Report of the investigation of the fire on board

Multitank Ascania

in the Pentland Firth

on 19 March 1999

Marine Accident Investigation Branch
First Floor, Carlton House
Carlton Place
Southampton
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Report No 22/2000

Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1999

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

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACGIH	:	American Conference of Governmental Industrial Hygienists
ATSDR	:	Agency for Toxic Substances and Disease Registry
BA	:	British Admiralty
BCH Code	:	*Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (for tankers built before 1 July 1986)*
°C	:	degrees Celsius
CO_2	:	Carbon dioxide
dwt	:	deadweight tonnage
EmS	:	*Emergency Schedule*
ETV	:	Emergency towing vessel
gt	:	Gross tonnage
kg	:	Kilogramme
kW	:	Kilowatt
m	:	metre
m^3	:	Cubic metre
MAIB	:	Marine Accident Investigation Branch
MARPOL 73/78	:	*International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978*
MCA	:	Maritime and Coastguard Agency
MFAG	:	*Medical First-Aid Guide*
IARC	:	International Agency for Research on Cancer
IBC Code	:	*International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (for tankers built after 1 July 1986)*
IMDG Code	:	*International Maritime Dangerous Goods Code*
IMO	:	International Maritime Organization
RNLI	:	Royal National Lifeboat Institution
SOLAS	:	*International Convention for the Safety of Life at Sea (SOLAS)*
UN	:	United Nations
UTC	:	Universal co-ordinated time
VHF	:	Very high frequency
WHO	:	World Health Organisation

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SYNOPSIS

The Marine Accident Investigation Branch (MAIB) was contacted by Pentland Coastguard at 0453 on 19 March 1999 and informed that a chemical tanker was on fire and drifting in the western approaches to the Pentland Firth. An investigation was started that day.

Multitank Ascania, a Tuvalu registered chemical tanker of 2,780 gross tonnage with 1,800 tonnes of vinyl acetate monomer on board, was on passage from Eastham towards Teesport, via the Pentland Firth. Shortly before 0245 on 19 March, while approaching the Firth, a fire broke out in the machinery spaces.

The crew responded properly by attempting to extinguish the fire using portable extinguishers, and then flooding the machinery spaces with the fixed CO_2 system. At 0305, the master contacted Pentland Coastguard. Immediate assistance was arranged and, with the agreement of the master, the coastguard broadcast a "Mayday Relay".

Various search and rescue units were tasked and the Orkney harbour's tug *Einar*, which was secured to her mooring buoy in Scapa Flow, was made available and got underway to assist.

By 0537, all the crew except the master, had been airlifted off. With the casualty drifting towards land, the tug *Einar* was able to connect a tow rope to a mooring line that had been lowered from the tanker's bow. She started to tow the tanker clear of the Dunnet Head peninsular, but after about 20 minutes the connection parted. The master then let go an anchor, and the Thurso lifeboat recovered the mooring rope in an attempt to tow the vessel clear of the headland.

The anchor eventually held in a position approximately 7 cables off Scarfskerry Point. The master was then evacuated by helicopter and, at 0836, the coastguard invoked its powers of intervention. A temporary exclusion zone was established around *Multitank Ascania*, which involved the evacuation of up to 600 people from their homes in the affected area.

At 1026 the following morning, two salvage personnel were lowered on to the vessel. An hour and a half later the salvage master reported that the fire appeared to be out. The vessel was eventually towed to safety. There was no pollution, only minor injuries and the damage was light.

The fire was caused by thermal oil leaking from a thermal oil pump mechanical seal and/or a nearby flanged joint on a pressure relief valve. Cause of ignition has not been positively identified. The quantity of oil involved was little more than $1m^3$.

Recommendations are aimed at improving measures to prevent, and extinguish, similar fires in the future, and to reduce unacceptable risks associated with loaded chemical tankers when transiting particular areas of concern.

Figure 1

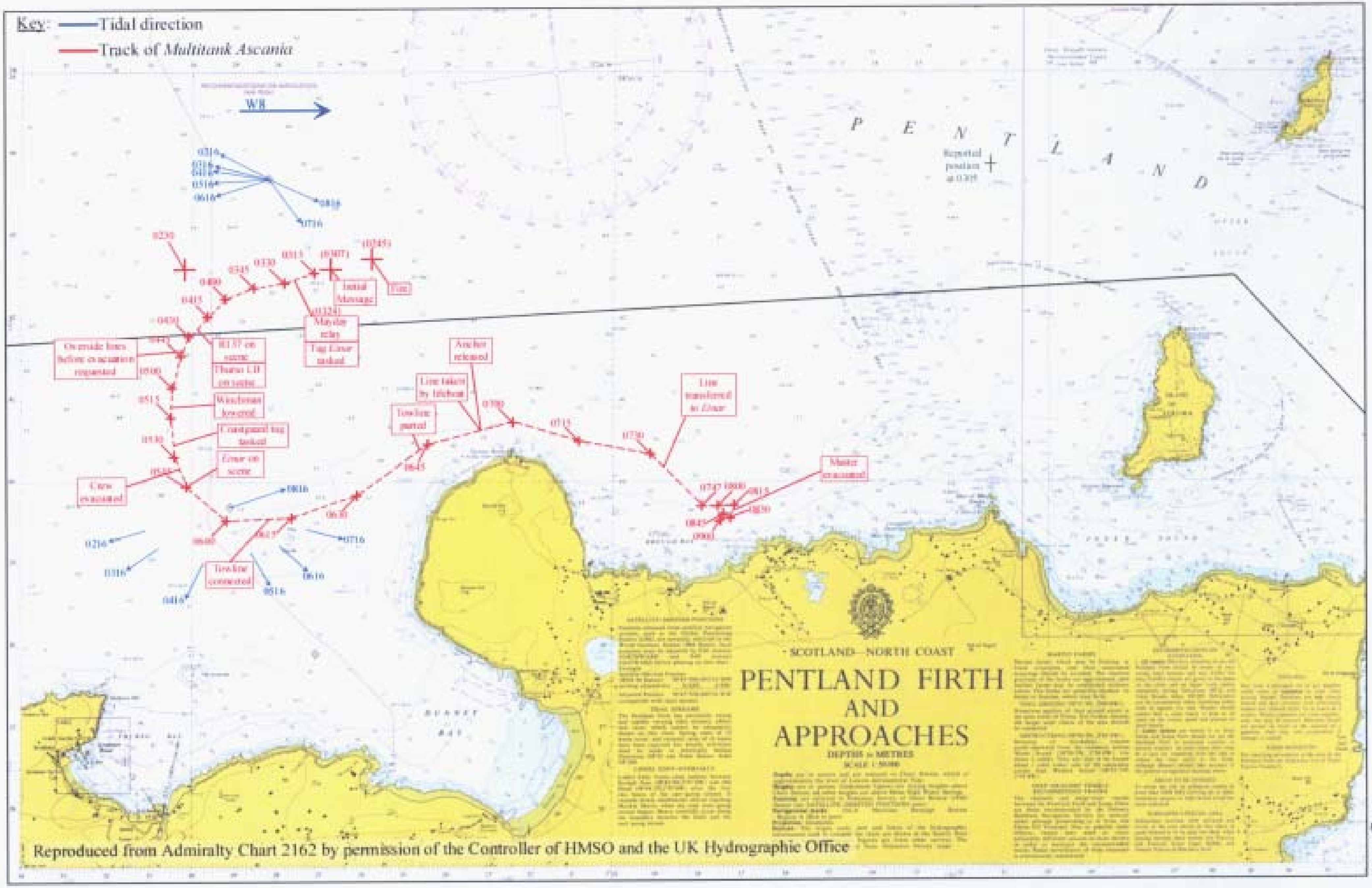
Multitank Ascania

PARTICULARS OF VESSEL AND ACCIDENT (Figure 1)

Name	:	*Multitank Ascania*
Official number	:	006
LR number	:	8003905
Port of registry	:	[1]Funafuti, Tuvalu
Type	:	Chemical tanker, IMO type 2
Cargo	:	Vinyl acetate monomer UN No 1301
Gross tonnage	:	2,780
Deadweight	:	4,034
Length overall	:	102.77m
Breadth	:	14.00m
Maximum draught	:	5.45m
Engine power	:	1,721kW
Owner	:	C F Ahrenkiel Shipmanagement
Classification society	:	Germanischer Lloyd
Place and year of build	:	Germany, 1981
Place of accident	:	Pentland Firth, 58° 43'N 003° 26'W
Date and time	:	19 March 1999, 0245 (UTC)
Injuries	:	Four, smoke inhalation
Damage	:	Heat and smoke damage to engine room casing and smoke damage to accommodation

[1] Tuvalu, formerly the Ellice Islands, is a South West Pacific State of nine islands with a total land area of 26 sq km and a population of about 10,000. Funafuti is the capital, with a population of about 2,800.

Figure 2



Key: Tidal direction
Track of *Multitank Ascania*
W8
P E N T L A N D
Reported position at 0305
Initial Message
Fire
Mayday relay
Tug Eraer tasked
Override lines before evacuation requested
0137 on scene
Thurso LB on scene
Winchman lowered
Coastguard tug tasked
Eraer on scene
Crew evacuated
Towline connected
Towline parted
Line taken by lifeboat
Anchor released
Line transferred to Eraer
Master evacuated
SCOTLAND–NORTH COAST
PENTLAND FIRTH
AND
APPROACHES
DEPTHS in METRES
BUNNET BAY
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SECTION 1 - FACTUAL INFORMATION

All times are UTC.

1.1 Narrative (Figure 2)

1.1.1 On the afternoon of 13 March 1999 *Multitank Ascania* sailed from Bayonne, France for Eastham, Liverpool, with a cargo of 2,703 tonnes of vinyl acetate monomer.

She arrived at her destination during the morning of 16 March and discharged 903 tonnes of cargo. She left Eastham the following morning bound for Teesport on the east coast of England. She sailed northabout with the intention of transiting the Pentland Firth, and had an estimated time of arrival at 2400 on 19 March. Her final discharge port was to be Antwerp.

1.1.2 At 1730 on 18 March the two engineers and the motorman finished their work for the day. The chief engineer was duty engineer and set the engine room alarm system to sound in his cabin, the messroom and the bridge.

The chief engineer made further checks of the machinery spaces at 1830, 2000, 2200 and 2400. All appeared normal.

Between 1830 and 1900 a machinery alarm activated. It was found to be a low-level alarm on the expansion tank of the secondary thermal oil heating system which had been set off by the rolling motion. This system was not in use and the alarm system was reset.

At 2300, the bridge watchkeeping seaman conducted a fire round. This included an inspection of the machinery spaces.

Having completed his midnight check of the engine room, the chief engineer spent about 20 minutes talking to the second officer on the bridge before retiring to his cabin and bed.

Multitank Ascania rounded Cape Wrath at about 2230 and was approaching the Pentland Firth between the north coast of mainland Scotland and the Orkney Islands.

It was a foul night with a westerly gale blowing and very rough seas.

It was spring tides.

<u>The fire</u>

1.1.3 Shortly before 0245 the next morning, Friday 19 March, the fire alarm sounded in both the chief engineer's cabin and on the bridge. The chief engineer awoke and went immediately to investigate the source, and by the time the officer of the watch, the second officer, telephoned him he had already left his cabin and was on his way to the engine room. He was seen doing so by the bridge watchkeeping seaman who was in the galley and had also heard the alarm.

On entering the engine room the chief engineer went aft on the starboard side and seeing traces of smoke, stopped the accommodation fans. When he realised the smoke was coming from the other side, he moved forward and over to port, and then aft through the generator room to the boiler flat. There he saw flames, about 1m high, coming from the thermal oil circulating pumps, but could see no obvious discharge of oil feeding the flames.

He switched off the circulating pump at the control panel and then attempted to tackle the fire using a portable foam extinguisher.

1.1.4 Meanwhile, the bridge watchkeeping seaman had seen black smoke coming from the funnel door. He ran to the bridge to alert the second officer who telephoned the master and activated the general alarm.

Realising he could not tackle the fire alone, the chief engineer ran to fetch the second engineer from his cabin. While doing so he met the chief officer and described the extent of the fire. On returning to the engine room he carried a CO_2 extinguisher taken from the control room and used this on the fire. It appeared to have little effect.

The second engineer then arrived in the engine room carrying another extinguisher and the two made further, unsuccessful, attempts to tackle the fire. The spread of smoke forced them to evacuate the space.

Meanwhile, the master had arrived on the bridge followed by the chief officer and the radio officer. The master took over charge of the ship allowing the second officer to join other crew members on the poop deck by the funnel.

Moving to the control room, the two engineers stopped the generator and telephoned the bridge requesting the main engine be stopped. The master put the propeller pitch control to neutral, but the main engine continued to run. The emergency generator started automatically and came on load a few seconds after the generator had stopped.

1.1.5 The chief officer, having told the master that it was not possible to extinguish the fire locally, was instructed to close all ventilation flaps and doors to the engine room and prepare to activate the CO_2 flooding system.

After ensuring the engine room doors were securely closed, the two engineers went out on deck. The chief officer relayed the master's instructions to the chief engineer, while the second officer reported to the master that all crew members were accounted for. The chief and second engineers closed the quick-closing fuel valves, and stopped the ventilation fans and the fuel transfer pumps. With the help of other crew members who had mustered on deck, they also closed ventilation flaps and dampers to the engine room. Attempts to open the dumping valve on the thermal oil header tank inside the funnel poop deck door, were thwarted by heat and smoke.

The chief engineer then went to the bridge and asked the master to activate the main engine emergency stop. After stopping the main engine at about 0255, and with the chief engineer's agreement, the master ordered the engine room be flooded with CO_2.

The chief engineer returned to the poop deck and activated the CO_2 system at the funnel control panel. He then went forward to the main CO_2 room to check that the system had worked fully.

The second engineer meanwhile started the emergency fire pump before returning aft to the poop deck. Crew members had run out two fire hoses, coupled them to the fire main on the poop deck and started cooling the funnel and surrounding deck areas.

The rescue

1.1.6 At 0305, the master called Pentland Coastguard on VHF radio channel 16 before transferring to channel 67. He reported there was a fire in the boiler room of his vessel, that the main engine was stopped and that he was drifting 3 miles north-west of Stroma with 15 people and 1750 tonnes of vinyl acetate monomer UN No1301 on board. He added that the CO_2 system had been operated. Pentland Coastguard suggested that it should broadcast a "Mayday Relay" and arrange for assistance to standby the vessel. The master agreed.

Notwithstanding this action, the master was optimistic the fire would be extinguished quickly, and that it would be possible to re-enter the engine room after about an hour. He would then be in a position to restart the main engine. He was also confident the vessel would remain in a safe position and, hence, did not calculate her anticipated drift.

He had mistakenly interpreted the radar echo of the Dunnet Head peninsular as that of the Island of Stroma some 8 miles further along his track. He was, at 0305, 3 miles north-west of Dunnet Head.

Pentland Coastguard tasked the Longhope RNLI lifeboat at 0311, and requested helicopter support from Kinloss Air Rescue Co-ordination Centre (ARCC) at 0314. Orkney Harbour Authority was also asked to monitor the casualty on radar. At 0323, the Orkney Harbour tug *Einar*, lying secured to her mooring buoy off the Island of Cava in Scapa Flow, was tasked to proceed. A minute later a "Mayday Relay" was broadcast by Pentland Coastguard.

By 0335, Pentland Coastguard had established that the vessel was about 3 miles north-west of Dunnet Head and, realising her predicted drift would be westwards, tasked the Thurso RNLI lifeboat at 0340. The coastguard then attempted to contact a number of tug brokers with the aim of identifying suitable towing vessels. None were available. The vessel's owner was also contacted and informed about what was happening.

Einar got underway and reported her estimated time of arrival at the scene at between 0500 and 0530. The tugmaster's intention on arrival was to pass a messenger rope to *Multitank Ascania* by means of a rocket line, and connect two towing pendants in the form of a bridle.

1.1.7 By 0354, smoke was still leaking from the engine room. The master interpreted this to mean that the fire had not been extinguished. He called Pentland Coastguard to ask if any help was on the way, and was told that a helicopter and a lifeboat had been tasked to assist and would be able to evacuate the crew if he wished. At 0411, the master asked the coastguard to confirm that the owner had been contacted and was informed that he had. The master saw no need to communicate with the owner himself.

By 0413, the master recognised he had previously passed an incorrect position to Pentland Coastguard and reported that he was now at 58°41'N, 003°30.5'W. As the tide began to turn, *Multitank Ascania* began to drift southwards towards Thurso Bay.

The Longhope RNLI lifeboat arrived on scene at 0424 but had to depart for Scrabster almost immediately following an injury to one of her crew. The Thurso RNLI lifeboat and rescue helicopter R137 arrived a minute later.

1.1.8 The master then discussed the situation with his officers to establish whether or not to evacuate the crew. In view of the prevailing circumstances, he considered that to do so by lifeboat would be impossible. Not only was he having to contend with a fire, but he realised there was now a risk that *Multitank Ascania* might ground as she drifted to the south towards land. He decided that evacuation by helicopter at that time would be the best option because he wanted to ensure that his crew were off the vessel before she grounded.

At the same time he thought the smoke leaking from the engine room was reducing, and it occurred to him that if he were to remain on board he might be able to do something to prevent the vessel grounding and so save the vessel. He had previously discussed the option of anchoring with the chief officer, but had decided that there was a risk of the anchor dragging in the deep water.

At 0437, the pilot of rescue helicopter R137 told *Multitank Ascania* that following a practice approach, he would lower a winchman on to the aft deck. By now the vessel was on a northerly heading and rolling heavily with the wind on the port beam. Because of this the helicopter had difficulty lowering a winchman, and consideration was given to turning the vessel into the wind using the Thurso lifeboat to pull the bow round. No one, however, was made available on board the casualty to take a towline. *Multitank Ascania* was now 3.7 miles north-west of the Dunnet Head peninsular.

At 0443, Orkney Towage Company Ltd requested Pentland Coastguard to make sure that those on board *Multitank Ascania* put lines over the side before the crew were evacuated because it would be impossible for anyone to transfer from *Einar* in the prevailing weather conditions. At 0448, Pentland Coastguard broadcast the tug's estimated time of arrival as 0530, and asked the rescue helicopter to tell *Multitank Ascania* to rig lines if it was intended to evacuate the entire crew.

1.1.9 A hi-line (a weighted guideline) was passed from the helicopter to the aft deck at 0503. The winchman was lowered at 0511 and, once on deck, was informed by the crew that the situation was getting worse. The evacuation was started immediately. The helicopter's intention at that stage was to lift off as many of the crew as possible.

While this activity had been taking place, the coastguard tug *Anglian Prince* had been at anchor in The Minch. She was tasked by Pentland Coastguard at 0520.

Seven minutes later at 0527, Pentland Coastguard broadcast a reminder for *Multitank Ascania* to run lines if possible before totally evacuating the vessel.

By 0537, all the crew except the master, who said he wanted to remain on board, had been airlifted from the vessel. The winchman was then recovered and the helicopter departed for Wick to land the survivors who reported that the situation on board was deteriorating and that the vessel was about to explode.

1.1.10 As soon as the helicopter had departed, the master took a telephone call from the owner. Explaining the situation, the master said that although he could not be sure, he hoped the fire was out and that he intended to anchor the vessel. When asked when the tug was expected, the master said he was unsure but thought it would be in about an hour. He was unaware that *Einar* was already in his immediate vicinity. The owner then enquired about the expected drift and learned that the master was unsure whether the vessel would pass clear of the Dunnet Head peninsular. Having not previously considered using a tug, the master thought it would be advantageous to make the tug fast once it had arrived. The owner suggested that the helicopter might be able to land people back on board to connect the tug. In the meantime he agreed that the master should attempt to anchor the vessel.

At 0545, the master told Pentland Coastguard that he would lower a mooring rope from the bow ready to connect the tug. Immediately afterwards, *Einar* reported he was lying off *Multitank Ascania*'s bow and asked the master to lower a mooring line from either the bow or stern. The tug also asked whether it would be safe to fire a rocket line and if the vessel had power forward. Pentland Coastguard replied that on the basis of the information held, it would not be safe to fire a rocket line and it was not known whether there was power forward. As this exchange was taking place the master was already making his way forward.

The master lowered about 100m of mooring rope from both the bow and stern. *Einar* recovered the bow rope at 0601 but her master considered the sea conditions were too rough for his crew to work on the aft deck safely, and decided to tow the vessel bow-to-bow. The shackle required to secure his polyester towing rope to *Multitank Ascania*'s bow rope was, however, too large to pass through the foredeck fairlead. Therefore, the eyes of both the bow rope and the tug's polyester towing rope were secured by using about eight turns of a messenger rope. The tugmaster considered this would be as strong as the mooring rope. Going astern *Einar* then started to tow the casualty in an attempt to clear the headland. By this time the tide had turned again and *Multitank Ascania* was drifting in an easterly direction. She was 2.5 miles west of the peninsular.

1.1.11 At 0617, the owner confirmed to Pentland Coastguard that *Lloyds Open Form* had been agreed with Orkney Towage Company Ltd.

Four minutes later at 0621, Pentland Coastguard received confirmation from the casualty's master that he would be able to anchor the vessel if necessary.

Shortly afterwards, the messenger connecting the towing rope and the bow rope parted. The time was 0643. Pentland Coastguard then told the master he would be evacuated, and requested him to let go an anchor. Rescue helicopter R137, which was now at Thurso, was requested to return to the vessel to evacuate the master. It was unable to respond immediately and reported a starting problem.

The master attempted to let go the port anchor but was unable to do so. It would not drop. He then let go the starboard anchor to about 7 shackles in the water and reported this to the coastguard at 0655. He added that he now wished to be evacuated. With R137 still out of commission, the coastguard rescue helicopter OH at Stornoway was tasked to proceed at 0657.

By this time, the Thurso RNLI lifeboat had recovered the bow rope from *Multitank Ascania* and was attempting to tow her to the north in an effort to keep her clear of the land. The Longhope lifeboat had returned meanwhile and was standing by in close proximity.

While awaiting the helicopter, the master put the end of a fire hose into the cofferdam between the accommodation and cargo area in an attempt to provide additional boundary cooling.

1.1.12 By about 0700 *Multitank Ascania* was in a position some 4 cables off Dunnet Head and had begun to drift in an east-south-easterly direction towards the next headland. The Thurso lifeboat and *Einar* discussed the feasibility of connecting a stronger towline from the tug and, at 0731, the lifeboat let go the bow rope from *Multitank Ascania*. *Einar* recovered it at 0746 and the lifeboat stated its intention to transfer two of its crew to *Multitank Ascania* to connect a stronger towline from *Einar*. This plan was however aborted on the instruction of the Divisional Inspector of Lifeboats due to a perceived risk of an explosion from the burning vessel. At about this time *Multitank Ascania*'s anchor was reported to be holding in a position approximately 7 cables off Scarfskerry Point.

Coastguard rescue helicopter OH arrived on scene at 0813 and airlifted the master from the vessel at 0819. Shortly before he left, the master noted that the radar picture had disappeared from the screen and that there was no longer any pressure on the fire main.

When questioned by the helicopter crew, the master said the fire was still burning but was, in his opinion, sufficiently contained to enable crew to return on board to secure a stronger line to the tug.

1.1.13 At 0836, the Maritime and Coastguard Agency's (MCA) Director of Operations, invoked powers of intervention and established a temporary exclusion zone of 2 miles radius around *Multitank Ascania*. He also requested a temporary danger area of 5 miles radius on the casualty, up to a height of 30,000 feet. This was established at 0846 by Kinloss ARCC. At this time, the police, working in conjunction with the local authority, were implementing a land evacuation plan in an area embracing all territory within a 5 kilometre radius of *Multitank Ascania.* The decision to do so was made having received advice from AEA Technology's National Chemical Emergency Centre that everyone should be removed from the vicinity. As a result, up to 600 people were evacuated from their homes.

At 0902, Pentland Coastguard asked rescue helicopter OH to attempt to identify any heat source using its thermal imaging camera. At 0910, the helicopter reported that the engine room and funnel area were very hot and that smoke was coming from the engine room ventilators. At 0924, Pentland Coastguard instructed *Einar* to release the bow rope and to remain at least 2 miles clear of the vessel.

At 1132, in consultation with the police, the temporary exclusion zone was increased to 5 kilometre so that land and sea exclusion zones were of the same radius.

During the day, the rescue helicopter made further flights over *Multitank Ascania*. At a later stage the aircraft carried a fire officer and a salvage master. No blistering of paint around the engine room nor other signs of heat forward of the accommodation were seen but an initial increase of smoke and heat in the vicinity of the engine room and accommodation was reported.

The coastguard tug *Anglian Prince* arrived at the edge of the temporary exclusion zone at 1440 and took up station.

At 1702, with the vessel maintaining her position and the fire apparently contained in the engine room, it was decided to wait until the following morning before taking any further action.

The wind strength reduced overnight to force 3.

At 1026 the following morning, two salvage personnel were lowered on to *Multitank Ascania* and, at 1157, the salvage master reported that the fire appeared to be out. Further personnel were then transported to the vessel and salvage operations were started.

1.2 Environmental conditions

The wind was initially westerly force 8 with hail showers and very rough seas. The tidal stream flowed initially in a westerly direction before turning southerly at about 0430, and easterly at about 0600. Tides were at springs.

High water at Wick on 19 March was 0011 with low water at 0558.

1.3 Vessel description and certification (Figure 3)

1.3.1 *Multitank Ascania* was one of four sister vessels operated by the same company. Cargo could be carried in a total of 21 tanks, all separated from the outer hull

General arrangement

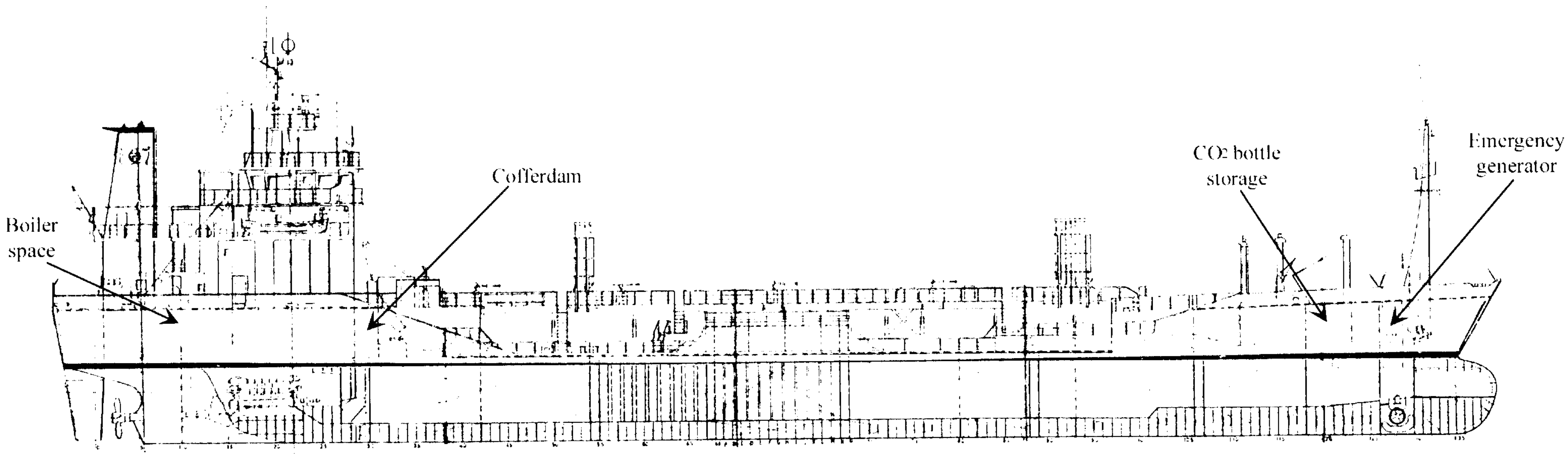


Figure 3

according to the requirements of the *Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH Code)* for a type 2 chemical tanker.

Aft of the cargo tanks was a cofferdam separating the aftermost tanks from the engine room. The engine room extended upwards, above the level of the main deck to form the poop deck.

A catwalk leading to the forecastle from the poop deck, ran along the centreline of the vessel.

The accommodation deckhouse was on the poop deck, with the wheelhouse at its upper level. The funnel was situated aft of the deckhouse.

1.3.2 All statutory survey certificates were valid.

1.4 Requirements for chemical tankers

Under the provisions of the *International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78)*, chemical tankers constructed before 1 July 1986 must comply with the provisions of the *BCH Code*.

The requirements for *Multitank Ascania* to comply with the *BCH Code* are also contained within *The Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 1996*. These Regulations apply to United Kingdom vessels wherever they may be, and to other vessels while they are in United Kingdom territorial waters.

The *BCH Code* sets out minimum requirements for chemical tankers carrying noxious liquid substances. Vinyl acetate monomer is listed as having a pollution category C, posing a safety hazard and requiring a ship type 3 for its transport at sea.

- *A type 3 ship is designed to carry products of sufficient hazard to require a moderate degree of containment to increase survival capability in a damaged condition.*

  A ship of this type is required to be capable of sustaining a specified level of collision and stranding damage but there are no special requirements for the location of its cargo tanks.

- *A type 2 ship is designed to transport products which require significant preventive measures to preclude the escape of such cargo.*

  A ship of this type is required to be capable of sustaining the same level of collision and stranding damage as a type 3 ship. However, cargo tanks are required to be located outside areas of specified damage and nowhere closer to the ship's shell than 760mm.

- *A type 1 ship is designed to transport products which require maximum preventive measures to preclude escape of such cargo.*

This type of ship is required to be capable of withstanding a greater level of collision and stranding damage than types 2 and 3.

Multitank Ascania was built in 1981 and met the requirements of a type 2 ship.

1.5 Cargo

1.5.1 *Multitank Ascania*'s cargo, carried in bulk, was 1800 tonnes of vinyl acetate monomer. A safety data sheet for vinyl acetate monomer was displayed in the wheelhouse.

The *International Maritime Dangerous Goods (IMDG) Code* indicates that vinyl acetate monomer UN No1301 has a flashpoint of -8°C, is a colourless to slightly yellow liquid and is immiscible with water. It is classified as a class 3.2 flammable liquid. Explosive limits are quoted as between 2.6% and 14% by volume when mixed with air.

Further advice is contained in the *Emergency Schedule (EmS)* and *Medical First Aid Guide (MFAG)* supplements to the *IMDG Code*. The *EmS* advises that any fire or spillage involving vinyl acetate monomer should be tackled by personnel wearing protective gloves, boots and breathing apparatus. In the event of fire, the fire-fighting medium should be foam, dry powder or water spray. The *MFAG* indicates that vinyl acetate monomer is a member of a group of substances which may vary in their toxic effects but are mainly irritants which also cause depression of the nervous system.

MARPOL 73/78 categorises vinyl acetate monomer as a category C substance, which it defines in regulation 3 of Annex II as a:

- *Noxious liquid substance(s) which if discharged into the sea from tank cleaning or deballasting operations would present a minor hazard to either marine resources or human health or cause minor harm to amenities or other legitimate uses of the sea and therefore require special operational conditions.*

Categorisation of substances is expressed on a scale A,B,C,D. Those considered to offer the greatest risk to aquatic life and human health are placed in category A; those offering the least in category D. Substances which are considered to offer no risk are listed as "other liquid substances".

1.5.2 Data supplied by AEA Technology's National Chemical Emergency Centre are as follows:

Specific gravity = 0.934 (water = 1)
Vapour density = 3 (air = 1)
Auto ignition temperature = 400°C

This source adds that vinyl acetate monomer is readily biodegradable and unlikely to bio-accumulate.

1.5.3 The International Agency for Research on Cancer (IARC), an arm of the United Nation's (UN) World Health Organisation (WHO), classifies vinyl acetate monomer as *possibly* carcinogenic to humans.

1.5.4 The United States Environmental Protection Agency quotes laboratory test results on rats and concludes that vinyl acetate monomer is a possible human carcinogen.

1.5.5 The American Conference of Governmental Industrial Hygienists (ACGIH) considers that it is not likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.

1.5.6 A third American source, the Agency for Toxic Substances and Disease Registry (ATSDR), makes no conclusion on the carcinogenic classification of vinyl acetate monomer and mentions the lack of data on the subject.

1.5.7 Other authorities offer no clear guidance on the substance's likely effects on humans and do not classify the substance as carcinogenic or otherwise damaging to humans.

1.6 Particulars of crew

1.6.1 *Multitank Ascania* carried 15 crew. These were:

master	chief engineer	pumpman/bosun
chief officer	second engineer	able seamen (3)
second officer	motorman	ordinary seamen(2)
radio officer	cook	steward

The master was German, the officers were Croatian, and the ratings were from either Tuvalu or Fiji.

1.6.2 The master held a German master's certificate of competency in respect of cargo vessels up to 8,000gt operating in any trading area. He also held various ancillary qualifications, but had not received specific training in bridge teamwork or crisis management. He had been employed by the vessel's owner in the capacity of master since 1990, and had served regularly on *Multitank Ascania* and her three sister vessels. He joined the vessel most recently in November 1998.

The chief officer had also served on the four sister vessels. He and the second officer joined *Multitank Ascania* in December 1998.

At sea, the master, chief officer and second officer each stood a watch. An additional watchkeeping seaman was employed between 1800 and 0600.

The radio officer held a general operator's certificate of competency and joined the vessel on 5 February 1999.

1.6.3 The chief engineer had worked for the vessel's owner since 1997 and had served on the three sister ships to *Multitank Ascania*. He joined the vessel in January 1999. He was qualified to serve as chief engineer on vessels with an engine power of up to 3,000kW.

The second engineer joined the company in June 1998 and had served on one sister ship before joining *Multitank Ascania* in December 1998.

The motorman joined the vessel in December 1998. He had over 20 years experience at sea as a motorman.

All machinery space duties were performed by the chief and second engineers and the motorman. The engineers normally worked daywork hours but shared out-of-hours duties when called by the alarm system. The motorman's normal duties covered daywork hours only.

The machinery spaces were normally operated unattended with the vessel at sea. However, the two engineers took responsibility for the machinery outside daywork hours on alternate nights.

1.7 Main machinery

1.7.1 Main propulsion power was from a single 12-cylinder B&W Alpha main engine, geared to a single shaft driving a controllable pitch propeller. The main engine was rated at 1,721kW output and ran on heavy fuel oil.

Control of the main engine and propeller was normally conducted from the bridge. The machinery spaces were usually unmanned outside normal daytime working hours. Alarm panels in the engineers' cabins and mess room provided the means of alerting the designated duty engineer to machinery problems or fire. Machinery alarms were indicated by a continuous sound and the fire alarm by an intermittent sound.

1.7.2 Three diesel powered generators supplied electrical requirements; each was of 208kW and ran on marine diesel oil. These units were fitted on a flat above the main engine and level with the machinery control room.

Aft of the generator flat was a boiler space housing a thermal oil boiler and circulating pumps. This space was immediately beneath the funnel and below the poop deck level.

1.8 Fuel heating

To ensure acceptable engine performance, heavy fuel for the main engine was heated to between 120°C and 130°C. For this purpose heavy fuel oil was passed through a heat exchanger supplied by hot thermal oil. The heavy fuel oil pressure was 4bar.

Fuel for the auxiliary engines was marine diesel and required no heating before use.

1.9 Thermal oil system

1.9.1 The function of the thermal oil heating system was to heat cargo and fuel. The vinyl acetate monomer cargo required no heating. Therefore for the voyage from Eastham to Teesport the thermal oil system was only required to heat the fuel for the main engine.

The system's oil-fired boiler, exhaust gas boiler and circulating pumps were positioned in the boiler room beneath the funnel. The system's header tank was at a slightly higher level within the funnel casing.

Thermal oil could be heated by either the exhaust gas boiler, with the main engine running, or by the oil-fired boiler. If the main engine's load was insufficient to produce the required exhaust gas boiler output, the oil-fired boiler could be used in parallel. Temperature of the thermal oil was maintained at 220°C at the boilers' outlets, then circulated around the external system by pumps which were also within the boiler room.

1.9.2 The system's header tank normally contained approximately $1m^3$ of oil, filling half the tank's volume, with the ullage space pressurised with inert gas to about 1bar. Low-level alarms monitored the tank's liquid contents.

A valve in the lower part of the header tank could be used to dump the tank's contents to a drain tank in the lower part of the engine room. Access to the header tank, and its dump valve, was from the door in the starboard side of the funnel, or by a ladder from the aft end of the boiler room.

1.9.3 The system's normal operating pressure was 6bar, but due to pressure losses caused by friction etc, it varied throughout the system. At the main engine's fuel oil heater, the thermal oil pressure was normally 3.5bar. Fuel oil pressure at this heater was about 4bar.

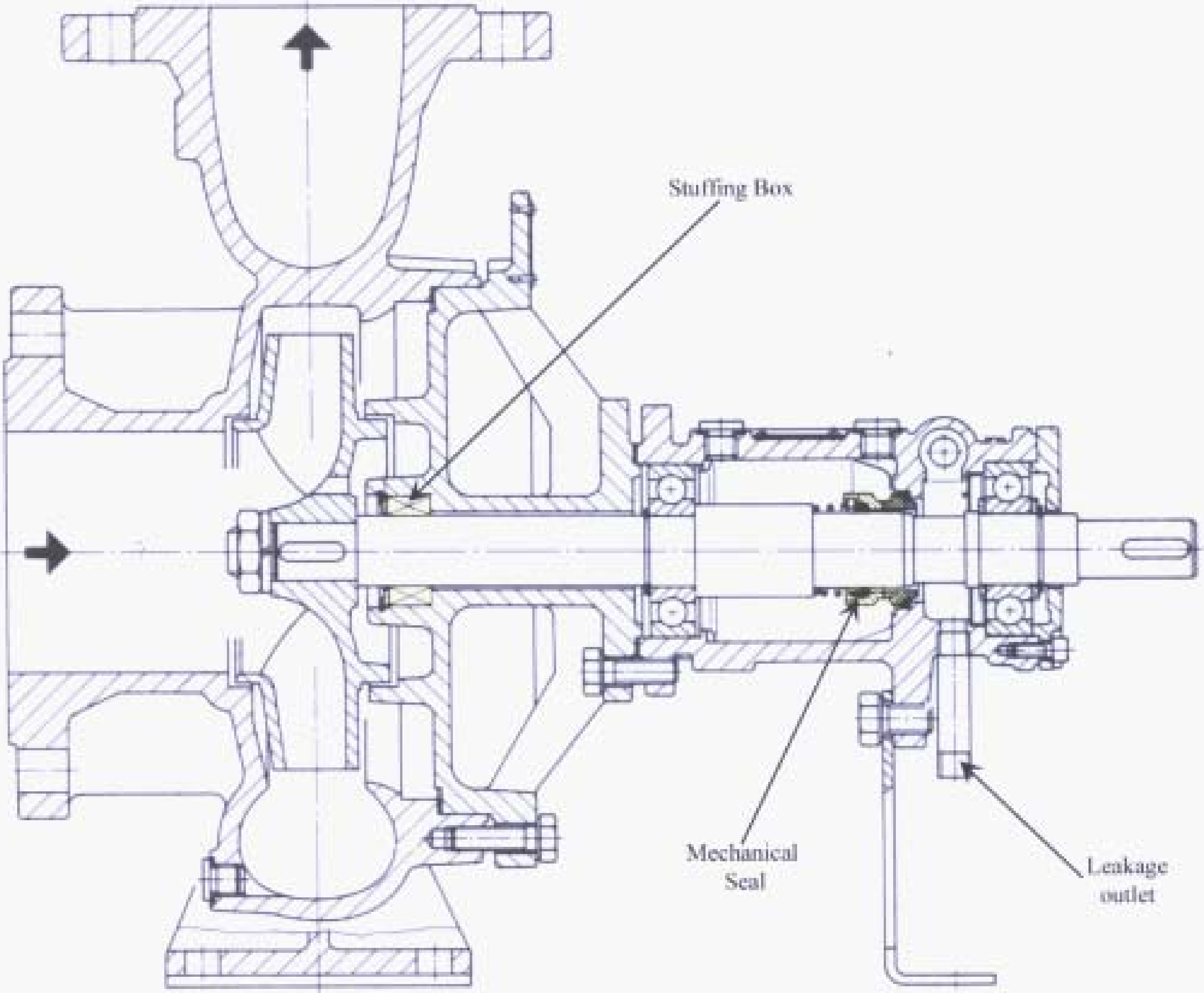
The thermal oil had the following relevant properties:

Normal range of bulk operating temperature:	-10°C to 320°C
Density:	$875kg/m^3$
Flash Point:	210°C (closed cup)
	221°C (open cup)
Fire Point:	243°C

1.10 Thermal oil pumps (Figure 4)

1.10.1 Each of the thermal oil circulating pumps was a single-stage, motor-driven centrifugal type. Drive-shafts were sealed by a mechanical seal. The shaft's seal and bearing arrangement was such that one bearing was lubricated by the thermal oil and the other by grease. Any leakage of thermal oil from the mechanical seal was prevented from

Thermal oil pumps



spraying by an extension of the seal casing, and drained downwards through the leakage outlet. In the event of a mechanical seal failing, flow of thermal oil into the seal housing was restricted by an inner stuffing box. Total leakage rates through the leakage outlet would have been limited by this feature. This arrangement also prevented significant circulation between the fluid being pumped and that within the seal housing. One consequence of this arrangement was that the fluid within the seal housing ran at a lower temperature than that being pumped.

1.10.2 The mechanical seal on the upper centre pump had failed about two months before the fire. On that occasion, leakage was seen to be modest; reported as being in the form of a drip rather than a spray. Following this failure, a new mechanical seal was fitted.

The discharge flange joint on this centre pump was also replaced within the two months before the fire.

There is no other record of any recent work having been carried out on any of the thermal oil pumps.

1.11 Emergency generator

A compartment housing the emergency generator and switchboard was accessed from the forecastle.

The second engineer tested the emergency generator weekly, usually on a Saturday morning. The test was undertaken once a month by opening the main breaker on the running auxiliary engine. This resulted in loss of electrical power, causing the automatic starting system to start the emergency generator and put it on load. Such tests were only carried out after liaising with the master to ensure the vessel's safety was not affected.

1.12 Emergency fire pump

The emergency generator was in the same compartment as the emergency fire pump. The pump was powered from the emergency switchboard.

1.13 CO_2 flooding system

1.13.1 The machinery spaces were equipped with a CO_2 total flooding fire extinguishing system. System controls were in a cabinet set into the starboard side of the funnel at poop deck level **(Figure 5)**. The CO_2 storage bottles were forward in a space just aft of the emergency generator room. This space was at main deck level and accessed from the forecastle.

Inside the control cabinet was a small inert gas bottle which, when opened, activated a servo-cylinder coupled to the release mechanism of three 45kg CO_2 bottles in the main

Aft deck arrangement

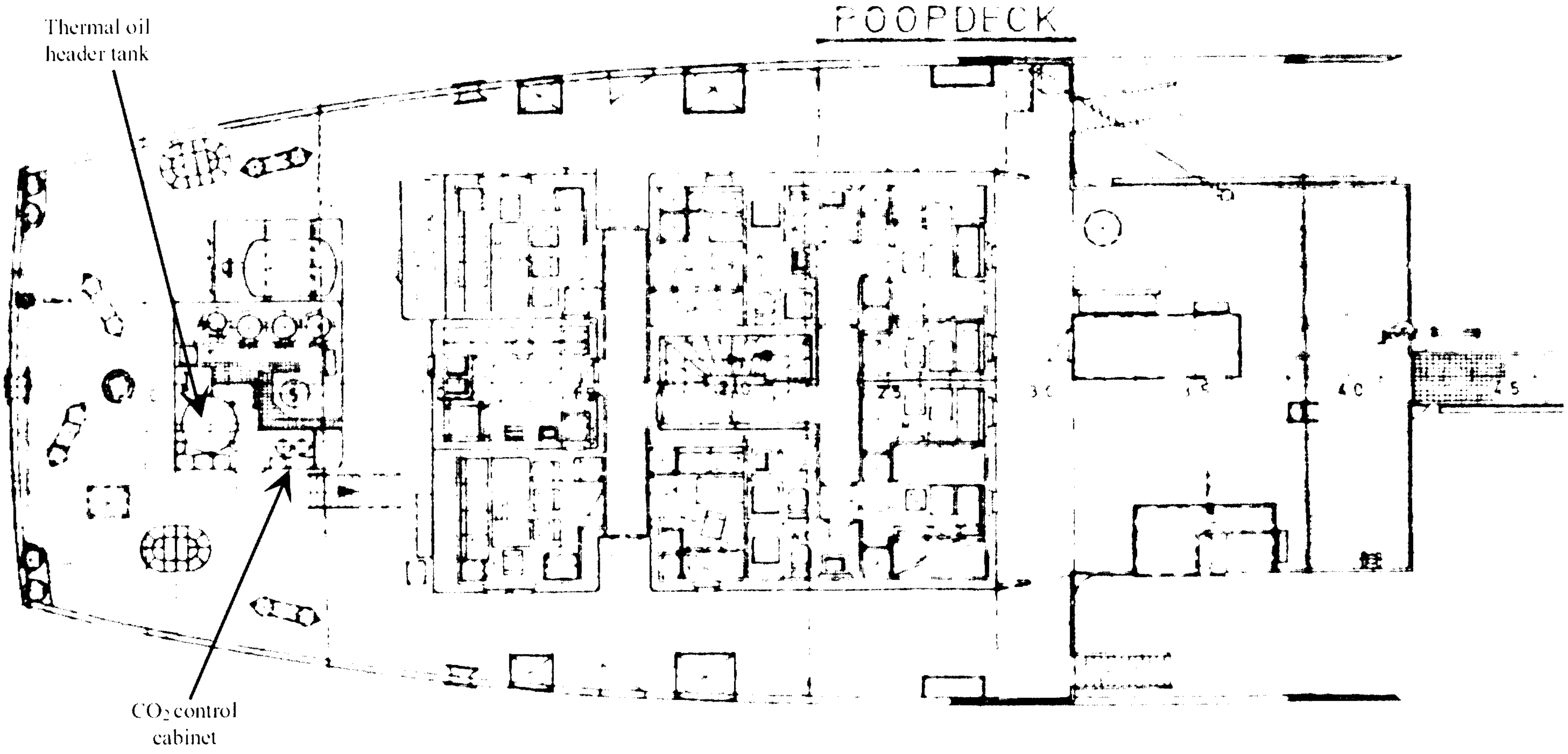


Figure 5

CO_2 room. A small bore pipe along the main deck carried the pilot gas from the cabinet to the CO_2 room.

These three bottles were supplemented by 12 further 45kg CO_2 bottles. The system was arranged so that the additional 12 bottles were activated by the discharge from the initial three bottles. The contents of all 15 bottles passed through piping along the main deck to the control cabinet at the funnel and then to the machinery spaces via an isolating valve within the cabinet.

1.14 Engine room ventilation

The main machinery spaces were ventilated by port and starboard forced draught fans set within trunks leading above poop deck level. In common with ventilation arrangements in the funnel, each trunk was fitted with a local, hand-operated damper to shut down the machinery space. Smaller air vents serving the after spaces were also fitted with hand-operated dampers or flaps.

Forced draught ventilation fans could either be shut down from a cabinet on the starboard side of the funnel casing or from inside the machinery spaces.

1.15 Safety procedures

1.15.1 Checks were made on critical safety systems during the second engineer's Saturday morning testing routine. These covered the engine room fire detection system; engine room CO_2 flooding alarm; engine room ventilation fans shut-down; engine room ventilation ducts' closing flaps; emergency fire pump; emergency generator; main fire pump; fuel oil quick-closing valves; fuel pump emergency stops; and emergency batteries.

Dated records for tests on all this equipment were maintained on board. The most recent tests were recorded as having been made on 20 March 1999, the day following the accident and <u>after</u> the vessel was abandoned. In the first few weeks of 1999 tests were recorded for all Saturdays except for 30 January and 27 February.

1.15.2 In addition to the above, a number of safety equipment checks were carried out weekly by the second officer, and the crew were exercised regularly in emergency procedures. In the event of an engine room fire, the emergency party comprised the second engineer, the motorman, and other members of the crew who normally performed engine room fire watch duties and were familiar with layout of machinery spaces.

1.15.3 The watchkeeping seamen normally carried out fire inspections of the machinery spaces at 2200, 2400, 0200 and 0400.

1.16 Damage

1.16.1 Structural damage due to heat was limited to the forward face of the funnel and the adjacent deck. This area was immediately above the thermal oil circulating pumps. Heat damage had spread into a fire equipment locker at the aft end of the accommodation causing smouldering damage to equipment, particularly to spare fire hoses. A group of portable plastic bins secured against the aft end of the accommodation at poop deck level and close to the heat-affected deck, suffered no serious damage.

Inside the machinery spaces, heat damage was confined to the boiler space and the area of the thermal oil circulating pumps. The pumps' starter boxes, control switches, indicator lamps, cabling to their motors and adjacent light fittings were damaged by heat.

1.16.2 In the boiler space, horizontal surfaces in particular had a heavy covering of soot; several millimetres thick in places. Other parts of the machinery spaces were also affected by soot and smoke, but generally to a lesser extent.

Smoke damage extended into the accommodation spaces and the wheelhouse.

1.16.3 Cargo spaces were not affected by heat or smoke. No heat or smoke damage had occurred in the cofferdam between machinery and cargo spaces. This cofferdam was found to contain a negligible quantity of water when the salvors boarded on 20 March.

1.17 Passage planning

1.17.1 Pentland Firth separates Orkney Islands from the Scottish mainland. It is entered from the west between Dunnet Head and Tor Ness, and from the east between Duncansby Head and Old Head. The islands of Stroma and Swona lie within the firth, respectively 3 miles north-west and 5.5 miles north of Duncansby Head. The Outer Sound is between Stroma and Swona. It is 2.5 miles wide and is the usual route for vessels passing through Pentland Firth. Tidal streams are strong and can attain a spring rate of up to about 9 knots.

1.17.2 The following extracts are taken from the *North Coast of Scotland Pilot* (NP52):

Passage planning. *Because of the very strong tidal streams, the eddies and races to which these give rise and the extraordinarily violent and confused seas which occur at times, particularly in some of the races, navigation in Pentland Firth requires careful preparation and is attended by special problems. These are such that some mariners find it advantageous to adjust their arrival at the firth so as to pass through under favourable tidal conditions, or alternatively, to use Fair Isle Channel rather than transit Pentland Firth in unfavourable conditions.*

Laden tankers. *Masters of laden tankers not bound to or from Flotta and Scapa Flow should not use the Pentland Firth in restricted visibility or adverse weather. At other times, there may be a case for transiting with the tide to reduce the time spent in* *the firth, although Masters should take account of the general precautionary measures and navigational advice herein.*

Tidal streams run with great strength, rates up to 16 kn having been reported close W of Pentland Skerries; in 1984 MV Proud Seahorse was unable to make headway over the ground in many parts of the firth when making 11kn through the water.

Even in calm conditions there can be heavy turbulence in the races; in disturbed conditions, particularly when the tidal streams are opposed by strong winds or a swell, the sea in the races can be extraordinarily violent and confused, and extremely dangerous to smaller vessels which may become unmanageable.

Advice for laden tankers is also provided on BA Charts Nos 1954 and 2162 which were in use on board *Multitank Ascania.*

1.17.3 The *Admiralty List of Radio Signals Volume 7(1) 1998/1999* (NP287(1)) states:

Laden tankers not bound to or from Flotta and Scapa Flow should not transit the Pentland Firth against the tide or in restricted visibility or other adverse weather.

It also requests all laden vessels to report to Pentland Coastguard on VHF radio channel 16 at least one hour before their estimated time of arrival and on final departure of the Pentland Firth.

Multitank Ascania was a laden tanker, was not destined for Flotta or Scapa Flow and was intending to transit the Firth against the tide. She did not report to Pentland Coastguard at any time before the incident.

1.17.4 *Multitank Ascania*'s passage plan from Eastham to Teesport followed a clockwise route around the United Kingdom via Pentland Firth. It included a charted courseline of 087° from a position 2.4 miles north of Cape Wrath to a position 1 mile north-east of Stroma. The planned track passed 0.6 mile to the north of Stroma.

The master thought the charted advice above applied only to laden tankers of more than 10,000 tonnes. He was mistaken. There is a tonnage limitation of 10,000gt that applies to laden tankers intending to pass through the nearby Minch that lies between mainland Scotland and the Western Isles but it does not apply to the Pentland Firth.

The master was aware that he would be transiting the Pentland Firth against the tide and had planned to avoid its maximum strength by keeping close to Stroma. In doing so, he recognised the need for increased vigilance and intended to be present on the bridge during the transit. He marked a position on the chart in Pentland Firth approximately 5.2 miles from the waypoint off Stroma with an instruction to be called when the vessel had reached that position. No instruction was left for Pentland Coastguard to be informed prior to the vessel entering Pentland Firth, and no contact was made with Pentland Coastguard before 0305 on 19 March.

1.18 Thermal imaging

Coastguard rescue helicopter OH was fitted with a FLIR Systems International Ltd Ultra 4000 Dual Sensor surveillance system. Having established a total exclusion zone around *Multitank Ascania*, Pentland Coastguard requested the helicopter to attempt to identify and monitor any heat source using its thermal imaging camera.

The thermal imaging camera forms part of the surveillance system and is used by the helicopter primarily as an aid to locating bodies in the sea during search and rescue operations. The "level" control selects a span of temperatures relative to the mid-point temperature of the scene, while the "gain" control selects the upper and lower limits of the span of temperatures displayed. By manually adjusting the "gain" and "level" controls, the operator is able to pictorially identify the hottest spots and surrounding heat gradient within a particular scene. However, because the camera is in constant motion, the "viewing area" and therefore the mid-point temperature, will continuously change, necessitating a corresponding adjustment of the controls to maintain a specific temperature span display.

A temperature scale is not fitted to the camera.

1.19 Intervention

1.19.1 Section 100A of the *Merchant Shipping Act 1995* empowers the Secretary of State to establish a temporary exclusion zone where a vessel is in distress and an identified risk that significant pollution or damage to persons or property will occur can be prevented or reduced by establishing such a zone.

1.19.2 Sections 137 and 138A of the *Merchant Shipping Act 1995* additionally empowers the Secretary of State to give directions to the owner or master of a vessel involved in an accident where pollution on a large scale will, or might, result from oil or other substances liable to create hazards to human health, marine life, amenities or other legitimate uses of the sea.

Both of the above powers were used during the incident.

1.20 *Green Lily* investigation

1.20.1 Following a main engine failure in bad weather, the 3,624gt Bahamian registered general cargo vessel *Green Lily*, grounded off the east coast of Bressay, Shetland Islands, on 19 November 1997. As a result of its investigation, the MAIB made a number of recommendations to the Maritime and Coastguard Agency including:

In consultation with the Royal National Lifeboat Institution, Ministry of Defence and Civil Aviation Authority, produce guidelines for exchanging relevant information and intentions between key on-scene personnel during an emergency.

This recommendation, made after the *Multitank Ascania* incident, was accepted.

1.20.2 The MAIB also recommended the Director of Logistics and Maritime Transport of the Department of the Environment, Transport and the Regions to review earlier decisions not to provide previously recommended Emergency Towing Vessel (ETV) cover in "Fair Isle", and re-examine the need for emergency towing cover in the area.

At the time of the accident a coastguard ETV was anchored in the Minch, but there was no provision for one in area "Fair Isle". The *Green Lily* report was published on 11 August 1999 and the recommendation concerning ETV cover in the area was accepted. A dedicated ETV has since been stationed at Kirkwall, Orkney Islands.

SECTION 2 - ANALYSIS

2.1 Introduction

At a very early stage in the investigation, it became apparent that there were many lessons to be learnt which went beyond the fire and its cause.

It is possible to view the whole incident as "successful" in the sense that no lives were lost, there was no pollution, and the vessel and her complete cargo were salvaged. However, such an assessment is only possible with hindsight, which overlooks the genuine concerns of many people involved with the shore-based evacuation. It also overlooks the contribution made by an element of good fortune, without which the incident might have ended in disaster.

2.2 Thermal oil system

2.2.1 The only two people to see the fire were the chief and second engineers. They were able to identify clearly the area of the thermal oil pumps as the fire's centre. This was confirmed during the subsequent inspection of the vessel.

Because of their experience with thermal oil circulating pumps on this and sister vessels, the two engineers probably suspected that one of these pumps was related to the cause of the fire. This suspicion was supported by the failure of the mechanical seal on the centre pump a few weeks before. This pump was running at the time of the fire.

However, during the earlier leakage incident, oil was seen as a drip rather than a spray. Owing to the pump's double seal design, and the drainage arrangements for leaking fluid, this would be the expected symptom of a mechanical seal failure.

Although leakage due to failure of the pump's mechanical seal cannot be completely discounted, such a failure would not have produced a spray of fluid. Nor would any leakage have been in the form of a jet.

2.2.2 The seal casing design was such that oil leakage past the mechanical seal drained through an orifice at the bottom of the casing **(see Figure 4)**. From there oil would be able to drip on to the mounting platform of the pump, eventually running on to other pumps and piping below. The pumps' design made provision for this leakage orifice to be connected to a collecting tank. No arrangement of this type was in place on *Multitank Ascania.* Had it been so, any leakage would have been comparatively innocuous and would probably have continued unnoticed until the system's low-level alarm on the header tank sounded. The installation of such a system on *Multitank Ascania* and, if relevant, her sister vessels, would be a sensible precautionary measure.

2.2.3 The thermal oil pumps were mounted on a simple framework to form a very compact unit. The size of this unit resulted in poor access to some parts on the lower level. In particular, piping and associated joints positioned at the centre of the lower pumps' level was difficult. Any work in this area, such as joint replacement, was less than straightforward due to difficulty of access for repair personnel. They were required to work sandwiched between upper platform and lower pumps. If this work was undertaken with the thermal oil system in service, these access problems would have been compounded by the heat of adjacent components.

These access problems made the replacement of any joint, or any other components in this area of the unit difficult, and possibly resulted in non-uniform tightening of fixings or less than ideal cleaning of joint faces. Each has the potential to result in a joint which might be susceptible to leakage in service.

2.3 Cause of the fire

2.3.1 The investigation concludes that the fuel for the fire was the thermal oil. This is shown by the loss of contents of the header tank. The site of the leakage is less certain.

The vessel's engineers saw the fire, knew the unit's recent history and based their views on their experience. They suspected the centre pump's mechanical seal.

Pump seal failure is unlikely to have produced a spray or jet. The leakage rate would have been limited by the pump's inner seal design and the leaking fluid would at least, initially, have been at a significantly lower temperature than the system temperature. It would, furthermore, have been below its flash point.

The local fire damage pattern indicated that the lowest point of the fire was slightly beneath the upper circulating pumps but above the lower pumps. This indicates that oil was burning at the lower level.

2.3.2 Although leakage of oil from the seal on the upper centre pump might have occurred, before or after ignition, there are other parts of the thermal oil system that could have been a source of leakage and need to be considered.

Some components at the lower level were static; a pressure gauge; a pressure relief valve; piping and joints. Some of these, particularly the pressure gauge, were heat-damaged. All had been subjected to some degree of heating. Each operated at system pressure and the failure of any could have resulted in oil leaking on to the lower part of the thermal oil unit.

Inspection of the area suggested that a flanged joint on a pressure relief valve immediately beneath the upper centre pump may have leaked. However, the possibility exists that this failure was due to high temperatures generated by the fire, rather than the cause of it. Owing to its proximity to the running centre pump, a failure of this connection would have been consistent with the engineers' observations and, in view of their recent experience with the pump, encouraged them to identify the pump as a possible source.

2.3.3 Whichever of these components was leaking, thermal oil escaped into the space close to the centre of the thermal oil pumps' mounting frame. Whether this oil was at system temperature of 220°C, and thus above its flash point, was probably irrelevant since much of the piping in this area was at system temperature and able to heat the leaked oil when contact was made. The quantity of vapour associated with this oil, at just over its flash point, would have been small and unlikely to have been sufficient to travel to any known point of ignition within the machinery space.

2.3.4 There is thus no clearly identified cause for ignition. However, thermal oil clearly leaked on to parts of the piping system and its lagging. Instances of spontaneous ignition, caused by a heat generating oxidation mechanism of the oil within lagging, are well documented. Conditions required for this process have been confirmed by laboratory testing. It cannot be proven that spontaneous ignition occurred on the thermal oil unit of *Multitank Ascania* but some of the required conditions, such as oil-affected lagging and temperature were probably present. In the absence of any other identifiable cause of ignition, spontaneous ignition is a possibility.

2.3.5 The header tank arrangement of the thermal oil system placed a limit on the quantity of oil able to escape from any leak to feed the fire. The usual volume in the header tank was $1m^3$ which, together with a further unknown but limited volume from the pumps and adjacent piping, would have been the maximum quantity released. The absence of widespread fire damage, particularly at lower levels beneath the thermal oil pumps' unit, also suggests that the leakage rate was not large and that ignition occurred before leakage was able to spread either horizontally or downwards.

2.4 Initial fire-fighting

Once he had been alerted by the fire alarm in his cabin, the chief engineer went to inspect the engine room to assess the problem. Although he was unable to identify the exact seat of the fire, it was clear to him that it was centred on the thermal oil pumps. His action of stopping the pumps followed by an attempt to extinguish the fire with a foam extinguisher was sensible.

He quickly, and properly, realised that he needed assistance and left the engine room to call the second engineer. In a larger vessel where raising the alarm from the control room would have been more effective, this would have been judged time-consuming. But in *Multitank Ascania*, the distance between the engine room and the second engineer's cabin was short, and the time needed to call the second engineer and return to the engine room was minimal.

The general alarm was sounded shortly after the second engineer had been called, indicating that little, if any time was lost as a result. It ensured that the person likely to be of greatest assistance in tackling a machinery space fire, the remaining engineer, was alerted without further delay.

2.5 Use of CO_2

2.5.1 Once the fire-fighting efforts of the two engineers had proved unsuccessful, there was little option open to the vessel's master other than to use the CO_2 flooding system.

2.5.2 When an engine room fire has developed to a stage where a CO_2 total gas flooding system has been deployed, the affected space must be kept closed down for a substantial period. This is to ensure that the fire's remaining fuel and the heat-affected structure can cool. Where a vessel is in confined waters, a master and his crew might, understandably, be anxious to make an inspection of the space as soon as possible. They would wish to do so with a view to making repairs and restoring power, but the introduction of air can cause a fire to re-ignite if the cooling period has been inadequate. No further CO_2 is normally available to re-inert the space. If the space is ventilated and the fire re-ignites, the crew would have no recourse other than to fight the fire with hoses etc, or close down the space again and possibly abandon the vessel. Great care is required not to waste the single opportunity a CO_2 system provides.

2.5.3 Assessing the cooling period is not straightforward. In this incident several indicators were available and used to judge the severity of the fire once the CO_2 had been released. The first was the temperature of the deck and funnel casing above the thermal oil pumps. Another was the smoke issuing from the ventilators, particularly the one which was improperly closed on the port side of the accommodation deckhouse. Although not great in volume, this smoke was dense and black, indicating it was predominantly unburned fuel. If the fire was still burning, it would indicate it had been largely smothered and that the CO_2 had served its primary purpose. Despite this, it would not have been sensible to attempt a re-entry to the engine room until the space showed signs of cooling. This would have taken several hours. Wisely, no such action was taken before the crew evacuated the vessel.

Although the results took several hours to verify, all CO_2 bottles were released into the engine room.

2.6 Alternative method of fire-fighting

The investigation took the opportunity to examine another system which is sometimes available to fight an engine room fire.

2.6.1 Having failed in their efforts to extinguish the fire using hand-held extinguishers, the two engineers and others making up the emergency party, might have sought to employ fire hoses. Reliance on these as the main intermediate fire-fighting system is commonplace on board ships. But the disadvantages must not be overlooked. In *Multitank Ascania* the amount and density of smoke, and the limited working space in the boiler room, would have made further local fire-fighting operations difficult, dangerous and probably ineffective. Hoses are manpower intensive, and take time to deploy, and they can spray saltwater over equipment not designed for such treatment. Had they been used on this occasion and successfully extinguished the fire, it is unlikely that electrical and propulsive power could have been restored quickly. Heat and water damage to cabling, electrical equipment and other systems would almost certainly have delayed, or prevented, their restart.

2.6.2 Quickly deployed portable extinguishers are valuable for tackling a fire in its early stages, but when a machinery space is unmanned, there is invariably a delay before such first aid action can be taken. The duty engineer is, typically, alerted by the fire detection and alarm system. Even the most alert and conscientious individual will require time to reach the affected space, assess the extent of the problem, raise the alarm and initiate the deployment of fire-fighting parties.

The time he spends making his assessment might, of necessity, be brief. If the extent of the fire is obviously beyond the capability of hand-held extinguishers, the existence of a system capable of containment while fire-fighting parties are being mustered and which does not require constant attendance, is attractive.

2.6.3 Dedicated fire-fighting systems that employ fresh water sprays have been demonstrated to contain and even extinguish a fire in its early stages. In recognition of their value, and after a period of consideration stretching over several years, the Maritime Safety Committee of the International Maritime Organization (IMO) has issued guidelines for the approval of such systems in machinery spaces since the *Multitank Ascania* incident. They were issued on 4 June 1999.

Spray systems covering machinery where the fire risk is greatest, such as main engines, generators and other plant using oil under pressure, could have major benefits. Had a dedicated water spray system been fitted over the thermal oil unit in *Multitank Ascania*, it would have had, at the minimum, the potential to contain the fire without having to stop the main engine and generators. It may even have extinguished the fire. Had it done so there would have been no need to shut down, flood the engine room with CO_2, or abandon the vessel. Even if it had not been successful in preventing damage to main and auxiliary machinery, it may have meant that the crew were able to remain on board. Had they done so there would have been fewer problems in attaching a suitable tow line.

2.6.4 Apart from such a system's advantages in containing and extinguishing fires, benefits such as the improved chances of maintaining power, or quickly restoring power, and gaining earlier access would be especially attractive. Flag states, including the United Kingdom's MCA should consider thermal oil heating units as high risk areas, and promote the installation of local water-based fire-fighting systems, particularly on chemical, gas and oil tankers. This should be done with the long term objective of making their fitting to high risk areas mandatory in the revised Chapter II of SOLAS. In following this policy, the MCA should view these systems as intermediate fire-fighting systems to be fitted in addition to any required total gas flooding systems.

2.7 Shutting down the space

The crew's efforts to shut down the engine room's ventilation arrangements were generally effective. All fan stops operated, and most ventilation dampers and flaps were closed as intended. Only one ventilation flap, the one positioned at the forward port corner of the accommodation structure, was not closed properly. No reason to explain the failure to shut it correctly has been found. There was no material reason or evident defect to prevent it being closed, but due to its comparatively small size and remoteness from the seat of the fire, it is unlikely to have significantly influenced events.

2.8 Boundary cooling

The crew easily identified the forward face of the funnel and the adjacent deck as the hottest part of the engine room's boundary. This was confirmed by later inspection. Boundary cooling of the external surfaces using fire hoses prevented significant heat transfer beyond this area. There was no serious heating inside the accommodation. However, secured to the after end of the accommodation and just forward of the funnel, were a number of large plastic waste bins. In spite of their comparatively combustible nature, none were removed during the fire-fighting operations. Had they been it would have ensured better access to the aft boundary of the accommodation for boundary cooling and the elimination of material that could, conceivably, have ignited.

Notwithstanding this observation, the crew's efforts at boundary cooling were successful.

2.9 On board response to the emergency

2.9.1 All *Multitank Ascania*'s mandatory safety equipment used during the incident worked as intended, and on later inspection, was seen to have been well maintained. On board records show that safety equipment was tested weekly. Although the most recent tests are dated the day after the fire and are therefore clearly incorrect, there is no suggestion that this was due to anything other than a clerical error.

The crew responded promptly and effectively to the emergency, demonstrating the benefits of holding realistic and regular emergency drills.

2.9.2 The lack of a voyage data recorder greatly complicates a thorough analysis of how the vessel's master, officers and crew react at a time of an emergency. Appropriate measures to improve manning, training and operating procedures cannot therefore be made on a definitive analysis of what occurred.

The master responded immediately to the general alarm. After arriving on the bridge, he was promptly advised of the situation, and quickly assessed that CO_2 flooding of the engine room would be necessary. However, during the early stages of the incident, the master failed to appreciate the potential danger his disabled vessel posed to his crew, the environment and those ashore.

His confidence that it would be possible to re-enter the engine room after about an hour to restart the main engine, was unfounded and naive. He allowed himself to remain optimistic instead of planning for the worst scenario. This was demonstrated by his delayed and non-prefixed call to Pentland Coastguard at 0305, and his failure to calculate the vessel's anticipated drift. The position transmitted to the coastguard at 0305 was incorrect.

Having agreed to Pentland Coastguard's suggestion that it should broadcast a "Mayday Relay" and arrange for assistance to standby the vessel, the master made no attempt to establish what help was available or when it might arrive. There were also several instances when he either failed to absorb, or ignored, relevant information broadcast on the VHF radio.

2.9.3 It was not until 0354, with smoke still leaking from the engine room, that the master realised he might need assistance, and asked Pentland Coastguard if help was on the way. On being told a helicopter and a lifeboat were proceeding if he wanted to evacuate his crew, he made no attempt to enquire after tugs. His reluctance to communicate with the owner at this time, in the knowledge that Pentland Coastguard had already done so, suggests he had no wish to involve himself in any salvage negotiations. In this regard, it is significant that, when he finally spoke to the owner immediately after the evacuation of his crew, the master was unaware of the imminent arrival of the tug *Einar*, even though a broadcast had been made at 0448 by Pentland Coastguard stating the tug's estimated time of arrival of 0530.

2.9.4 By 0425, the master was concerned for the safety of his crew due to the threat posed by running aground. The crew stated a wish to be evacuated by helicopter. The master acceded although he was confident the fire was almost out. This opinion was not shared by his crew, who told the helicopter winchman that the fire was getting worse.

Difficulty was experienced lowering a winchman to the deck due to the heavy rolling. Thurso lifeboat was aware of the problem, so stood by ready to connect a line forward and make an attempt to turn the vessel into the wind. Although this intention was broadcast by the rescue helicopter and acknowledged by the master, it is apparent that nothing was done on board to implement such a plan.

The master's decision to evacuate his crew was sound given that he was unaware of the tug's imminent arrival. His decision to remain behind in the circumstances was commendable. Had he not done so the incident might well have ended in disaster. He was able to pay out mooring ropes for towing and to let go an anchor to prevent the vessel grounding.

2.9.5 It is unknown why the port anchor failed to drop. In the absence of forward power on board *Multitank Ascania*, the windlass could not be used to walk the anchor out. The master had previously discussed the possibility of anchoring the vessel with the chief officer, but had decided that because the water was so deep, there would be a danger of the anchor dragging so decided not to. He might have been right, but even a dragging anchor would have reduced the vessel's drift and so allowed more time to connect a tow. On the other hand, the vessel would have been unable to recover the anchor without forward power. This could have added to the difficulties in effecting a successful tow.

2.9.6 Before leaving the vessel, the master put the end of a fire hose into the cofferdam in an attempt to provide additional boundary cooling. Although the intention was sound, very little water was eventually found in the cofferdam to indicate that had the fire spread towards the cargo tanks, such action would have had little impact on containing or extinguishing it.

2.9.7 Although the master's actions during the later stages of the incident were commendable, his shortcomings during the early stages might have been overcome had he received specific training in crisis management.

2.10 External response to the emergency

2.10.1 The commitment shown by all external parties to effect a successful tow and evacuate the crew of *Multitank Ascania* was commendable. During the early stages of the incident, Pentland Coastguard recognised the potential danger posed by the disabled vessel and did not hesitate to summon assistance. In its advisory role, it also strongly advised the master that it should broadcast a "Mayday Relay". Although he agreed, the master was confident that help would not be required. With the master adopting a passive role, Pentland Coastguard recognised the need to take an active role while relying on the master's co-operation. If necessary, the coastguard realised it could resort to powers of intervention.

Until such powers are invoked during, or following, an accident, the master remains in sole control, and is responsible for any measures taken to safeguard his vessel and his crew. It is therefore essential that he remains, so far as is practicable, fully appraised of the nature and limitations of any assistance which might be available to him. This can only be achieved by positive reporting of such information and confirmation that it has been received.

2.10.2 At 0354, the master was informed that a helicopter and a lifeboat were on their way and would be available to evacuate the crew. Pentland Coastguard had it in mind that any non-essential crew members should be airlifted off, but the master's agreement to this intention was not sought. In the event of a total evacuation, the coastguard wanted an anchor to be let go beforehand, but failed to convey this wish to either the master or the helicopter.

When the helicopter winchman was lowered to the vessel at 0511, the crew told him that the situation was deteriorating. Furnished with such information, the pilot judged it necessary to take off as many of the crew as possible and intended to do so. The master meanwhile had decided to stay, but had not informed either Pentland Coastguard or the helicopter of his decision before the start of the evacuation. By 0537, all the crew except the master had been airlifted off. It was only then that the master said he intended to remain on board. He was unaware at that time of the imminent arrival of the tug *Einar*. Although Pentland Coastguard had broadcast advice earlier to the effect that mooring ropes should be run out before a total evacuation, this was not acknowledged by the master.

In the absence of a positive exchange of information between the master, the helicopter, *Einar* and Pentland Coastguard, it was fortunate that the master remained on board. Had he not done so it would not have been possible to run out the mooring ropes or let go an anchor. Had he been aware of *Einar*'s imminent arrival, he could have delayed evacuating his crew to ensure sufficient manpower remained on board to receive and secure the tug's towing pendants. Safety of life was however, paramount and even if he had been aware of the tug's imminent arrival, he might still have decided not to delay evacuating his crew.

2.10.3 The coastguard tug *Anglian Prince* was tasked at 0520, but was too far away to be of immediate assistance and did not arrive on scene until 1440.

2.10.4 One of the factors that dictated much of the decision-making both on board and ashore was the extent of the fire and its effect on board. Much was placed on the findings of the thermal imaging camera fitted on board coastguard helicopter OH. The extent of heat damage suggests that the fire was not as hot or extensive as interpreted from the camera. This may have been due to the inherent difficulty in assessing temperatures using this equipment, and may have resulted in unnecessary delay in getting salvage personnel on board the vessel.

2.11 Shipping of chemicals

2.11.1 Several factors affect the design of chemical tankers. The properties of chemical cargoes impose constraints on materials, piping, pumps, tanks and systems to ensure they are unaffected by adverse reactions and that the quality is assured. The safety of the vessel and her crew requires systems such as inert gas supplies. The potential consequences of an accident with toxic, explosive or corrosive chemicals being released into the marine environment are potentially so damaging that they have to be prevented so far as possible by careful design and sound operating procedures. As the varieties of chemicals carried by sea increase and their associated hazards are better understood against an acceptable level of risk, the evolution of the chemical tanker continues.

2.11.2 When carried by sea, international conventions (*MARPOL 73/78*) require that chemical cargoes are assessed for the likely environmental damage if released into the sea. The second consideration concerns the safety hazards which a cargo might pose to the vessel in which it is to be carried. Most of the chemicals routinely carried by sea have already been assessed against these basic criteria. The results are set out in internationally accepted codes and conventions which specify the minimum standards of chemical tanker construction and equipment for a given cargo.

2.11.3 *Multitank Ascania* was a type 2 chemical tanker as defined in the mandatory *BCH Code*. The carriage of vinyl acetate monomer requires a ship to be a type 3, minimum. As the type 2 ship offers a greater level of protection than a type 3, *Multitank Ascania* exceeded the minimum requirements of the *BCH Code* and the associated United Kingdom regulations.

2.12 Pollution

2.12.1 Following major maritime disasters such as *Sea Empress, Braer, Exxon Valdez, Amoco Cadiz* and *Torrey Canyon*, the problems associated with the release of oil from tankers have been addressed by the shipping industry and media alike. Each of these high profile accidents has drawn public attention to the consequences of an accident involving a tanker carrying very large quantities of crude, often in very emotive ways.

2.12.2 Because of the relatively small quantities involved there is generally less public awareness of the pollution potential of the bunker fuel carried by most commercial seagoing vessels. Bunker fuel can, however, be far more damaging to the environment than crude.

2.12.3 There is also less widespread public awareness of the likely pollution problems resulting from a major accident involving a chemical tanker. There are two possible explanations:

(a) There have been few major chemical tanker accidents to bring chemical pollution to the attention of the general public. This is probably a result of the requirements that chemical tankers are built, operated and inspected to high standards.

(b) The perception that the pollution properties of oil are relatively uniform in spite of large variations between crudes from different fields. Chemical cargoes, however, vary enormously. They have many different properties and are numerous in type, from the innocuous to the highly aggressive. Some chemicals are hazardous to marine life, some are toxic to humans, while others are flammable or explosive. For many chemicals carried by sea, the full extent of the likely hazards remain unknown. The consequences of a major chemical tanker accident or spillage is therefore far less predictable than oil. This gives no clear image on which public opinion can focus.

2.13 Risk

2.13.1 Assessment of the minimum ship type requirements, for any given chemical cargo, requires that consideration is given to both pollution and safety hazards.

The safety of chemical tankers is, in common with the vast majority of other vessels on international voyages, covered by the safety requirements of the *International Convention for the Safety of Life at Sea (SOLAS)*.

However, many of the internationally accepted requirements for chemical tankers contained in *MARPOL 73/78*, appear to have been composed with an emphasis placed on pollution prevention rather than safety.

The philosophy which is the result of the application of these international agreements is that the safety of a ship and her crew is covered by *SOLAS* while the crew remain on board, and the well-being of the environment is preserved by the application of *MARPOL 73/78* whether the crew remain on board or not. This pattern changed slightly with the 1983 amendments to *SOLAS*, which made reference to the *International Bulk Chemical Code for Chemical Tankers built after 1 July 1986, (IBC Code)*, bringing both safety and pollution prevention requirements for these vessels under the umbrella of the safety convention.

The *IBC Code* was a development of the *BCH Code*. Both these codes include classification of a range of substances according to safety and their perceived pollution hazards. Their development was a result of concerns about potential, and unusual, risks posed by vessels carrying these substances into densely inhabited port cities.

The blurring of any boundary between safety and pollution was further increased in United Kingdom legislation by its definitions of oil pollution and those situations where the Secretary of State may use his powers of intervention.

The requirements of the *SOLAS* convention tacitly accept that events may occur which give a master and crew no option but to abandon their vessel. Lifesaving equipment such as lifeboats, liferafts, and lifejackets is required to be carried for preserving the life of those on board.

In the case of a ship being abandoned, as was *Multitank Ascania,* there is no longer any need to consider the safety of any persons on board, but the protection of the environment remains important. To a degree, this protection is satisfied by the location and containment of the vessel's cargo within the hull.

2.13.2 The risks to safety which may be posed by an abandoned vessel are not, however, addressed by either *SOLAS* or *MARPOL* conventions, although some elements of the *BCH* and *IBC Codes* can be seen as serious attempts to reduce these risks. The risks may be substantial, particularly in confined waters, busy shipping routes or if the vessel is close to an inhabited shore. They were judged as significant in the vicinity of *Multitank Ascania*'s abandonment and resulted in large numbers of people being evacuated from their homes.

It is unlikely that any national or international convention covering the design, construction and equipment of chemical tankers could fully remove the potential risk which an abandoned or disabled vessel and her cargo might pose to human life, health and the environment. Indeed, for the majority of chemical cargoes no comprehensive risk assessment has yet been carried out. This makes any judgment on the possible effects of an uncontrolled release of a substance unreliable.

Very large numbers of different chemicals are carried by both land and sea. Carriage by sea has been shown to be practical and safe. But because of many difficulties, it is unlikely that any comprehensive risk assessment of many chemicals will be undertaken for a considerable time. This makes a full risk assessment of an individual chemical tanker's voyage impracticable.

2.13.3 There are alternative, and practical, courses of action available for loaded chemical tankers. One alternative to accepting the largely unknown risk is to route these vessels away from areas where the risk is considered to be unacceptable. Another is to introduce operational factors to reduce the risk when transiting them.

2.14 Passage Plan

2.14.1 *Multitank Ascania*'s passage plan followed a route through the Pentland Firth. Published advice warns against laden tankers transiting the firth against the tide, or at any time during adverse weather. However, the master was mistaken in his assumption that such advice applied only to laden tankers of more than 10,000 tonnes, and decided to transit the firth against a spring tide with a following force 8 wind and very rough seas.

In complying with the published advice the master should have adjusted his time of arrival at the firth so that he would pass through under favourable tidal conditions to reduce the transit time. However, the master planned to reduce transit time by keeping close to Stroma to avoid the maximum strength of the tide, at the expense of the need for increased vigilance and his own presence on the bridge throughout the transit.

Regardless of how quickly a vessel is able to pass through the firth, the risk of her becoming disabled during the transit essentially remains the same. The consequences of disablement will depend on a number of factors, including the strength and direction of the wind and tide, and the ability to arrest any drift towards a lee shore.

2.14.2 The term "adverse weather" without qualification is ambiguous. It could mean adverse in a general sense. Alternatively, it could mean adverse with respect to a particular vessel, or with respect to the particular course and speed of that vessel. If the latter meaning is taken, the master of *Multitank Ascania* was arguably justified in passing through the Pentland Firth in the prevailing weather conditions. However, the consequences of doing so were potentially disastrous.

There is a need for the published advice to be reviewed with the aim of providing consistency and clarity.

2.14.3 A number of similar chemical tankers carrying substances, or a combination of substances classified as dangerous, regularly transit the Pentland Firth and voluntarily report to Pentland Coastguard. *Multitank Ascania* did not. So when she first reported the nature of her predicament, the coastguard watchkeepers had no prior warning of her presence or the cargo she was carrying, and were not given the opportunity to rehearse what action they might take in the event of an emergency.

A compulsory reporting scheme for both oil and chemical tankers, or indeed any other vessel carrying a hazardous cargo through the Pentland Firth, would be a sensible measure.

2.15 Routeing

2.15.1 The fire in the engine room of *Multitank Ascania* began as the vessel was approaching the very narrow waters of the Pentland Firth. Had the fire occurred while the vessel was well clear of land, the only people to have been affected would have been the crew: there would have been little risk to anyone else or the environment. There is no reason to believe the fire would not have been extinguished using the CO_2 flooding system. Had this been achieved it is likely the vessel would have been taken into tow without having to evacuate the crew.

The incident took place very close to land. Because of the engine room fire and the nature of the cargo being carried, there was concern for the safety of people in the vicinity of where the incident was taking place.

2.15.2 The locations of many chemical processing plants, and loading and discharging facilities in the United Kingdom and elsewhere, mean that chemical tankers will continue using conventional harbour and port facilities for the foreseeable future. The plants offer expertise in chemical handling, while the availability of port services such as tugs should ensure the risks related to a visit by a chemical tanker are kept to a minimum.

2.15.3 Except for the need to load or unload cargo, a vessel on passage has little need to pass close to land unless there are geographical features that dictate otherwise. The Pentland Firth is one such place.

There are others around the United Kingdom coast; Dover Strait, The Minch, North Channel to the Irish Sea, and the passage between Land's End and the Isles of Scilly. Of these, the Dover Strait and North Channel offer no practical alternatives.

2.15.4 A practical alternative to the Pentland Firth is the Fair Isle channel between Orkney and Shetland. Commercial considerations, such as the extra time and fuel consumed, might cause a shipowner to decide not to use this passage voluntarily. However, the substantial extra sea room offered by this route would result in a corresponding increase in the time available for emergency towing vessels or other assistance to reach a disabled vessel.

2.16 Emergency Towing Vessel (ETV)

2.16.1 Although the tug *Einar* and the Thurso RNLI Lifeboat contributed to towing *Multitank Ascania* clear of the land, it is uncertain how crucial their actions were in preventing the vessel from grounding.

Having a tug available to take a tow does not guarantee a successful outcome to an incident involving a drifting casualty, especially if the weather is bad. This incident again demonstrated the difficulty of connecting a tow to a vessel without forward power. Because of the difficulties involved working on *Einar*'s aft deck safely, her master decided to tow the vessel bow-to-bow. But as the tug's foredeck fairlead was too small to use with the size of shackle needed to secure the tug's polyester towing rope to *Multitank Ascania*'s bow rope, a messenger rope was used to connect the two. It was only partially successful, and gave way soon after the tow was underway.

2.16.2 It is possible that had ETV cover been based in the area, appropriate assistance would have been rendered. Although a dedicated ETV would have significant advantages over most other vessels tasked to provide a tow, there is no guarantee that its efforts would be successful. There is always the prospect that because of the dangers associated with a chemical cargo, the crew may have been evacuated before the ETV's arrival. Connecting a tow to an unmanned vessel without power forward in a high sea state is far from easy.

2.16.3 The difficulties associated with securing tow lines to a disabled vessel were recognised during the MAIB investigation into the grounding of *Braer* at Garth Ness, Shetland Islands, on 5 January 1993. Following that incident the IMO sub-committee on ship design and equipment held its 36th session, which included a revision of Resolution A.535(13) on emergency towing equipment on tankers. It was agreed that emergency towing arrangements should be fitted to tankers of 20,000 dwt and above. This did not apply to *Multitank Ascania* because she was only 4,034 dwt.

2.16.4 The deployment of any vessel to assist an abandoned and disabled chemical tanker can be extremely hazardous to the assisting vessel. This danger was recognised during the incident when the coastguard declared a temporary exclusion zone around *Multitank Ascania*.

SECTION 3 - CONCLUSIONS

These conclusions identify the causes and factors contributing to the incident and should not be taken as apportioning either blame or liability.

3.1 Findings

1. The fuel for the fire was the thermal oil, as shown by the loss of contents of the header tank. [2.3.1]

2. Oil from a leaking mechanical seal on the upper centre thermal oil pump might have fallen into the area between the thermal oil pumps before or after ignition. [2.3.2]

3. Inspection of the area suggested that a flanged joint on a pressure relief valve immediately beneath the upper centre thermal oil pump may have leaked. [2.3.2]

4. Whether the leaking oil was at a temperature above its flash point was probably not significant, as many parts of the system piping in the area would have been able to heat the leaked oil to that temperature. [2.3.3]

5. The quantity of oil able to feed the fire was little more than $1m^3$, the usual capacity of the system's header tank. [2.3.5]

6. No certain cause of ignition can be identified. Spontaneous ignition of oil-affected lagging is a possibility. [2.3.4]

7. The provision of an enclosed drain tank for the purpose of collecting oil leakage from the thermal oil pumps would be a sensible precautionary measure. [2.2.2]

8. Access problems to the area between the thermal oil pumps would have made the replacement of any joint, or any other components in this area difficult, and possibly resulted in non-uniform tightening of fixings, or less than ideal cleaning of joint faces. [2.2.3]

9. The chief engineer's initial actions of stopping the thermal oil pumps, and making an attempt to extinguish the fire with a nearby foam extinguisher, were sensible. [2.4]

10. A dedicated water spray fire-fighting system fitted over the thermal oil unit would have had, at the minimum, the potential to contain the fire without the need to stop the main engine and generators. [2.6.3]

11. All CO_2 bottles were released and discharged into the engine room as intended. [2.5.3]

12. All of *Multitank Ascania*'s mandatory safety equipment used during the incident worked as intended, and on later inspection, was seen to have been well maintained. [2.9.1]

13. *Multitank Ascania*'s crew responded promptly and effectively to the emergency, demonstrating the benefits of conducting realistic and regular emergency drills. [2.9.1]

14. During the early stages of the incident, the master of *Multitank Ascania* failed to appreciate fully the potential danger his disabled vessel posed to his crew, the environment and those ashore. His shortcomings might have been overcome had he received specific training in crisis management. [2.9.2, 2.9.7]

15. It is apparent that *Multitank Ascania*'s master had no wish to involve himself personally in any salvage negotiations. [2.9.3]

16. Without knowledge of *Einar*'s imminent arrival, the master's decision to evacuate his crew was sound. [2.9.4]

17. The master's decision to remain behind in the circumstances was commendable. Without his presence on board to run mooring ropes for towing, and to let go an anchor to prevent the vessel grounding, the incident might well have ended in disaster. [2.9.4]

18. Earlier use of an anchor would have reduced the vessel's drift and allowed more time to connect a tow. However, without forward power, the vessel would have been unable to recover the anchor and this might have caused difficulties in effecting a successful tow. [2.9.5]

19. The commitment shown by all external parties to effect a successful tow and evacuate the crew of *Multitank Ascania* was commendable. [2.10.1]

20. In the absence of a positive exchange of information between the master, the rescue helicopter, *Einar* and Pentland Coastguard, it was fortunate that at least the master remained on board to run the mooring ropes, and to let go an anchor. [2.10.2]

21. With the knowledge of *Einar*'s imminent arrival, *Multitank Ascania*'s master could have delayed evacuating all of his crew. This would have ensured that sufficient manpower remained available on board to receive and secure the tug's towing pendants. [2.10.2]

22. The coastguard tug *Anglian Prince* was too far away to be of immediate assistance. [2.10.3]

23. The extent of heat damage to *Multitank Ascania* suggests that the fire was not as hot or extensive as interpreted from the thermal imaging camera fitted on board coastguard rescue helicopter OH. This may have been due to the inherent difficulty in assessing absolute temperatures using this equipment, and may have resulted in unnecessary delay in getting salvage personnel on board the vessel. [2.10.4]

24. When carrying vinyl acetate monomer, *Multitank Ascania*, as a type 2 chemical tanker, exceeded the minimum requirements of the *BCH Code* and the associated United Kingdom regulations. [2.11.3]

25. Vinyl acetate monomer is one of many chemicals carried by sea for which no comprehensive risk assessment has been made. [2.13.2]

26. The risks posed by *Multitank Ascania*'s close proximity to the shore in her abandoned condition were judged to be sufficiently high as to result in large numbers of people being evacuated from their homes. [2.13.2]

27. One alternative to accepting the largely unknown risk associated with loaded chemical tankers, is to keep these vessels away from areas where the risk is considered to be unacceptable; another is to introduce operational factors to substantially reduce the risk when transiting those areas. [2.13.3]

28. There is a need for published advice concerning passage planning through the Pentland Firth to be reviewed with the aim of providing consistency and clarity. [2.14.2]

29. The voluntary reporting scheme for vessels transiting the Pentland Firth would need to be made compulsory for increased effectiveness, particularly with respect to vessels carrying hazardous cargoes. [2.14.3]

30. It is possible that if ETV cover had been based in "Fair Isle", appropriate assistance would have been rendered to *Multitank Ascania*. [2.16.2]

31. The deployment of any vessel to assist an abandoned and disabled chemical tanker can be extremely hazardous to the assisting vessel. This danger was recognised during the incident when the coastguard declared a temporary exclusion zone around *Multitank Ascania*. [2.16.4]

3.2 Causes

1. The fire was caused by a leakage from the thermal oil unit. [2.2.3]

2. The cause of ignition has not been identified. [2.3.4]

SECTION 4 - RECOMMENDATIONS

C F Ahrenkiel Shipmanagement is recommended to:

1. Consider providing an enclosed drain system for the purpose of collecting oil leakage from the thermal oil pumps fitted on board its vessels.

2. Although not mandatory, consider providing crisis management training for senior officers employed on its ships.

The Maritime and Coastguard Agency is recommended to:

3. Consider thermal oil heating units as high risk areas and to promote the installation of local water-based fire-fighting systems, particularly on chemical, gas and oil tankers, with the long-term objective of making their fitting to high risk areas mandatory in the revised Chapter II of the *International Convention for the Safety of Life at Sea (SOLAS)*. In following this policy, the MCA should view these systems as intermediate fire-fighting systems, to be fitted in addition to any total gas flooding systems which might also be required.

4. Include the need for positive reporting and confirmation of information received between key personnel during an emergency, in the guidelines to be produced following the MAIB investigation of the grounding of *Green Lily* on 19 November 1997.

5. Consider equipping its rescue helicopters with thermal imaging cameras capable of measuring and displaying temperatures.

6. Consider making compulsory the voluntary reporting scheme for vessels transiting the Pentland Firth, particularly with respect to vessels carrying hazardous cargoes.

7. Consider introducing either routeing requirements for loaded chemical tankers, or operational factors, such as the availability of emergency towing vessels and their ability to effect a timely and successful tow in a range of circumstances and conditions, to reduce unacceptable risks associated with loaded chemical tankers when transiting particular areas of concern.

8. Review published advice concerning passage planning through Pentland Firth with the aim of providing consistency and unambiguity.

Marine Accident Investigation Branch
July 2000