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ERIKA - INVESTIGATIONS INTO THE CAUSE OF THE INCIDENT

Note by the Director

Summary:	The Malta Maritime Authority and the French Permanent Commission of Enquiry Into Accidents at Sea (CPEM) have conducted investigations of the *Erika* incident. This document summarises the reports of these investigations.
Action to be taken:	To take note of the information contained in this document.

1 Introduction

1.1 On 12 December 1999 the Maltese tanker *Erika* (19 666 GT) suffered structural failure and broke into two approximately 45 miles from the Brittany coast in the Bay of Biscay. The two sections subsequently sank in about 120 meters of water and a part of the ship's cargo of heavy fuel oil was spilled. It is estimated that some 19 800 tonnes of fuel oil were spilled.

1.2 Since the *Erika* was registered in Malta, the Malta Maritime Authority conducted a Flag state investigation into this incident. The Maltese Maritime Authority issued its report in September 2000. The Maltese investigation team was made up of personal from the Merchant Shipping Directorate of the Maltese Maritime Authority, an independent ship surveyor and consultants from the Salvage Association.

1.3 An investigation was also carried out by the French Permanent Commission of Enquiry into Accidents at Sea (La Commission Permanante d'enquête sur les évènements de mer, CPEM). The report of this investigation was published in December 2000. The French investigation team consisted of the Director of Bureau – Enquêtes-Accidents Mer (BEA/Mer), the Secretary General of the French Institute of Navigation, BEA/Mer hull experts and BEA/Mer engine experts and the Director of operations of the salvage company Les Abilles International.

1.4 This document summarises these investigation reports.

1.5 A criminal investigation into the cause of the incident is being carried out by the Tribunal de Grande Instance in Paris. This investigation has not yet been completed.

2 Details relating to the *Erika* and its management

2.1 The *Erika* was built as a product tanker at a Japanese shipyard in 1975, and was designed to carry ballast in cargo tanks during ballast voyages. In August 1990 the ship's No.4 and No.2 port and starboard tanks were converted to clean ballast tanks. The general description of the ship is as follows:

Class Notation:	100 - A1.1 - Nav IL; Cst(oil) ESP
Gross Tonnage:	19 666
Net Tonnage:	13 730
Length Overall:	184.54 meters
Breadth:	28 meters
Depth:	15.00 meters
Main Engine:	IHI Sulzer 8RND 68 13 200 BHP
Service Speed:	15.2 knots

2.2 Since delivery, the ship's name was changed seven times. It was entered successively with four classification societies, all members of the International Association of Classification Societies. The ship sailed at different times under three different flags and has had several different owners and managers. In 1998 the ship was assigned class by Registro Italiano Navale (RINA).

2.3 At the time of the incident, the registered owner was Tevere Shipping Company Limited, Valetta (Malta). From 1997 to the time of the incident, Panship Management and Services Limited were the technical managers of the *Erika.* Panship Management and Services Limited had been founded in 1997 and was incorporated in Ravenna (Italy).

2.4 In the Maltese report it is stated that when the *Erika* was built, its lightweight to displacement ratio was in the lower part of the spectrum applicable to ships of this type. It is further stated that this may have reduced some of its built-in redundancy[<1>] with a great susceptibility to corrosion.

2.5 In the French Commission's report it is stated that the light displacement of the *Erika* and its sister ships was no more than 7 000 tonnes, which was about 1 000 tonnes less than other tankers in this category.

3 Certification and statutory documentation

3.1 The ship had valid trading certificates issued by RINA on behalf of the Flag State. The certificates of Registry and Safe Manning were issued by the Flag State and were valid at the time of the incident.

3.2 The ship's officers and crew had valid certificates of competency with the necessary endorsements. The French Commission's report states that the crew had a good knowledge of oil transport and had experience of working on tankers. The Maltese report states that all crewmembers were qualified and met all the training requirements to operate this type of ship.

3.3 When Panship was formed in 1997, the company contacted RINA requesting them to perform the audit that was necessary for Panship to acquire International Safety Management Code (ISM)

[<1>] Ships are normally built to specifications that are beyond the requirements of the relevant classification society for example using extra steel plates or thicker steel plates.

certification. The International Safety Management Document of Compliance (ISM/DOC) was issued by RINA to Panship on behalf of the Maltese Government on 5 May 1998. The ship was issued a Safety Management Certificate by RINA in June 1998. Panship was issued with an ISM/DOC by RINA on behalf of the Italian Government on 24 November 1998.

3.4 In the Maltese report it is mentioned that following the detention of a ship other than the *Erika* managed by Panship Management Services in July 1999, the Flag State (Malta) requested that an additional audit be carried out by RINA on the *Erika* and Panship. As a result of this audit in 13 August 1999, RINA drew attention to 18 practices that were not in conformity with the ISM code and proposed improvements in four areas of Panship's operations. It is suggested in the Maltese report that some of these non-conformities would have existed at the time of Panship's annual audit held earlier in April that year, but were not raised by RINA then. Following a further audit by RINA of three other ships managed by Panship, a company audit was carried out on 12 November 1999 by RINA. In the Maltese report it is stated that following corrective actions taken by Panship, RINA confirmed that the company's safety management system satisfied the ISM requirements. After conducting another audit of Panship on 26 and 27 January 2000, as requested by the Malta Maritime Authority after the *Erika* incident, RINA recommended on 7 February 2000 that the ISM/DOC be withdrawn.

3.5 The French Commission report stated that following the above-mentioned audit in August 1999, RINA had in a letter dated 23 August 1999 recommended that the Malta Maritime Authority should suspend Panship's ISM/DOC. It is suggested in the French Commission's report that RINA issued this letter to the Malta Maritime Authority after having noted a large number of major deficiencies symptomatic of serious failings in the safety management system run by Panship. According to the French Commission, the recommendation by RINA to the Malta Maritime Administration to suspend the ISM/DOC was not acted on. The French Commission suggests that if the ISM certification had been suspended as soon as the alarm had been raised by RINA's recommendation, subsequent events might have been different.

3.6 Between 1998 and 1999, The *Erika* underwent three port state control inspections. It also underwent seven vetting inspections[<2>] between November 1998 and December 1999. The French Commission's report indicates that these inspections did not include an inspection of the ship's structures, especially the ballast tanks. In the Maltese report it is mentioned that with respect to Flag, Port State Control and vetting inspections, none of the deficiencies pointed out by the various inspectors were in respect of the condition of the ballast tanks. It is mentioned in the report that it is unusual for vetting inspectors to check the condition of a ship's tanks.

4 Condition of the ship prior to the incident.

4.1 In the Maltese report it is stated that during an inspection conducted between April and June 1993, by the then classification society, the forepeak tank and the No.2 and No.4 ballast tanks were found to be devoid of coatings and cathodic protection. In the French Commission's report it is stated that in 1993, the No.2 clean ballast tanks were designated as segregated ballast tanks (SBT), whereas the No. 4 clean ballast tanks were not assigned the same usage until 1997. In the French Commission's report it is stated that this delay in transforming the No. 4 tanks into SBT explains why those ballast tanks were subsequently found to be in better condition than the No.2 ballast tanks.

4.2 However, in the Maltese report it is stated that No. 2 port and starboard ballast tanks were not designated as segregated ballast tanks in accordance with MARPOL 73/78 until April 1997. The Maltese report mentions that in August 1996, following the discovery of oil contamination in No.2 port and starboard ballast tanks, instructions were issued by the classification society for the hydrostatic testing of No.2 and No. 4 ballast tanks, cargo lines and ballast lines. The report does

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<2> These are specific inspections carried out on tankers on behalf of oil transporters to ensure that the ship carrying that transporter's oil complies with the various standards imposed by that transporter.

not indicate the findings of these tests, nor whether any subsequent repairs were conducted in line with the results of these tests.

4.3 In April 1997, thickness measurement of the steel structures in No.2 and 4 ballast tanks was conducted on behalf of the then classification society (Bureau Veritas). Whilst the reduction in the thickness of the steel structures in No.4 ballast tanks was found to be within acceptable limits, the web frames of No.2 port and starboard ballast tanks showed considerable deterioration. According to the Maltese report, the classification surveyor's report showed that necessary repairs had been carried out. In the French Commission's report it is stated that the report on this survey also mention the absence of interior coatings and cathodic protection.

4.4 In February 1998, during a classification pre-entry survey carried out by RINA, the No.2 port and starboard ballast tanks were noted to be contaminated by oil. In the Maltese report it is stated that this was especially noticeable in the No. 2 starboard ballast tank, in respect of which the classification surveyor had reported that further inspection could not be carried out due to a large quantity of oil residue inside the tank. The French Commission's report mentions that in addition to the oily residues, the tank was at first sight in extremely bad condition. The report mentions that it had cracked web frames and showed heavy corrosion of stiffeners and that its access ladders were so corroded as to make entry into the tanks difficult. In the Maltese report it is further stated that during this survey, heavy localised pitting on the main deck was also reported and that the surveyor considered the ship unsuitable for classification in such a condition. According to the French Commission's report there was extensive corrosion on the main deck plating (with pitting and rust patches) with a reduction in thickness of the steel plating varying between 18% and 68%, holes between frames and very severe corrosion of the plate welds in certain areas.

4.5 Between June and August 1998 substantial repairs under the supervision of RINA were conducted on the ship at Bijela shipyard, including steel renewals in the forepeak, No.2 port and starboard ballast tanks and on the main deck. In the French Commission's report it is stated that the quantity of steel replaced during these repairs would have been only 100 tonnes. In the Maltese report it is indicated that a total of 275 square meters of main deck steel plating was renewed. The Maltese report further mentions that deck plating was renewed in way of No. 2 starboard ballast tank with 12 mm steel and not 16 mm as shown on the approved plans. According to the Maltese report, the RINA surveyor confirmed that all tanks were hydrostatically tested on completion of the repairs. The Maltese report suggests that other non-destructive testing techniques such as radiographic or ultrasonic should have been used for selected welds. In the French Commission's report it is noted that some panels of deck plating with original scantlings of 16 mm were replaced by new plating which was only 14 mm or in some cases 12 mm thick. The Commission also noted that there were differences between the work indicated on the plans drawn up by RINA and the work indicated on the drawings and on the invoice of the shipyard. The French Commission considers that such practices are not in keeping with the code of normal practices in ship repairing. The Commission further notes that non-destructive testing of welds went no further than kerosene testing and water tightness testing with hosepipes and that neither X-ray nor ultrasonic checks were carried out on the welds even in such sensitive areas as the bilges.

4.6 In the Maltese report it is mentioned that in November 1999, a survey was conducted in Augusta (Italy) to complete the first annual hull survey (after the special survey in 1998) and that all ballast tanks were examined internally. It is mentioned that the RINA surveyor reported that all ballast tanks had hard coating, which he indicated was in poor condition, that No. 4 port and starboard ballast tanks and the aft peak were reported to be in a satisfactory condition and that there was general corrosion of the forepeak and thinning of the deck longitudinal in No.2 port and starboard ballast tanks. It is mentioned in the Maltese report that RINA recommended that further inspections and thickness measurements followed by the necessary repairs should be carried out no later than January 2000.

5 The voyage

5.1 The *Erika* left on 8 December 1999 from Dunkirk (France) for Milazzo (Italy) carrying a cargo of 30 884 tonnes of heavy fuel oil. The ship's final destination was changed on 10 December 2001 to Livorno (Italy). The voyage plan of the ship was to cross the Bay of Biscay, re-fuel at either Gibraltar or Algericas and go across the Mediterranean Sea to Italy.

5.2 In the Maltese report it is indicated that the ship departed with a shear force of 46% of the maximum allowable and bending moments of 54% of the maximum allowable and that it departed on an even keel at a draft of 10.55 metres. The Maltese report mentions that it is calculated the ship had a sag of 6 cm to 8 cm. In the French Commission's report it is stated that the ship had a sag of 5cm, the shearing forces and the bending moments were within allowable limits and that the shearing stress was 40% of the maximum allowable and the bending moments were 75% of the maximum allowable.

5.3 The *Erika* turned into the Bay of Biscay off Ushant on the evening of 10 December 1999 on a course that would have taken the ship via Cape Finistere. By the morning of 11 December the ship was experiencing heavy swell from the west with wind speeds of 40 - 45 knots (Beaufort Sea State force 8/9) and rough seas with waves of more than 6 metres height. The ship was reported to be rolling and pitching heavily with seas breaking over and on the deck.

5.4 At 12:40 hours, the Master noticed that the ship was experiencing an unexplained list to starboard. In the French Commission's report it is stated that the Master estimated the list at 15^0. The Maltese report mentions that the Chief Engineer reported that the ship was rolling 10^0 to 12^0 to starboard and about 2^0 to port and that by 14:00 hours the ship was rolling 12^0 - 15^0 to starboard and not returning to an upright position.

5.5 In the French Commission's report it is stated that when the crew checked the ballast tanks, it was observed that No.2 starboard ballast tank, which should have been almost empty, was in fact half full, that the level of the oil cargo in No.3 centre cargo tank which should have been with an ullage of 1.49 metres had "dropped significantly". It is also mentioned that there were three cracks and three folds found on the deck plating forward of No.2 starboard ballast tank. According to the Maltese report, No. 2 starboard ballast tank, which was empty on departure, was flooded up to an ullage of 4.8 meters, that oil was also noticed on the surface of the ballast water, that the level in No. 3 centre cargo tank had gone down to an ullage of 3.5 metres and that cracks were found on deck in way of No. 2 starboard ballast tank.

5.6 Both reports mention that the list was subsequently corrected by pumping out ballast from No. 4 starboard ballast tank. At 14:18 hours the ship took a north easterly course until 16:29 hours when the ship deviated and steered an easterly course for Donges, which was selected as a Port of Refuge by the Master in consultation with the ship's managers.

5.7 By the early morning of 12 December 1999 the weather had worsened to south westerly winds of about 50 knots with very rough seas and swell. In the French Commission's report it is stated that at 05:54 hours, the Master reported to the nearest coastal Marine Rescue Co-ordinating Centre (MRCC) that the ship's hull had breached resulting in an ingress of water and requested immediate assistance for the evacuation of all crewmembers. According to the Maltese report, a distress alert was transmitted from the ship by telex at 06:04 hours and an acknowledgement to this telex was received from MRCC Etel, France, after which MRCC Etel maintained contact with the ship by VHF radio. In the Maltese report it is also mentioned that at 08:08 hours the ship suffered structural failure and broke into two sections about 80 metres from the bow of the ship.

5.8 French naval rescue helicopters winched all the ship's crew up by 10:43 hours on 12 December 1999. The bow section sank during the night of the 13/14 December 1999. The stern section sank on 14 December 1999 at 14:45 hours after an attempt by a tug to tow the section to deeper waters had failed.

5.9 A detailed examination of the sunken sections was conducted by remotely operated vehicles (ROVs) and some parts of the sunken sections were retrieved from the ocean floor for further examination. In the French Commission's report it is stated that this examination revealed *inter alia*:

a) A steel stiffener/scantling recovered from that wreck which was sent for analysis had an average decrease in thickness of about 28% reaching 50% in some places for web plates and 22-35% for the faceplates.

b) The stiffener welded seam beads had fractured under tension and the thickness of weld beads, of what appeared to be relatively new breaks, were between 2.7 and 3 mm. Some weld seams had disappeared.

c) One of the samples of deck plating recovered from the sunken stern section appeared to have been a new plate, which was 12 mm thick. This confirmed the thickness indicated in the RINA report (cf paragraph 4.5 above) and the shipyard invoices, but contradicts the thickness indicated on the shipyard's work diagram.

5.10 In the Maltese report it is stated that the ROV video footage of the wreck indicated substantial local corrosion of the side shell plating in the vicinity of the failure zone and also showed that parts of the structure in the vicinity of the failed section were corroded. In the report it is suggested that if this corrosion had been detected during the special survey in 1998, renewal of these corroded plates would probably have been called for.

6 Analysis in the reports

6.1 It is common ground between the two reports that the side shell plating adjacent to No. 2 starboard ballast tank failed at some stage during the incident. This is verified by the underwater inspection of the wreck carried out after the incident.

6.2 It is suggested in the French Commission's report that this failure was preceded by a breach in the longitudinal bulkhead between No.3 centre cargo tank and No. 2 starboard ballast tank. In the report it is stated that it cannot be disputed that a crack occurred running longitudinally in one of the strakes of the longitudinal bulkhead between No. 2 starboard ballast tank and No. 3 centre cargo tank. The French Commission suggests that the initial crack on the side shell adjacent to No.2 starboard ballast tank was not sufficient at the initial stage to cause the steadily increasing severe list experienced by the ship on 11 December 1999. According to the French Commission its calculations showed that if the hull failure had been limited to the opening of No.2 starboard ballast tank to the sea, the ship would have been able to withstand the internal stresses caused by the ingress of seawater into the tank.

6.3 In the Malta Maritime Administration's report it is concluded that on the balance of probabilities the initial flooding of the No.2 starboard ballast tank was due to the failure of the ship's side shell plating above the mean waterline in the forward part of the tank. It is concluded in the report that in order to match the observations made by the crew, the longitudinal bulkhead between No.2 starboard ballast tank and No. 3 centre cargo tank remained in place during the early stages of the incident. It is further concluded by the Maltese Authority that the transfer of contents between the two tanks was either through a small aperture below the oil surface in No.3 centre cargo tank or via a larger aperture at some position near the top of the tank.

6.4 There is therefore no agreement between the French Commission and the Malta Maritime Authority as to whether the incident started with a failure of the side shell or whether the failure of the longitudinal bulkhead of No.3 centre cargo tank commenced the sequence of events which ended with the total loss of the ship.

6.5 The French Commission expresses the view that the damage suffered by the longitudinal bulkhead between No.2 starboard ballast tank and No. 3 centre cargo tank led to a weakening of one or more transverse webs in No. 2 starboard ballast tank due to the fact that the plating attached to the vertical stiffeners was no longer intact. According to the Commission all of the web frames were affected by this weakening and the side shell (in the vicinity of No. 2 starboard ballast tank) cracked at right angles to the weakened web frame, a scenario that is compatible with the observations made on board. It is mentioned in the report that the transverse webs gradually lost their rigidity and began to buckle causing the side plating to become more flexible in the transverse direction. It is also mentioned that the internal structures of No.2 starboard ballast tank progressively fell apart, that the tank became increasingly more open to the sea and that subsequently the side shell plating broke away from the rest of the internal structure in at least two pieces. It is mentioned that as soon as No.2 starboard tank was fully open to the sea, the loss of buoyancy led to a substantial increase in the longitudinal bending moment. According to the French Commission's report the appearance of the plating attached to both parts of the wreck, suggested that the bottom of the vessel broke due to tensile stresses.

6.6 In the Maltese report it is stated that commencing from a hole or split in the side shell plating adjacent to No. 2 starboard ballast tank, at some distance above the mean water line, the damage progressed down the side and below the water line leading to a rapid flooding of No. 2 starboard ballast tank. It is suggested in the report that the progressive development of the initial breach led to the side shell detaching in way of No. 2 starboard ballast tank and that with the loss of the side shell and the deck plating there would have been a significant loss of strength to resist the prevailing sea state. The view is expressed in the report that, in addition, the discontinuity of the structures in the vicinity of the ballast tank would have given rise to high stress concentrations which in turn would have been highly conducive to the propagation of cracks and to the progressive collapse of the remaining structure.

6.7 Both reports state that corrective actions taken by the Master included the removal of ballast from No.4 starboard ballast tank and equalising the levels of liquid in both No.2 port and starboard ballast tanks by gravity that corrected the list temporarily and created a trim by the bow. In the French Commission's report it is stated that calculations show that these weight transfers were compatible with the hull girder strength criteria and that they even reduced the shearing stresses and bending moments. The Commission's report also confirms that the speed and courses followed by the ship were not decisive factors in the cause of the disaster. In the Maltese report it is stated that the Master's actions in correcting the list were reasonable and did not run contrary to the action other Masters would have taken in the same circumstances

7 Conclusions drawn as a result of the investigation.

7.1 The conclusions of the Malta Maritime Authority can be summarised as follows:

1 It is not possible to determine with certainty the cause of the initial and subsequent structural failure. It is likely that the failure was caused by a combination of:

a. corrosion

b. local cracks and failures

c. quality of repairs carried out during the special survey in 1998

d. quality of the surveys carried out by RINA

e. vulnerabilities in the design of the ship

f. sea conditions

2 The *Erika* was built in accordance with the rules applicable at the time and in some areas in terms of specifications exceeded present day requirements.

3 The *Erika* had encountered very bad weather throughout the voyage from Dunkirk. However, the ship should not have been overwhelmed by the wave loads encountered during her last voyage or by the hull loading, even taking into account the reduced thickness measured during the last special survey.

4 The degree of local wastage, apparent from the ROV footage, indicates that such corrosion could not have occurred in the 16 months which had passed since the last special survey. It is likely that significant corrosion existed after the repairs at Bijela (cf paragraph 4.5 above) and had not been seen or taken note of for repairs by the attending surveyor.

5 Surveys carried out by RINA at Bjela in 1998 and at Augusta in 1999 failed to identify and / or take note of significant areas with localised corrosion. The ship's managers who attended to the ship while she was in drydock at Bijela also failed to identify and / or take note of areas of significant local corrosion or to monitor the repairs correctly.

6 The ISM audit, carried out by RINA, failed to identify adequately and / or take note of the problems that existed in the way some of the ships were being managed by Panship.

7 The Master failed to make a realistic assessment and monitoring of the situation following the initial listing of the ship.

8 There is no evidence or any reason to believe that use of alcohol or drugs were factors in the conduct of the Master or crew responding to the hull failure and during the evacuation of the crew.

9 Analysis carried out following similar incidents has shown that it is extremely unlikely that a freely floating object could strike the side shell of a ship, while underway, with sufficient energy to cause a breach.

7.2 The French Commission's conclusions can be summarised as follows:

1 The *Erika* was an old ship, which was used for transporting black products at freight rates which were insufficient to cover costs, unless those costs, especially those for maintenance, were drastically reduced.

2 The *Erika* had always been 'sensitive' to corrosion, but she really began to fall into disrepair when No. 4 and especially No. 2 wing tanks became dedicated ballast tanks. This is witnessed by:

a. The thickness measurements made of tank internals in 1997 and especially in 1998 revealed an acceptable overall average thickness except in the No.2 ballast tanks.

b. The absence or poor condition of the protective coating and insufficient cathodic protection.

c. The replacement of half the longitudinal deck stiffeners and those of the upper parts of practically all the transverse webs in No.2 ballast tanks.

d. The extensive corrosion and deposits of rust observed by the ROV.

3 The inadequate repairs carried out at the Bijela shipyard were also a decisive factor in the sequence of events leading up to the casualty.

4 The weakening of the structure in the region of No. 2 ballast tanks was due to insufficient maintenance and the corresponding rapid development of corrosion, leading to a succession of ruptures that caused the whole structure to collapse. This factor was decisive to such an extent that the other factors can be considered as secondary. The state of the vessel and her rapid deterioration in the last hours of her life were such that nothing could have prevented the disaster.

8 Action to be taken by the Executive Committee:

The Executive Committee is invited to:

a) take note of the information contained in this document; and

b) to give the Director such instructions as regards the investigation into the cause of the incident as it may deem appropriate.