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MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

Marine Accident Report 1/00

Report of the Inspector's Inquiry into the loss of

mv *Rema*

with the loss of four lives
on 25 April 1998
about 22 miles north-east
of Whitby, North Yorkshire

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is an
INVESTOR IN PEOPLE

February 2000

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28 January 2000

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

Sir

I have the honour to submit the report of Mr S Withington and Mr A Rushton, Inspectors of Marine Accidents, into the circumstances which led to the loss of four lives and the sinking of the Belize registered cargo vessel mv Rema, approximately 22 miles north-east of Whitby, North Yorkshire, on the 25 April 1998.

Once the loss became known the International Merchant Marine Registry of Belize (IMMARBE) contacted the Marine Accident Investigation Branch (MAIB) and requested it to undertake an investigation on its behalf. I agreed, and this report fulfils that undertaking. In parallel with my submitting the report to you, it is also being forwarded to the Director of IMMARBE.

I have the honour to be
Sir
Your obedient servant

J S Lang
Rear Admiral
Chief Inspector of Marine Accidents

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.

CONTENTS

Glossary of Abbreviations and Acronyms

CCD	Charged Coupled Device
EPIRB	Emergency Position Indicating Radio Beacon
GL	Germanischer Lloyd Classification Society
GPS	Global Positioning System
HRU	Hydrostatic Release Unit
IMMARBE	International Merchant Marine Registry of Belize
LAT	Lowest Astronomical Tide
MAIB	Marine Accident Investigation Branch
MOB	Man Overboard
MSBV	Mooring, Salvage and Boom Vessel
MRSC	Marine Rescue Sub-Centre
MPCU	Marine Pollution Control Unit
OSGB(1936)	Ordinance Survey Great Britain 1936
PSC	Port State Control
RNLI	Royal National Lifeboat Institution
ROV	Remotely Operated Vehicle
RYA	Royal Yachting Association
SAR	Search and Rescue
SIT	Silicon Intensified
SOLAS 74	Safety of Life at Sea 1974
STCW 78	Standards of Training, Certification and Watchkeeping for Seafarers 1978
UTC	Universal Co-ordinated Time
VHF	Very High Frequency Radio

Marine Safety Agency (MSA) and The Coastguard Agency (TCA) merged in April 1998 and are now known as the Maritime and Coastguard Agency (MCA).

Rema arriving at Berwick-upon-Tweed on 22 April 1998

Synopsis

At 0422 Universal Co-ordinated Time (UTC) on Saturday 25 April 1998 the Marine Accident Investigation Branch (MAIB) was notified by Humber Coastguard that the cargo vessel *Rema* had apparently sunk in the North Sea some 20 miles off the Yorkshire coast.

Rema was registered in Belize but sank in international waters with the loss of her four man crew. They were all British. Inquiries began that day and, on 8 June 1998, MAIB agreed to undertake an investigation on behalf of the Belizian Authorities. On 16 June, a United Kingdom investigation was initiated and upgraded to an Inspector's Inquiry. It was carried out by Mr A Rushton with Mr J S Withington, Principal Inspector appointed as Inspector in Charge.

Rema was a 748gt, steel, general cargo vessel, built in the Netherlands in 1976. Her accommodation and engine room were aft, and she had a single hold fitted with MacGregor single pull hatch covers. She was diesel driven and fitted with a fixed pitch propeller.

The vessel arrived in Berwick-upon-Tweed in ballast on 22 April 1998. The cargo of "Redstone Chippings" was loaded on 23 April and she sailed for Terneuzen, the Netherlands at about 1230 on Friday 24 April. The weather on departure was good, the wind south-west 3–4 and the seas slight to moderate. Only four crew were on board.

At 0321 on Saturday 25 April, *Rema* transmitted a "Mayday" on Very High Frequency (VHF) Channel 16 giving her position as about 22 miles north-east of Whitby. Humber Coastguard responded by mobilising local RNLI lifeboats, RAF helicopters and several merchant vessels. There was no sign of *Rema*, but debris found confirmed she had sunk in position 54° 41'.95'N, 00° 08'.86W.

An underwater survey was carried out on the wreck during the period 24–27 June 1998. The vessel was found to be upright and intact, but with evidence of soft contact bow damage due to impact with the sea bed. When she sank her cargo had shifted forward and forced its way out of the forward hatches to spill onto the sea bed. Implosion damage to the hatch covers, forecastle head and wheelhouse was found, together with propeller blade contact damage. The bow damage was consistent with the vessel plunging almost vertically by the head to the sea bed before settling back down on an even keel and into an upright position.

The investigation found that *Rema* left Berwick-upon-Tweed with a full cargo and all ballast tanks empty. Calculations carried out for various conditions of stability showed she would founder if an additional 769 tonne of water was to enter her hold.

The cause of the foundering was water entering the hold without anyone being aware of it. This eventually caused a loss of buoyancy and *Rema* was lost. At that point, she plunged bow first to the sea bed so quickly that it was unlikely that anybody on board had time to escape.

Although the available evidence was scrutinised very carefully and the video tapes from the underwater survey were enhanced, it proved impossible to identify the means by which water entered the hull. None of the observed damage could account for any flooding. Although it has proved possible to determine what happened when *Rema* sank, the investigation has not been able to explain why.

SECTION 1
Factual Information

1.1 PARTICULARS OF VESSEL AND INCIDENT

Name	:	"*Rema*" (ex "*Fival*" 1995)
Official No	:	01961755
Port of Registry	:	Belize City, Belize
Owners	:	Herbert Trading Ltd 50 Shirley Street CB 139737 Nassau, Bahamas
Managing Agents	:	Halcyon Shipping Ltd, Gt Yarmouth
Classification Society	:	Germanischer Lloyd + **100A5M** (Restricted International Service) + **MC**
IMO Number	:	7519438
Gross Tonnage	:	748
Deadweight	:	1,041 tonne
Overall Length	:	59.55m
Breadth	:	9.40m
Maximum Draught	:	3.12m
Year of Build	:	1976
Type	:	Low air-draught bulk carrier/dry cargo
Main Engine	:	BRONS 6GV-H 552 kW @ 375rpm
Propulsion	:	Four blade fixed pitch propeller
Date and Time	:	25 April 1998, 0221 UTC
Place of Incident	:	22 miles north-east of Whitby
Injuries	:	Skipper and three crew missing
Damage	:	Total loss, vessel foundered

1.2 BACKGROUND TO VOYAGE

Rema was owned by the Herbert Trading Company of Nassau, Bahamas and managed by Halcyon Shipping Limited, of Great Yarmouth, UK. The management company's involvement was primarily for cargo broking and business management. Crewing, maintenance and repairs were the responsibility of the owner, who was also the master.

The vessel was bought in a laid up condition by the master from Dutch interests in 1995. She was surveyed by Germanischer Lloyd (GL) and re-entered Class in December 1995. Under the new owner, the registry was changed from Dutch to Honduran and the name from *Fivel* to *Rema*. The vessel's registry was changed from Honduran to Belize on 20 February 1997.

Rema carried a variety of cargoes such as grain, fertiliser, coal stone, etc., between various ports in the UK and Northern Europe. She arrived in Buckie from Walsoorden, Belgium at 0900 on 19 April 1998 with a cargo of malt. While in Buckie, one crewman left for personal reasons and another joined. Discharge was completed using grabs and a bob-cat. The vessel sailed in ballast for Berwick-upon-Tweed at 1530 on Tuesday 21 April. All double bottom tanks and the deep tank were ballasted with sea water. The forepeak tanks remained empty. The weather was fine and the anticipated passage time was 18-20 hours.

During the voyage south, the hold was cleaned and washed by the crew in preparation for the next cargo at Berwick-upon-Tweed. The washing water was discharged overboard using a portable submersible pump.

1.3 NARRATIVE

1.3.1 *Rema* arrived off Berwick-upon-Tweed at 1330 on Wednesday 22 April and she berthed alongside Stoneberth at 1350 the same day. She had a crew of five, plus the 11 year old son of the master. Soon after arrival, the young boy left the vessel and returned home.

A pre-loading hold survey carried out by an independent surveyor on Wednesday 22 April, confirmed it was suitable for carrying "hardened stone chippings". Loading started at 1500 and finished at 1115 on Thursday. The intended discharge port was Terneuzen, the Netherlands.

The cargo consisted of two grades of bulk stone chippings:

439.92 tonne of 2-5mm "Harden Redstone Chippings"

572.56 tonne of 5-8mm "Harden Redstone Chippings"

1.3.2 Having been informed that loading was complete and that high water was at 1246, the vessel's agent visited the ship during the morning expecting the master would wish to sail at noon. While he was discussing this with the master, they were joined by the mate who said they had a mechanical problem and an "oil seal" needed to be renewed. With the necessary repair time unknown, the master decided to delay his departure until the following day. The agent asked the master whether he would consider sailing on the next high tide at midnight but was told that because there was plenty of time in hand before *Rema* needed to be at Terneuzen for a Monday morning discharge, there was no pressing requirement to sail earlier.

The agent was not told what item of machinery was defective nor asked to provide any assistance or spare parts.

1.3.3 The agent returned to the vessel at about 1700 the same day and was told that the repairs were complete and a new seal had been fitted. Although the vessel was fit to sail, the master decided to abide by his earlier decision and depart at noon the following day.

Early next morning, the junior deckhand left the vessel to return home.

When the agent visited the vessel that morning, he was shown copies of the weather forecast for the Tyne that day indicating that the wind would be south to south-west force 3 increasing south force 5, and later veering south-west force 4 to 5.

Rema left Berwick-upon-Tweed at 1230 on Friday 24 April for Terneuzen, with a crew of four. After dropping the pilot, she cleared the harbour and was full away on passage by about 1300.

1.3.4 Nothing further was heard from her until an incomplete "Mayday" was heard on Channel 16 at 0321 the following morning. The call "Mayday" was repeated three times, the call sign twice, and the vessel's position, 54° 42'.N 08° W (sic), once.

Despite an immediate response and continual monitoring by Humber Coastguard, no further transmissions were heard or contact made. A "Mayday Relay" was broadcast at 0332 and adjacent coastguard stations were contacted to see if any had better information. None had. Helicopter assistance was requested, followed by the launch of both the Whitby and Scarborough lifeboats. The weather was reported as south-west force 3 to 4, sea/swell slight, with good visibility and a clear sky. The helicopter arrived at the "Mayday" position at 0431, followed by the two lifeboats at 0455 and 0703 respectively.

An overturned dinghy, five lifebelts and a large oil slick were seen, together with general debris, but there were no signs of survivors. The helicopters, lifeboats and other vessels in the area carried out an expanding box search. The search continued until 2100 when senior coastguards decided to end the search. Nothing further was found. Two helicopters, four RNLI lifeboats, a MPCU aircraft and four commercial vessels had been involved in the search.

MRSC Humber continued to broadcast to all ships in the area requesting them "*to keep a sharp lookout whilst transiting the vicinity of 54° 38° N, 000° 4W, and report any findings to Humber Coastguard.*"

1.3.5 Items recovered during the search were:

1 Zodiac type inflatable dingy
1 liferaft
1 liferaft casing
5 lifebelts (one with light)
1 lifejacket
2 survival suits
1 thermal bag
1 safety bag
Assorted wooden debris.

These items were taken ashore and stored at Whitby, Scarborough and Teesmouth RNLI stations, and Humber MRSC.

1.3.6 At the time of the incident, the Trinity House Vessel (THV) *Patricia* was in the vicinity of the Greenwich light float in the English Channel and was instructed to proceed to where *Rema* was believed to have sunk and to search for the wreck. She arrived at the position at 1036 on 26 April and started an underwater search straight away.

Using a search pattern centred on the reported position of the sinking, she located an underwater obstruction, believed to be a wreck, at 1527 that afternoon. Further survey work was carried out which included the use of a chain sweep. This was completed at 1713 on 27 April.

1.4 VESSEL CERTIFICATION

1.4.1 All statutory survey certificates were valid.

Details of certification are in **Annexe 2**.

The Minimum Safe Manning Certificate required by SOLAS 74 Regulation V/13(b) was issued by the International Merchant Marine Registry of Belize (IMMARBE) on 19 February 1998 and was valid for a year. The certificate stated that *Rema* was required to operate on short international voyages as defined in chapter III regulation 3.16. This states that such a voyage is one "*which a ship is not more than 200 miles from a port or place in which the passengers and crew could be placed in safety*".

The minimum safe manning authorised by the certificate was a master, mate, two able seamen and one ordinary seaman. On her final voyage, *Rema* sailed with a crew of four: master, mate and two men acting as seamen.

1.5 CREW PARTICULARS

1.5.1 None of *Rema*'s crew possessed any certificate of competency issued by UK authorities.

The master, Michael Stuart Clayton, was a 41 year old British national and had been at sea since 1970. He had served on various motor vessels before joining *Rema* in December 1995. On the strength of previous sea experience he had been issued with an Honduran Master's certificate for vessels up to 10,000gt in 1992. He subsequently applied for, and was issued with, a Certificate as Master from the Belize Authorities on 9 December 1996. It was granted on the basis of past service, not as a result of training and assessment. The certificate (No 0122088) was valid for vessels up to 1600gt and for three years.

1.5.2 The mate, Robert Neil Clayton, was a 40 year old British national. He was the brother of the master, and had served a two year apprenticeship as a welder/boilermaker in Plymouth between 1974 and 1976. He served at sea between 1976 and 1981, then came ashore to manage a boatyard. He held a Coastal Skipper and Yachtmaster Offshore certificate issued by the RYA, together with Sea Survival and First Aid certificates issued by the MSA at Plymouth in 1988. From early 1993, he had sailed as relief master/mate on coastal vessels and sailing schooners and had also undertaken general boat maintenance and engineering repairs.

On 22 July 1997, he was issued with a licence by the Belize Authorities to act as master on vessels up to 1600gt. This licence, (No 0122104), was valid until 24 June 2002. The basis on which it was issued is not known.

1.5.3 The two crew members were British nationals. The older man, Andrew Richard James was 34 years of age and had never been to sea before. He joined the vessel on 21 April in Buckie, four days before the accident.

He had never attended any pre-sea training courses.

1.5.4 The younger seaman, Shaun Norton, was 26 years of age, and had first joined *Rema* in late summer 1997. He had been sailing on and off the vessel since then and was on board when she arrived at Buckie on the 19 April. He had taken two days leave and re-joined before sailing on 21 April.

He had never attended any pre-sea training courses.

1.6 DESCRIPTION OF VESSEL (Figures 1&2)

1.6.1 The vessel was a steel hulled, single hold, motor driven general cargo vessel with engine room and accommodation aft and a raised forecastle. The wheelhouse was integral with the accommodation.

She was built in the Netherlands in 1976 and was fitted with a Brons six cylinder vee diesel engine, a solid four bladed propeller, a Bekker rudder, and two diesel generators, one port and one starboard. Bilge alarms were fitted in the engine room but not in the hold.

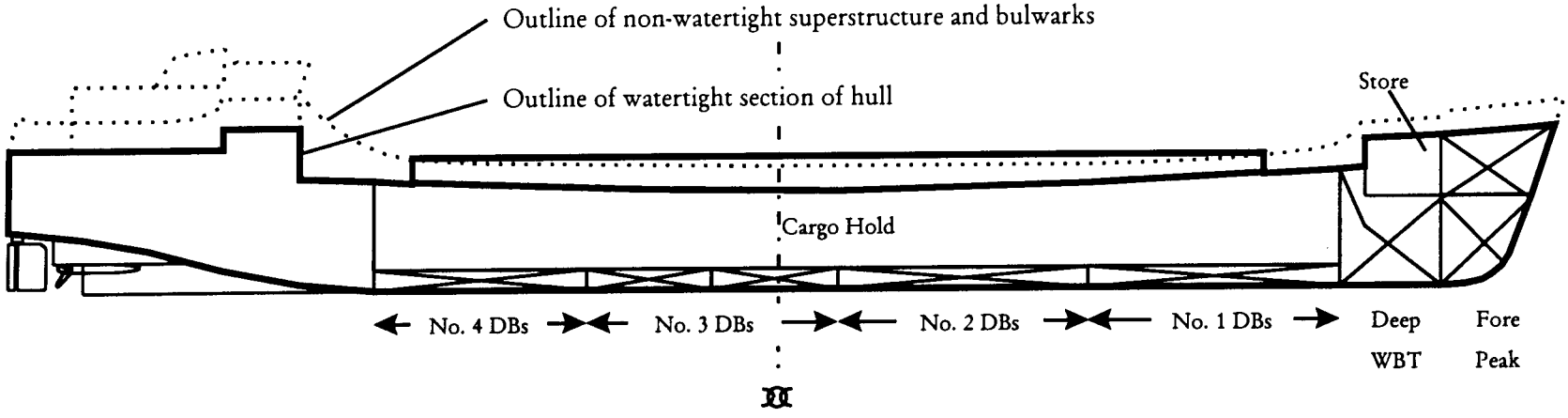
The 14 hatch covers were steel, single pull MacGregor type. Seven opened forward and seven aft. The hatch cover opening and closing mechanism had originally been electrically operated but had since been modified. On leaving Berwick-upon-Tweed, the forward section continued to operate electrically but the aft section was operated using a running whip from the windlass.

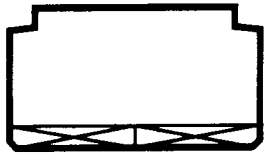
Ballast capacity was about 500m^3, of which 270m^3 was contained within eight double bottom tanks, four port and four starboard. The remainder of the ballast capacity was in the deep tank forward, a combined upper and lower forepeak tank, and four deep tanks aft of the engine room.

Two 60 m^3/hour bilge and ballast pumps were fitted in the engine room, one port and one starboard, each driven off a generator. Clutches for engaging the pumps could be operated either electrically from the wheelhouse or manually in the engine room. Ballast tank valves were fitted on the forward engine room bulkhead with the ballast lines running forward through the double bottom tanks. There were four hold bilges, two forward and two aft, with the valves grouped on the forward engine room bulkhead.

The accommodation was on two levels. Six crew cabins were situated aft on the main deck level with three cabins on either side of a central hall. The master's cabin was on the same deck but at a slightly higher level and beneath the wheelhouse. It was separate from the crew accommodation. The messroom and galley were aft at boat deck level, with the wheelhouse forward and slightly higher.

Figure 1: **Main arrangements of mv *Rema***

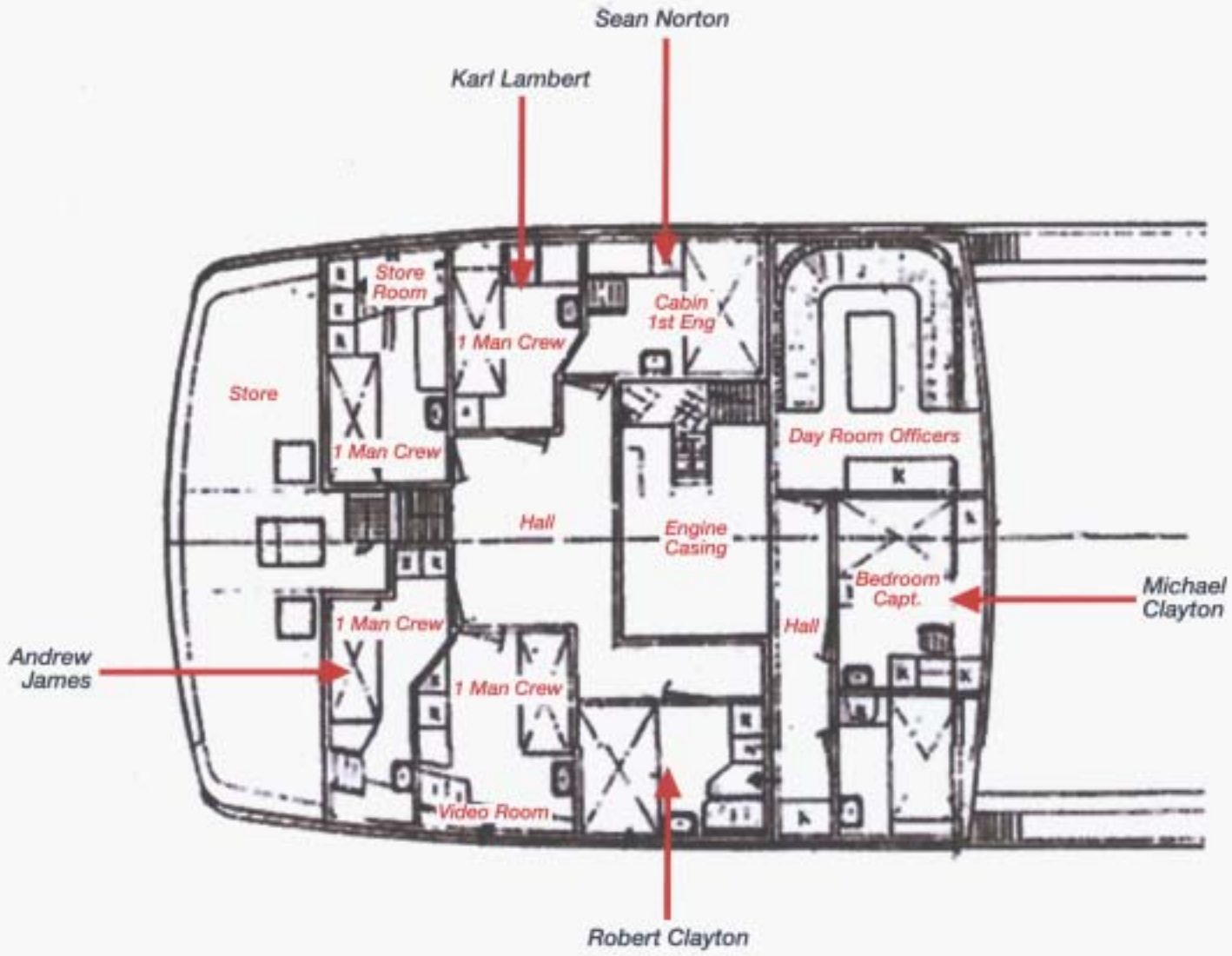




Section at forward end of hatch

Length BP	59.80m
Breadth	9.40m
Depth	3.80m
Draught (S)	3.12m

Figure 2: **Crew accommodation layout**



1.6.2 The wheelhouse control console was fitted hard up against the forward windows and ran the full width of the wheelhouse. The layout, from port to starboard, was as follows:

Various generator and pump controls
Light switches, gauges & meters
VHF set
Steering wheel on centre line including automatic pilot
12" Radar
Main engine controls, rev counters etc
New Radar
Engine alarm panel
VHF set

At the back of the wheelhouse on the centre line were the emergency radio, the 2182 watch receiver and the charging rack for three hand held VHF sets. On either side of the emergency radio were bench seats, under which emergency equipment was stored. Flares, spare aerials etc were stored to port, with lifejackets to starboard. A movable chair was normally positioned on the port aft side of the wheelhouse.

1.6.3 There were two exits from the crew cabins. The first used a central stairway aft up to a hallway on the boat deck. The second was through a fire door into the upper part of the engine room casing and up again to either the boat deck on the port side, or through a low height door into the wheelhouse.

The exit from the master's cabin was up a starboard side stairway into a side hallway and up again, forward into the wheelhouse, or from the side hallway aft into the galley and then out onto the starboard boat deck.

At the time *Rema* foundered, the port aft cabin was used as a store room while the central cabin on the starboard side served as a video viewing room. The younger crewman used the forward port cabin while his older colleague used the starboard aft. The mate used the forward port cabin.

Access doors from the accommodation onto the boat deck starting from the port side of the wheelhouse going aft were:

Wheelhouse door	Port side
Engine room door	Port side
Toilet/Store door	Port aft
Hallway door	Centre aft
Galley door	Starboard side
Wheelhouse door	Starboard side

An Emergency Position Indicating Radio Beacon (EPIRB) was fitted above the entry door to the paint locker on the aft rails of the boat deck.

Rema was neither fitted with, nor required to have, a Voyage Data Recorder.

1.7 VESSEL HISTORY

1.7.1 Built in 1975 as the motor vessel *Fival*, she was originally owned and operated by Dutch owners. She was registered in the Netherlands and classed by the Germanischer Lloyd (GL) classification society. Following a number of years trading, she was laid-up in the Netherlands with her classification suspended while new owners were sought.

In December 1995 she was bought by Herbert Trading Limited, Nassau, Bahamas. Before the sale could be completed, dry docking, survey and repairs were necessary. These were undertaken at Scram-Bolnes Shipyard, Rotterdam, where work was carried out in dry dock and afloat, with GL attending during November/December 1995. Details of the work carried out are described below:

Port side shell plating of 1st and 2nd strake below the sheer, frames 103-108 and 83-88, renewed including shell frames. Deep tank bulkhead inserted. The dimensions of the insert plates were 2500 × 4000 × 10mm and 2500 × 1600 × 10mm respectively.

Ultrasonic thickness measurements of shell and deck plating were taken and showed % thickness losses as below:

Strake	No of plates	0-5%	5-10%	10-15%	15-20%	20%+
"K"	22	6	5	10	1	–
"A"	39	7	10	12	5	5
"B"	29	7	12	6	3	1
"C"	11	6	5	—	–	–
"D"	25	19	6	—	–	–
"E"	26	18	7	1	–	–
Shear	6	4	2	—	–	–

Those plates identified as having the greatest thickness loss in the "A" and "B" strakes were:

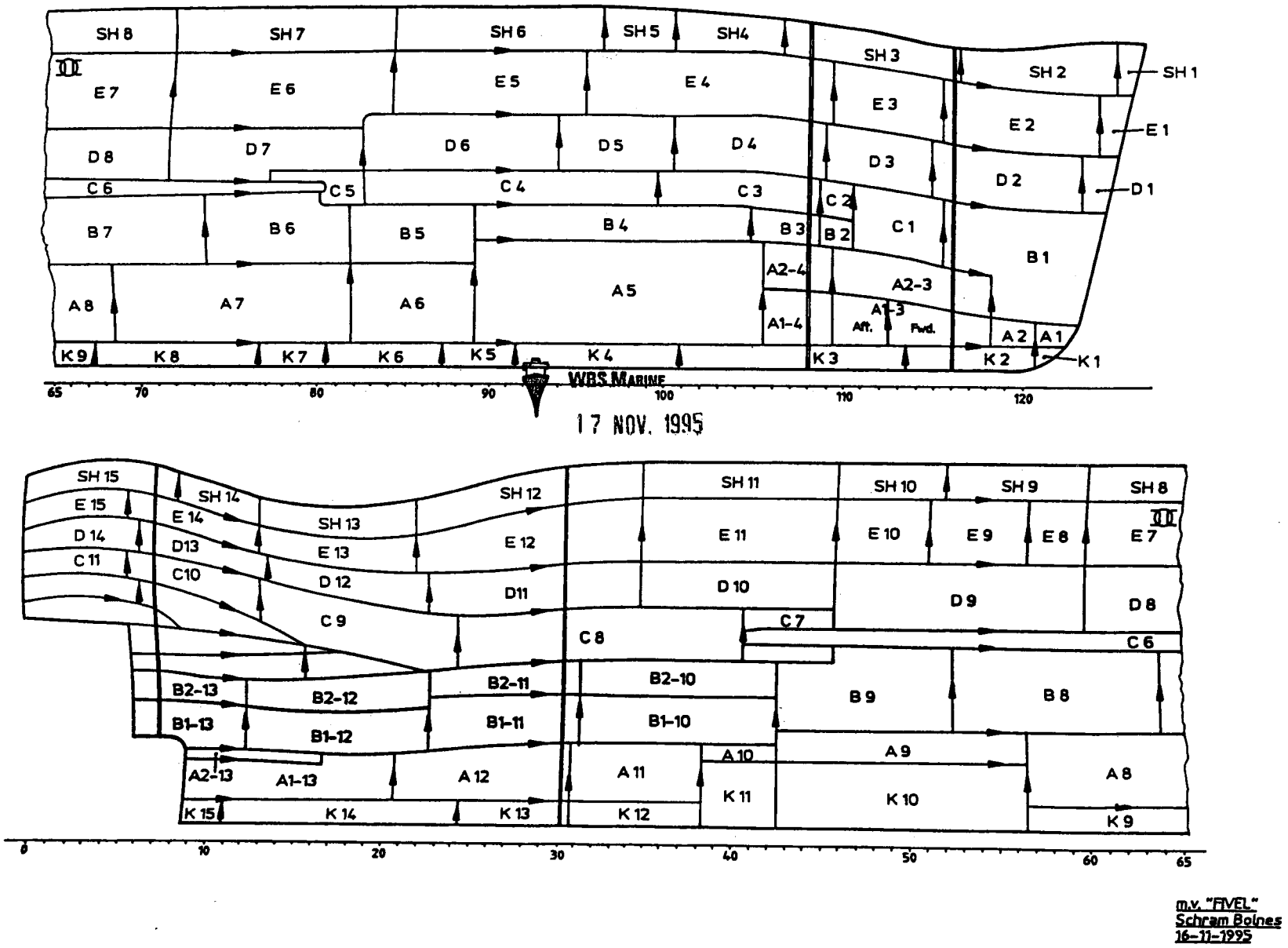
		Fwd	Aft
A1-4	(Stbd)	17%	11%
A1-4	(")	23%	0%
A1-4	(")	**27%**	8% (orig 10mm to 7.3mm)
A2-4	(")	12%	16%
A4	(Port)	19%	0%
B9	(Stbd)	19%	—

The worst affected were in "A" strake, plate A1-4(s) on the starboard side, next to the keel between frames 110 and 105. Each plate was measured in two areas, forward and aft, with the worst readings showing that maximum wastage occurred in the forward part of the plate. This wastage in "A" strake, between frames 108 and 109, was very localised and in the form of "pits". These were repaired by welding.

A cracked streamline plate by frame 10 starboard, was repaired by a plate insert, 600 × 600mm.

Tanks internally pressure tested and inspected. Local deep indentations on tank top plating repaired by insert plates at No 2 port and No 3 starboard double bottom tank tops. Plate sizes were 1800 × 1200 × 12mm and 1600 × 1000 × 12mm respectively.

Figure 3: **Bottom & side shell plating, starboard side**



Damaged cargo hold shell framing repaired by heating and fairing. Cracked frames welded.

Holes and local thinning spots on lower forepeak deck were repaired by inserting plates.

Leaking ballast line No 2 port DB tank repaired.

Anchor chains ranged and found acceptable. Swivel and D connection shackles renewed.

Rudder stock and rudder removed, bearings rebushed and rudder stock renewed.

Propeller removed and repairs carried out, one blade tip straightened and two blade tips built up by welding.

Hatchcovers hose tested, ventilation closing appliances, sounding pipes and watertight door repaired.

On completion of the dry dock work, the vessel's class was renewed for hull and machinery from December 1995. The next dry docking for hull bottom and propeller and rudder surveys was due in June 1998.

Statutory surveys were carried out and certificates were issued by GL on behalf of Honduras. The relevant dates and certificates are listed below.

Load line certificate renewal date:	14 December 2000
Load line annual survey due date:	14 December 1996
Safety construction certificate renewal date:	31 December 2000
Safety construction annual survey due date:	31 December 1996
Safety equipment certificate renewal date:	31 December 1997
Safety equipment annual survey date:	14 December 1996
Radio certificate renewal date:	17 December 1996

The next annual classification survey of hull and machinery was due in December 1996.

With the change in ownership in December 1995 she was renamed *Rema* and her registry changed from the Netherlands to Honduras. She re-entered service for trading between UK and continental ports.

Rema operated throughout 1996 without any incidents reported or recorded by class.

All required annual class and statutory surveys were completed by January 1997. Her ship registry was changed from Honduras to Belize at the same time.

1.7.2 Soon afterwards in March 1997, *Rema* collided with a bridge in Blexen, Germany, following a total loss of electrical power and steering. The cause of this breakdown has not been established.

The damage was surveyed in Bremerhaven, Germany by a GL surveyor. The forecastle deck, fittings, bulwark, forepeak internal structure and the windlass hydraulic system were all damaged and as a result she was detained by the German port state authority. Details of

the detention are described in paragraph 1.8.2. With GL's agreement, temporary repairs were carried out at Bremerhaven and arrangements made for the permanent repairs to be undertaken in Goole, UK, by the end of April 1997.

1.7.3 *Rema* arrived in Goole on 1 April 1997 and the following repairs were completed between 9 and 23 April:

Bulwark plating 8000 x 1200 x 6mm renewed including stiffening brackets.

Bow plating 1000 x 800 x 8mm renewed.

Deck plating forward of anchor windlass 4000 x 2000 x 8mm with underdeck stiffening renewed where damage had occurred.

Longitudinal division washplate in forepeak 2000 x 1000 x 8mm plate renewed and painted.

Figure 4: Port side bow damage to *Rema* after collision with service jetty at Keadby, River Trent — March 1998

Anchor windlass hydraulic motor pipework and controls renewed.

Chain clamping devices modified and windlass tested.

These repairs were organised by the master and carried out by himself, the crew and self employed workers. Materials, such as steel plate etc, were bought direct from steel suppliers by the master. On 23 April, a GL surveyor surveyed the repairs and confirmed that they had been completed to his satisfaction. A Class certificate was then issued.

1.7.4 While *Rema* was visiting Immingham in January 1998, a GL surveyor carried out the mandatory annual surveys.

In March 1998, while leaving in ballast from the top Gunness berth on the River Trent, she struck the service jetty at Keadby with her port bow, and sustained damage between the hawse pipe and the stem just above the boot topping. Scuff marks on the port anchor flukes indicated hard contact with the concrete jetty. A small hole in the forepeak tank, and a 6" to 8" split in the hull plating of the deep tank were the consequences (**Figure 4**). The crew repaired the split by welding while the hole was sealed by welding a bolt head into it. Other external damage was largely cosmetic. No further repair work was undertaken.

The vessel continued to trade successfully between the UK and northern Europe until she foundered off the Yorkshire coast on 25 April 1998.

1.7.5 Propeller damage was seen when the vessel was lying in a dry berth at Mistley on the River Stour in June/July 1997. The tips of the propeller blades were seen to be either broken off or bent over. The master was aware of the damage and had suggested to the mate on board at that time, that he intended to carry out repairs when *Rema* was dry docked for survey in June/July 1998 as required by Class.

1.7.6 At some time after the vessel's last dry dock in December 1995, a submersible pump was purchased by the master. This was permanently fitted in the deep tank with the 3" discharge outlet on the deep tank port side forward. It had been installed to reduce the time needed to discharge ballast forward and to enable cargo to be loaded sooner after arrival. A separate portable submersible pump had also been purchased to remove water from the hold after washing down. The reason why the existing hold bilge system was not used to pump out any water has not been established.

1.8 PORT STATE CONTROL INSPECTIONS

1.8.1 The MCA carry out targeted and unscheduled inspections of United Kingdom and foreign registered vessels using UK ports. These inspections focus on either one particular feature or are more general to ensure compliance with international safety, pollution and operational standards. Vessels found to be operating unsafely or not complying fully with the requirements of the regulations are subject to sanctions depending on the nature of the deficiencies. These can involve detaining the vessel in port, suspending its certificate or issuing an improvement notice.

The UK, with 12 other European Union (EU) countries and 5 non-EU countries, is signatory to the Paris Memorandum of Understanding on Port State Control (Paris MOU) to harmonise procedures, and make more effective use of resources to deter sub-standard shipping.

Each signatory to the Paris MOU undertakes to inspect 25% of individual foreign flag ships entering their ports each year. The UK has regularly exceeded this figure, inspecting 27% in both 1996/97 and 1997/98.

Under a European Directive (95/12/EC), certain categories of ships are targeted for priority of inspections. These are passenger ships; ships visiting the MOU region for the first time or after an absence of 12 months or more; older ships with a special hazard such as oil, gas and chemical tankers; ships classed with non-EU recognised classification societies; and ships registered with certain flags.

1.8.2 In addition to the need for individual foreign flag vessels to be inspected on a routine basis, *Rema* had been especially targeted because she was registered under the Belizian flag. This administration has a poor detention record and is currently number four on the UK's list of flag states being detained after Port State Control Inspections.

Rema had been inspected on eight occasions during the three years preceding her loss. The last took place in Montrose, Scotland, about two months before she sank. Four of the eight inspections were undertaken in continental ports.

The following is a list of the inspections:

Plymouth	12.08.96	Deficiencies	not detained
Rotterdam	20.08.96	Deficiency free	
Vlaardingen	19.02.97	Deficiency free	
Bremerhaven	14.03.97	Deficiency	detained
Hartlepool	30.07.97	Deficiency	not detained
Amsterdam	19.08.97	Deficiency	not detained
Rotterdam	29.10.97	Deficiency free	
Montrose	09.02.98	Deficiency	detained

Deficiencies recorded at Plymouth on 12.08.96 were:

- two lifebuoys smoke signals to be replaced
- anchor lights aft/forward to be repaired
- faulty 2155kHz watchkeeping receiver.

Deficiencies recorded at Bremerhaven on 14.03.97 were:

- hull damage impairing seaworthiness
- railing catwalks
- ventilator air pipes
- anchoring devices
- musters and drills
- minimum safe manning certificate
- charts
- auxiliary engines
- steering gear
- certificates of competency.

Deficiencies recorded at Hartlepool on 30.07.97 were:

- reflecting tape on lifebuoys to be replaced

- oil collected in forecastle to be cleaned
- fireman's outfit not available for immediate use
- lifejackets and immersion suits to be located in cabins
- crew cabins very untidy
- man overboard (MOB) rescue boat to be serviced and reflecting tape to be renewed
- chief mate (Mr B Clayton) to fax yacht master's certificate
- original safe manning certificate to be placed on board.

There is no information available on the deficiencies found at Amsterdam on 19.08.97.

The reasons for detention at Montrose 09.02.98 were:

- no lifeboats on board as required under SOLAS 60 111/35
- the captain was unable to show his certificate of competency required under STCW78 Art VI
- no evidence to show that two qualified radio operators were on board in accordance with SOLAS 74 IV/7(b)
- charts and nautical publications out of date in contravention of SOLAS 74 V/20
- fire hose leaking in contravention of SOLAS 74 II-2/21
- no fixed fire fighting system in paint locker which was required under SOLAS 74 IV/13(2).

Rema was detained for 5 days.

1.8.3 While she was detained in Montrose the MSA surveyor raised two principle concerns: the status of the life saving appliances (LSA), and the legality of the certificates of competency for the master and mate.

1.8.4 SOLAS 74 Regulation 35 (chapter III) states that *Rema* should have carried two lifeboats, although Regulation 5 (chapter I) allows for an equivalent arrangement. There was no document on board to show the surveyor that the two liferafts and the MOB rescue craft met this requirement.

GL had completed the mandatory annual survey and issued the safety equipment certificate about one month before the port state inspection. The MSA therefore requested GL to provide the evidence on which these life saving appliances satisfied the convention.

GL said that when the vessel was first built in 1975, the survey and safety certification was carried out by the flag state authority of the Netherlands which accepted the MOB rescue craft and two liferafts as equivalent to two lifeboats. This arrangement was published as an IMO circular, No 20 dated 28.05.82, "Equivalent arrangement accepted under regulation 5 of chapter 1".

Since the Netherlands, and then Honduras, had accepted the LSA arrangement, GL judged that the arrangement was still acceptable under the Belize flag and therefore satisfactory for the issue of the safety equipment certificate.

The MOB rescue craft was stowed on the poop and had to be manhandled into position for it to be launched by a single arm davit. The davit had a manpower drive winch with a wire on a drum. There was no slewing arrangement. The Montrose surveyor considered this arrangement to be impractical.

The GL surveyor was requested to survey the MOB craft and its launching arrangement. He was not satisfied with the latter. As a result, the hand operated arrangements were replaced by a 240 volts dc winch with a stall load of 2313kg. A new winch wire and hook was fitted as well as two sets of wire pulleys for slewing the davit.

A dynamic test of the launching appliance was undertaken using a 1.1 times maximum working load. The test was satisfactory and the appropriate certificates were placed on board.

Despite these modifications, the surveyor still thought the launching arrangements failed to satisfy SOLAS requirements and took the view that it could only be a temporary arrangement. He therefore stated that an approved system had to be installed and Class approval obtained in 1998.

He advised the master to contact the Belize Authorities requesting the issue of an exemption for her lifeboats. This certificate was issued on 30 March 1998 on two conditions:

- the vessel must not proceed more than 100 miles from the nearest land, and
- liferafts must be on each side of the ship of such aggregate capacity as will accommodate everyone on board, and shall carry an approved boat for use in the case of a man overboard.

The MSA surveyor recommended that MSA inform GL of its concerns about the quality of their safety equipment survey on January 1998 when the GL surveyor failed to identify deficiencies when launching and recovering MOB rescue craft.

1.8.5 The MSA surveyor's second concern was the legality of the skipper's and mate's qualifications. The master held a Belize licence for "Master Limited to 1600gt", issued on the strength of a Honduras Licence. The mate was issued with a similar licence because of a document issued by Panama stating that he had paid his exam fees and was entitled to be examined.

The MSA surveyor felt that these certificates failed to meet the STCW Convention requirements because licences cannot be issued on either the basis of sea service alone or eligibility for an examination.

Despite these concerns, Belize confirmed that its seafarers identification documents were issued to both the master and mate which allowed them to sail as master on cargo ships of 1600gt or less.

MSA accepted this assurance. Once the Belize licences were accepted as certificates of compliance under STCW 78, the deficiency of having no qualified radio operators on board was considered rectified.

The remaining deficiencies were resolved and the vessel was released from detention.

1.9 VESSEL MANAGEMENT

1.9.1 The vessel was operated by the master/owner with Halcyon Shipping Ltd acting as exclusive chartering broker. The master/owner was responsible for providing a ship in every

respect ready to trade. Maintenance, manning, surveys, certification, insurance etc were the sole responsibility of the master/owner. Halcyon Shipping Ltd arranged all cargoes for the vessel, and dealt on the owner's behalf, as necessary, with the parties having an involvement in the various voyages, for example, port agents, charterers and cargo interests. Halcyon collected all freight payments and settled the voyage costs on the owner's behalf. They accounted to the owners for monies so collected and disbursed.

Halcyon Shipping state that during its period of involvement with the vessel until her loss, it had no record of any cargo damage or shortfall.

The vessel's reputation for cleanliness and watertightness was good with a number of cargo shippers specifying *Rema* as the preferred carrier. Two such cargo shippers were S&T Shipping Ltd of King's Lynn who arranged a cargo of malt for a passage from King's Lynn to Bremen in late March 1998, and Kurt A Becher GmbH & Co, (Grain Trade & Processing Division), Bremen with a cargo of flaking grits from Bremen to Goole in mid March 1997.

An independent surveying company ECC International Europe inspected the hold at Par, Cornwall, before loading clay for Antwerp on 16 April 1996 and commented in a report – "Passed for bags but looks a good ship for bulk".

1.9.2 The selection and training of crew members was undertaken by the master. Crew were originally selected on the basis of their previous sea going experience but latterly, given the background of the crewmen, it appears to have been based more on availability and family connections.

1.10 BERWICK-UPON-TWEED HARBOUR

1.10.1 Berwick harbour is a small commercial and fishing port at the mouth of the River Tweed in Northumberland. Pilotage is compulsory, with the harbourmaster and his deputy acting as pilots. Vessel movement is normally restricted to between three hours before high water and high water.

A tidal berth in an area called Spital is situated on the south side of the river. Called Stoneberth, it is used exclusively for the loading of stone chipping cargoes and is where *Rema* sailed from on 24 April 1998. Constructed of timber it is sheathed in wood with heavy timber fenders on the river face. Fixed to the face of every alternate fender is a sacrificial wooden rubbing strake. These rubbing strakes are secured to the main timbers by large metal bolts with their heads recessed into the wood strakes.

Rema lay alongside this berth for nearly 48 hours without any reported damage or incident.

1.11 CARGO LOADING

1.11.1 The bulk cargo loading machinery at Stoneberth consists of a large hopper, gravity feeding a conveyor belt operating at right angles to the berth. The conveyor belt support structure was fixed, although limited movement was obtainable at the discharge shute by rotating the shute in a fore and aft direction. The movable loading shute covered an arc of about 20° with the loading arm extending out from the berth for about 6m. Symmetrical loading of a cargo in the hold required fore and aft movement of the vessel along the berth.

Before loading started on *Rema*, the hold was inspected by a surveyor from Inspectorate Griffith Ltd who confirmed that:

> *"... at the time of our inspection the holds were found to be clean, free from extraneous matter, suitable for the transportation of "Harden Redstone Chippings".*

1.11.2 Loading started at the forward end of the hold with the larger chippings being loaded first. Two piles were created forward, one was 282.56 tonne right forward and a second of 290 tonne overlapping but aft of it. A black plastic sheet was placed over the aft end of the second pile of chippings to separate the two sizes. A third pile of the smaller 2.5mm chippings was then loaded at the aft end of the hold. This pile weighed 349.92 tonne. In addition to the black plastic sheet, a reasonable separation gap was left between the two grades of cargo.

During loading, *Rema* was discharging ballast water continuously. Loading was suspended for a short time on 22 April as insufficient ballast had been discharged from the forepeaks and the deep tank.

Loading was carried out between 1500 and 1700 on Wednesday 22 April and 0700 and 1115 on Thursday 23 April 1998. On completion the master signed a letter attached to the Bill of Lading confirming that:

> *"the cargo has been loaded, stowed and trimmed according to your instructions and you are satisfied with the stability of the vessel throughout the forthcoming voyage."*

1.12 ENVIRONMENTAL CONDITIONS

The two to five day Southern North Sea planner issued on Wednesday 22 April 1998 for the sea areas Tyne, Dogger, German Bight, Humber and Thames, predicted the following for Friday 24 April:

> Tyne: South to south-west force 3 increasing south force 5, later veering south-west force 4 to 5. Humber: South to south-west force 4, increasing force 5. Thames: South-west force 3 or 4 increasing force 5.

The actual weather recorded by the coastguard in the area where *Rema* foundered on 25 April was wind south-west force 3 to 4, sea/swell slight, good visibility and a clear sky.

The weather conditions experienced by *Rema* from the time she left Berwick until the time she foundered were moderate.

Sunset was at 1924 on Friday 24 April with nautical twilight at 2050. There was little moonlight. There was a new moon on 26 April.

High water at the River Tyne on 24 April was at 1652. Spring tides were on 27 April.

1.13 PASSAGE DETAILS AND POSSIBLE SIGHTINGS

1.13.1 No confirmed details of *Rema*'s final passage are known and no charts or other navigational data have been recovered.

Her sinking was reported extensively in the media. This publicity led to two independent witnesses claiming they had seen her in the hours preceding her loss.

1.13.2 At 1906 on 27 April 1998, Humber Coastguard were telephoned by a member of the public living in Newbiggen-by-the-Sea in Northumberland who said he had seen a vessel close inshore on the evening of 24 April which he thought might have been *Rema*.

He described the vessel to the coastguard as *"a small old type coaster seen about 2210, very close inshore near Fairy Rocks. Vessel stopped and headed straight out east. I am concerned it may have been the Rema that may have hit the Fairy Rocks and sprung a plate. Vessel had a single derrick forward, old type coaster doing about 9–10 knots. The vessel was seen by my wife and myself on the night the Rema left port. Lights on the vessel's port holes were lit up and could be seen quite clearly."*

1.13.3 The person making this report was interviewed at his home in Newbiggen-by-the-Sea on 29 April. He stated that:

> *"On the evening of Friday 24 April, I returned home at 2205, and noticed a small coaster hove to ENE of Church point. I particularly noticed the vessel because the lights were on in its wheelhouse, deckhouse at main deck level, and three scuttles in the stern. Her bows were pointing down the coast and, when I first sighted her, I was in a position where I could see both her port and starboard navigation lights suggesting that her heading was SW. I was able to see no activity on the vessel.*
>
> *About 10 minutes after I first sighted it, the vessel swung around and headed out to sea before turning S×SE to head down the coast.*
>
> *As it was dark, I was unable to see any details of colour on the vessel. I did see a single mast forward and got the impression that her stern deckhouse was quite tall and old fashioned. I think she had a raised poop deck with two further decks in the deckhouse and a wheelhouse on top."*

Fairy Rocks are about 300m offshore, exposed at low tide, and lie in the bay between Church Point and Beacon Point. Church Point is about 4 nautical miles north of Blyth, Northumberland, and about 41 nautical miles south of Berwick-upon-Tweed. The nearest town is Newbiggin-by-the-Sea, which spreads up to Church Point.

1.13.4 During an interview with the assistant harbourmaster at Berwick-upon-Tweed, it became known that the Hon Secretary of the Seahouses lifeboat had seen a vessel he had taken to be *Rema* pass inshore of the Farne Islands during the afternoon of 24 April 1998. His house was at Seahouses, immediately opposite the islands.

The Hon Secretary subsequently informed the investigation that the vessel he had seen was probably *Rema*, as he particularly remembered seeing the letter "R" on its stern through his binoculars. He recorded the wind at this time as south-east about 8 to 9 knots. His time of sighting was between 1530 and 1630. He said that there was a buoyed channel through the islands and although it was not unusual to see vessels using it, the one sighted on this occasion was larger than those normally seen.

The Farne Islands are about 15 nautical miles south of Berwick-upon-Tweed. They consist of a chain of rocky islets, reefs and shoals which are divided by Farne Sound, running east/west, and Staples Sound, which runs roughly north/south separating the inner and outer islands. The inner island lies 2¼ miles east of Black Rocks Point and is separated

from the mainland by the Inner Sound. This is the route that the vessel thought to be *Rema* was taking.

1.13.5 The only event to have been recorded during her final voyage was the "Mayday" transmission in the moments before it was assumed she sank. The incomplete call was made by the master, whose tone of voice rose before stopping.

1.14 HUMBER COASTGUARD MRSC ACTIONS

1.14.1 At 0221 (UTC) on the 25 April 1998, Maritime Rescue Sub-Centre (MRSC) Humber, received a "Mayday" call from a vessel giving her call sign and position, but no further information. The coastguard immediately answered, but nothing further was heard.

The position given was plotted, and checked against direction finding bearings obtained from the coastguard aerial at Whitby. This gave a position about 21 nautical miles north-east of Whitby. "Mayday Relays" were made by MRSC Humber from 0232 but no vessel responded until 1417. Further investigations identified the vessel as *Rema*, that she was a coaster and on passage from Berwick-upon-Tweed to Terneuzen in the Netherlands carrying a cargo of Redstone Chippings. Crew numbers were either four or five.

The sequence of the search and rescue operation that followed is in **Annexe 4**.

1.14.2 The vessels, aircraft and helicopters used during the search and their time spent on scene were:

Whitby RNLI lifeboat	18 hours
Scarborough RNLI lifeboat	10 hours
Teeside RNLI lifeboat	4 hours
RAF Leconfield rescue helicopter 128 (minus re-fuelling)	12 hours
RAF Boulmer rescue helicopter 131	3½ hours
MPCU aircraft ATLANTIC 405	2 hours
MV 1. (*"BIKANES"*)	5 hours
MV 2. (*"ROLF BUCK"*)	5 hours
MV 3. (*"SYDSTRAUM"*)	5 hours
MV 4. (*"ASPERITY"*)	4 hours

SAR units spent about 17 hours in the vicinity of the "Mayday" position searching for *Rema*'s missing crew. The coastguard estimated that given the likely water temperature in the search area, the maximum survival time for anybody in the sea without proper survival suits or lifesaving equipment was about three hours.

1.15 TRINITY HOUSE SURVEY

1.15.1 Following the incident, THV *Patricia* sailed from the Greenwich light float at 0745 on 25 April to locate the wreck of *Rema*.

She arrived in the area and started searching at 0936 on 26 April using Simrad SQ 270 sonar and a Simrad EA500 hydrographic echo sounder. The initial search was carried out based on the positions obtained from Humber MRSC. No sign of a wreck was found and

the search was extended along the tideline towards the "Mayday" position near to where the oil had been seen welling to the surface. The wreck was located by sonar with the first echo sounder contact being obtained at 1427. Sixteen echo sounder contacts of the wreck were recorded. Attempts to obtain a clearance height using a chain sweep were unsuccessful due to the prevailing wind against tide conditions. Operations were suspended at 1915.

1.15.2 Survey operations resumed at 0920 the following day to establish clearance over the wreck by chain sweeping. This was completed during the morning and *Patricia* was released at 1613 to continue with her programmed work.

The wreck's position was confirmed as 54° 41'.94N, 000° 08'.75W. This position was based on fixes obtained from raw GPS information on OSGB (1936) datum. Clearance over the wreck was established as 44.6m LAT.

The sea bed was found to be level and consisting of sand and sea shells.

1.16 ROV SURVEY

1.16.1 An underwater survey using a remotely operated vehicle (ROV) was undertaken by Dronik Consultants Limited (Underwater Search & Survey) on behalf of the Ocean Marine Mutual Insurance Association, MAIB and the Salvage Association.

The vessel used for the survey was mv "*Goosander*", registered in Kingstown, St Vincent & Grenadines, and classed as an anchor handling vessel. She was managed and operated by Underwater Technical Services Limited (UTEC) of Loddon, Norwich. The chosen ROV was a SEAEYE 600, equipped with a CCD colour camera, SIT camera, obstacle avoidance sonar and two 150w quartz halogen lights.

Goosander left Lowestoft on 23 June 1998 and arrived on site at 1000 the following morning where she anchored. The wreck was found at a depth of 60-65m, in position 54° 41'.95N, 00° 08'.86W, with the ship's head on 018°. She was sitting upright, keel down, on a sea bed of heavy mud and shells. Conditions during the operational period were good with calm seas and good surface/sub-surface visibility. Sub-surface currents were experienced during both flood and ebb tide and all ROV operations were timed to coincide with the periods of slack water.

1.16.2 The initial underwater survey found that cargo had emptied out of the hold and was under and around the wreck, mostly on the starboard side to a distance of 75m. No debris other than cargo from the casualty was found.

Subsequent detailed survey runs progressed from main deck level to the bilge keel, bow to stern. The findings of the survey are described below:

Port Side

No obvious ruptures or breaches to the hull were identified although some areas of scouring were found. All portholes were found intact. A small amount of cargo was seen on the sea bed, spread between the bow and stern.

Starboard Side

A "V" shaped crease from the rubbing strake to the bilge keel was found in the hull plating

between frame 29 and 22 below the starboard wheelhouse wing. Although areas of scouring were seen, no other ruptures or breaches to the hull were identified. The fourth porthole from the stern had lost its glass. The others were intact. A large quantity of cargo was scattered over the whole length of the casualty, with some large deposits, about one metre thick, lying close to the hull.

Bow Area

The top of the stem had been pushed backwards to crush the forward forecastle bulwark and deform the hull plating on both sides of the stem and the forecastle deck. Quantities of mud and cargo were visible right forward on the forecastle deck with further large deposits of mud on the upper side of the starboard anchor. Both forepeak storeroom hatches had collapsed inward with the remote winch control lying on the deck by the port access hatch.

The port side of the main deck area between the forward hatch coaming and the break of the forecastle was obscured by the displaced forward hatch cover. A portable gangway and ladder were stored amidships while on the starboard side, a quantity of cargo had built up on the main deck around the forecastle access ladder.

Stern Area

On the starboard side of the transom, the hull plating was creased from the bulwark downwards.

All four propeller blades were found damaged to varying degrees; the tips were missing on three, the fourth was bent.

The rudder did not appear to be damaged.

Hatch Covers and Hold

All 14 hatch covers were present. Many had distinctive "V" shaped damage in the centre portion and all had been displaced to varying degrees. The forward hatch, No 1, had been totally displaced. Its starboard forward end had shifted towards the bows and over the hatch coaming to point upwards, with the port aft end dipping down into the hold. The drive chains were intact and still holding the hatch cover in that position.

The ROV visited the hold twice, once from forward via the displaced No 1 hatch cover, the other via the gap between No 14 hatch cover and the distorted No 13 hatch cover.

Only a small amount of cargo was found in the hold. It was lying against the starboard forward bulkhead, and covered an area of approximately two square metres and about one metre deep. The hold tank top was covered in a fine film of mud, with a number of larger piles being distributed down the starboard side. At the aft end of the cargo hold, the starboard bilge well cover was distorted, with the port cover missing. Some distortion of side frames was found without any visible sign of hull plating damage.

Wheelhouse and Accommodation

The top centre section of the wheelhouse, 6mm thick aluminium (2700 × 3200mm), was crushed downwards so that it had forced the front of the wheelhouse inward and forward. The deckhead in the wheelhouse had collapsed, preventing any survey of the interior, or examination of the wheelhouse controls. The starboard wheelhouse door was shut, with the port one only slightly open. It was not possible to open these doors. A number of windows in the wheelhouse front were missing with the side and rear wheelhouse windows intact.

The main mast and both radar masts were in place and undamaged with the searchlight slightly displaced due to the crushed wheelhouse top.

The port side liferaft was missing with the launch gate open. The painter from this liferaft was wrapped round the port stay on the stern mast and led to the surface.

The starboard liferaft had also released but was jammed aft of the cradle between the guard rail and the roller block starboard aft. Although the securing band was intact, the liferaft container had partially opened at one end.

An EPIRB, still secure in its cradle, was seen fixed to the boat deck rails at the stern, above the paint locker door.

The port accommodation door was shut and secured by a single clip.

The starboard galley door was open, with interior fittings either collapsed or displaced making access impossible. The starboard accommodation door forward of the galley door, was shut and secured by a single clip.

The paint locker door situated port aft was open, as was the aft accommodation door. Although access was made into this compartment, collapsed bulkheads, loose radiators and messroom equipment together with poor visibility, prevented further investigation.

Cargo Displacement

The majority of the cargo was lying on the sea bed both underneath, and to starboard, of the wreck. Large cargo deposits extended for a distance of about 75m from the bow to the starboard quarter, at an angle of about 100° to the centre line of the wreck. Only small deposits were seen on the port side and at the stern.

SECTION 2
Analysis

The investigation set out to establish why an apparently well found vessel sank so rapidly that there was only time to transmit a partial distress message. It also examined the background to the accident to determine whether there were any other factors that might have contributed to her loss.

At the time of *Rema*'s disappearance, the weather was moderate, with winds south-west force 3 to 4. There were no known deficiencies on departure from Berwick and she was sailing with an experienced master and mate.

The sudden disappearance of *Rema* led to the decision to conduct a detailed underwater survey of the hull using an ROV to determine why she sank. This section analyses the results of all the evidence collected.

2.1 THE SHIP – SEAWORTHINESS

Although *Rema* had been detained twice in the 20 months before her loss for Port State Control (PSC) deficiencies, the only evidence available to indicate that she did not comply with regulations when she sailed from Berwick-upon-Tweed was that she was short of one seaman. The Safe Manning Certificate issued to her on 19 February 1998 stipulated a crew of five. On her final voyage she carried a crew of four.

All statutory survey certificates for *Rema* were valid and in date according to the Belize Authorities. They had been accepted by the MCA.

Apart from the delay in sailing due to an unknown mechanical fault, *Rema* had no known structural problems or defects. A pre-loading survey had found her hold sound, with no evidence of standing water.

2.2 THE CREW – QUALIFICATIONS AND EXPERIENCE

According to the Belize Authorities, both master and mate held valid Belize licences. They were therefore qualified to sail as master and mate and had also served on board *Rema* for some time and were familiar with her handling and operational characteristics.

Any licence or Certificate of Competency issued by one flag state under the STCW 78 Convention, is required to be recognised and accepted by other flag states. The MCA surveyor who carried out the PSC inspection in Montrose was unable to confirm the validity of the master and mate's licences until the actual licences were produced on board. As these licences were issued to the seafarers concerned on 9 December 1996, prior to the convention entering into force for Belize on 24 April 1997, they are valid under Article VII (1) Transitional provisions.

Rema's mate who had been the subject of MSA attention in Montrose was no longer on board. He was relieved in early April 1998 by Robert Neil Clayton, who was issued with a Belize licence on 22 July 1997. This would be valid under Article V11 (2) Transitional provisions.

The MAIB understands that a Belize licence issued to seafarers at that time, was based either on possession of a licence or certificate issued by another flag state, or by demonstrating a record of previous sea service.

The minimum manning authorised for *Rema* was master, mate, two able seamen and one ordinary seaman. She actually sailed with master, mate and two men who had limited sea service and no pre-sea training whatsoever. One of the two ratings had never been to sea before he joined on 21 April.

One rating left *Rema* on the morning for personal reasons.

Rema was undermanned on her final voyage.

The investigation draws no conclusions about whether the manning shortcomings contributed to the loss of *Rema*: it is thought unlikely. Nonetheless the efficient and competent handling of any emergency at sea is highly dependent on having the right number of qualified, experienced and well trained crew on board.

2.3 POSSIBLE CAUSES OF DAMAGE – PRE-SAILING

From the outset of the investigation, the inspectors attempted to identify how *Rema* foundered and the means by which she flooded. Among the many possible leads, a check was made to see whether there was anything untoward with the Stoneberth jetty at Berwick that might have affected *Rema*'s watertight integrity.

During the course of the investigation it was found that another vessel, very similar in size and design to *Rema*, *mv Celebrity*, had used the same berth some six weeks after *Rema* and had subsequently reported damage.

Celebrity's hold had been inspected by a surveyor on arrival, and she had loaded a cargo of stone chippings using the same method as that on *Rema*. She sailed as normal into what was predicted to be moderate weather with force 5 to 6 south-south-easterly winds and improving. Some time after leaving Berwick, her master felt she was not responding normally. A member of the crew was sent forward to check the hold and found 3 feet of water in it. The hold bilge pump and an emergency pump were started and the vessel made port safely. A subsequent inspection found a 30mm diameter hole in the side plating about 2m above the level of the keel.

It was assumed initially that this hole had been made while the vessel was lying alongside in Berwick. A comprehensive survey of the Stoneberth jetty was therefore carried out by an independent surveyor accompanied by the harbourmaster to establish whether there was anything, such as a projecting bolt, that could have penetrated *Celebrity*'s hull. Since *Rema* had loaded stones at this berth several weeks before, the finding of anything that could have been responsible would have been very significant.

This survey found no evidence of a projecting bolt or any other feature likely to have caused the damage.

To double check that Stoneberth jetty was unlikely to have damaged *Rema*, the investigation sought to establish whether any other vessel using the berth between the 26 April and 6 June when *Celebrity* sailed had reported any damage.

In addition to *Celebrity*, six other vessels had used this berth during this period but none had reported any damage to their hulls while alongside or subsequently.

There was no evidence to indicate that whatever caused *Rema* to sink had been initiated while she lay alongside at Berwick.

2.4 CONDITION WHILE ALONGSIDE AT BERWICK-UPON-TWEED

2.4.1 Only limited maintenance and repair records of the vessel are available, but the agents and the Berwick harbourmaster (pilot) state that, on the basis of observations made during their visits to *Rema* between 22 and 24 April 1998, the vessel was in a reasonable condition for her age.

Despite being 22 years old, *Rema* was well thought of by cargo shippers. The master maintained the hold in a good, clean condition and ensured the hatch covers remained watertight and that the hatch seals and compression bars were in good condition. *Rema* had been given a clean discharge after unloading water sensitive malt at Buckie on 19 April 1998.

Photographs taken of *Rema* arriving at Berwick-upon-Tweed show evidence of the stem damage caused by the collision on the River Trent on 10 March 1998. Although the ballast tank penetrations had been repaired, the shell plating damage remained untouched. The damage was largely cosmetic and unlikely to have affected the seaworthiness or operation of the vessel.

2.4.2 Although *Rema* would have taken the ground during her time alongside in Berwick, there would have been no reason to examine or notice the condition of the rudder or propeller even if water levels had been low enough for such an examination to have taken place. No conclusions about their state immediately before sailing can therefore be drawn.

2.5 CONDITION OF *REMA* ON DEPARTURE

2.5.1 General

On departure from Berwick-upon-Tweed, the master informed the pilot that the vessel's draught was 3.3m. It is not clear whether this was the mean or maximum draught. As the pilot would be most concerned about the clearance beneath the keel, it has been assumed the master was referring to the maximum draught.

Had 3.3m been the mean draught then *Rema* was over-loaded on departure. Calculations show that in this condition, there would have been an unidentifiable and additional weight of about 95 tonne present. Had this been ballast water, then either the deep tank forward was full, or the lower forepeak tank and one set of double bottom tanks was filled with that amount.

The harbourmaster who piloted *Rema* to sea has said that while he was on board he neither saw nor felt anything to indicate she was unseaworthy. She responded to the helm without hesitation and displayed no unusual characteristics.

Although there is a possibility that *Rema* was overloaded when she sailed from Berwick-upon-Tweed on 24 April. There is no evidence to indicate she was unfit for sea.

2.5.2 Underwater Damage

The master was known at various ports as a "rock dodger"; someone who chose to operate in shallow water or close to land. Although there is no record or evidence of *Rema* having grounded at any time, the propeller may well have touched the sea bed, or other underwater obstruction, at some time in the weeks before she foundered.

Given the nature of *Rema*'s trading pattern, the frequent need to transit up and down rivers and occasional requirements to lie in a mud berth, the opportunities to sustain minor hull and propeller damage were forever present.

Apart from the damage known to be present as the result of previous accidents, there is no evidence to show that *Rema* was suffering from any underwater damage when she sailed from Berwick.

2.6 NAVIGATION PLAN

2.6.1 General

It has not been possible to reconstruct the track used by *Rema* on her final voyage. No navigational records or charts were ever recovered and no confirmed sighting of her while on passage has been identified. The only two certainties about the final voyage are that she sailed from Berwick-upon-Tweed at 1300 on 24 April and sank in position 54° 41'.95N 00° 08'.86W at 0321 the following morning.

It was nonetheless important that the passage was reconstructed as far as possible to see whether anything could have occurred to explain her loss.

There was no evidence to suggest she had been involved in a collision with an unknown vessel.

2.6.2 Previous passages (Figure 5)

In view of this lack of positive evidence, the investigation attempted to find out what passage plans or records existed for previous voyages.

An examination of *Rema*'s log book for the period 25 October 1997 to 22 April 1998, shows that when sailing up and down the east coast of the UK, she consistently followed the coast, although a track further offshore would have been more direct and shorter. This routine was very evident for the passage between the Farne Islands and Flamborough Head.

Scrutiny of the log reveals that on a very similar voyage between Berwick-upon-Tweed and Terneuzen in late October 1997, *Rema* had, in relatively calm conditions, selected a route that took her inside the Farne Islands and hugged the coast for some time before altering course to steer for the OG1 buoy off Flushing. Her average speed for that passage was 7.7 knots. Although there is no obvious explanation for this practice, there are a number of possible reasons why she might select an inshore route. It is known, for instance, that some vessels prefer an inshore track to remain within mobile telephone coverage for as much of a voyage as possible.

Figure 5: **Track of a previous passage on 25–27 October 1997**

2.6.3 Final Voyage

On her last voyage, the master selected a course that took her, eventually, further to seaward than normal. The wreck was found some 20 miles offshore and to the east of tracks adopted on previous voyages. The reasons for this departure from the master's normal practice are not known.

Although the route taken by *Rema* after leaving Berwick-upon-Tweed on the 24 April is not known, precedent and the available evidence suggests she probably followed an identical track to that taken six months previously until she had cleared the Farne Islands. She would then have taken a more direct route across the North Sea to her destination.

The distance between Berwick-upon-Tweed and the Flushing pilot station is 362 nautical miles and, assuming an average speed of 6.25 knots, the steaming time would have been two days, 10 hours. At this speed, *Rema* would have arrived at about 2300 on Sunday 26 April. The pilotage time up river, from sea to the Dutch port, would have been about three hours. With discharge scheduled for Monday morning, *Rema* would have arrived on time.

2.6.4 Sightings on Passage

There were two possible sightings of *Rema* while on passage. Both are examined.

1. Newbiggin-by-the-sea
   A member of the public informed Humber Coastguard that he had seen a vessel lose inshore near Fairy Rocks, close to Newbiggin-by-the-Sea at 2210 on the evening of 24 April.

Rema's distress call was made at 0321, five hours six minutes after she was alleged to have been seen in the Fairy Rocks area. The distance from Fairy Rocks to the position given in the distress call is about 56 nautical miles. Had the vessel sighted been *Rema*, she would have had to make a good 11 knots to reach that position. Given that her maximum speed was no more than 8 knots, and the tidal stream was against her, this rules out any possibility that the vessel sighted was *Rema*.

The description of the vessel sighted by the Fairy Rocks did not match that of *Rema*. Although it was dark, the description was sufficiently specific to identify certain features that were very different to those of *Rema*.

A vessel may well have been seen in the vicinity of the Fairy Rocks between 2200 and 2210 but the investigation is confident it was not *Rema*.

2. Farne Islands
   The second sighting was made by the Hon Secretary of the Seahouses lifeboat at 1530 on the 24 April. A vessel was seen inshore of the Farne Islands. The timings of this sighting and the distress call show some correlation. If this vessel was *Rema*, it suggests she was maintaining an average speed of around 6 knots. It also suggests she was following an identical passage to one she had adopted before.

Although there is no absolute proof to show that *Rema* did pass inshore of the Farne Islands on the afternoon of 24 April, the investigation concludes that she may well have done so.

2.6.5 Grounding

Because one of the most likely causes of hold flooding was hull damage due to grounding, the investigation considered whether *Rema* had done so in the hours before she sank.

Notwithstanding the report that *Rema* had been sighted inshore off Newbiggen-by-the-Sea, there is no firm evidence to support this and the timing was wrong. It is thought most unlikely that *Rema* passed so close to the Fairy Rocks that she grounded on them.

The report that she had been sighted taking the inshore, or inner sound, passage past the Farne Islands between 1530 and 1630 on the afternoon before she foundered was, on the other hand, more credible. Because the master had undertaken this passage before and the speeds involved tied in with overall progress, there was a distinct possibility that he had retraced his earlier passage and taken the inshore route once again.

There is nothing difficult, or indeed dangerous, about taking a vessel through the inner sound, but it would be relatively unusual. It requires making a deviation from the direct route and involves (on this occasion) taking a low powered vessel through waters where strong tidal streams could be expected. Spring tides were running in a south easterly direction at about 2 knots at the time *Rema* would have passed the Farne Islands lighthouse.

Although she may have done, there is no evidence whatsoever to indicate *Rema* touched bottom, even momentarily, when she passed the Farne Islands. If she did, it was not reported. The master was not known for reporting anything untoward. It seems that on previous occasions when damage had been sustained he chose not to make an official report but merely repaired the damage at a time convenient to himself.

2.6.6 Passage Speed

The propeller damage, first identified in Harwich in June/July 1997 and seen again in the underwater video of the wreck, would have adversely affected *Rema*'s speed. It may also have caused uncomfortable vibration aft. It has not been possible to quantify the difference in the degree of damage between that seen in June/July 1997 and on the 1998 video, but with no evidence of damage to either rudder or stern revealed during the underwater survey, it is unlikely *Rema* grounded during her passage south on 24 April to the extent that she sustained any damage aft.

Rema was usually chartered with a quoted service speed of about 8 knots. This should have been well within her capability for passages with an undamaged propeller, or one with only slight tip damage. The propeller damage seen on the video was sufficiently extensive to prevent her achieving the quoted service speed of 8 knots.

To determine *Rema*'s average passage speed on past voyages, her log book for the period 25 October to 22 April 1998 was examined. (Because the voyage record pages were full, it was landed before the final voyage). Using samples from four passages undertaken in the North Sea, her achieved average speed was close to 7.6 knots.

Although exact timings on *Rema*'s last voyage are not known, a speed estimate has been calculated on the basis that she sailed from Berwick-upon-Tweed at 1230 on 24 April, passed close to the Farne Islands between 1530 and 1630 that same day, and sank where the wreck was found at 0321 on 25 April. Two speed estimates have been made on the assumption that she cleared Berwick at 1300, passed the Farne Islands at 1530 and sank at 0321.

1. The distance from the breakwaters at Berwick to a position abeam the Farne Islands lighthouse (the approximate position where *Rema* was most probably last seen) is 15 nautical miles. The time between departure and sighting was about 2.5 hours indicating that she was making good of about **6.0 knots**. Had she passed the lighthouse later than 1530, the average speed would have been less.

2. The distance from abeam the Farne Islands lighthouse to the wreck position, is 76 nautical miles, with a time lapse of about 12 hours. This resultant average speed made good is **6.3 knots**.

The conclusion drawn from this analysis is that whichever route *Rema* actually adopted on her final voyage, she was probably making good a speed no more than 6.0 to 6.5 knots.

Although there is the possibility that *Rema*'s master had deliberately chosen to proceed at reduced speed in view of the time in hand, this would have been in total contrast to all previous passages when an average speed of between 7.5 to 8.0 knots was always made good.

It is therefore concluded that the damaged propeller affected the overall speed and led to a speed reduction of about 2 knots on what she normally achieved. This was not however, a significant factor in the subsequent loss of the ship.

2.7 WHEELHOUSE WATCHKEEPING

2.7.1 It has been established that the usual watchkeeping pattern in *Rema* was for the master to take the 1800 to 2400 watch and for the mate to be on watch between 0000 and 0600. If, during his watch, the mate was either uncertain of something or a major decision needed to be taken, he would call the master.

Both the master, and to a lesser extent, the mate, were experienced mariners and familiar with *Rema* and her characteristics when at sea. They were familiar with the North Sea and there was nothing about the passage that would have caused either of them any misgivings or anxiety.

Shipping in the area that night was, by all accounts, light. Three vessels arrived in Teesport that evening, the last one berthing at 2225. On 25 April 1998, (the day of the incident), only one vessel was recorded as berthing in Teesport in the early morning (0514), and this had come from Terneuzen – the same port that *Rema* was heading for.

2.7.2 During normal wheelhouse watchkeeping, it was not unusual for the watchkeeper to sit on the bench seats at the rear of the wheelhouse. His view forward when seated, gave a clear view over the bow as well as down either side. He could monitor the radar but would not be able to see the main deck below the forecastle or the hatch covers. If *Rema* was taking water into the hold, the watchkeeper sitting on the bench would not necessarily notice the vessel sinking lower in the water. The forecastle would remain visible and clear of any significant spray until the flooding had reached an advanced stage.

With the watchkeeper in an enclosed wheelhouse with both doors shut and no obvious indication of anything wrong, (no hold bilge alarms were fitted) any change in the usual background noise level or intensity would probably go unnoticed. Unusual external noises such as seas breaking on deck and the movement of water against the forecastle bulkhead would, to a large extent, be muted. With a dark night, nothing showing on the radar, a

moderate sea and the main engine providing a rhythmic background, it would be easy to keep watch without becoming aware of a problem until the vessel started to act sluggishly. Even had the watchkeeper moved to the front of the wheelhouse, it is most likely that he would have focused his attention seaward rather than on what might have been happening on deck.

If the normal watchkeeping arrangements were in force, the mate would have been on watch in the hours before, and at the time of, her foundering. Once he became aware that something was seriously amiss, he would have called the master. There is no means of knowing exactly what happened, but it is known that the master and not the mate made the distress call. Based on the incomplete message received by the coastguard, *Rema* appears to have sunk while that call was in progress.

All the indications show that *Rema* sank so rapidly that escape was impossible.

2.8 THE ROV SURVEY

2.8.1 The ROV survey revealed the main areas of damage to be structural, particularly the bow area and hatches, and to the propeller. It showed that whatever caused *Rema* to sink, it was not as a result of a collision. There was no collision damage nor was there any sign of explosion or fire.

2.8.2 Although some of the observed hull damage existed before the accident, nearly all the structural damage was caused by either the very rapid sinking or by the bow impacting on the sea bed.

The damaged areas are considered in turn.

2.8.3 The stem damage is consistent with the vessel plunging almost vertically to the sea bed. The length of time the vessel remained vertical would depend on how long the stern remained buoyant. The only way that mud could have accumulated on top of the stem and behind the port anchor was for the stem to dig into the sea bed before the stern flooded, allowing her to settle back onto an even keel.

2.8.4 The damage to hatch covers, forecastle head store, forepeak tank (the upper and lower peak tanks being common) plus, possibly, the deep tank is consistent with implosion damage caused by the head of water as the vessel sank. The deep tank access hatch was found to be open. Since the tank was normally empty during loaded voyages, water would have entered the tank through this access, but because the sinking was so rapid, implosion damage would have been possible.

2.8.5 The "V" shaped distortion of the hatch covers is consistent with implosion damage and supports the view that the hatch covers were secured in place at the time *Rema* foundered. Although they moved forward slightly when *Rema* first nosed into the sea bed, they were unable to withstand the forces presented by the cargo of stones sliding to the front of the hold. As they did so, they would have forced open No 1 hatch cover and then spilled out onto the seabed. Although some water would have entered the hold through the gaps caused by hatch movement as she sank, the speed at which *Rema* then settled back down onto her keel on the sea bed, created such a large pressure differential between the hold and the surrounding sea, that the hatch covers would have imploded.

Had the hatch covers not been secured, it is likely that they would have become detached while *Rema* was vertical and be scattered, largely undamaged, on the sea bed.

Had *Rema* capsized, the dismounted forward hatch cover would not have remained on deck.

Buckling of the hold frames at tank top and deck level is consistent with the implosive pressure exerted on the hold as described above.

The small quantity of stone chippings found forward of the vessel and on the forecastle deck confirms it spilt through the displaced forward hatch cover while *Rema* was vertical.

2.8.6 The wheelhouse damage is also consistent with rapid foundering and differential pressures that caused implosion. Water pressure crushed the aluminium centre section of the wheelhouse deckhead, causing the deckhead lining to collapse. With wheelhouse fittings probably damaged and loose equipment moving as *Rema* became vertical, the subsequent deckhead collapse completed the devastation.

2.8.7 Both the galley door on the starboard side and the stern door into the crew accommodation aft were found open. This probably reflects their normal position at sea in fine weather. It is unlikely they had been opened for escape purposes.

Internal damage seen through the open doors and in the hallway aft, is most probably due to a combination of the vertical position of *Rema* in the early stages of the foundering, and the subsequent inrush of water.

2.8.8 The damage to the propeller is consistent with contact damage. Part of it was probably present in June/July 1997 – see Section 1.7.5. Despite this, the investigation found that *Rema* maintained an average vessel speed of about 7.5 knots when carrying cargoes before her arrival in Buckie. The average speed made good on her last ballast voyage, Buckie to Berwick-upon-Tweed was about 6.4 knots.

The absence of damage to the rudder and/or skeg suggests that the propeller damage seen in the video, existed before *Rema* left Berwick-upon-Tweed and is not related to the subsequent sinking. It has not proved possible to explain why the propellor became so damaged.

Rema's ship's head on the sea bed was 018°. The course she would have been steering at the time she foundered would have been in the order of 140°. MAIB has found on many previous occasions that the heading of a wreck on the sea bed is often totally different to the last known course being steered before a vessel sinks. This is due to the effects of the inrush of water, movement of cargo, structural collapse and the release of large quantities of air.

2.8.9 Although the liferaft launch gates for both liferafts were open and might have been released by human action, they were probably opened by the vertical plunge. Both liferaft hydrostatic releases worked. The port hydrostatic release unit (HRU) activated allowing the liferaft to float to the surface. The starboard liferaft also released but during Rema's plunge to the sea bed it became trapped abaft its cradle and between a deck fitting and the hand rail.

The EPIRB had not floated free and was found still attached to the boat deck railings. Its make or type has not been established. Checks with the Coastguard EPIRB Registry show that it had not been registered in the UK under *Rema*. Its failure to operate did not affect the outcome of the accident.

2.8.10 Visible hull damage was minimal, with no hull penetration being found. Hull deformations seen at the stern of the vessel are consistent with structural tanks imploding under water pressure. A number of rust patches and paint scrapes were identified but none were significant. If the vessel had touched ground after leaving Berwick-upon-Tweed, the video survey of the bilge keels failed to show any evidence of serious damage. With the vessel in her current position, it was not possible to see whether there was any damage on the underside of the hull.

2.9 VIDEO ANALYSIS

2.9.1 The initial study of the video taken of *Rema* sitting on the sea bed failed to show anything likely to have caused major flooding of the hold. A second, more detailed study was therefore undertaken using image enhancement techniques. The objective was to try and identify any areas of the hull, particularly in the hold, where cracks or heavy pitting might have occurred but were hidden by corrosive products or shadow.

A number of areas where severe corrosion appeared to exist were analysed and found to be a combination of plate erosion and variations in the basic paint colour. Prominent weld or plate edges were highlighted, but failed to reveal any evidence of cracks or plate splitting. One or two possible hull plating penetrations were found above the load water line and in the area of the deep or forepeak tanks.

No hull penetrations or plating cracks were detected in either the side plating of the double bottom tanks or the hold.

The internal survey of the hold, although confirming that compression had occurred due to water pressure, did not identify any tank top or bulkhead damage. A thin layer of silt on the tank top did not conceal any plate deformation, but prevented detailed examination. Too close a viewing resulted in large clouds of silt fogging up the cameras. Detailed examination of the air pipes and their attachment to the tank top was not possible due to their proximity to the hull plating, side stringers/webs, and silt accumulation.

2.9.2 A photographic mosaic of the damaged bow on the starboard side was constructed and showed recent scrape marks. None were found to penetrate the hull. Other mosaics showed pressure buckling of side frames in the hold and to the forward hatch. Other photographs suggest that a number of small hull rust patches just below main deck level may have penetrated the hull plating but, because of their position, would not have led to serious flooding of the hold.

One enhanced photograph identified what looked like the main engine control stand with the handle indicator registering STOP. If correct, this would be consistent with what would be expected had an emergency developed. The main engine would have been stopped while the matter was being investigated.

Apart from confirming that an EPIRB was on board, an enhanced photograph was unable to provide sufficient detail to establish its make or why it had failed to float free.

2.10 FLOODING CALCULATIONS

2.10.1 With no direct evidence to explain the cause of sinking, the Salvage Association was asked to carry out a series of flooding calculations to establish the following:

1. The known and/or estimated departure condition of *Rema* from Berwick-upon-Tweed;

2. The amount of water, and the flooding rate, required to sink *Rema*;

3. What condition would be necessary for *Rema* to suddenly plunge to the sea bed.

The flooding calculations considered two basic conditions: direct hold flooding, and the flooding of individual tanks as well as the hold. Calculations for the second condition took account of the variations on what tanks could have been involved and their effect on the hold flooding time.

The weather conditions after leaving Berwick-upon-Tweed were moderate with a south to south-west force 4 wind, good visibility and a clear sky.

Daylight had faded by 2100, and given the fair conditions, it has been assumed that a significant change to the vessels trim would have been noticed. Under those conditions, an assumption has been made that flooding was symmetrical, with the vessel slowly sinking while maintaining an even keel. This parallel sinkage continued until just before *Rema* plunged.

Two considerations lend weight to this assumption:

1. Both master and mate were experienced seamen, and had there been any unusual list or trim, they would have been aware of it at an early stage and taken appropriate action.

2. No distress message was sent until just before it is believed the vessel plunged. The message was incomplete with the tone of the voice rising before it ceased.

2.10.2 The calculations found that even with her full cargo and all double bottom, forepeak and deep tanks full of ballast water, *Rema* would have remained afloat. It would have been necessary for the hold to be flooded before she was capable of foundering.

The flooding scenarios were based on the following:

a. Flooding of the cargo hold alone;

b. Flooding of different combinations of double bottom tanks, always including the lower forepeak tank and the deep tank;

c. Flooding of (a) and (b) together.

There is no evidence to indicate *Rema* sank by the stern, so no flooding of the aft spaces has been considered. All the evidence indicates she sank by the bow.

With hold flooding identified as the critical factor, a flooding time index based on an imaginary 50mm × 50mm hole positioned at tank top level was constructed. Although no

such hole was found during the ROV survey, the size and position provides a reference point. The flooding time indexes quoted in the calculations are based on the head of water applied at tank top level. If the hole was positioned higher up, then the inflow would decrease proportionally and the time index would increase. This time index only applies to the time necessary to flood the hold using the notional hole. Any flooding of a tank or tanks before hold flooding occurs would either be added flooding time or, if ruptured at the same time as the hold, occurring simultaneously with hold flooding.

The maximum time available for flooding assumes it started when *Rema* left Berwick-upon-Tweed and ended about 14.4 hours later when the distress call was made. If, however, it started at, or soon after leaving the Farne Islands, then the available flooding time was just under 12 hours. In both cases, the last seven hours of any flooding would have occurred in darkness.

The discussion on how the vessel probably sank is based on the Salvage Association's calculations and the findings of the ROV survey. The full calculation report is in **Annexe 5**.

The results of the calculations were based on both symmetrical and asymmetrical flooding of the double bottom tanks, followed by progressive flooding of the hold. Seven flooding conditions were studied. The three asymmetrical ones (cases E, F, & G) have been rejected as they would have caused a severe list and/or a large trim by the head and would have been noticed by the master or mate who would have taken appropriate action.

In the four cases of symmetrical flooding, three involved flooding of the combined forepeak tank but the ROV evidence does not support such an event. The video evidence suggests that the combined upper and lower forepeak tank imploded. With a full cargo aboard, it would be usual for this tank to be empty. In Case C, the simultaneous flooding of No 1 and 2 port and starboard double bottom tanks, plus the additional flooding of No's 3 and 4 double bottom tanks in Case D, would require a significant grounding event. Apart from being unlikely, no evidence of this was seen during the ROV survey. These two cases are therefore also rejected.

2.10.3 Having eliminated certain causes of flooding, the two remaining cases examined by the Salvage Association are looked at together with three other possible explanations.

i) Deep tank flooding followed by hold flooding through the aft deep tank bulkhead (Case B – Salvage Association Report).

The immediate past history of hold inspections before loading and cargo turn-out, point to sound steel work. This does not totally preclude steel work failure but it does suggest that had it occurred it was likely to be relatively minor. It would also indicate that the deep tank itself was open to the sea allowing free flooding. As it contained ballast water on arrival Berwick-upon-Tweed, any breach of the bulkhead between tank and hold would have meant that water would have started to seep into the hold. This would have been noticed at the pre-loading survey.

Even ignoring flooding of the forepeak tank, flooding of the deep tank would have given *Rema* a noticeable trim by the head. This theory is also rejected as being unlikely.

ii) Hold flooding through ruptured double bottom tank *and* tank top:

Direct hold flooding via the double bottom tanks would require penetration of the hull in addition to failure of the tank top plating. Had *Rema* touched bottom causing hull damage

during her last voyage or earlier, it is theoretically possible for water to penetrate into the hold if the tank top plating suffered from corrosion. Any hole or rupture would have to be the result of corrosion, as any sudden failure of the steel would have caused visible tank top deformation. No such evidence was seen during the internal ROV survey of the hold. Similarly, there is no visual evidence of any significant damage along the port and starboard bilge keels indicating possible bottom damage.

With the vessel sitting on the sea bed in an upright position, inspection of the bottom plating was not possible.

Flooding through a ruptured double bottom tank and the tank top is unlikely.

iii) Direct hold flooding via damaged hull (Case A – Salvage Association Report):

Direct flooding of the hold through a cracked weld, corroded plate/weld interface or a plate split was thought to be the most likely source of flooding. Cracks of this nature are not easily discernible, so a detailed study of the ROV video covering the port and starboard shell plating was carried out. For flooding to occur on the scale necessary to sink Rema within the maximum available time scale, the size of the opening would need to be about $100mm^2$.

Despite video enhancement of suspect plate areas, no weld or plate defect has been identified in the hull. Flooding occurring through a weld or an opening, however, remains a possibility.

iv) Hold flooding through ruptured double bottom tank *and* broken or corroded air pipe or pipes in hold:

If *Rema* had touched bottom while passing the Farne Islands, the hull might have been damaged, causing flooding of No 3 double bottom tank. Because this tank does not have a centre division, any flooding would not cause a list. Although sounding of this tank would identify flooding, extra ballast would only have had a marginal affect on *Rema*'s stability.

If, however, one or more of the air/overflow pipes for that tank were damaged or corroded close to the tank top, then serious hold flooding would occur. Bearing in mind that mechanical shovels are used in the discharge of malt and other bulk cargoes, mechanical damage to air pipes can, and does, occur.

This, too, could have been the source of flooding.

Although a thorough ROV survey was carried out on the plating on both sides of the hull from the bilge keels upwards, the upright position of the vessel prevented any inspection of the bottom, other than at the stem and the stern.

2.10.4 The most likely explanation arising from the ROV survey observations and the Salvage Association calculations, is hold flooding through a ruptured double bottom tank.

Three conditions would, however, have to be fulfilled first:

a. *Rema* to have had to have touched bottom either on leaving Berwick-upon-Tweed, while passing the Farne Islands or somewhere not identified.

b. No 3 double bottom would have to be ruptured.

c. One or more of the air pipes from No 3 double bottom tank would have to have either suffered mechanical damage or been heavily corroded.

There were four air pipes in No 3 double bottom tank, each measuring 75mm in diameter. If one was damaged or seriously corroded when the double bottom tank flooded under a head of 2.5m, the maximum inflow of water would be about 72 m^3/hour.

Calculations show that 769 tonne of water were needed to sink Rema and would have required a steady rate of inflow of 72 m^3/hour to achieve this in 10.68 hours. As more flood water enters the hold, the increasing draught would increase the rate of inflow and reduce the time taken.

For this not to be noticed by the crew, it has to be assumed that hold flooding started at or about the time *Rema* passed the Farne Islands. If flooding was already taking place at the maximum rate at that time, about 340 tonne of water would have been present in the double bottom and the hold by sunset. At that time, the vessels' freeboard would have been reduced from about 1.2m to about 0.4m. At 2050, nautical twilight, the amount of water in the hold would have increased to 450 tonne reducing the freeboard to about 0.15m Thereafter the situation would have continued to deteriorate in the dark until something caused somebody on board to become aware of the loss of freeboard. It is likely that this occurred at about 0320, prompting the master to start making the distress call that he never completed.

2.11 OTHER FLOODING CONSIDERATIONS

2.11.1 Two further possible sources of flooding have been considered:

i) back flooding into the hold or ballast tanks via bilge suction lines; and

ii) flooding between the time loading was complete and departure.

2.11.2 To ensure efficient suction, bilge pumps require a water seal to be present in the pump casing at all times. When a bilge becomes dry, air is sucked in and the pump loses suction. To restore suction, sea water is allowed to trickle continuously into the pump casing through a partially open sea valve. Back flooding occurs when both the bilge or ballast suction line valve and bilge pump sea valve are left open once the bilge pump has been stopped. Sea water, under the action of gravity, is then free to flood back into the ballast tank or tanks. *Rema* would, however, have remained afloat even if all the ballast tanks were flooded.

In the case of hold bilge lines, back flooding can only occur if the bilge non-return valve is either missing or jammed open by debris and the sea suction valve is open for pump priming. If the non-return valve is jammed open, back flooding would be a continuous process until the problem was either identified or the hold became flooded. There is no evidence to indicate this valve was defective.

The hold had been empty since cargo discharge in Buckie but had been washed down during the passage southwards to Berwick-upon-Tweed. Water from this washing down was removed from the hold using a submersible pump. The reason why the bilge pump was not

used on the hold bilge line on this occasion has not been established. The pre-loading inspection at Berwick-upon-Tweed confirmed that no water was present and the hold was fit for loading. With little or no water in the cargo, hold bilge pumping after loading would not have been a requirement.

2.11.3 Because of two potentially significant factors, the uncertainty of the departure draught and the delayed sailing, the possibility of hold flooding starting while *Rema* was in Berwick-upon-Tweed has been examined.

The departure draught was given as 3.3m without any comment on whether it related to the maximum or mean draught. It would be usual for the draught marks to be taken and recorded on completion of loading and after the hatches had been closed. Loading was completed by 1115 on Thursday 23 April but departure was delayed until 1230 on the following day. During this time, the hatches would have remained closed and it is unlikely that any further inspection of the hold or check on the draught marks would have been made.

If cracks had developed between the ballast and load waterlines during the ballast voyage from Buckie to Berwick-upon-Tweed, the crew are unlikely to have been aware of them as they washed down the hold. Being above the water line, cracks would not have been subjected to water pressure and the hold would have remained dry. The pre-loading survey was also unlikely to have identified any cracks. Only during, or after loading was completed, when the cracks would have been submerged, would flooding have become noticeable. Its start would also be dependent upon the state of the tide as the vessel would, at low water, be sitting on the bottom. Once the hatches had been secured, it is unlikely that any flooding would have been noticed, especially as no bilge alarms were fitted in the hold. If pre-arrival hull cracking had occurred, and water entered the hold while alongside the Stoneberth, the available flooding time would increase to a maximum of 38 hours. That is 24 hours while alongside loaded and with hatches secured, plus the 14 hours between leaving Berwick-upon-Tweed and sinking.

The size of crack would have a direct affect on the flooding rate. If water entered the hold while *Rema* was alongside, the crack must have been quite small, since a large quantity would have affected the handling of the vessel on sailing. When leaving, neither the pilot or pilot boat crew mentioned any difficulties in handling *Rema* or had cause to comment on an excessive draught. It follows that if the water ingress was that small over the preceding 24 hours, the flooding rate, once at sea, would have been insufficient to sink her at 0322 the next day.

If the crack had been larger, then either the vessel would have sunk at the berth, or the effect of the flooding would have been noticed by the harbour authorities and/or the crew.

As it is unlikely that *Rema* had flooded during the 24 hour delay in sailing, some other explanation for the flooding has to be found.

2.12 HULL THICKNESS MEASUREMENTS

2.12.1 As part of the process of re-registering *Rema* into Class under her new owners in December 1995, Germanischer Lloyd, *Rema*'s classification society, required a full ultrasonic hull material thickness check to be carried out. This is a normal process for a 20 year old vessel and with *Rema* in dry dock for repairs, it provided an ideal time for this survey to be carried out.

The particular GL Rules covering this survey are contained in Part O of the Rules for Classification and Construction and are as follows:

"*Para 2.4.3. Local strength*

Maximum permissible large surface reduction of plate thickness and web thickness of profiles: t_k

For thickness equal to or less then 11.5mm $t_k = 1.5mm$"

In the same paragraph, it is stated that the maximum permissible locally limited reduction of thickness is 0.2t or 20%.

2.12.2 The original hull plate thickness on *Rema* varied between 11.0mm on the keel, 10.00mm on the bottom and side shell plating, with inserts of 15mm on the midship waterline level and midship in the sheer strake.

The ultrasonic survey showed that plate thickness loss through corrosion, erosion and general wear and tear varied between 0 and a maximum of 27% (a 10mm plate reduced to 7.3mm at the worst place). These results identified 6 out of a total of 90 bottom plates that had suffered a level of wear which was either unacceptable to class or approaching the limit. This wear, which class has identified as local pitting, was repaired by welding.

These repairs were directly beneath the deep tank or No 1 starboard double bottom tank and any subsequent failure in these areas would have resulted in the flooding of these tanks. Such flooding would not have resulted in water entering the hold unless either the deep tank bulkhead, tank top or an air pipe had suffered corrosion or mechanical damage. As *Rema* had arrived in Berwick-upon-Tweed with all double bottom and the deep tanks ballasted, any structural damage would have resulted in water entering the hold. None was seen by the crew or the independent cargo surveyor before loading.

There was nothing abnormal about the condition of the hull at the time of purchase (December 1995), and nothing in the recent history of *Rema* to indicate that her condition had seriously deteriorated during the period up to her departure from Berwick-upon-Tweed on 24 April 1998.

2.13 SCUTTLING ALLEGATIONS

2.13.1 In early March 1999, an allegation was made in the local north-east press, that *Rema* had been deliberately sunk. Although nothing had arisen during the course of the investigation to indicate fraudulent practice, the MAIB believed it important to establish the source and nature of the allegations.

The allegations appear to be based on two events:

1. Immediately prior to *Rema* leaving Berwick-upon-Tweed, the master sent the vessel log book, together with other papers, to his current address in Castleford. He addressed them to himself.

2. The day after the vessel was lost, the wife of one of the crew members is reported to have told his mother-in-law that she was not to worry as he would be home later that day. When asked why she said that, she was reported to have said that she had been

told that it was planned to sink the vessel at some time in the future at a suitable time and location. She had been told this during a telephone conversation with her husband before *Rema* sailed.

2.13.2 The log book and papers that had been landed were disclosed and passed to MAIB for examination. The papers were company bank statements covering the period 1992 to 1996. The log book, marked No 5, covered the period 25.10.97 to 22.04.98, the last entry being the voyage south from Buckie to Berwick-upon-Tweed.

Although there were 29 unused daily sheets in the log, the page on which each voyage arrival, departure and cargo details were entered, was full. The last entry on the page being the arrival at Berwick-upon-Tweed. For that reason alone, the master would need to start using a new log book.

There is therefore a plausible explanation for the master to send both the log book and old company bank statements ashore.

2.13.3 Attempts were made to unravel the sequence and content of the various telephone conversations made between relatives of the crew and the crew before the accident, and between the relatives both before and after it. Nothing emerged from the investigation to give credence to the suggestion that *Rema*'s sinking had been planned in advance.

2.13.4 The investigation found no evidence to indicate the existence of a plan to scuttle the ship or that it had gone badly wrong in its execution.

2.14 ACCIDENT RECONSTRUCTION

Like many accident investigations in the past, the quality of reliable evidence available for reconstruction was limited. Despite using modern underwater cameras and image enhancement techniques, many questions remained unanswered. Very little is known, for instance, about the details of her last voyage and there is no means by which it has been possible to discover what was happening on the bridge in the final moments before she sank including what those present were saying. Had a Voyage Data Recorder (VDR) been fitted, such information would have been available and done much to establish exactly what occurred.

Rema was not fitted with any form of VDR, was not required to be and there are no plans to fit them in such small vessels in the future. Yet the fact remains that lack of such a recorder in a vessel the size of *Rema* has greatly frustrated the investigation process. There are just as many questions to be answered in a small ship as a large one. Four lives lost is four too many and until VDRs are fitted to all vessels above about 100gt, it will not be possible to establish exactly what happened or take the appropriate measures to prevent the same thing happening again.

This accident has reinforced the need to fit VDRs in all vessels and it is recommended that Belize argues strongly for their introduction in IMO.

SECTION 3
Conclusions

3.1 FINDINGS

3.1.1 *Rema* was seaworthy on departure from Berwick-upon-Tweed, with all certificates valid and a reported draught of 3.3m.
[Ref: 1.4, 2.1, 2.5.1]

3.1.2 The ROV survey showed the vessel sitting on the sea bed in an upright position with soft sea bed impact damage to the bow, plus implosion damage to the forecastle, hatch covers and hold, and wheelhouse.
[Ref: 1.16.1]

3.1.3 Propeller damage was seen in June/July 1997 but could not be quantified against the damage seen on the wreck in June 1998.
[Ref: 1.7.5, 2.8.8]

3.1.4 The stem and bow damage seen during the ROV survey was not the result of a collision with another vessel or object.
[Ref: 2.8.1]

3.1.5 During the process of plunging, and before settling on the sea bed, the cargo of stone chippings had fallen out of the hold, through the forward end of the hatch covers to settle underneath, and around, *Rema*'s final resting place.
[Ref: 1.16.2, 2.8.5]

3.1.6 Both liferafts hydrostatic releases operated. The port liferaft surfaced, the starboard one becoming trapped under a deck fitting and guard rail after it had been released.
[Ref: 2.8.9]

3.1.7 The estimated maximum survival time, given the temperature of the sea water in the area of the foundering, was three hours.
[Ref: 1.14.2]

3.1.8 The position of the hatch covers shows that the vessel did not capsize.
[Ref: 2.8.5]

3.1.9 The EPIRB did not float free and was found still attached to the vessel. Its failure to operate did not affect the outcome of the accident. It was not registered in the UK under *Rema*.
[Ref: 1.16.2, 2.8.9]

3.1.10 The weather conditions likely to be experienced by *Rema* during the early morning of 25 April 1998 were south-west force 3 to 4, sea slight, and good visibility but with no appreciable moonlight (a new moon due on 26 April).
[Ref: 1.12, 2.10.1]

3.1.11 With the watchkeeper in an enclosed wheelhouse, both doors shut and no obvious indication of anything wrong, any change in the usual background noise level or intensity would probably not be noticed.
[Ref: 2.7.2]

3.1.12 That *Rema* flooded without the crew being aware of the situation suggests it occurred slowly until either the bow began to submerge, or the watchkeeper's attention was drawn to the vessel's sluggish response.
[Ref: 2.7.2]

3.1.13 With all ballast tanks full, plus the cargo of stone chippings, *Rema* would have remained afloat.
[Ref: 2.10.2]

3.1.14 Calculations show that *Rema* required 769 tonne of water in the hold to have foundered while carrying a cargo of stone chippings and with empty ballast tanks.
[Ref: 2.10.4]

3.1.15 Video enhancement of apparent severe corrosive areas and/or suspected cracks in the hold plating and plate/weld interface showed no evidence of any crack or hull penetration.
[Ref: 2.9.1]

3.1.16 With the wheelhouse layout and environment it would be easy for the watchkeeper to be unaware of a developing problem.
[Ref: 2.7.2]

3.1.17 The vessel sighted in the inner sound off the Farne Islands at about 1530 on 24 April was most likely to have been *Rema* on passage.
[Ref: 2.6.4]

3.1.18 Clean cargo discharges over the years, including discharge of malt at Buckie between 19 and 21 April 1998, show that the master maintained the hold and hatch covers in a good, clean and watertight condition.
[Ref: 1.9.1, 2.4.1]

3.1.19 The River Trent collision damage had been partially repaired making the hull watertight.
[Ref: 1.7.4, 2.4.1]

3.1.20 Flooding of *Celebrity*'s hold after leaving Berwick-upon-Tweed with a cargo of stone chippings was not caused by any damage sustained at Stoneberth. Six vessels loaded at Stoneberth after *Rema*'s departure and before *Celebrity*'s arrival. None have reported any damage.
[Ref: 2.3]

3.1.21 There is no evidence to indicate *Rema* grounded on her final voyage.
[Ref: 2.6.5]

3.2 CAUSE OF FOUNDERING

The cause of *Rema* foundering was the slow flooding of 769 tonne of sea water into the hold. The investigation has not been able to identify how, where or over what period of time it happened.

3.2.1 Eight possible flooding causes were considered and rejected as either unlikely, or through lack of supporting evidence:

1. Penetration of the hull side by bolt projecting from berth structure while alongside Stoneberth, Berwick-upon-Tweed.

   Rejected on the basis of a survey carried out on the loading berth at Berwick-upon-Tweed. No evidence found of any projecting bolt or other cause of damage.
   [Ref: 1.10.1, 2.3]

2. Penetration of hull bottom plating while loading alongside Stoneberth, Berwick-upon-Tweed.

   Rejected as there have been no recorded instances of any bottom damage at this berth before or after *Rema*'s departure.
   [Ref: 2.3]

3. Recently developed cracks in hull between ballast and load water line during passage from Buckie to Berwick-upon-Tweed.

   Rejected as flooding rate too slow to cause foundering at 0322 and absence of comment on *Rema*'s handling or draught during port departure.
   [Ref: 2.11.3]

4. Rupture and flooding of all ballast tanks, with additional direct hold flooding.

   Rejected as simultaneous rupture and flooding of all double bottom tanks either asymmetrically or symmetrically is unlikely.
   [Ref: 2.10.2]

5. Rupture and flooding of deep tank followed by hold flooding through breached deep tank aft bulkhead.

   Rejected as unlikely due to pre-loading hold inspection.
   [Ref: 2.10.3 i)]

6. Rupture of double bottom tank and tank simultaneous rupture and/or corrosion failure of tank top.

   Rejected as unlikely.
   [Ref: 2.10.3 ii)]

7. Back flooding of the hold through an open sea valve and bilge line.

   Rejected as the hold bilge had not been in use for some time and there is no evidence that either the sea valve was open or that the non-return valve in the bilge line was defective.
   [Ref: 2.11.2]

8. Deliberate scuttling.

   Rejected for lack of any evidence.

3.2.2. Two other flooding causes were considered and accepted as possible, although no direct supporting evidence is available:

1. Crack in hull side plating.
   [Ref: 2.10.3 iii)]

2. Rupture of double bottom tank and broken or corroded air pipe or pipes in hold.
   [Ref: 2.10.3 iv)]

SECTION 4
Recommendations

4.1 **The International Merchant Marine Registry of Belize (IMMARBE)** is recommended to:

1. Advocate through IMO the fitting of hold bilge alarms in all single hold vessels.

During the course of the inquiry, certain aspects of the way *Rema* was operated have prompted other recommendations being made to improve safety at sea.

2. Introduce a formal audit procedure that will lead to a better understanding, and closer monitoring of the relationship, between the Belize Flag state Authority and classification societies charged with carrying out surveys of Belize registered ships.

3. To re-emphasise to owners the need to comply with the STCW Code, chapter six, regulation VI/I Mandatory Minimum Requirements for Familiarisation, Basic Safety Training Instruction for all Seafarers.

4. Advocate, within IMO, the introduction of Voyage Data Recorders in all vessels above 100gt to remove the uncertainties when investigating marine accidents so that the correct recommendations can be made to improve safety at sea and preserve the lives of seafarers.

4.2 **The Maritime and Coastguard Agency** is recommended to:

5. Advocate, through IMO, the fitting of hold bilge alarms in all single hold vessels.

IMMARBE has informed the MAIB that it fully understands the importance of the recommendations directed to it and accepts both these, and those made in the Chief Inspector's overview at Section 6.

SECTION 5

The International Merchant Marine Registry of Belize

The Belize Authorities have informed the MAIB that the following actions have been undertaken:

5.1 Clear and unambiguous regulations have been approved by the Belize Government and are in the process of being implemented by IMMARBE, reflecting the requirements of the STCW Convention 1978 as amended in 1995. This has been done notwithstanding the fact that Belize was not obliged, under the terms of the Convention, to introduce such regulations until 1 February 2002.

Guidelines relating to these regulations have also been distributed to the relevant parties.

Before the approval of these regulations, the interim procedure required by the Convention had been set up and enforced by IMMARBE, since January 1998.

5.2 An evaluation and acceptance procedure is incorporated into the written agreement between IMMARBE and the Classification Societies and other Recognized Organizations authorised to act on IMMARBE's behalf. This procedure is in accordance with the guidelines set out in IMO Resolutions.

Furthermore, a monitoring and inquiry procedure (developed with the technical staff of the Recognized Organizations) is in place and is triggered by any notification of detention or inspection by a Port State Control authority or a general safety inspector.

IMMARBE holds annual technical meetings and requires the participation of all the Recognized Organizations authorised to act on its behalf. The most recent meeting was held in Belize City in August 1999. The purpose of these meetings is to ensure that those organisations operate in full compliance with the IMO provisions and guidelines for conducting statutory certification services.

Where IMMARBE has reason to believe that a recognised organisation has not acted in a professional manner, and in accordance with its agreement with IMMARBE, the organisation in question will be subject to disciplinary action.

5.3 All Port State Control reports, when received by IMMARBE, are promptly evaluated and addressed with the concerned parties (the owners, Recognized Organizations, and the Port Sate Control authorities). Appropriate action to prevent the repetition of the offences is then taken by IMMARBE, in accordance with the disciplinary regulations contained within the Belize Statutory Instruments.

Since January 1998, (when those regulations were introduced) over one hundred sanctions, including de-registration of vessels, have been imposed by IMMARBE in cases of violation of the regulations.

SECTION 6
Chief Inspector's Overview

This investigation was conducted on behalf of the International Merchant Marine Register of Belize (IMMARBE), and as a United Kingdom Inspector's Inquiry. The report is submitted to both the Managing Director of IMMARBE and the Secretary of State for the Department of the Environment, Transport and the Regions. The two reports are identical and, in both cases, I recommend they be published.

The investigation has taken an unusually long time to complete. This was due in part to conflicting demands on my inspectors, and because the evidence failed to reveal what caused *Rema* to sink. It was therefore necessary to spend much longer than normal examining all the evidence to see whether anything had been overlooked.

The inquiry has been very thorough and has included the extensive examination of underwater video pictures of the wreck. My inspectors have concluded that *Rema* was lost because enough water flooded into her single hold to sink her but they have not however been able to find out how, or over what period, this occurred. Although other questions remain unanswered we are still left with the most difficult question of all; what was it that caused *Rema* to sink?

Throughout the investigation we have not closed our minds to the possibility that *Rema*'s loss was fraudulent in some way. Had there been anything, other than some circumstantial evidence and speculation, to suggest that a crime had been committed, I would have had no hesitation in drawing the matter to the attention of the appropriate authorities. No evidence has been found to suggest that her loss was anything other than a tragic accident.

The investigation has, therefore, gone as far as it can without having access to far greater resources than I have at my disposal. The matter can either rest as it stands or be pursued further. I think it unlikely that another underwater survey will reveal anything new. On the other hand the wreck could be raised to enable a far more detailed inspection of the hull and its fittings to be made. Until the remaining questions are answered, other vessels may be lost in similar circumstances and more sailors may die. The rationale for pursuing the investigation further is to establish whether anything more will emerge to improve safety at sea and prevent a similar accident happening again.

Rema is a small vessel lying in one piece in relatively shallow water. Raising her may shed further light on what occurred. Evidence, hitherto unavailable, might provide the breakthrough my inspectors have sought over the past few months. Recovering *Rema* is feasible but the complications, including finding somewhere suitable to take her once she has been salved, must not be under-estimated. Nevertheless it is an option that Belize should carefully consider.

In drawing attention to the possibility of her being raised, I am very conscious that the wreck is probably the resting place of the four men who were onboard at the time she sank.

Although no bodies were found in the immediate aftermath of the disaster, it is assumed that all four crew went down with the ship and that their remains are still there.

Sometimes a marine accident investigation doesn't come up with all the answers but its findings, conclusions and recommendations can, nonetheless, still play a valuable part in improving safety at sea. The *Rema* investigation may be one such example.

We know *Rema* was an old ship, had been detained twice in Port State Control inspections and was flagged to a state with a poor detention record. She was also undermanned, and there are questions about the qualifications and experience of her crew but, despite these findings, there is no evidence to connect any of them with the direct cause of the loss.

The inquiry focused its attention on determining the cause of the sinking. It did not extend beyond this objective and, despite speculation that *Rema*'s flag state, Belize, was somehow to blame for the loss, the investigation found no such connection.

Nonetheless, at several stages of the investigation, certain factors emerged to indicate that if *Rema* was representative of the standards being adopted by vessels registered in Belize, improvements could, and in my opinion, should be made. Although it goes beyond the strict undertaking of an accident investigation, I have, after careful consideration, endorsed a proposal put forward by my inspectors that some recommendations should be included in the report to assist Belize improve its safety record.

The recommendations made are those that I believe Belize should act on to prevent similar accidents to this happening again.

There is one final point to ponder. Once again, marine accident investigators have attempted to reconstruct the circumstances of a serious casualty without the benefit of the technology available in other modes of transport. Had *Rema* been an aircraft, or a train, there would have been the widespread assumption that the data recorder would have revealed vital evidence to indicate what had happened. *Rema* was, however, like every other vessel of her size in the world; she was not fitted with one. Furthermore there is not a single proposal to include such vessels in future fitting plans. She is 'too small'. Yet four men died; and we do not know why. The shipping industry has, in my opinion, been far too slow to push hard for Voyage Data Recorders (VDRs) to be fitted in all new construction vessels irrespective of type or size. Some flag states argue strongly for their widespread introduction. Others refuse to even contemplate them on the grounds that they are too expensive to fit and there are no commercial benefits. This cannot be right.

I very strongly advocate the introduction of VDRs in vessels of all sizes, and direct my remarks not at the United Kingdom or Belize, but the flag states of the world. Until this happens we will continue to be uncertain about what causes many accidents at sea and, perhaps more important, why they happen. A widespread fitting programme would see a substantial reduction in the costs involved. The need exists today; not tomorrow.

J S Lang
Rear Admiral
Chief Inspector of Marine Accidents

Glossary of Terms

Class	–	Classification Society
"Mayday"	–	Distress signal
"Mayday Relay"	–	Relay distress signal
Implosion	–	To burst inwards or to crush
Parallel sinkage	–	sinking in a level plane
Low air draught	–	Low distance between waterline and top of mast
Bob-cat	–	Small mechanical tractor fitted with shovel
Chain sweep	–	Chain towed below the surface to establish clear depth
Bekker rudder	–	Type of high lift rudder
Ultrasonic	–	Low ultrasonic waves at high frequency used in non-destructive testing of metals
Submersible pump	–	Pump designed to operate submerged in water
Nautical twilight	–	Time at which daylight disappears (this occurs after sunset)