escape route from spaces above the freeboard deck, which could have been achieved with the standard doors. However, in 2001, the 1975 Rules were amended so that all accommodation spaces would require two escape routes. It is also noted that the other vessels in the class appear to have a variety of combinations of escape route configurations from the accommodation, including no such windows at all on *Aalskere*.

Other options could have been available to provide secondary escape routes, and the challenge must be for designers and regulators to provide practical means of escape, without further endangering the vessel in the process.

2.7 TONNAGE VALVES

2.7.1 General

Non-return freeing ports or tonnage valves similar to the arrangement shown at **Figure 24** have for many years been the means of freeing water from enclosed spaces on board fishing vessels. SM 54 provided guidance on their application, and it is understood that their name derives from their development for use in intact watertight spaces, to allow such spaces to continue contributing to the vessel's tonnage calculation.

2.7.2 Arrangement on *Harvest Hope*

Although originally fitted with four such scuppers in the net drum space, two further tonnage valves were added in 1999, as required by the MCA. However, the owners decided to have all six tonnage valves welded up externally, having experienced problems with back-flooding, exacerbated by the low aft freeboard.

Photographic evidence at **Figures 27** to **30** supports the owners' testimony that these valves were permanently closed, and that they remained so until the vessel sank. The owners were in fact extremely candid about the reasons why the tonnage valves were welded up, despite the fact that these were unauthorised alterations to the vessel. Although such modifications can never be condoned, and should never be conducted without first seeking regulatory approval, one can sympathise with the practical considerations that the owners made. The original tonnage valves had already caused them operational problems, yet they had been required to fit two more, which they duly did to meet the regulatory requirement. However, it was they alone who had to endure the regular consequences of net drum space flooding.

The decision to weld up the aft tonnage valves would not have been taken lightly, and would have been done with their best intentions to improve both the safety and practical operation of the vessel. It is also worth noting that the owners retained the fish processing space tonnage valves, knowing that given the greater forward freeboard, these valves safely served their intended purpose.

2.7.3 Practical limitations

It appears that the tonnage valves fitted to *Harvest Hope* were far from ideal. It has not been possible to confirm some reports that the otherwise steel assembly contained aluminium flaps, although this might have explained why a flap fell off in 1999, flooding the net drum space. **Figures 24** to **26** also show that the housings were installed with a gap above deck for structural purposes, which, although increasing the effective freeboard to the openings, would have allowed the retention of a certain amount of water on the deck.

In general terms, the limitations of tonnage valves are also widely known among surveyors, designers and fishermen, including:

- restricted access to open or close the flaps, particularly if flooding is already present in the area;
- the flap and screw arrangement is prone to seizure and requires regular maintenance;
- there is a possibility of the flap becoming jammed open or closed, due to trapped debris.

Although *Harvest Hope*'s SIAS survey records contain little reference to tonnage valve problems, the reports for the sister vessels, summarised at **Annex EE**, note seized tonnage valves requiring rectification, as well as a requirement to fit an appropriate operational warning sign on *Vandal* in 1998. The owners of *Harvest Hope* were never requested to fit such signs. A similar sign fitted on *Kinnaird* is shown at **Figure 26**.

Furthermore, there are a number of previous flooding incidents attributed to possible tonnage valve back-flooding, including the capsize of *Elegance* at her moorings in 2002, and the 15.2m fishing vessel *Angela*, which capsized and sank, following a build-up of water in her enclosed shelter deck.

It is evident from the foregoing that, although common in enclosed shelter decks on modern fishing vessels, tonnage valves are by no means ideal, and their ongoing application and design requires careful consideration.

2.8 REGULATORY SURVEY REGIME

2.8.1 General

The role of an MCA fishing vessel surveyor is challenging and demanding, requiring the need to balance high levels of technical expertise, and thoroughness, with commercial pressures, and the demands and requirements of the modern hard-pushed fishing industry.

Like any profession, occasional errors will occur. It seems that during the later surveys on *Harvest Hope*, some defects were not recognised, including:

- welded up tonnage valves in the net drum space, despite additional tonnage valves being requested as part of the freeboard dispensation;
- both the original and final liferaft stowage positions were behind high, non-removable handrails, likely to cause manual deployment problems;
- potential problems with the location and fitting of associated electrical installations for the submersible pumps, although it has not been possible to ascertain the exact causes of the port pump failure.

The exact reasons for these apparent oversights can not be determined. What is clear though, is that the current system for undertaking and recording fishing vessel surveys could be enhanced to reduce the likelihood of oversights.

It was noted that different surveyors regularly conduct the two parts of a UK FVC renewal survey. Visits are required when the vessel is both docked, to survey the hull, and afloat, to confirm the status of on board systems. Given resource requirements, it is understandable that different surveyors may be required to attend on separate occasions. Indeed, this can be beneficial, potentially leading to the identification of more issues. However, it is understood that for other vessel types, the MCA has moved recently towards the allocation of a single surveyor to a vessel. If different surveyors are to be regularly used, a robust procedure for the transfer of information collated during each of the two surveys needs to be in place; something that did not appear to occur during the survey of *Harvest Hope*.

2.8.2 Survey records

Unfortunately, the procedures for recording the surveys on *Harvest Hope* and her sister vessels appear to have been neither consistent nor robust. Survey records and reports were not always routinely filed, nor were notebooks or records, used to record the survey findings, retained. Although not on the CM files, the original copies of survey reports were retained as part of the SIAS entry process; however forms prior to 2002 were no longer held.

It would appear that there is no standard format for recording survey findings, and different surveyors tend to adopt their own approach to conducting and recording surveys. Provided the results are consistent, there is no problem in this, but if the whole survey process is to fulfil the true value that it can offer, a consistent system of recording and monitoring is essential.

There are pros and cons to using checklists for any task, but it is suggested that an appropriate aide-mémoire could not only structure and standardise the conduct of surveys, but also assist in recording the specific tests undertaken, as well as the

identified defects. It is worth noting that the NAO audit in 2001 **(see Annex AA)** also identified that MCA survey records were inconsistent, and suggested that positive checklists may be advantageous, but these are yet to be developed for fishing vessels.

It is also understood that although cameras are issued to surveyors, there is no guidance on their use during surveys. It is suggested that a simple set of photographs attached to the survey record or Record of Particulars would assist a surveyor, perhaps returning to the vessel after a long gap. These could assist in identifying any key alterations, such as a liferaft re-location, or structural change, as well as helping to record the general condition of the vessel.

2.8.3 Record of Particulars

Part of the process defined by the 1975 Rules for the surveying and certifying of fishing vessels requires the production and updating of a Record of Particulars, outlining the vessel's key design features, such as watertight openings and lifesaving equipment.

The copies of the Record of Particulars for *Harvest Hope* were neither comprehensive from the outset, nor maintained as an updated and true record of the vessel. Details of the internal watertight windows in the net drum space, although informally recorded on the original Record of Particulars prepared by the BV surveyor in Poland, were never transcribed to the official Record of Particulars. It would appear that this was because the template did not include an appropriate section to record their details. Likewise, key alterations, such as the new engine and the submersible pumps in the net drum space were not recorded, nor were the two additional net drum space tonnage valves requested by the MCA.

For fishing vessels that don't benefit from the detailed records and documentation associated with a "Classed" vessel, it is arguable that the Record of Particulars is one of *the* most important documents, due to:

- its use as the basis for re-issue of a UK FVC (in accordance with the 1975 Rules);
- its use as the basis for undertaking vessel surveys. Clearly if the record omits certain design features, then the surveyor will be less likely to survey or inspect them;
- if a vessel is latterly sold and safety-critical modifications are not recorded, then such changes may be unknown to future operators;
- its general use by owners and crew as a detailed reference of their vessel's capabilities and features.

It is noted that the original format for the Record of Particulars, form FV2 offers no method for document control, with no means of recording the date of the relevant survey(s), or the surveyor updating the record. A later version of the record, MSF 1301 does allow the recording of these details, but is currently only used for post-1998 vessels. It is therefore suggested that a major improvement to the current FV2 form would be to simply adopt the front page of MSF 1301. However, neither FV2 nor MSF 1301 contain a simple "Modifications" sheet, which could be used to quickly record vessel changes.

2.8.4 Ship Inspection and Survey (SIAS) database

SIAS is the MCA-wide database system, used to maintain a central and valuable record of surveys and inspections conducted on vessels. However a number of observations can be made about the SIAS records for *Harvest Hope* and her sister vessels, including:

- no record of the 2000 UK FVC renewal survey on *Harvest Hope*;
- an inconsistent standard for recording defect details, with often limited information included;
- no facility for identifying the surveyor conducting a survey.

Given the first point, it is clear that the procedures for confirming that survey details have been successfully entered onto the system, require review.

2.8.5 Defect rectification

It was not evident from *Harvest Hope*'s CM files that the vessel was granted a freeboard dispensation, nor indeed that part of this process required the installation of door alarms and two further tonnage valves in the net drum space. Given the lack of survey records, it was also not clear whether any MCA representative ever confirmed that the requested alterations had been carried out. It would therefore appear that there is no current procedure for highlighting and confirming that requested constructional modifications have been satisfactorily completed.

Similarly, little guidance is currently provided to MCA surveyors regarding the level of defect identified during a survey or inspection, which requires a surveyor to physically confirm rectification. Currently, any identified minor defects can be cancelled on receipt of written confirmation from a vessel's owner or agent that the defect has been addressed. However, the definition or scope of 'minor defect' to which this applies is not clear.

2.9 VESSEL CERTIFICATION

2.9.1 Short term certificates

For *Harvest Hope* and her four sisters, a number of anomalies were also identified regarding their safety certification. Once a vessel has been satisfactorily surveyed, a full UK FVC can be issued or re-issued, with a 4 year periodicity for vessels over 24m registered length. However, a Short Term Certificate (STC) can also be issued, if the issue of a full term certificate is temporarily precluded, whilst, for example, awaiting the approval of an already provided provisional stability booklet. The five vessels in fact had:

- extended periods of STCs, often lasting many years, and of varying durations;
- limited or no details of the reasons for the issue of a STC, either on the certificates or covering letters. For some certificates, it was also not clearly stated as to whether the certificate was full or short term;
- numerous gaps and lapses in certification, often for significant periods.

Particular anomalies noted were that:

- *Vandal/Aalskere* appears to have been issued with a Full UK FVC some 26 months before her provisional stability booklet was approved;
- *Harvest Hope* doesn't appear to have been initially issued with any UK FVC until after being in service for almost 20 months;
- Although *Harvest Reaper III* was issued with STCs for a number of years awaiting the approval of her stability booklet, she does not appear to have been issued with a full UK FVC following this approval.

Such certificates form the basis on which UK fishing vessels are allowed to safely operate; without a valid UK FVC a vessel can not proceed to sea. The apparent breakdown of the system for issuing and monitoring these certificates is a serious matter, requiring urgent attention and rectification. For a modern vessel, such as *Harvest Hope,* to be operating on temporary certification for nearly 5 years, while an issue relating to the safety-critical area of stability was being addressed, is clearly unacceptable. It is suggested that for vessels on STCs for extended periods of time, consideration should really be given to detaining the vessel or suspending the certification until the matter is properly resolved.

Some action on this has already been taken following the foundering of *Elegance* in 2004, when the extended duration of STCs issued to the vessel became evident. OAN 343, at **Annex U**, was issued by the MCA regarding STCs, and has tightened up their application and implementation. Although a temporary OAN, the MCA intends to include similar guidance in the forthcoming revision of its guidance available to surveyors.

Although it does not appear to be clearly defined in the relevant regulations, a fishing vessel is also required to be issued with a valid UK FVC, before she can enter or remain on the British Registry. However, *Harvest Hope* appears to have been registered on entering service and issued with a Certificate of British Registry, despite there being no records of an initial UK FVC having been issued. The current system for fishing vessel registration by the Registry of Shipping and Seamen (RSS) involves their review of monthly reports of current UK FVC certification, produced from a database maintained by the MCA's Fishing Safety Branch. RSS therefore generally do not view copies of a vessel's UK FVC. Given the anomalies observed for *Harvest Hope* and her sister vessels, it is suggested that this system requires review.

2.10 FILING SYSTEM

It is evident that the registered CM files for *Harvest Hope* and her sisters were not as complete as they should have been. Some important documents referred to were missing, while other items of key correspondence didn't seem to exist, including internal correspondence and documentation relating to policy decisions, such as freeboard dispensations. Without a proper audit trail, it is extremely difficult for the certification and survey history of a vessel to be properly interpreted. Appropriate guidance is already provided internally by the MCA on filing policy, but this appears to require reinforcement and amplification.

Also noted was the use of unregistered "Rough Office" files to record operational documentation. Clearly files can become overwhelmed if all trivial documentation is placed on the official CM files, especially for complex cases. However for *Harvest Hope,* original unique copies of documentation were filed in unofficial files, including the original BV-produced Record of Particulars, and later survey documentation. It is important that such documents are always officially filed, so that they can always be easily retrieved, and the opportunities for information being lost are minimised.

2.11 REGISTERED LENGTH

Documentary evidence appears to indicate that the vessel had two registered lengths calculated, one just below 24.4m, the other at 25.68m. The former was based on the definition applicable, prior to the application of the International Tonnage Convention (ITC) 1969, the latter using the ITC calculated length, as invoked by the Merchant Shipping (Fishing Vessels – Tonnage) Regulations 1988 **(at Annex P)**. Interpretation of these regulations does indeed indicate that the vessel's registered length should have been 25.68m, and although both values are quoted on documentation for the vessel, it is the lower value that has been used for regulatory purposes. A registered length of 24.4m represents a cut-off point in the Fishing Vessel (Safety Provisions) Rules 1975 for various system requirements. The lower value therefore would require a lesser standard of equipment and machinery than otherwise. The MCA was aware of this anomaly, and offered an exemption to the consultant from the requirements for over 24.4m vessels.

The most significant difference appears to be that *Harvest Hope* should have had a boat on board, as part of her lifesaving equipment. However, it is not suggested that the presence of such a boat would have made any difference to the outcome of this accident.

2.12 DRAUGHT MARKS

All significant vessels are fitted with marks on the sides of their hulls to allow the draughts to be read. Commonly referred to as draught marks, these are required, not only to comply with the relevant regulations, but more importantly, to assist in the operation and stability testing of the vessel. Both regulatory and practical considerations suggest that at least four marks should be fitted, two on each side of the hull, forward and aft.

Harvest Hope was originally fitted with five such sets of marks: two forward, on either side; two aft on either side, and one set on the centreline of the transom. However, there appears to have been ongoing doubts about the accuracy of the three aft marks since originally fitted, with the problem identified by the MSA surveyor visiting the vessel in Poland. It is not clear whether the problem was initially resolved, but by the time of the UK FVC renewal survey in 2000, the surveyor requested that the transom mark be re-positioned and the two aft side marks removed.

The implications are that the inclining experiments and displacement checks conducted prior to 2000 might have identified inaccurate displacements. Likewise, with the aft side marks no longer present, there was no practical means of determining the vessel's list from the remaining draught marks, again raising doubts over the accuracy of subsequent stability tests. **Figure 27** shows the transverse separation of the forward marks would have been insufficient to accurately gauge the vessel's angle of heel, from these alone.

Accurate draughts marks are an essential aid in determining the trim, list and displacement of the vessel during displacement checks and inclining experiments. It is also surprising that a vessel with a history of freeboard problems and a known starboard list problem can be permitted to dispose with the fitting of draught marks on either side of the hull.

2.13 MCA AUDIT SYSTEM

All MCA departments are subject to both regular internal and external QA audits to confirm that the processes and management systems being utilised comply with the ISO 9001 (2000) standard. It is, however, evident that none of these QA audits identified any of the many problems regarding the surveys and certification for *Harvest Hope* and her four sisters.

Given their nature, any audit can only hope to perform spot checks of a system. Indeed, it is not suggested that audits could review every CM file, or necessarily have spotted all of the above problems. However, it is proposed that they could possibly have a more technical bias, and certainly delve deeper into a random selection of cases.

It is noted that after the 2001 NAO report **(see Annex AA)**, the MCA introduced a system of "Peer Reviews", facilitating internal comparison of processes, which is a worthwhile scheme, allowing identification of best practice.

2.14 WINCH CONTROL SYSTEM

2.14.1 System design

Automatic trawl winch systems, such as the PTS 3000 system installed on *Harvest Hope* have become an essential part of the equipment on modern trawlers. However, although they offer increased trawling efficiency, they tend to be highly complex hydraulic systems, with numerous features and options.

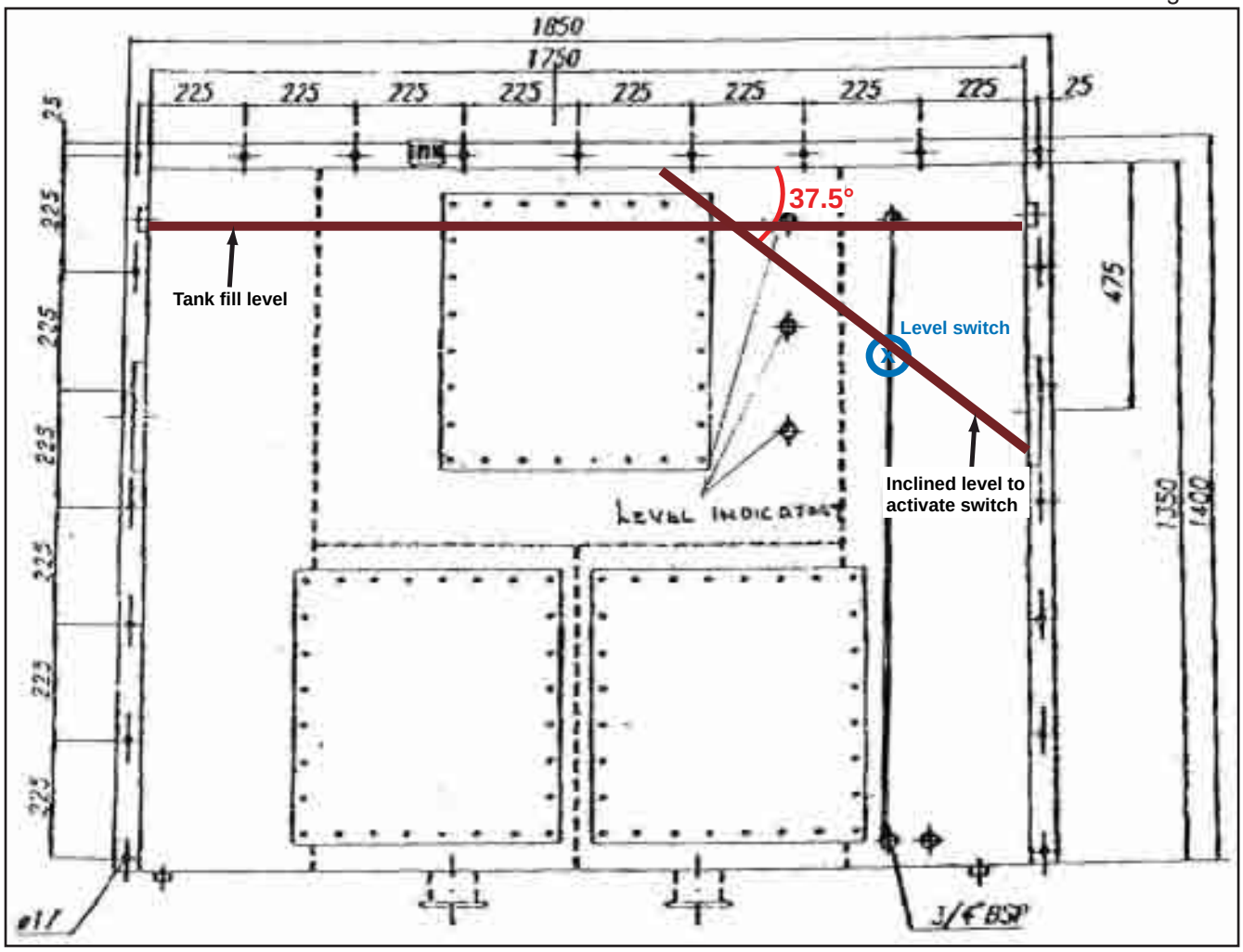
The contribution of the automatic trawl winch system to the loss of *Harvest Hope* is evident. After the vessel came fast, and main hydraulic power had been lost on board, not only could the winches no longer be operated, but band brakes, referred to as the "fail safe brakes", were engaged on the trawl winches. The only options available to release these brakes required crew members to either enter the engine room and override the loss of hydraulic pressure, or to attempt to manually release the brakes. In an emergency situation, none of these options are considered appropriate, potentially placing personnel at further risk. With no main hydraulic pressure, there was no quick, easy means of releasing the brakes. The vessel was effectively anchored to the seabed on the port side, with green seas pouring in through the port transom door. If the trawl warp tension could have been relieved more quickly, it is possible that the vessel's precarious situation might have been stabilised sufficiently to thwart capsize, and perhaps allow salvage pumps to be embarked.

Although the crew of *Harvest Hope* chose to cut the trawl warps, this required them to fetch and operate a grinder. It would have been far preferable to have had available a simple, quick and reliable, means of releasing the brakes integrated into the system, ideally requiring little or no maintenance.

It seems probable that main hydraulic pressure was lost with the activation of the low level cut-out or “Murphy switch” in the hydraulic oil tank on the starboard side of *Harvest Hope*’s engine room. The skipper could remember hearing the vessel’s hydraulics shutting down, but couldn’t recall noticing the corresponding visual and audible alarm in the wheelhouse. The latter is apparently no more than a low buzzing, and in a rapidly developing emergency scenario, it is highly likely that such an ineffectual alarm could go unnoticed. On the later PTS Pentagon system, this audible alarm has been greatly enhanced, and it is suggested that such an upgrade should also be considered for the remaining PTS 3000 systems.

Based on the descriptions of the crew, the hydraulic oil level during the voyage and the position of the “Murphy switch” have been marked on a diagram of the tank, at **Figure 42**. Although baffles were understood to be fitted in this tank to dampen the fluid motion, the level in the tank would tend to settle at angles approximating to the vessel’s angle of heel. Therefore, assuming no loss of oil during the incident, it can be seen that a heel of about 35° would have been required to activate the alarm, and shut down the main hydraulic pumps. However, the possibility of hydraulic oil system loss, perhaps when the hydraulic ram became detached from the port transom door, can also not be discounted. What is evident from **Figure 42** is that if the “Murphy switch” had been positioned more centrally in the tank, it would have been less prone to activation while the vessel was rolling or listing to port.

Figure 42



Drawing of hydraulic oil tank on *Harvest Hope* showing level of oil

The “fail safe brakes” are rightly considered an essential part of the system, preventing loss of winch control following a loss of power, while crew are working on deck. Although the “fail safe brakes” activate for all instances of trawl winch power loss on the PTS 3000 system, the later PTS Pentagon system has been enhanced with the introduction of a “safety brake feature”. This can be used to override the “fail safe brake” once 46m or 25 fathoms of warp have been shot, and skippers are recommended to have this feature enabled to avoid the type of situation encountered by *Harvest Hope*. Clearly this is a desirable facility, and consideration should be given to retrospectively fitting this to systems prior to the PTS Pentagon.

Harvest Hope is the latest in a list of vessels, where an “auto-trawl” system contributed to the vessel sinking. Prior to the foundering of both *Heather Bloom* and *Radiant*, an “auto-trawl” system prevented the quick release of the warp tension when the vessel had come fast. Both of these accidents tragically resulted in a fatality during the vessel abandonment. It is also possible that such a system contributed to the loss of *Audacious II*.

So-called “auto-trawl” systems offer sophisticated automated trawl winch technology but, when a vessel comes fast, there can be system limitations potentially endangering the vessel’s survival. It is clear that the emergency features of such systems require careful design and the crew must be aware of the system functionality, when an emergency situation begins to develop.

2.14.2 System documentation and training

Although the skippers of *Harvest Hope* were highly proficient fishermen, and described by RAPP as some of the more capable system users, it was evident that even their system knowledge could have been better.

They were, for example, not aware of the full capability of the “Potentiometer” or “Pot. Meter”, used to manually adjust the tension on the trawl warps while in an “Automatic” mode. By reducing this setting to 0%, the tension in the trawl warps could have been quickly released prior to the loss of hydraulic power to the winches. However, this capability is not obvious from any of the documentation available with the system.

Indeed, the general guidance provided with, what is a relatively expensive system, is at best, limited. It is suggested that the Trouble Shooting section of the Instruction Manual **(see Annex K)** currently provides very basic advice regarding emergency procedures, and could be significantly enhanced.

It is also noted that the true functionality of the system’s “emergency start switch” appears to be ambiguous. For the PTS Pentagon system, this feature will start the main hydraulic pumps in all scenarios, yet it is understood that for the PTS 3000 system, the switch has no effect until the “Murphy switch” has been de-activated at the hydraulic oil tank.

Although general training is provided to users by RAPP, both following system installation and during the early stages of operation, it is suggested that the important system features required, such as the “Pot. Meter” and “fail safe brakes” require further emphasis during such training, which should ideally be reiterated during regular “refresher” sessions.

It is clear, from the numerous discussions that the MAIB has had with RAPP, following this incident, to try to understand the system, that the PTS 3000 is technically complex. Unless adequate documentation and training is provided, it is difficult to determine system functionality, let alone when such knowledge is really needed, in a critical on board emergency situation.

2.15 LIFESAVING APPARATUS

2.15.1 Liferaft stowage and deployment

It is apparent that the crew experienced some difficulties during the manual deployment of the starboard liferaft. Fortunately they finally succeeded in deploying it, and it clearly contributed to saving their lives. However, any delays or hindrance to the deployment of the liferaft are of grave concern.

The canister weight was well below the maximum allowed by Rule 98(1) of the 1975 Rules, which also requires that a liferaft shall be stowed to allow deployment under unfavourable conditions of trim and up to 15° of list either way. Given the speed of *Harvest Hope*'s capsize, it seems likely that the angle of list had already exceeded 15° by the time of the liferaft deployment. The "high" starboard liferaft was selected, as the port side was already perilously near the waterline, and having to deploy a liferaft against a large prevailing list can not be easy.

Nonetheless, what is notable is that both liferafts were located behind 1.0m high permanent handrails. Although such standard rails comply with regulatory safety requirements, it is obvious that this is a far from ideal liferaft stowage location. **Figure 31** confirms that the liferafts had latterly been moved forward from their original location, and it was initially thought that this may be the reason for their unsuitable position. However, the original starboard stowage location was also behind a permanent handrail, although the port liferaft was originally stowed in the area of the folding handrail for access purposes **(see Figure 34)**. This accident demonstrates the need for careful consideration of the location and suitability of liferaft stowage positions.

2.15.2 Non-activation of port liferaft

Harvest Hope's port liferaft failed to operate or surface during the foundering. The initial assumption was that as the vessel capsized to port, it must have rolled over on top of the liferaft, thus preventing its deployment.

ROV underwater footage revealed that this liferaft was lying on the seabed in a depth of 99 metres, approximately 10m away from the port side of the wreck. Although still in its intact container, the painter was observed running fairly taut from the container and away from the hull, as shown at **Figure 21**. Unfortunately, it is impossible to ascertain from the footage what length of painter had been deployed, nor what the painter was secured to, if indeed to anything at all. However, it appears to have been no longer attached to any part of the wreck. The painters for the liferafts fitted to *Harvest Hope* are 28m long, with 26m stored internally, and 2m externally, but it was not possible to determine what length of the internal painter had been deployed from the canister.

It would seem probable that the HRU was able to release the liferaft from its cradle. Although the raft was 10 years old, it had been serviced about 6 months before the accident, and the HRU replaced. There are a number of possible reasons for the non-inflation, including:

- the liferaft canister was held down by part of the vessel, following the capsize to port, and lost its inherent buoyancy due to water ingress through drainage holes in the canister;
- having partially deployed, the painter became snagged on the vessel, and was unable to deploy sufficiently to inflate the raft. The painter latterly detached from the cradle, by which time the canister's buoyancy had been lost;
- possible poor packaging of the liferaft or incorrect assembly after an inspection;
- the liferaft was incorrectly attached to its cradle.

Although the owners of the vessel are insistent that the liferaft was correctly stowed in its cradle on the vessel, and so the latter reason can be discounted, it cannot be determined which of the other possible causes are most likely.

This is the latest instance of a fishing vessel sinking with a liferaft failing to deploy and being found in the vicinity of the wreck, including *Westhaven* and *Margaretha Maria* in 1997, and *Elhanan T* in 2003. Following the former two incidents, the MCA commissioned a study into the positioning of liferafts to minimise the possibility of entanglement in a wreck, resulting in the issue of MGN 104 (M+F). Certainly the position of the liferafts, beneath the main mast, was not ideal, but there is no evidence of specific entanglement in this case.

2.15.3 Lifejacket stowage

During the MAIB interviews with the crew, one matter raised repeatedly was the stowage location of their lifejackets, with the suggestion of a centralised upper deck stowage for quick, easy access in times of emergency.

Despite the rising flood level and increasing list, the mate bravely returned to the accommodation area on several occasions, attempting to locate sufficient lifejackets for all of the crew. However, the lifejackets were mostly stowed in individuals' lockers or bunks, and were not all located in time.

Consequently, not all of the crew were wearing lifejackets when they abandoned. Although this time it didn't matter, under a slightly different set of circumstances, it is easy to imagine that the story could have been very different. One need only refer to the loss of *Radiant* in 2002, following a fastener, and the tragic loss of one of her crew, to reiterate the importance of being able to quickly access a functional lifejacket in an emergency.

Rule 98(6) of the 1975 Rules already states that lifejackets shall be stowed so as to be readily accessible to all persons on board, with their position clearly and permanently indicated. Although it is common for lifejackets to be stowed individually, perhaps now is the time for fishermen to review this trend, and for the development of a practical and safe solution for a centralised stowage arrangement.

2.16 SUBSEA PIPELINES

2.16.1 Cause of *Harvest Hope*'s fastener

Given the underwater video footage **(see Figure 23)**, and the findings of the Boreas report at **Annex H**, it would appear that *Harvest Hope*'s trawl net became snagged on large mounds of boulder clay at the rim of the trench for the buried 4-inch MEG Shell Goldeneye pipeline. This is almost certainly a man-made hazard, probably created when the "plough" being used to flatten the trench, stalled, as described and depicted in the side scan sonar images at **Annex H**.

It is understood that *Harvest Hope* had trawled this area on a number of occasions before, and never come fast. Shell are also unaware of any previous trawler snagging incidents in the area.

2.16.2 Pipeline trawling

The skipper of *Harvest Hope* was extremely open in his admission that he had been trawling in the vicinity of pipelines. He had in fact been able to observe the location of the pipelines both using sonar equipment and FishSAFE, and was aware of the risks of coming fast on subsea hazards.

Admiralty charts and other information available to fishermen clearly highlight the risks and extreme dangers of trawling in the vicinity of pipelines. The extent of this practice is unknown, but it is common knowledge that increased numbers of fish often tend to congregate in the vicinity of certain seabed obstructions.

Despite the fact that trawling near pipelines is clearly risky, it is likely that modern commercial pressures will often tend to drive fishermen to take greater risks to catch fish, and this may include trawling in areas that otherwise might not be chosen.

The foundering of *Westhaven* in 1997, with the tragic loss of her four crew, was the first instance of a fishing vessel sinking after coming fast on a seabed pipeline. Since that tragedy, many initiatives have been instigated to enable seabed users to co-exist with a relatively low risk. Although it would appear that *Harvest Hope* is the first trawler to have been lost after coming fast on a seabed trench, the risks of trawling areas of seabed containing offshore infrastructure are still widely known, and can only be reiterated.

2.16.3 Charting of submarine pipelines

Admiralty Chart 278 covering the area where *Harvest Hope* sank only depicted two of the four seabed pipelines in the immediate vicinity of the foundering. Generic notes, both on this chart and in the annual Notice to Mariners referring to submarine pipelines, clearly state that not all pipelines are necessarily charted. The UKHO have confirmed that pipelines will not always be shown, unless they are considered "safety critical", for example, located in shallow water or isolated from other seabed obstructions, and the scale of the chart allows them to be clearly depicted. Therefore, the two later Shell Goldeneye pipelines, running closely parallel to the SAGE and Miller pipelines, were not shown on chart 278, both due to their proximity and the small chart scale of 1:200,000.

It is possible that a simple annotation could have been included on the chart to indicate that there are now four closely-located pipelines. However, it is considered reasonable to maintain overall clarity by not depicting all of the numerous seabed obstructions in the North Sea, unless considered to represent a particular risk. There are various other sources of seabed hazard data available, containing complete records of obstructions. It is essential that all seabed users are aware of the limitations of the information being used, and choose the most appropriate source for their particular needs.

2.16.4 Contact with North Sea Oil interests

In the aftermath of *Harvest Hope*'s sinking, it is apparent that the MRCC were not aware of the presence of all four seabed pipelines in the area. Admiralty Chart 278 was used to identify the two original Mobil and BP pipelines, but the MRCC only subsequently contacted Mobil to inform them of the incident. An assumption was made that, as both the Mobil and BP pipelines terminated at the same onshore terminal, only the former need be informed.

Unfortunately, the wreck and trawl gear actually contacted the seabed nearest to the pipelines operated by Shell, who only became aware of the incident several days later, and then commenced assessment action. It is paramount that the operators of pipelines or installations are made aware as soon as possible of any incident potentially affecting the integrity of their infrastructure, to allow appropriate action to be taken.

The internet website www.subseahazards.org.uk **(see Figures 18 and 19)** was developed for use by Coastguard stations in situations similar to this, and was available on the day of the incident. It appears, however, that the MRCC perception was that, as this website was only updated twice a year, Admiralty Charts were a more accurate source of seabed information.

It is noted that during the aftermath of the sinking of *Elhanan T*, in the vicinity of a subsea pipeline in August 2003, the same MRCC experienced difficulties in identifying the operators of the seabed pipelines.

It is evident that a consistent and reliable system of immediately informing all seabed infrastructure operators of any incidents potentially affecting their installations is required.

2.17 FATIGUE

There is no suggestion of fatigue among any of the crew. The skipper of the vessel was well-rested, having just rejoined the vessel after his normal trip off, and would not have been suffering from either fatigue or sleep deficit.

SECTION 3 - CONCLUSIONS

3.1 CAUSE AND CONTRIBUTORY FACTORS

The following safety issues are identified as a result of the MAIB investigation into the loss of *Harvest Hope*. They are not presented in any order of priority:

1. The vessel was knowingly trawling in the area of seabed pipelines. It is likely that her net snagged on large boulder clay mounds by a pipeline trench. [2.16.1, 2.16.2]

2. The port transom door leading into the net drum space had been left open while the vessel was trawling before the wind and sea. This initiated the flooding, but this space was not part of the "intact" volume for stability purposes, so there was no requirement for a door. [2.3.1, 2.6.1]

3. The transom doors were inward hinging and required the use of a single hydraulic ram on the outer edge of the door to close them. This single ram, as the only practical means of closing the doors, was susceptible to damage. [2.3.2]

4. Windows in the forward watertight bulkhead in the net drum space were open at the time of the accident. These windows neither had warning signs highlighting the risks of leaving them open, nor open/closed indicators fitted. [2.3.3, 2.6.3]

5. The vessel's freeboard was lower than when originally designed due to the fitting of additional ballast. The aft freeboard did not comply with the requirements of Marine Notice M975, and a 27% dispensation was granted to by the MCA in accordance with the internal Survey Memorandum 55. [2.4.1, 2.5.2]

6. The vessel's owner had had the openings for the six tonnage valves in the net drum space welded up at the side shell, as they tended to allow water ingress. [2.3.4, 2.7.2]

7. The junction box for the electric submersible pumps was located in the same non-watertight space as the pumps. [2.3.4]

8. A window in the watertight bulkhead at the forward end of the main deck accommodation was open. This would have allowed progressive flooding from the accommodation area into the fish processing space. [2.3.3]

9. A number of openings in the fish processing space were not watertight, which would have allowed progressive flooding from this space into the fish hold. [2.3.3]

10. The low level cut-out switch in the hydraulic oil the tank was positioned on the starboard side of the tank, making it susceptible to activation when the vessel was rolling or listing to port. The resultant audible alarm on the system control console was also inadequate for providing a suitable level of warning. [2.14.1]

11. The automatic trawl winch system offered no simple means of releasing high tension loads from the winches. [2.14.1]

12. The automatic trawl winch system is technically complex, making understanding of its operation and failure modes difficult. The system manual provided limited instructions, and inadequate emergency operating procedures. [2.14.2]

13. The "emergency start" function on the automatic trawl winch system's control console was misleading, only re-starting the system in certain emergency situations. [2.14.2]

3.2 OTHER SAFETY ISSUES

A number of safety issues were identified, that although not directly related to the cause of the vessel's loss, are of sufficient concern to be highlighted. Again, these are not presented in any order of priority:

1. There was no centralised storage space for lifejackets. Not all of the crew of *Harvest Hope* were able to locate and put on lifejackets as they abandoned. [2.15.1]

2. The liferaft stowage positions were behind 1.0m high non-collapsible handrails. This, combined with the heavy port list, contributed to difficulties in deploying this liferaft. [2.15.1]

3. The port liferaft did not inflate during the vessel's sinking, and was observed to be intact in its canister on the seabed, approximately 10m off the port side of the wreck, with the painter deployed to an undetermined length. [2.15.2]

4. The stability booklet for *Harvest Hope* contained neither clear guidance on the practical assessment of compliance with the required freeboards, nor did it identify all of the vessel's downflooding points. [2.5.4]

5. Admiralty Chart 278, covering the area where the vessel sank, does not depict all submarine seabed pipelines in the area. It is not unusual for Admiralty Charts to omit subsea pipelines for clarity purposes or if the pipeline locations are not considered "safety critical". [2.16.3]

6. The registered length of *Harvest Hope* appears to have been approved as 24.37m, when it was in fact 25.68m. This reduction meant that the vessel did not require to have a number of features fitted in accordance with The Fishing Vessel (Safety Provisions) Rules 1975, including a lifeboat. [2.11]

3.3 REGULATORY AND OPERATIONAL ISSUES

During the MAIB investigation a number of issues were identified relating to:

- The MCA's actions during the design and construction phases of the vessel. [2.3.4, 2.4.2, 2.5.1, 2.5.2, 2.6.3, 2.7.3]
- The MCA's survey and certification processes. [2.8.1, 2.8.2, 2.8.3, 2.8.4, 2.8.5, 2.9.1, 2.12]
- The procedures used by the MRCC for informing pipeline operators following the incident. [2.16.4]

These issues were brought to the attention of the MCA, as detailed at Section 4, and are subject to ongoing MCA action.

SECTION 4 - ACTIONS TAKEN

Following the sinking of *Harvest Hope*, and in the initial stages of the investigation into the incident, the MAIB wrote to the MCA highlighting various concerns identified regarding the design of *Harvest Hope*, which might have been of relevance to sister vessels. The MCA responded, confirming, among other things, that the only remaining vessel of this class still fishing, the longer *Aalskere*, had no openings in the forward bulkhead of the net drum space, which was now used as a store.

Other actions taken include:

The **Maritime and Coastguard Agency** has:

- Changed the arrangements for the stability approval of vessels. In 2003 the MCA Directorate of operations established a Stability Unit staffed by shipping experts employed solely on stability approvals to ensure consistent stability standards.

- Changed the arrangements for providing technical support for Marine Offices when in 2002 a strategic decision was taken to move more surveyors to the regions.

- Introduced MGN 281 (F) in 2004, which provides a revised recommended format for fishing vessel freeboard and stability book layout.

- Included in surveyor competence requirements, training for non naval architecture surveyors in stability and freeboard matters.

- Introduced OAN 464 in October 2005 regarding the identification of subsea hazards, and informing subsea operators following an incident.

- Incorporated in the draft Code of Practice for Fishing Vessels of over 24 metres reference to the recommended stowage positions of lifejackets similar to that already included in the Code of Safe Working Practice for 15m (LOA) to less than 24m (L) fishing vessels.

- In the interim, prior to the approval of the draft Code of Practice for Fishing Vessels of over 24 metres, issued an OAN advising MCA surveyors and inspectors to pay particular attention to the stowage of lifejackets on over 24 metre fishing vessels.

The **MAIB** has:

- On 11 January 2006, written to the MCA highlighting the regulatory issues identified during this investigation. The MCA accepted the concerns raised and replied stating that those issues not already addressed by earlier procedural changes (i.e. those identified above under “Actions Taken by the MCA”) would be subject to an internal inquiry by staff from the MCA Directorate of Standards Quality Assurance and Development Branch. Terms of reference for the Inquiry Team required their report to be completed by mid September 2006.

Shell UK has:

- Contracted Boreas Consultants Ltd to analyse the risks posed by the presence of *Harvest Hope*'s trawl gear in the vicinity of their Goldeneye pipelines, and the possible cause of the snagging.

  The final Boreas report, at **Annex H**, made a number of recommendations to Shell UK.

  As a result of these recommendations, Shell UK has:

- Removed the trawl gear from the seabed and returned it to the owners of *Harvest Hope*;

- Delivered a presentation to UKOOA, fisheries liaison officers, National Federation of Fishermen's Organisations and Scottish Fishermen's Federation at their annual seminar on 18 May 2006. The presentation related to the foundering of *Harvest Hope* and issues around fishing in the vicinity of pipelines. An entry has been placed in the Kingfisher fortnightly bulletin to warn fishermen of the mound and recommending that they note the co-ordinates in their fish plotter. Laminated chartlets of the area have been produced and sent to SFF for distribution to vessels likely to fish in the vicinity;

- Delivered a presentation, with the support of Boreas, to a Pipeline Users Group meeting which highlighted the procedures to be adopted when a backfill plough "stalls" to avoid the creation of seabed 'mounds'.

SECTION 5 - RECOMMENDATIONS

RAPP HYDEMA is recommended to:

2006/188 Develop a simple and quick method, requiring minimal maintenance, of releasing the “fail safe brakes” on their automatic trawl winch systems in the event of hydraulic or electrical power loss.

2006/189 Review the instruction manuals and training schedules, for their automatic trawl winch systems, to include more comprehensive system information, including:

- the use of the “Potentiometer” to quickly release trawl warp tension;
- the risks associated with the activation of the “fail safe brakes” following a seabed fastener, and a description of the means available to release the brakes.

and to place more emphasis on the above during system training.

Marine Accident Investigation Branch
August 2006