Report on the investigation of

the entrapment of an engine room fitter

in a watertight door

on board the ro-ro passenger ship

Eurovoyager

approaching Ramsgate, UK

3 November 2008

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

Report 17/2009
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Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

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

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

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

Add.	-	Addendum
BMI	-	Belgian Maritime Inspectorate
BV	-	Bureau Veritas
DfT	-	Department for Transport
DPA	-	Designated person ashore
ECR	-	Engine control room
EU	-	European Union
GA	-	General arrangement
IMO	-	International Maritime Organization
LED	-	Light emitting diode
MCA	-	Maritime and Coastguard Agency
MGN	-	Marine guidance note
MSC	-	Maritime Safety Committee
NV	-	Naamloze Vennootschap. (Nameless Partnership)
PA	-	Public address
PUWE	-	Provision and Use of Work Equipment
RMT	-	Regie voor Maritiem Transport
ro-ro	-	Roll-on roll-off
SMS	-	Safety Management System
SOLAS	-	International Convention for the Safety of Life at Sea
TSL	-	Transeuropa Shipping Lines
UTC	-	Universal Co-ordinated Time
VDR	-	Voyage Data Recorder
VHF	-	Very high frequency
WTD	-	Watertight door

Times: All times used in this report are UTC +1 unless otherwise stated

SYNOPSIS

At 1126 on 3 November 2008, an engine room fitter was found trapped in a hydraulically operated steel watertight door in a machinery space on board the ro-ro passenger ferry *Eurovoyager*. The fitter was released from the door by the duty motorman and was airlifted to hospital at 1315 after the ferry arrived in Ramsgate. He was treated for crush injuries and was not expected to be able to return to work for at least 6 months.

A number of factors contributed to the fitter's entrapment. In particular:

- The door's rate of closure was almost three times faster than allowed on board newer vessels.
- The fitter could not have followed the recommended transit procedure when passing through the watertight door.
- Contrary to SOLAS requirements, the watertight door was in 'remote' and closed automatically as soon as its operating handle was released.
- There was no indication at the door to show that remote operation was selected.
- On board procedures for the operation of watertight doors were poorly promulgated and were not monitored or enforced.

It was the usual practice on board for the watertight doors to be in local control. However, VDR data showed that many of the doors were routinely left open at sea, which potentially compromised the vessel's watertight integrity. Remote control had been selected on this occasion to ensure that the doors remained closed while a Belgium Maritime Inspector was on board conducting an EU ferry inspection.

A recommendation has been made to the Department for Transport, the Maritime and Coastguard Agency and the Belgium Federal Public Service, Mobility and Transport aimed at harmonising EU guidance and SOLAS requirements for the operation of powered watertight doors. Further recommendations have been made to the Cyprus Maritime Administration, the Maritime and Coastguard Agency and the Belgium Federal Public Service, Mobility and Transport to propose amendments to current international regulation to make the operation of powered watertight doors safer on all vessels, and to improve the effectiveness of EU inspections. A recommendation has also been made to Transeuropa Shipping Lines Ltd aimed at improving its crews' compliance with the procedures for the operation of watertight doors within its fleet.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *EUROVOYAGER* AND ACCIDENT

Vessel details

Registered owner	:	Hawthorn Shipping Co Ltd, Limassol, Cyprus
Manager	:	Transeuropa Shipping Lines Ltd, Koper, Slovenia
Port of registry	:	Limassol
Flag	:	Cyprus
Type	:	Ro-ro passenger
Built	:	1977, Belgium
Classification society	:	Bureau Veritas
Construction	:	Steel
Length overall	:	118.85m
Gross tonnage	:	12,110
Engine power and/or type	:	2 x 8611kW, Pielstick
Service speed	:	20 knots

Accident details

Time and date	:	1126 on 3 November 2008
Location of accident	:	51° 19'.61 N, 001° 46'.22 E, 13m off Ramsgate, UK
Persons on board	:	43 crew and 49 passengers (including 35 vehicle drivers)
Injuries	:	Crush injury to a fitter-mechanic (fitter)

1.2 BACKGROUND

Eurovoyager was engaged in a regular service between Ostend, Belgium and Ramsgate, UK. In a 24 hour period, she completed two return voyages: a day voyage departing Ostend at 0800, returning at 1830; and a night voyage departing Ostend at 2130, returning at 0600 the next morning. The deck department was divided into a day crew and a night crew and changed over when the vessel called at Ostend. There were two masters on board, the senior of the two being in charge of the day watch.

In compliance with the European Union (EU) Directive for inspection of roll-on roll-off (ro-ro) ferries and high-speed passenger craft, a surveyor from the Belgian Maritime Inspectorate (BMI) had arrived on board 20 minutes before departure from Ostend on the morning of 3 November 2008. She had a brief meeting with the master and discussed her intentions for the passage to Ramsgate. The watertight doors were not mentioned during this meeting.

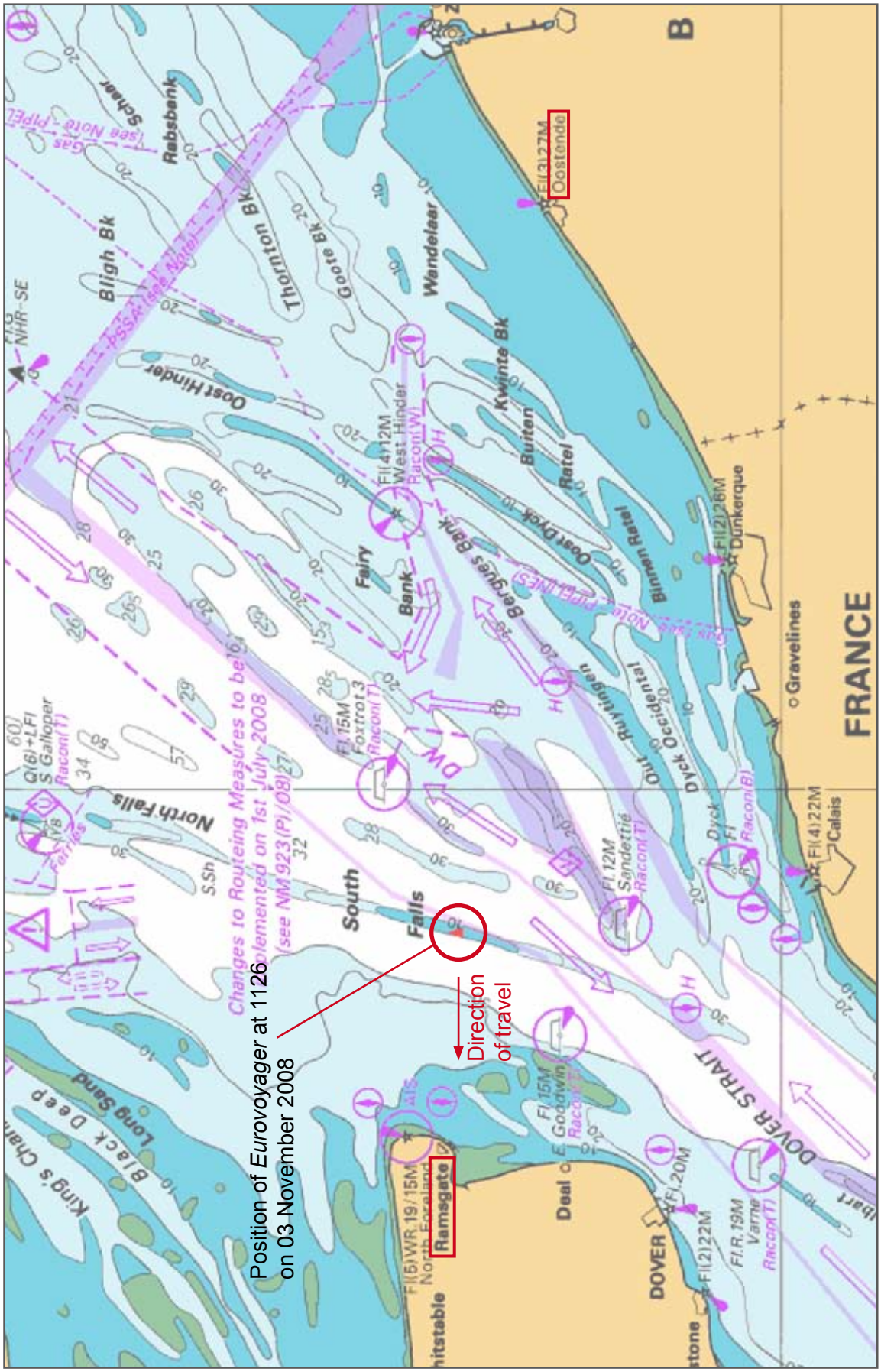
At the time of the accident, the day master, two second officers, the duty AB, a nautical advisor to Transeuropa Shipping Lines (TSL) and the surveyor from BMI were on the bridge. The third engineer, two electricians and the duty motorman were in the engine control room (ECR). The vessel was about 13 miles from Ramsgate **(Figure 1)** at a speed of 16 knots. The sea was moderate with a north easterly wind of between Beaufort force 4 and 6.

1.3 NARRATIVE

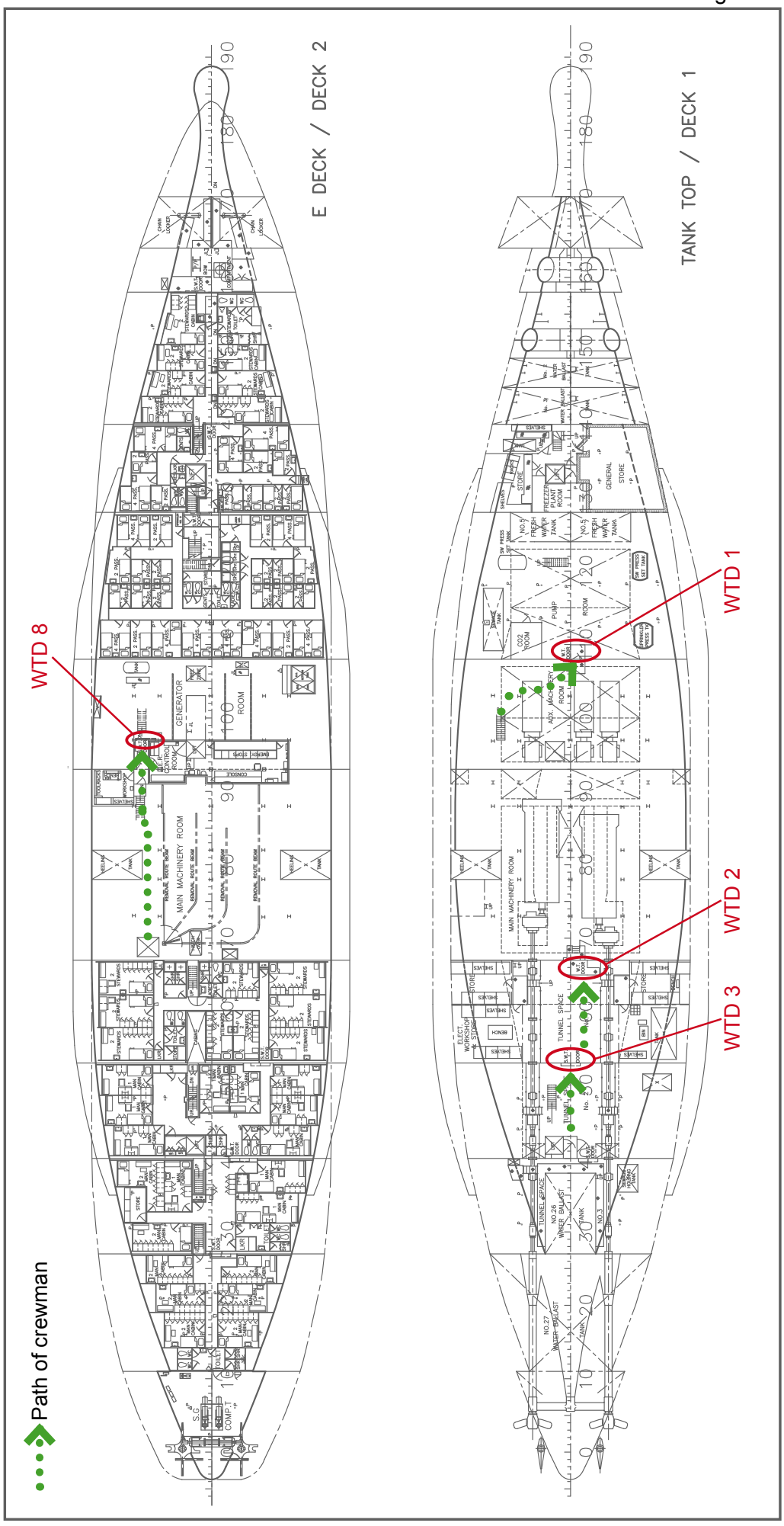
At around 0750 on 3 November, the fitter went to the engine control room (ECR) and made himself a cup of coffee. At 0759, as the vessel was departing Ostend, the master announced on the public address system that he intended to close the watertight doors. He then switched the doors to remote operation from the bridge. Just after 0800, the second engineer asked the fitter to tidy and clean the workshop. At 1123 the fitter left the workshop located aft of the main engine room for an early lunch. He went to the changing room which was forward of the auxiliary engine room, operating three watertight doors on his way **(Figure 2)**. The changing room used by the engine ratings was an adapted machinery compartment. It contained a washing machine and facilities for cleaning hands. At 1126, as the fitter was coming out of the changing room in to the auxiliary engine room, he became trapped between the frame and door of watertight door number 1 (WTD1).

The fitter was found by the duty motorman nearly 4 minutes later. He was facing the door with his back to the door frame and operating handles. He was dressed in his overalls and slippers and held a plastic bag containing boiler suits in his left hand. The colour had drained from his face and he was unconscious with his eyes wide open.

Figure 1



Extract of chart BA2182A showing the location of the accident



General Arrangement showing route taken by the fitter

The motorman immediately opened the door **(Figure 3)** and lowered the fitter to the deck in the changing room. He then ran back to the engine control room (ECR) and informed the third engineer, who was on watch. The third engineer alerted the master and then ran down to WTD1 along with the motorman and two electricians. The master changed the doors to local control from the bridge.

At 1136, the master informed Ramsgate port of the accident by VHF radio, and asked for an ambulance to meet the ship on arrival. Meanwhile, the second officer with the bosun and other crew strapped the injured fitter to a stretcher and carried him up the staircase to deck eight where the helicopter pad was located. The casualty was still unconscious. At 1142, the master called Ramsgate port again and asked if it could organise a helicopter evacuation. He was told to call Dover coastguard, which advised that it would be quicker to make port as soon as possible as at least 30 minutes was required to mobilise a helicopter. At 1230, the vessel was tied up alongside in Ramsgate, and at 1315 the fitter was transferred to a waiting helicopter and taken to Royal London hospital.

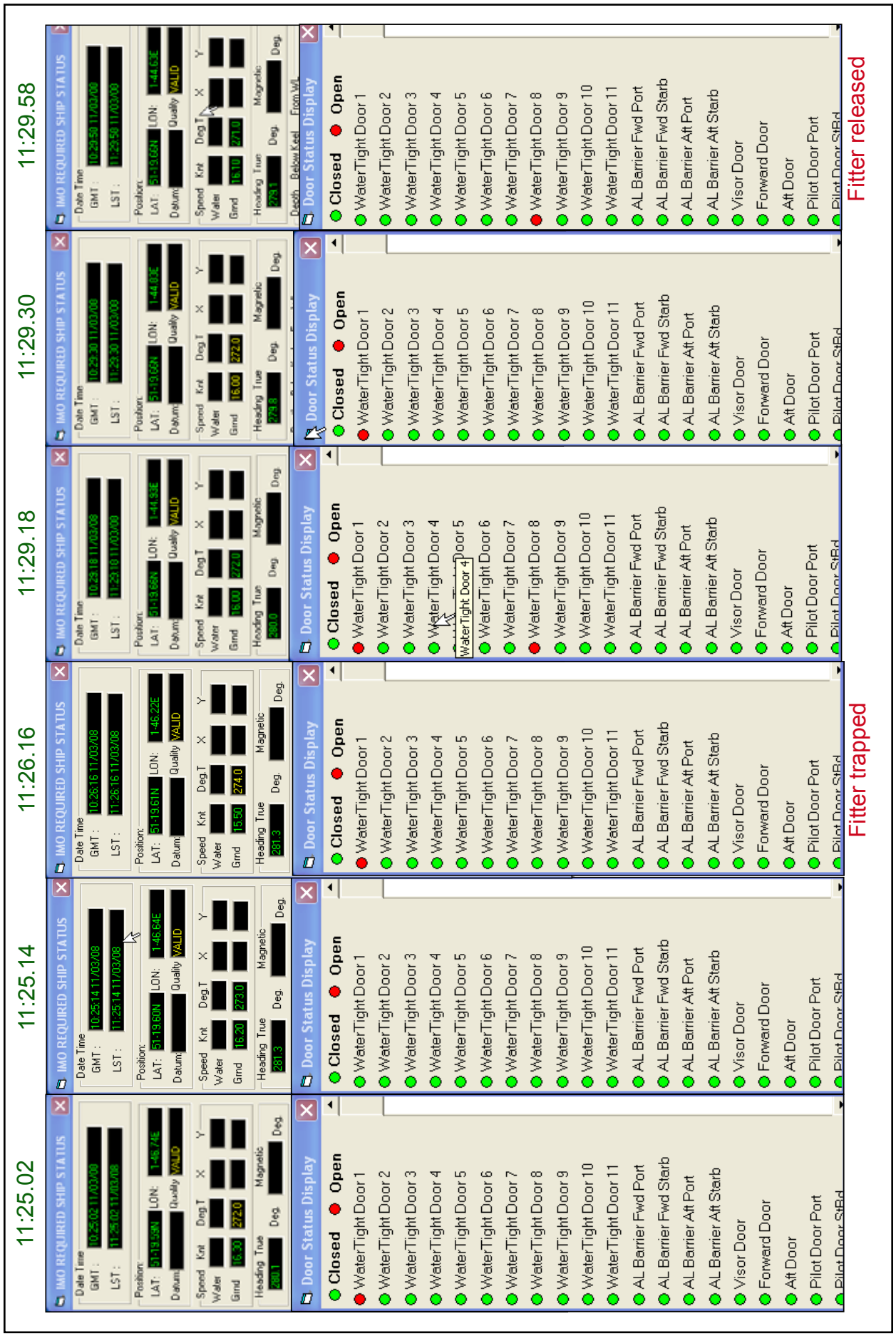
The next day, he was moved from the intensive care unit into a general ward. The door had left its imprint on the right side of his neck and left knee. He had dislocated a shoulder and lost neurological functions in his left leg. He had no memory of the accident or of any events on 3 November except waking up in the morning around 0530 and answering a mobile phone text message. The fitter returned to Croatia on 6 November 2008 and was not expected to return to work for at least 6 months.

1.4 COMPANY ORGANISATION AND VESSEL HISTORY

Eurovoyager was purchased by Hawthorn Shipping Company in 1998, and is one of seven vessels managed by TSL which is based in Koper, Slovenia. Since 1998, five of TSL's vessels have been engaged in a daily passenger ferry service between Ostend and Ramsgate. A sister company, Transeuropa Ferries N.V, which is partly owned by TSL, looks after shipping, stevedoring and all other commercial operations.

TSL's fleet manger is also the designated person ashore (DPA) for all the vessels and is assisted by a technical manager, safety manager (part time) and a superintendent. In addition, a retired harbourmaster of Ostend port is employed in a consultative capacity as a nautical advisor. He reports to the DPA on a regular basis, advises the ships' masters on regulatory issues, and organises services such as class surveys and audits at Ostend. He also liaises with the Belgian and UK administrations to facilitate joint EU inspections. TSL has its own crewing department.

Eurovoyager (originally named *Prins Albert*) was built to comply with the SOLAS Convention of 1960, and until 1998 she was owned by the Belgian national line Regie voor Maritiem Transport (RMT). Between 1993 and 1998, the vessel was used to provide a daily ferry service under a joint venture between RMT and Sally-Line UK.



Extracts from the VDR, showing the status of the watertight doors

1.5 CREW

All of the crew on board *Eurovoyager* were nationals of the former Yugoslavian Republic. The official working language on board was English, although Serbo-Croat was used by most crew for verbal communication. The officers had a working knowledge of English, but many of the ratings had little or no grasp of the language.

1.5.1 The fitter

The fitter had worked at sea for 22 years and had previously been employed for 20 years in a shipyard in Croatia. He joined TSL in 1988 and had worked on board ro-ro vessels since 1990. His employment followed the 4 on / 2 off pattern (4 months on board and 2 months on leave). As a member of the engine department he started his day at 0800 and finished at 1800, with lunch and tea breaks. He usually worked overtime from 1900 to 2100. The fitter was 186cm tall and of lean build. He was in good health and was not taking any medication. The fitter had maintained a good balance between his hours of work and rest since joining the vessel on 8 August 2008.

1.5.2 Senior master

The senior master joined *Eurovoyager* on 15 September 2008. He was a Croatian national and had sailed as a master since 1976. He held a deep sea master's licence for vessels over 3000 GT issued by the Croatian administration, and was widely experienced on ro-ro and container vessels. Since 1997 he had been employed on TSL's vessels plying between Ostend and Ramsgate and held pilot exemption certificates for these ports. On 3 November 2008, he had taken over the day watch before the vessel left Ostend, and was in command at the time of the accident.

1.5.3 Onboard familiarisation and drills

When new crew joined the vessel, the second officer gave a safety induction covering all the emergency and lifesaving equipment on board. This included a demonstration of the transit procedures for hydraulic watertight doors. The fitter completed this familiarisation on 15 August 2008. All new crew were required to complete a printed questionnaire in English to demonstrate their understanding of the safety instructions they had been given. This questionnaire did not contain any reference to watertight doors.

1.6 WATERTIGHT DOOR SYSTEM

1.6.1 Construction and drive

There were 11 watertight doors, excluding the bow and stern doors and 4 weathertight deck barriers. Four of these doors were located in the machinery space (Deck 1), and the remaining 7 on Deck 2 **(Figure 4)**. All of the doors were made of solid steel and were identical in construction except for two in the accommodation, which were narrower. WTD1 measured 1800mm x 750mm **(Figure 5)**.

Figure 4

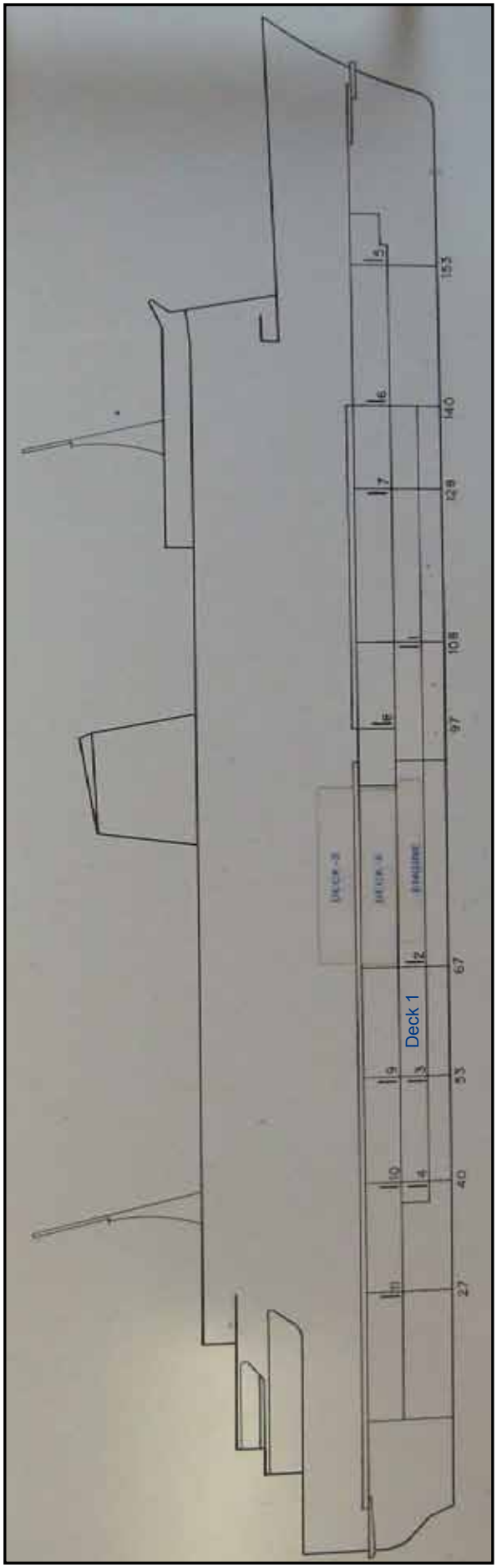


Diagram showing the location of the watertight doors

Figure 5a

Photograph of watertight door No.1 (open) - view from auxiliary engine room

Figure 5b

Photograph of watertight door No.1 (closed) - view from changing room

The doors were actuated by a centralised hydraulic system pressurised to 70 bars. At each door, a valve block directed the oil pressure to either side of a hydraulic ram and cylinder arrangement, thus achieving opening or closing movement. This block contained a spool valve attached to a common spindle which, in turn, was actuated by a handle on each side of the door **(Figure 6)**. The spool valve was also controlled by an electrically energised valve which applied closing oil pressure on the ram when in the remote mode of operation. The doors were tested every week in both remote and local modes, and were last tested before the accident on 31 October 2008 during the weekly crew drills.

1.6.2 Modes of operation

The doors could be operated in one of two modes: remote or local. The mode of operation was selected by activating a push button on the control panel located on the bridge **(Figure 7)**. In local operation, doors were controlled by a handle on either side. As long as a handle was activated in the opening direction, the door continued to open. When the handle was released, it stopped moving. It was thus possible to keep a door partially open in the local mode.

In the remote operation mode a continuous closing pressure was maintained causing all open doors to close automatically. In this mode, individual doors could still be opened locally using the operating handles. However, when the handle was released, the door automatically closed.

When the vessel was operated by RMT, the onboard practice was to keep the system in remote operation during sea passage and local mode while in port. Since being operated by TSL, the vessel's doors were usually kept in local control, with the remote control mode used only during tests and drills.

1.6.3 Operating console

The control, indication and alarm functions of the system were combined on a single operating panel which was located aft of the chart table in the wheelhouse. Each door was represented by a pair of lights: red for open and green for closed **(Figure 7)**. Remote or local mode was selected by activating a push button dedicated to each mode. A red light emitting diode (LED) illuminated when the remote mode was selected. Prior to the accident, the function of this LED was not understood by the two masters on board. The labels on the panel were originally in Flemish, but these had been covered over with English translations **(Table 1)**.

Original Flemish	Correct Translation	Translation on panel
SLUITEN DEUREN	CLOSING DOORS	CLOSING DOORS AT SEA
OPNIEUUI AANZETTEN	TO RESET	RESET/TENSION OFF AT PORT LOCAL OPERATING

Table 1 – Labelling on the door operating console

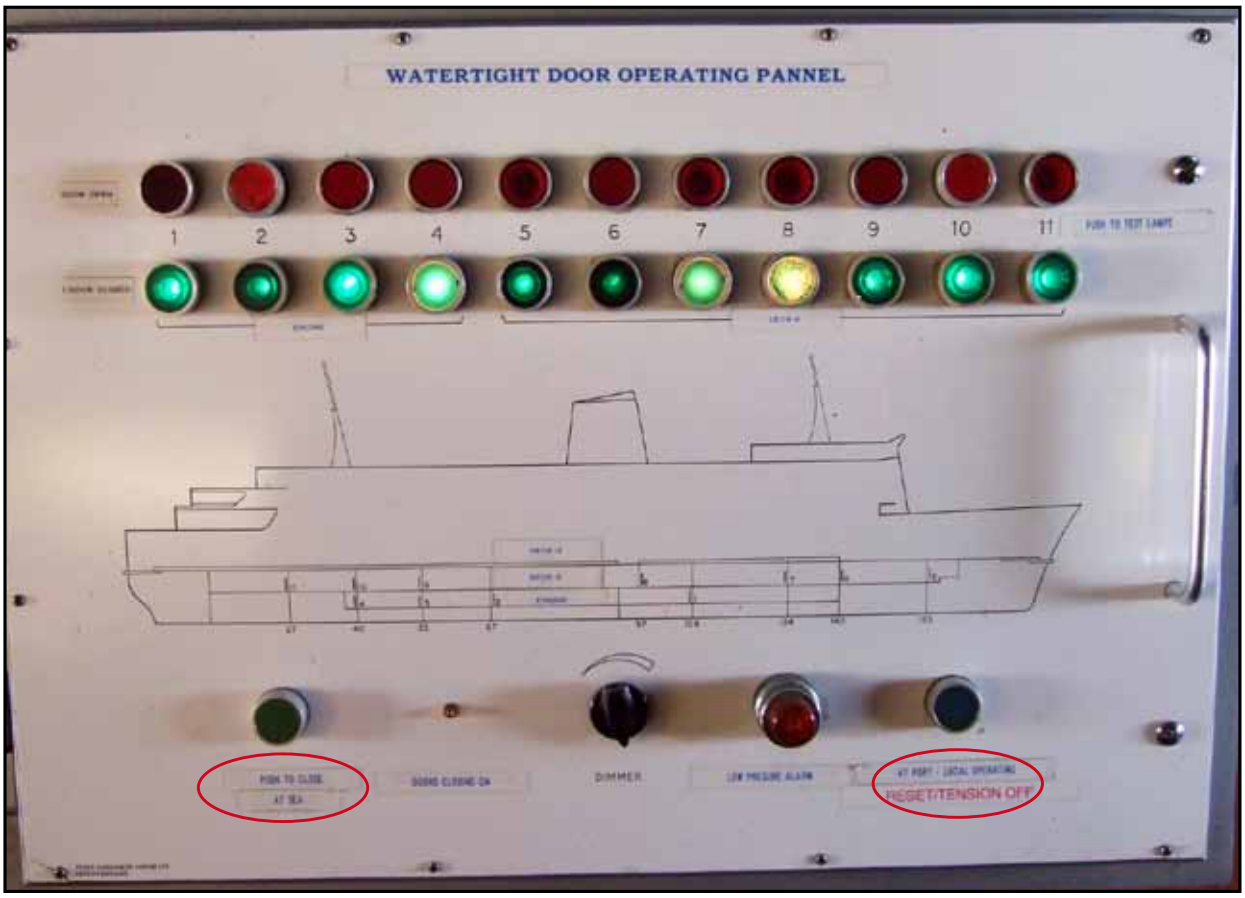
Figure 6a

Photograph showing door operating handle

Figure 6b

Photograph showing door operating handle

Figure 7



Watertight door operation panel

1.6.4 Local warnings signals and signage

When the watertight doors were in remote mode, a warning bell near a door activated as soon as a door began to open, and continued to sound until it was completely closed. There was no indication at any door to show whether remote or local operation was selected, and there were no visual alarms to show that a door was closing. In the machinery space, the speaker for the PA was located in the ECR.

Emergency operating procedures and instructions were available on either side of each watertight door stating that the operating handle was to be kept in the open position while transiting the door **(Figure 8)**. There were no instructions to open the door fully before passing through it. Furthermore, there were no posters or notices to indicate the potential dangers of entrapment if the correct transit procedures were not followed.

Figure 8

Instructions for transiting the watertight doors

1.7 GUIDANCE AND REGULATIONS

1.7.1 Purpose of watertight doors

Watertight doors provide access to compartments separated from each other by watertight bulkheads. In cruise liners, ro-ro ferries, dredgers, pipe layers and cable layers, and other special purpose vessels, machinery spaces extend almost all along the entire length of the vessel. The watertight bulkheads subdivide this continuous, under-waterline space into compartments of smaller sections, thus helping to maintain the watertight integrity of the vessel in case of flooding.

1.7.2 SOLAS 1960

SOLAS 1960 Part B – *Subdivision and stability* Regulation 13 only applies to passenger vessels and requires that all hydraulic watertight doors shall: be capable of being closed in 60 seconds or less; be kept closed during navigation and opened only when the working of the ship makes it necessary, but immediately closed on completion, and; give an audible signal during the closing operation. It also states:

The door shall take a sufficient time to close to ensure safety.

No requirements for the control mode (remote or local) to be used are provided.

1.7.3 Current regulations

The Consolidated 2004 edition of SOLAS on watertight doors: Part B - *Subdivision and Stability* Regulation 15 *Openings in watertight bulkheads in passenger ships*; and all regulations under Part B-1 *Subdivision and damage stability of cargo ships*, are applicable to ships constructed on or after 1 February 1992. The technical requirements for watertight door control mode, closure rates, warning signals and alarms, both at remote and local stations are detailed in Regulation 15 of Part B, which is applicable only to passenger vessels. There are no such detailed requirements for cargo and other ship types.

Regulation 15 requires that all watertight doors shall be capable of being closed from an operating console on the bridge in not more than 60 seconds with the ship in upright position, and be provided with an audible alarm distinct from any other alarm in the area, which shall sound for 5 to 10 seconds before the door begins to close in remote mode and shall continue to sound until it is completely closed. It also requires that:

> *The closure time, from the time the door begins to move to the time it reaches the completely closed position, shall in no case be less than 20 s or more than 40 s with the ship in the upright position*.

The Regulation also states that flag states may consider an intermittent visual signal, at doors in passenger areas and areas of high ambient noise such as machinery space, to supplement the audible alarm. There is no requirement for any local indication to show when doors are in remote operation.

The master mode switch on the operating console on the bridge is required to always be kept in local control mode, and the remote mode shall be used only in an emergency or for testing purposes. All watertight doors must be kept closed during navigation except when required to be opened to permit the passage of passengers or crew, or when work in the immediate vicinity of the door necessitates them to be opened; they shall be closed immediately afterwards. If considered absolutely necessary, certain watertight doors may be kept open with dispensation from the flag State and this shall be clearly indicated in the ship's stability information.

1.7.4 Future amendments to SOLAS

On 25 May 2005, the International Maritime Organization's (IMO), Maritime Safety Committee (MSC) issued circular 1176 titled *Unified interpretations to SOLAS chapters II-1 and XII and to the technical provisions for means of access for inspections*. In section 8 *SOLAS Chapter II-1, Parts B and B-1 Doors in watertight bulkheads of passenger ships and cargo ships*, sub section 3.4, states:

> *An indication (i.e. red light) should be placed locally showing that the door is in remote control mode ("doors closed mode").*

However, in the subsequently proposed amendments to SOLAS published under MSC 82/24/Add.1 Annex 2 there is no requirement for any indication, visual or otherwise, to show that the door is in remote operation mode.

1.7.5 Safe use of power operated watertight doors

Marine Guidance Note (MGN) 35 (M+F) **(Annex A)**, published by the UK's Maritime and Coastguard Agency (MCA), gives detailed guidelines on the safe use of power operated watertight doors. Irrespective of whether the mode of door operation is local or remote, the correct procedure for transit, according to the MGN, is: open the door completely using the local control lever; reach through the opening and, holding down the local control lever on the other side in the fully open position, step through. Following a serious accident on board the UK registered passenger ship, *Royal Princess* in 2001 (MAIB Report 34/2002), the MCA and the MAIB, jointly produced posters to warn users of the danger of incorrect usage **(Annex B)**.

Immediately after the accident on board *Eurovoyager,* all of her crew were re-briefed regarding the correct procedure to operate and transit the watertight door in line with MGN 35 (M+F). A few days later, while the system was being tested in remote operation mode, a crew member was observed to be passing through a partially open door.

1.7.6 Categorisation of watertight doors

The UK administration categorises watertight doors into three types A, B and C. During a potentially hazardous voyage, all watertight doors must be kept closed. During a normal voyage condition: type A doors may be kept open; type B doors must be closed, but may be kept open while there is someone in the adjacent compartment; and type C doors must be closed and may only be opened for sufficient time to permit someone to pass through. Before watertight doors are categorised, detailed stability calculations must be carried out and approved by the administration. The Cyprus administration does not have a similar system of door categorisation.

1.7.7 PUWE Regulations 2006

MGN 331 (M+F) provides details and guidance on interpretation of *The Merchant Shipping and Fishing Vessels (Provision and Use of Work Equipment (PUWE)) Regulation 2006*. The PUWE Regulation came into force on 24 November 2006 and implements, in part, the provisions of EC Directives 89/655/EC and 95/63/EC and applies to UK registered ships. Some sections of this Regulation also apply to all ships which are in UK waters. *"Work equipment" is defined as any machinery, appliance, apparatus, tool or installation for use at work.* Regulation 13 states:

> *The employer shall ensure that every dangerous part of the ship's work equipment is provided with guards or protection devices to prevent access to danger zones or to halt movements of dangerous parts before the danger zones are reached.*

1.8 INSPECTIONS, SURVEYS AND AUDITS

1.8.1 EU Directive

The European Union (EU) Directive 1999/35/EC provides the legal framework for a system of mandatory surveys to be carried out on ro-ro ferries and high-speed passenger craft plying between (or to / from) ports of member States. In addition, it provides detailed guidelines for carrying out these surveys. The primary consideration during the development of the Directive was to ensure that member States adhered to the principles of IMO conventions in a harmonised manner.

The EU Directive requires that two surveys are carried out by host States in every 12 month period. If there are two or more host States, they should liaise with one another in conducting these surveys. Of the two annual surveys, one is a specific survey which is exhaustive and normally carried out in port. Its purpose is to ensure that the vessel is in compliance with all statutory requirements. Emergency and lifesaving equipment are tested; vessels' planned maintenance systems are verified; and crews' competence, familiarity, training and rest periods are checked. Watertight doors are also tested in remote and local control modes of operation.

The second annual survey is required by the EU Directive to be unscheduled and to be carried out during passage. Important elements of the specific survey are repeated during this survey. The main purpose is to conduct an in-service audit of the procedures and documentation on board. Indicative guidelines to surveyors while checking watertight doors, state:

> *That the bridge control for the watertight doors is kept, when possible, on 'local' control. That the doors are being kept closed in restricted visibility and any hazardous situation.*

1.8.2 EU survey

The BMI and the MCA, co-operate to carry out in-service surveys on ro-ro ferries plying between Belgium and the UK. The specific surveys are usually conducted in April or May while the second annual surveys are carried out in October or November. To date, logistical difficulties have resulted in both surveys being arranged between 4 to 6 weeks in advance. Testing of watertight doors and auditing the procedures for their operation have always been included in these surveys, but the timing of individual doors and the verification that they could be closed simultaneously within 60 seconds has not been checked. During passage, the surveyor normally checked the watertight doors were closed by either monitoring the central operating console on the bridge or by the sighting of individual doors. Two to three years prior to the accident, a surveyor noticed that several doors (on other TSL vessels) were left open at sea, and had alerted a colleague regarding this matter. No issues were highlighted regarding the audibility of watertight door closing alarm bells in machinery spaces.

1.8.3 Other surveys and audits

The Passenger Ship Safety Certificate issued on 13 May 2008 by Bureau Veritas (BV), on behalf of the Cyprus administration, stated that *Eurovoyager* complied with the requirements of SOLAS concerning the watertight subdivision arrangements and details. No timing tests were carried out on the doors during this or previous surveys. An external audit carried out by BV in November 2006 (as part of the intermediate verification of the safety management system on board) and an internal audit carried out by TSL in April 2008 did not record any deficiencies or observations regarding the watertight subdivision arrangements.

1.9 SAFETY MANAGEMENT SYSTEM (SMS) AND OTHER DOCUMENTS

1.9.1 SMS

The SMS on *Eurovoyager* was implemented in February 2005. It contained checklists for pre-sailing checks on the bridge (F-057 item 23: *All watertight doors shut and on local control)*; pre-sailing checks in the engine room (F-063: *Check machinery space watertight doors are closed and on local controls*); taking over the bridge watch (F-053 item 19: *Status of watertight doors and stabiliser*); regular checks during the sea watch on the bridge (F-054 item 15: *Watertight door indicator lights displaying correct mode*) and pre-arrival checks for the engine room (F-066 item 12: *Machinery space watertight doors are closed on local control).*

1.9.2 Training manual

Two training manuals were on board the vessel at the time of the accident. One was dated 18 May 1998 and section 0 of this manual, entitled *Operational Instructions for the Control of Watertight Doors*, stated:

> *Each of the ship's 3* [*sic*] *doors has been given a specific number and if it is one which may be opened during a voyage assigned one of the following categories – Type A, Type B or Type C – to govern its use in "normal conditions".*

This section of the manual also contained a reference to an appended diagram which indicated the category of each watertight door, but the diagram was missing from the manual.

Section 1.11 paragraph c, stated

> *During crossing at sea, all doors are closed from the wheelhouse station, but can be opened locally with handle. They are closing automatically after passage* [*sic*].

Section 1.12 paragraph l, stated:

> *All members of the crew who have occasion to use any watertight doors must be instructed in the safe operation of those doors. In addition written instruction on the safe operation of the doors, given in easily understood terms and illustrated wherever possible, shall be available to all members of the crew. Such instructions should be based on the contents of this document* [*sic*].

There were no instructions in the training manual concerning the correct transit procedure through watertight doors.

The second training manual was issued in 2004 and had superseded the 1998 manual. It did not contain any reference to watertight doors.

1.9.3 Damage Control Information Booklet

A *Damage Control Information Booklet* for the vessel was produced in May 2005 by a company based in the UK. The booklet stated that an open door is indicated by green light and a closed door by red light. All the 11 doors were categorised as type C for the purpose of damage control and stability. In addition to the two voyage conditions defined by the UK administration, the booklet contained a third condition, which is given as:

> *Those applicable in service to and from the vessel's home port (including any similar time chartered service).*

This condition was not amplified or referred to further. The booklet also stated that except during an emergency, a drill or test, the mode of control for the doors should be selected to remote at the central operating console on the bridge. MGN 35 (M+F): *Accidents When Using Power Operated Watertight Doors* was included as an appendix. The booklet was sent to BV for approval in December 2006, but this has not yet been given.

1.10 ONSITE TESTS AND VOYAGE DATA RECORDER (VDR) INFORMATION

1.10.1 Timing tests

Following the accident, timing tests were conducted on all the watertight doors on board *Eurovoyager* with the door control mode in remote. The results are given in **Table 2**.

Door ID	Opening [seconds]	Closing [seconds]	Total [seconds]
WTD1	7	7	14
WTD2	12	8	20
WTD3	8	7	15
WTD4	11	6	17
WTD5	9	9	18
WTD6	10	8	18
WTD7	12	9	21
WTD8	7	7	14
WTD9	9	10	19
WTD10	9	7	16
WTD11	7	5	12

Table 2 – Results of timing tests on the watertight doors

In order to test the timing of the warning bell, the system was put into local mode and WTD1 opened fully. When the remote mode was selected, the bell could not be heard initially due to the ambient noise in the generator room. On listening to the bell at close quarters, it was heard to ring very faintly for 30 seconds before the door started to close.

WTD8 did not close completely, causing the warning bell to ring continuously and required manual intervention to close. This was reported to be a long-standing problem. The hydraulic oil in the system was sent to a laboratory specialising in used oil analysis. The test results revealed the oil to be in a clean condition, free from debris.

1.10.2 VDR data – 3 November 2008

The vessel's VDR, a Sperry Marine VoyageMaster, showed that at 1121 all 11 doors were closed. **Table 3** shows the movement of the doors for the time leading up to the accident. The timings are only accurate to within 10s, the interval at which the VDR saved this data. The International Electrotechnical Commission (IEC) standard 61996 (VDR performance standard) requires that a vessel's watertight door status is recorded each second. This was not achieved on board *Eurovoyager* due to the limitations of the watertight door alarm system.

Door No	Opens	Closes
3	1121:19	1121:29
3	1122:00	1122:10
3	1122:51	1123:04
3	1123:12	1123:22
2	1123:42	1123:52
8	1124:33	1124:44
1	1125:02	1125:14
1	1126:16	
8	1129:18	1129:29
1		1129:58
8	1129:58	1130:20
1	1130:20	
8	1130:29	

Table 3 – VDR data – watertight door movements (1121 to 1131)

Between 0800 and 1131 on 3 November 2008, 315 door operations were recorded **(Table 4)**. Of these, WTD2 was only partially opened 45 out of 61 occasions and WTD7 once out of 3 occasions. Due to the VDR recording interval, it was not possible to determine the number of partial opening operations for the other doors as the time taken to open and close these doors was less than 20 seconds.

Door ID	Timing test: total time to cycle from open to close [seconds]	No. of operations	No. of partial openings
WTD1	14	32	Uncertain
WTD2	20	61	45
WTD3	15	42	Uncertain
WTD4	17	11	Uncertain
WTD5	18	3	Uncertain
WTD6	18	3	Uncertain
WTD7	21	3	1
WTD8	14	54	Uncertain
WTD9	19	11	Uncertain
WTD10	16	80	Uncertain
WTD11	12	15	Uncertain

Table 4 – VDR data – watertight door movements (0800-1131)

When the vessel departed Ramsgate on 3 November 2008, doors 1, 2, 3, 4, 8, 9, 10 and 11 were open, and remained open during the passage to Ostend **(Figure 9)**. At 0755, while sailing out of Ostend, a conversation between the master and another person was recorded in which the master insisted that the watertight doors should be put in the remote mode of operation because an inspection was taking place.

1.10.3 VDR data 2003-2005

IEC standard 61996 requires that the performance of VDRs is tested annually. The annual performance tests on board *Eurovoyager* have been conducted by Northrop Grumman Sperry Marine (Antwerp) and the data from tests carried out on 15 July 2003, 19 February 2004, 4 April 2004 and 27 April 2005 showed that watertight doors 1,2,3,4,8,9,10 and 11 were left open during sea passages on these dates. No data from tests conducted after April 2005 was available for analysis.

Figure 9

Extract of VDR data showing the status of the watertight doors
on the vessel's previous passage

1.11 TECHNOLOGICAL DEVELOPMENTS

In order to understand the latest technological developments in watertight doors, the MAIB visited a 1 year old passenger vessel and a leading manufacturer of watertight doors. Detailed discussions were also held with a major ferry

operator which has a substantial new build programme. It was established that technological advances with respect to the design and construction of watertight doors include the provision of:

- Red lights on both sides of the door when in remote control mode. These lights begin to flash when the door moves.
- Downward pointing laser beam protection devices at the top of the door openings which prevent the door from closing when an obstruction is present.
- An audible alarm which sounds on the bridge if a door does not close completely (in remote mode only).
- Doors which revert to the open position if obstructed during closing (in local mode only).
- Bridge control consoles fitted with labels quoting SOLAS regulation (remote mode to be used only in an emergency or for testing purposes).
- Doors of lighter construction which require less power to operate.

1.12 PREVIOUS ACCIDENTS

This is the fourth serious accident due to entrapment within watertight doors that the MAIB has investigated since 1991. Three of the previous accidents occurred on passenger ferries while the doors were in local control and where the poor design of the door control lever was the main contributory factor.

The fourth accident occurred in August 2008, when a crew member of a UK registered ro-ro vehicle ferry died in an accident almost identical in circumstances to that on *Eurovoyager.* The doors were being operated at sea in remote operation mode, and the crew member tried to pass through without opening it fully. The MAIB is aware of at least six other recent accidents where crew members, passengers and shore workers have either been fatally injured or suffered major injuries due to being trapped by watertight doors which were left in remote mode.

In September 2000, the ro-ro passenger ferry *Express Samina,* struck a reef in the Aegean Sea, resulting in flooding of the engine room and loss of electric power. With 9 of the ship's 11 watertight doors open, the rapid ingress of water caused the vessel to sink. Eighty two people died.

In February 2004, the ro-ro passenger ferry *Stena Nautica*, with 128 people on board, collided with the dry cargo vessel *Joanna*. The watertight doors of *Stena Nautica* were open at the time and, although the system was switched to remote mode operation after the collision, many of the doors remained open, and the vessel almost foundered.

SECTION 2 - ANALYSIS

2.1 AIM

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

2.2 ENTRAPMENT

The fitter suffered memory loss following the accident, and there were no eye witnesses. It is therefore not possible to establish the precise sequence of events leading to the fitter's entrapment in WTD1. However, as all the crew working in the engine room were in the ECR, the door movements from 1121 onwards **(Table 3)** could have been executed only by the fitter. The repeated operation of WTD3 from 11:21:19 to 11:23:22 is likely to have been due to his movements between the workshop and the store rooms in the adjacent compartment.

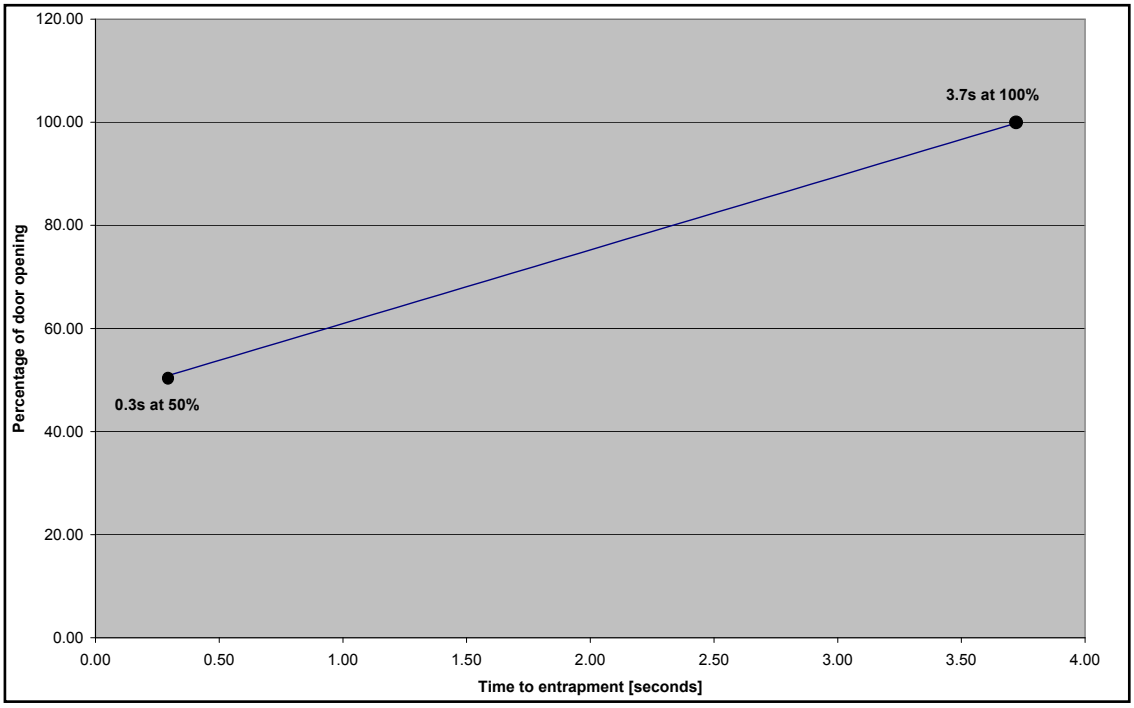
The position in which the fitter was found suggests that he only opened the watertight door by an amount which enabled him to pass through side-on, leading with his left shoulder. The door closure rate was almost three times faster than the rate required by ships built after 1992. Therefore, assuming a body depth of 35cm, he would have had 3.7 s to get through the door if fully opened, but only 0.3 seconds **(Figure 10)** if it was opened halfway. As the fitter was 6cm taller than the door opening, he is likely to have bent his knees when passing through, thus further reducing the time available.

It is possible that the fitter faced the door in order to monitor the danger moving towards him. Consequently, once trapped **(Figure 10)** he was unable to re-open the doors as the operating handles were behind him. The intense force exerted by the door would have quickly incapacitated the fitter, and given the time that elapsed before he was discovered, he was extremely fortunate to escape with his life.

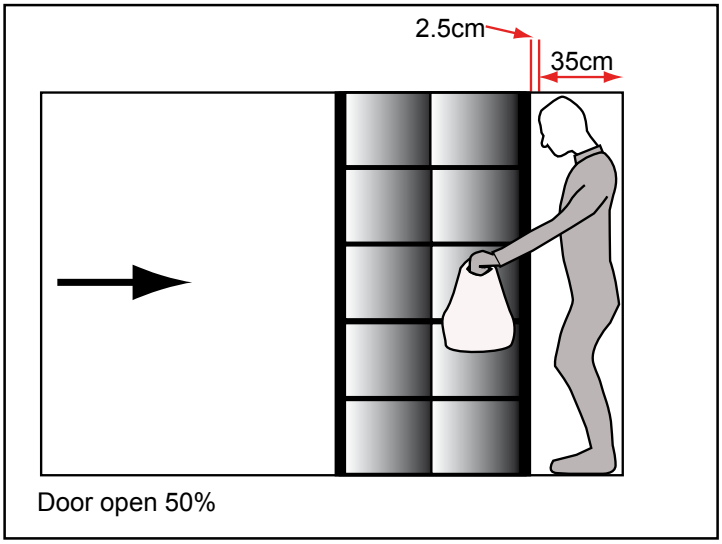
2.3 TRANSIT PROCEDURE

Had the fitter followed the recommended procedure for passing through the watertight door, it would not have been possible for him to be trapped between the door and its frame; he would have been clear of the door opening before the door even started to close. However, as both the VDR data for WTD 2 and WTD7 and the action of the crew member in paragraph 1.7.5 illustrate, this lack of adherence to the recommended procedure was not an isolated case.

Individuals are frequently prepared to take 'manageable' risks when faced with monotonous, repetitive or time-consuming tasks. Overcoming this sort of behaviour is often very difficult, and requires not only a commitment to safety at all levels; it also requires that procedures are reasonable, proportionate and easy to follow. It is evident that for many, the procedures for passing



Graph illustrating the relationship between transit time and door opening



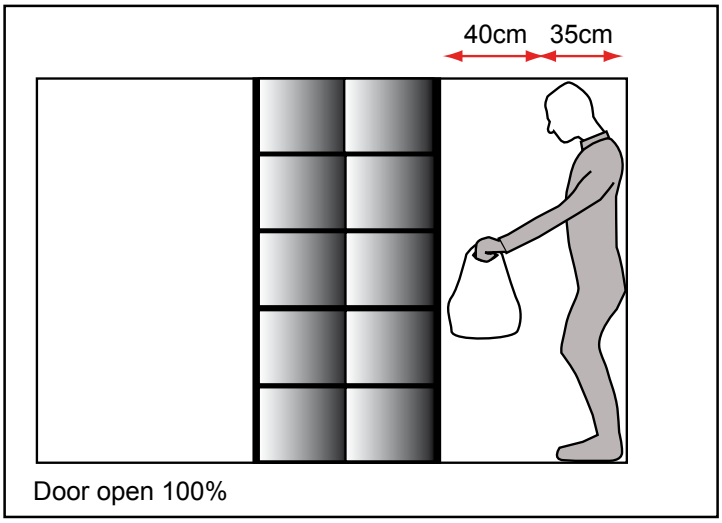


Diagram of door transit scenario

Door transit times and scenarios

through watertight doors are perceived as excessive and time-consuming, particularly when operating doors that are in frequent use. The development and application of technology to make the use of watertight doors as safe as possible (paragraph 1.11) is therefore likely to have an important role to play in preventing accidents in the future.

2.4 MODE OF OPERATION

The policy on board *Eurovoyager* was, in accordance with SOLAS, to keep the watertight doors in local control except during drills and tests. Local control reduces the risk to people passing through watertight doors, but it can lead to the doors being left open. Concern of his crew's discipline in this respect was the driving force behind the master's decision to deviate from normal practice and to keep the doors in remote mode while the BMI surveyor was embarked.

2.5 INDICATIONS AND SIGNAGE

2.5.1 At the door

A fundamental reason why the procedure for passing through watertight doors recommended in MGN 35 is the same for doors in remote or local operation is that it is often impossible to know what mode a door is in without opening it and releasing the handle. On this occasion, the fitter should have been aware that the doors had been closed from the bridge as he had operated three doors in the remote mode just before the accident. However, the remote mode was a rarely used function. The fitter was more familiar with the doors operating in the local mode, either passing through an open door or occasionally opening it just enough to get through, confident that when he released the handle, it would remain open.

When routinely undertaken, the use of watertight doors is almost subconscious, analogous to driving a car. When a person who is used to manual transmission gears drives an automatic car, it is inevitable that he or she will occasionally forget the change in car type and fumble with the gear stick. On this occasion, it is possible that on his return from the changing room, the fitter momentarily forgot that the door was in remote, and operated it as if it was in local mode. If this was the case, a visual indication at the door showing that it was in remote (as recommended by MSC Circular 1176 and as increasingly seen implemented in more recent installations) would have undoubtedly have helped prevent this lapse.

Such indication, along with warnings highlighting the potential danger of entrapment, would benefit all users of watertight doors, including shore workers, a number of whom have been trapped in watertight doors in recent years. It is also possible, that by reminding a user that a door is in remote operation immediately prior to passing through, the recommended transit procedure is more likely to be followed.

2.5.2 Operating console

The operating console on the bridge was installed more than 30 years ago and cannot be expected to match the ergonomic refinement of more modern equipment. However, the labelling on the console was extremely misleading: the label under the remote mode push button read *Push to close – At Sea,* and the label under the local mode button read *At Port – Local Operating* **(Figure 7)**. To help crews gain a better understanding of the policy governing the operation of watertight doors, it is essential that the labelling on operating consoles must be clear and unambiguous. It must also reflect the SOLAS requirement that the remote mode must only be used in an emergency or during tests. Had this been the case on board *Eurovoyager*, her master might have been less inclined to use this mode solely to meet the anticipated expectations of the Belgium surveyor with regard to watertight integrity.

2.6 WATERTIGHT INTEGRITY

The risk of death or injury to individuals operating hydraulic watertight doors exists regardless of whether they are operated locally or remotely. Therefore it might be argued that since all watertight doors must be capable of closure within 60s by switching to remote at the operating console, it would be safer to leave them open even when at sea, particularly if they are used regularly.

However, watertight doors can be prevented from closing by a number of conditions. These include the loss of power and a delay in providing emergency power, damage to the hydraulic system, loss of access to emergency control stations, and the distortion of bulkheads, causing doors to jam. These possibilities, along with the loss of *Express Samina* with 82 lives, and the near foundering of *Stena Nautica*, demonstrate that the need to keep certain watertight doors closed at sea is compelling. The risk based approach adopted by the MCA of categorising the doors and allowing some to be kept open during normal sea conditions is a sensible measure which balances the need to maintain a vessel's watertight integrity with the working routine and access requirements of her crew.

However, all of *Eurovoyager*'s watertight doors were required to be kept closed at sea, and the number left open during her voyage prior to the accident is of concern. Moreover, the similar status of the doors found in the VDR data recovered during the annual performance checks from as early as 2003, indicates that this was a long-standing practice. Not only did the crew fail to close doors after passing through, the indication on the door operating console on the bridge showing that the doors were open was ignored. For a vessel operating in the Dover Strait, which is one of the world's busiest waterways, such practices were potentially very unsafe.

2.7 SAFETY MANAGEMENT

A number of factors indicate that the safety management on board *Eurovoyager* with respect to the operation of the watertight doors was inconsistent and ineffective. In particular:

- The master's decision to operate the doors in remote was contrary to SOLAS requirements.
- The crew repeatedly did not comply with the recommended procedure for passing through watertight doors.
- Watertight doors were not kept closed when at sea.
- The requirement to check that watertight doors were closed on departure and arrival checklists was ignored.
- The dangers of the fast closure rate of the doors and the inaudible warning bell in the machinery space had not been recognised.
- The long-standing problem with WTD8, which required manual intervention to ensure that it was fully closed, had not been rectified.
- The use of a superseded training manual which contained erroneous and misleading information.
- The absence of information on the use of watertight doors in the 2004 version of the training manual.
- The presence of an unapproved damage control information booklet.
- The ambiguous labelling on the operating console.

Ensuring that watertight doors are used safely and remain effective in protecting a vessel's watertight integrity requires a strong commitment to educate and train crew in the purpose of the doors and their operation, to monitor and enforce adopted procedures, and to keep the doors operating within defined standards. In this case, watertight door procedures were ineffective.

2.8 INSPECTIONS AND SURVEY

A survey is only a periodic verification of a vessel's compliance with applicable regulations. Conducted within a narrow time frame, it is limited in its scope and cannot cover all aspects of applicable regulation. Testing of watertight doors is one of many items on a surveyor's list, and other equally important matters compete for prioritisation.

However, given the age of *Eurovoyager,* the lack of timing tests on the watertight doors during either her class or EU Directive surveys is surprising. Although surveyors frequently have to use their discretion when assessing conformity of older vessels with the technical requirements of regulation, the

extremely fast watertight door closure rates on board *Eurovoyager* would almost certainly have been identified as a potential danger to the ship's crew had such tests been conducted. Remedial action could then have been initiated.

It is arguable that the fast closure rate of the watertight doors and the audibility of the warning bells were covered by both PUWER and SOLAS. A watertight door might be classed as *machinery* as defined in the PUWE Regulation and its requirement for the provision of protection devices to prevent accidents is applicable to any vessel in UK waters. Although the PUWE Regulation was recently introduced, it is a positive step and, where possible, its enforcement during EU inspections would be of benefit to the safety of seafarers.

The annual in-service survey required by the EU Directive takes account of the constraints of time and practicability of surveys in port. Being unscheduled, the survey is intended to gain an accurate picture of a vessel's operation, and ship's staff have less opportunity to mask their normal operating procedures. Therefore, although the logistical difficulties of conducting in-service surveys without warning are acknowledged, the potential benefits of such surveys are considerable.

2.9 REGULATIONS

2.9.1 Applicability of regulations to other ship types

The detailed requirements of SOLAS for the performance criteria and technical functionality of watertight doors apply only to passenger vessels. Traditionally only passenger vessels had large underwater machinery spaces requiring subdivisions fitted with watertight doors. However, with the evolution of other vessel types, watertight sub-divisions with doors have also been installed on many other vessels. Perhaps it is in recognition of this development that MSC Circular 1176 included both passenger and cargo ships within its scope. It is logical that the SOLAS requirements for watertight doors are similarly extended, which would then allow port state and flag administrations to enforce these safety requirements on all vessels.

2.9.2 Visual indication at door in remote mode

The IMO's Maritime Safety Committee recognises that the operation of watertight doors in remote mode poses a serious hazard to personnel. Consequently, MSC Circular 1176 invites member governments to consider the installation of a visual indication at a watertight door to indicate when it is being operated in remote mode. It is of concern that this important feature has not been incorporated into the proposed amendments of SOLAS.

2.9.3 Requirements of the EU Directive

The fundamental principle behind the EU Directive is the harmonised implementation of the IMO conventions by member States in order to achieve a common minimum standard of safety. As all the member States of the EU

including UK, Belgium and Cyprus have ratified the SOLAS Convention, it is contradictory for the EU Directive to dilute the requirements of SOLAS. The use of phrases such as *when possible*, *on local control* is ambiguous and is subject to interpretation. Therefore, as written, some of the requirements of the guidance accompanying EU Directive 1999/35/EC are less stringent than those of the SOLAS Convention and might hinder the harmonised application of the IMO conventions within the EU.

2.10 VDR

VDRs will be mandatory on most ships by 2010. The performance of a VDR is required to be checked annually; the data downloaded during these checks is available for analysis. Although VDRs were originally intended as an aid to accident investigation, there is no reason why this data, along with data recorded on other occasions, cannot be more routinely used to assess the performance of ships and the onboard practices of their crews. This is already being undertaken by a number of forward-looking ship managers.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT WHICH HAVE RESULTED IN RECOMMENDATIONS

1. The fitter and many other crew did not always follow the recommended procedure for passing through the vessel's power-operated watertight doors. [2.2, 2.3]

2. The procedures for passing through a watertight door are often perceived as excessive and time-consuming, particularly when operating doors that are in frequent use. [2.3]

3. No visual indication was provided at the door to remind the fitter that the door was in remote control and would close as soon as the operating handle was released. [2.5.1]

3.2 OTHER SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION ALSO LEADING TO RECOMMENDATIONS

1. The development and application of technology to make the use of watertight doors as safe as possible is likely to have an important role to play in preventing accidents in the future. [2.3]

2. A number of factors indicated that the safety management of *Eurovoyager* with respect to the operation of watertight doors was ineffective. [2.7]

3. The PUWE Regulation is a positive step towards enhancing safety of life at sea and should be enforced where possible by including it within the scope of the EU inspection. [2.8]

4. Although watertight doors are fitted to several types of vessels, the SOLAS regulations for the operation of watertight doors applies only to passenger vessels. [2.9.1]

5. Although MSC Circular 1176 suggests that a visual indication be provided at a watertight door to indicate when it is being operated in remote mode, it has not been included in the proposed amendments to SOLAS. [2.9.2]

6. The requirements of the guidance accompanying EU Directive 1999/35/EC with respect to the operation of watertight doors are less stringent than those of SOLAS. [2.9.3]

3.3 SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION WHICH HAVE NOT RESULTED IN RECOMMENDATIONS BUT HAVE BEEN ADDRESSED

1. The watertight door in which the fitter was trapped closed at a rate almost three times faster than required by current SOLAS regulation. [2.2]

2. The watertight doors were operated in remote while the vessel was on passage. [2.4]

3. Many watertight doors were routinely left open when the vessel was at sea. [2.6]

SECTION 4 - ACTION TAKEN

4.1 MAIB

The UK's Marine Accident Investigation Branch has, in parallel with the publication of this report, produced a 2-page flyer of the accident and the principal lessons to be learned from it. This summary account is being circulated widely within the shipping industry. Safety issues, such as the need to ensure watertight doors are kept in local control and closed during navigation, and the importance of using the correct procedure when passing through watertight doors, have been highlighted. The flyer also promotes the benefits of VDRs in the audit of onboard procedures.

4.2 TRANSEUROPA SHIPPING LINES LIMITED

Immediately after the accident, Transeuropa sent a circular reminding its crew of the need to follow the SMS procedures which require all doors to be kept in local control and closed at sea. In addition, it has taken the following actions:

- Adjusted the closing timing of all doors in keeping with the current SOLAS requirements to be between 20 and 40s.
- Applied for approval from Bureau Veritas for the use of the Damage Control Information Booklet.
- Replaced the onboard training manual with an up to date document in which the procedures for the operation of watertight doors reflected those contained in the Damage Control Information Booklet and the vessel's SMS.
- Confirmed that all watertight doors close within 62s when switched to remote mode of operation.

SECTION 5 - RECOMMENDATIONS

The **Department for Transport,** the **Maritime and Coastguard Agency** and the **Belgium Federal Public Service, Mobility and Transport** are recommended to:

2009/147 Through representations to the European Commission, take steps to ensure that official guidance provided for inspectors in the annexes to EU Directive 1999/35/EC is amended to reflect SOLAS requirements regarding the operation of powered watertight doors at sea.

The **Cyprus Maritime Administration,** the **Maritime and Coastguard Agency** and the **Belgium Federal Public Service, Mobility and Transport** are recommended to:

2009/148 Present a joint paper to the IMO's Maritime Safety Committee on:

- Revision of SOLAS Regulation 15 (openings in watertight bulkheads in passenger ships) to reflect the contents of Section 4.3.8 and Section 8 of MSC/Circ.1176 which requires the provision of a local visual indication to indicate when a watertight door is being operated in the remote mode.
- The application of SOLAS Regulation 15 to <u>all</u> vessels fitted with powered watertight doors.

2009/149 Ensure that when inspecting ferries under EU Directive 1999/35/EC, inspections also take into account EU legislation (such as PUWER) which relate to the health and safety of workers.

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

2009/150 Explore potential means of improving the safe use of powered watertight doors, through industry bodies such as the National Occupational Health and Safety Committee, taking into account ship crews' apparent reluctance to observe existing guidelines, current technology and the need to keep watertight doors closed at sea.

Transeuropa Shipping Lines Ltd is recommended to:

2009/151 Adopt measures, including the review of VDR data, to ensure that its procedures for the operation of watertight doors are strictly observed.

Marine Accident Investigation Branch
July 2009