

Foreword

The official report by the Flag State for the sinking of LEROS STRENGTH is written by the Ministry of Communication and Works, Department of Merchant Shipping, Lemesos, Cyprus, and is titled "Marine Accident Report. Foundering of the Bulk Carrier LEROS STRENGTH on 8 February 1997 off Stavanger, Norway".

The present report by the Norwegian Maritime Directorate (NMD) may be regarded as a supplement to the report by the Flag State. The purpose of the NMD report is mainly to give a summary of the underwater inspections and other investigations performed by us into this accident. In our view, there are general lessons to be learnt from this accident, and our recommendations in this respect are given in section 5.3 of this report.

We are aware that an early internal draft of the NMD report, which was then titled "The Foundering of M.V. Leros Strength. The Anatomy of a Disaster and the Mystery of a Wreck", has been distributed to various parties. Please note that this early draft was not approved internally within NMD, for external distribution.

Prior to finalisation of the present report, the draft for Chapter 4 "Classification matters and statutory matters related to structural integrity" was sent to the classification societies ABS and RINA (which both had provided various documentation on the vessel) requesting their comments on *the facts* presented. We also requested that any comments or proposals should be accompanied by documentation verifying any new/amended information. Some changes were made to the draft in response to the comments received.

The complete draft for the present report was sent to the Department of Merchant Shipping in Cyprus. Under the circumstances, we did not consider it appropriate to ask for "approval" by Cyprus authorities of the NMD report, but we requested to be informed in case Cyprus Authorities should find any factual information in our draft, that they considered to be incorrect, incomplete or misleading. They responded as follows: "In general we agree with the text of the report and appreciate your recommendations which are of value to this Administration, to IMO and the Class Societies, and will be looking forward to their incorporation into future legislation. ...". Only some editorial amendments have been made to the final report compared to the draft submitted to Cyprus.

Please note that our report has been written on the basis of i.a. documentation provided to the NMD by two classification societies (as noted above). Generally speaking, the NMD has had no opportunity to *verify* the correctness and completeness of the information received. Consequently, the NMD can not be held responsible for any incorrect or misleading judgement or conclusion in this report, in case the information we have had available should prove to be incomplete or incorrect in certain respects.

Oslo, 06 July 2000



Ivar Asle Manum
Director General of Shipping and Navigation
Norwegian Maritime Directorate

EXECUTIVE SUMMARY

LEROS STRENGTH was a Greek owned and Cyprus flagged bulk carrier delivered in July 1976. The vessel sailed from Murmansk 2 February 1997 destined for Police, Poland, where she was expected to arrive 8 February 1997. She had a crew of 20 people, and was loaded with 18.180 tonnes of apatite, which is classified as a harmless, non-dangerous fertiliser.

On the 8 February 1997 at 7.50 a.m. the Captain of LEROS STRENGTH contacted the Rescue Co-ordination Centre in Sola/Stavanger, Norway, requesting immediate assistance. The ship was then approximately 30 nautical miles south west of Stavanger. The Captain reported that the bow was under water up to hold no. 1. He was unable to steer and the situation was getting progressively worse. After approximately 3 minutes the radio contact was abruptly cut off. It was later established that the vessel had sunk, and there were no survivors.

When Norwegian Authorities decided to become actively involved in the investigations into the sinking of LEROS STRENGTH, the main objective was to attempt to contribute to establishing the direct causes - and hopefully also the underlying causes - of this tragic accident. If the causes could be established, this could possibly be a basis for proposing new/revised regulations or procedures related to bulk carriers, thereby - in the longer term - hopefully contributing to preventing similar casualties in the future.

The Norwegian Ministry of Trade and Industry requested the Norwegian Maritime Directorate (NMD) to investigate the sinking by conducting underwater inspections of the wreck, in co-operation with the Flag State (Cyprus) and others. It was later decided that NMD should also examine relevant survey documentation on the vessel for the years preceding the accident, as part of these investigations. In this process it has been of particular interest to investigate the effectiveness of the Enhanced Survey Programme (ESP) for bulk carriers. Taking into account that LEROS STRENGTH had changed from one classification society to another some months prior to the accident, it was agreed that the investigation should also attempt to establish if the IACS "Transfer Of Class Agreement (TOCA)" had been working as intended, or if it was still possible to avoid necessary upgrading by switching from one classification society to another.

The Preliminary and Final Inspections were executed in September 1997 and June 1999 respectively in close co-operation with the Republic of Cyprus, the International Transport Workers' Federation and others. Summing up the underwater inspections, the results were clearly not providing the answers one was hoping for when making the decision to conduct these inspections. LEROS STRENGTH has been very severely crushed and distorted, and the damage is most likely accounted for by the geology of the wreck site. It has unfortunately not been possible to identify with certainty the specific direct cause of this accident. However, from other available information it is possible to identify the direct cause in *general* terms, which was clearly "ingress of water into the fore part of the ship". The "Marine Accident Report" written by The Department of Merchant Shipping in Cyprus concluded that "it is highly probable that when the Master was in contact with the RCC Stavanger the vessels fore-peak, no. 1 and no. 2 cargo holds were flooded".

The investigations into the sinking of LEROS STRENGTH have not established any other *external* factors than the weather that can explain the circumstances significant for progressive water ingress and subsequent sinking. As far as we know, no vessel other than LEROS STRENGTH ran into real problems because of the weather conditions in the areas where the voyage took place. Taking into account the circumstances and the large extent of flooding into different compartments prior to the sinking, it must therefore be concluded that the structural integrity of the ship during this voyage can not have been up to the required standards.

The study that NMD has carried out of the available information on surveys etc during the years prior to the sinking, has given a rather confusing picture of the structural condition of LEROS STRENGTH during this period of approximately 5 years. It must be concluded that much of the survey documentation on this vessel for the relevant period is inadequate. Descriptions of deficiencies found and their location are often imprecise/unclear, and very little information is available on the repairs carried out. There are examples of defects required to be repaired *immediately* by one surveyor, which have been *deferred* for a year by the next surveyor. Furthermore, in many cases it is impossible from the available documentation to determine with certainty whether defects found but not repaired at an earlier survey have actually been *repaired*, or if they have been *overlooked* at the next survey. When the ESP documentation is lacking - as in this case - it is also impossible to verify the effectiveness of ESP.

In most respects the TOCA requirements applicable at the time of class transfer of LEROS STRENGTH seem to have been complied with. However, our investigations indicate a need for introducing *stricter* requirements and restrictions regarding transfer from one classification society to another.

Detailed recommendations based on lessons learnt from this accident are given in the final chapter of this report. In summary, recommendations are given related to the following subjects:

- Survey reporting needs to be significantly improved.
- Negative reporting only should be banned.
- Standard terminology for reporting should be agreed and made mandatory.
- The possibilities for splitting up a given survey between different survey stations should be restricted.
- Repairs of items relevant for structural integrity should always be planned beforehand in co-operation with the classification society.
- No deferral of repairs previously required by a surveyor should be allowed, unless so decided by the Head Office.
- 3 months extension of the five-year period for continuous trading is not permitted according to the SOLAS Convention, and must be banned in practice.

- Renewed consideration should be given to the length limit for SOLAS Ch. XII (presently 150 m) so as to make these requirements applicable also for bulk carriers similar to LEROS STRENGTH.
- Consideration should be given to requiring more than one surveyor to carry out Special Survey for ships above a certain age; alternatively requiring supervision of parts of this survey by a surveyor from the Flag State itself.
- No transfer of class should be allowed until the *losing* society has confirmed that all outstanding recommendations have been rectified.
- When a periodical survey is due, no transfer of class should be allowed until the complete survey has been carried out by the *losing* society with satisfactory results.

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Sources of information

- American Bureau of Shipping (ABS): Survey Reports 1990/09 – 1996/03
- Blue Water Recoveries Limited: Survey Report 3 November 1999
- Ministry of Communications and Works, Department of Merchant Shipping, Lemesos, Cyprus: Marine Accident Report on LEROS STRENGTH
- Norwegian Maritime Directorate: Video films taken during Preliminary and Final Inspections
- Registro Italiano Navale (RINA): Survey Reports and Certificates 1996/06 – 1996/11
- Facsimile from RINA dated 19 and 21 June 2000 respectively.
- Facsimile from ABS dated 19 June 2000.

1. Background for the report

1.1. The sinking and the search

LEROS STRENGTH was a Greek owned and Cyprus flagged bulk carrier delivered in July 1976. The vessel sailed from Murmansk 2 February 1997 destined for Police, Poland, where she was expected to arrive 8 February 1997. She had a crew of 20 people, all from Poland. The vessel was loaded with 18.180 tonnes of apatite, which is classified as a harmless, non-dangerous fertiliser. The cargo was loaded in cargo holds nos. 1, 3 and 5 with holds 2 and 4 empty. The vessel was built to the extra requirements of American Bureau of Shipping to enable her to carry cargo in alternate holds.

On the 8 February 1997 at 7.50 a.m. the Captain of LEROS STRENGTH contacted the Rescue Co-ordination Centre in Sola/Stavanger, Norway, requesting immediate assistance. The ship was then approximately 30 nautical miles south west of Stavanger. The Captain reported that the bow was under water up to hold no. 1. He was unable to steer and the situation was getting progressively worse. After approximately 3 minutes the radio contact was abruptly cut off.

The Rescue Co-ordination Centre, Sola/Stavanger immediately initiated an emergency phase. The weather was reported as westerly gale / strong gale. Rogaland Radio was requested by the RCC to send Mayday-Relay. The Coast Guard vessel MV Nordsjøbas left Karmsundet 8.15 a.m., and a helicopter was on its way 8.09 a.m. The helicopter arrived at the reported distress position 8.47 a.m. only to inform that "the vessel has sunk. There is oil on the water, two rafts and a lifeboat are observed".

A hospital in Stavanger was alerted 8.48 a.m. about the potential need for treating up to 20 people. However, by 8.59 a.m. it was concluded that there were no survivors in the survival crafts. By mid-day a total of seven merchant vessels were participating in the search, which continued until darkness.

The next morning, 9 February 1997, the search continued with Nordsjøbas and one helicopter, and supplemented also by an area check by three air flights. By 12.00 a.m. that day the search was called off as futile.

1.2. Co-operation between Cyprus (the Flag State) and Norway

Shortly after the sinking of LEROS STRENGTH, Cyprus authorities contacted Norwegian authorities and informed that Cyprus had initiated an investigation into the accident. In this connection Cyprus requested a meeting with Norwegian authorities to exchange information on the casualty. Such a meeting was arranged at the Rescue Co-ordination Centre in Sola/Stavanger on 14 February 1997, with representatives from Cyprus Dep. Of Merchant Marine, RCC/Stavanger, the Norwegian Maritime Directorate and one of the Norwegian Maritime Investigators.

During this meeting all aspects of the rescue operation were gone through in detail. Furthermore, various information was given on LEROS STRENGTH, including its survey status. Views were also exchanged on the possibilities for - and expected usefulness of - making video recordings of the wreck. There was agreement that such

video recordings could *possibly* provide important information that could contribute significantly to being able to establish the causes and underlying causes of the sinking, but no decisions were made at this stage.

At the end of the meeting it was agreed that all parties were interested in continuing the exchange of information related to this tragic accident. It was later confirmed at Ministry level that Cyprus and Norway were willing to share and exchange information on the incident on the basis of reciprocity and within the framework and spirit of relevant IMO resolutions on marine casualty investigations.

1.3. Decision to perform an underwater inspection of the wreck.

As noted above, the idea of making video recordings of the wreck of LEROS STRENGTH was originally brought up as a possibility at the first meeting in Stavanger between representatives from Cyprus and Norway. NMD mentioned this subject again in correspondence with the Norwegian Ministry of Trade and Industry, in relation to finalising the co-operation agreement between Cyprus and Norway at Ministry level. NMD did not propose that such an underwater inspection should be (fully) funded by Norwegian authorities, but expressed the view that such investigations could possibly provide useful information in relation to the ongoing work within IMO aiming at increasing the safety of bulk carriers. At the same time NMD also made it clear, however, that even if such a mission was carried out it was far from certain that such investigations would provide the information necessary for establishing the causes of the accident.

Shortly thereafter, one of the Norwegian maritime labour organisations being a part of the International Transport Workers Federation (ITF) also approached the Ministry, requesting the Ministry to provide NMD with the funding needed to perform an underwater inspection of the wreck. Early June 1997, the Norwegian Ministry of Trade and Industry decided that NMD should co-ordinate an underwater inspection of LEROS STRENGTH in co-operation with Cyprus authorities and other parties. The Ministry made a funding of NOK 600.000 available for this task.

In the correspondence between NMD and the Ministry the main objective of the investigation was agreed to be to attempt to clarify the direct and underlying causes of the foundering of LEROS STRENGTH. In relation to possible underlying causes, the Enhanced Survey Programme (ESP) for bulk carriers was mentioned specifically; i.e. attempt to assess whether the enhanced inspection requirements can be relied upon on its own as sufficient for ensuring the safety of old bulk carriers. Taking into account that LEROS STRENGTH had changed from one classification society to another some months prior to the accident (in connection with the 20 year Renewal survey), it was agreed that the investigation should also attempt to establish if the "Transfer Of Class Agreement (TOCA)" of the International Association of Classification Societies (IACS) is working as intended, or if it is still possible to avoid necessary upgrading by switching from one Classification Society to another (ref. chapter 4.3).

Due to their strong interest in establishing the causes of the foundering the International Transport Workers' Federation (ITF) offered to pay a contribution to the Norwegian underwater inspection of LEROS STRENGTH. The Norwegian Maritime Directorate accepted this offer, and in total the ITF paid approx. NOK 167.000 for the

underwater inspections in addition to the funds provided by the Government of Norway.

2. Investigation of the wreck of LEROS STRENGTH

2.1. Introduction

Subsequent to the Ministry's letter of 3 June 1997, requesting NMD to co-ordinate an underwater inspection, NMD made a study of which companies had the experience and resources to carry out the underwater (ROV) inspections. Reports and results from other companies and institutions that already possessed know-how and experience from similar operations supplemented this study, e.g. the survey of MV Derbyshire.

An "Invitation to tender for ROV-assisted fact-finding and inspection of foundered ship LEROS STRENGTH" was prepared and sent out to selected companies in early July 1997. In late August 1997 NMD decided that the inspections should be completed in two stages: A Preliminary Inspection would be done by a naval specialist vessel, KNM Tyr, and a Final Inspection by Stolt Comex Seaways A/S.

2.2. Survey strategy

The Norwegian Maritime Directorate developed an "Objective, Methodology and Plan & Check List" which was intended as the basis for both the Preliminary and the Final Inspection.

It was decided that both the preliminary as well as the final inspections should be executed in two separate parts, i.e. an initial overall inspection which was intended to give input to the more detailed inspection. The objective of the overall inspections was twofold, i.e. it was desirable:

- a) To spot, identify, navigationally locate and record any detached structural parts or lost objects to gain an understanding of the chain of events during the foundering.
- b) To establish how the wreck was situated on the seabed and to define areas of high priority for the more detailed inspections.

2.3. Preliminary Inspection – KNM Tyr

The Preliminary Inspection was executed as planned on 2 and 3 September 1997 by the naval vessel KNM Tyr.

KNM Tyr was made available to the NMD by Headquarter Allied Forces North Europe. This vessel is a specialised ship, which is equipped with DGPS navigation, dynamic positioning and a Scorpion ROV.

2.3.1. Preliminary Inspection Findings

After the preliminary inspection a meeting was arranged between the personnel having participated; i.e. K. Kofteros (Cyprus), J.E. Olsen (NMD), E. Skraastad (external consultant to NMD) and B. Turner (ITF). The main findings of the Preliminary

Inspection were summarised in a Memorandum dated 8 September 1997, which reads as follows:

1. The vessel is substantially submerged in the mud, and this may cause problems for the further investigations.
2. The vessel suffered structural damage when striking the ground, which must be seen separately from the initial damage, which was the cause of the casualty.
3. The bow is turned upwards and it appears that the vessel went down with the bow first.
4. It is observed that plates and frames are missing in hold nos. 2 and 3 on starboard side and in hold nos. 1, 2 and 5 on port side, calling for further investigations.
5. The bulkhead between nos. 1 and 2 holds is missing and the two holds are a common compartment.
6. The hatch covers are missing on hold nos. 1, 2 and 3. On hold nos. 4 and 5 the hatch covers are dislocated.
7. Doublers on deck and possible holed deck plating have not been sighted on this occasion, but this should be done at the next inspection.
8. The seabed further to the north of the wreck should be investigated to find possible debris.
9. It is reported that no.1 hatch always was provided with a tarpaulin.

2.4. The first attempts to carry out the "Final Inspection"

An Agreement was signed with Stolt Comex Seaways and the NMD with the planned objective of starting the Final Inspection on 11 November 1997. After office hours Friday 7 November 1997 the NMD received a telefax from the lawyers representing the Owner's of LEROS STRENGTH regarding the planned mission. The telefax stipulated a number of conditions which the NMD deemed unacceptable, as formulated, and the NMD concluded that there was not sufficient time to resolve these issues before the cancellation deadline Sunday 9 November 1997. The NMD consequently decided that it was necessary to postpone the investigation indefinitely.

A press release concerning the halting of the inspection was sent out early the following week.

The problems related to the conditions for to the underwater inspection set out by the owners of LEROS STRENGTH were later sorted out. The solution included a joint effort between Cyprus and Norway to develop and agree detailed "Terms and Conditions" for the Final Inspection. The Agreement spelled out conditions regarding the purpose, participants/observers, possible removal of physical items from the wreck for testing, financial aspects as well as formalising the decision process regarding all parts of the Final Inspection.

After the postponed mission, NMD was in frequent contact with Stolt Comex Seaways to find a new date for the Final Inspection. However, during 1998 and the beginning of 1999 the activity level on the Norwegian Continental Shelf was consistently very high. Stolt Comex Seaways had large contracts with the major oil companies and there was unfortunately no available "time window" even for comparatively small missions like the underwater inspection of LEROS STRENGTH.

After a long delay, NMD decided to make a renewed attempt; this time with a smaller company having some experience with similar type of missions. An attempt to execute the Final Inspection was done in the period 25 – 27 September 1998. However, for various reasons including severe technical problems, the outcome of this mission did not produce useful new results, and the mission was considered unsuccessful.

2.5. Final Inspection – KNM Tyr

After the unsuccessful mission in September 1998, the Royal Norwegian Navy was again contacted regarding possible assistance, and was again willing to co-operate. The NMD was of the opinion that a successful outcome of the Final Inspection would be dependent upon the availability of high resolution Side Scan Sonar equipment, which was not part of KNM Tyr's outfit. In co-operation with the Royal Navy an agreement was made with Blue Water Recoveries Ltd., Haslemere, UK, to supply the required hardware and also to provide general consultancy advice during the actual inspection.

The main purpose of the Side Scan Sonar equipment was to make possible a sonar survey of the wreck site and to provide sonar "photographs" of starboard and port ship-sides and the main deck.

The seaborne part of the Final Inspection was carried out in the period 16– 19 June 1999. The sonar equipment worked well, but the findings, which are summarised in Chapter 2.5.1 and 3.1, were not as detailed and specific as hoped for, due to a combination of bad weather, some persistent mechanical problems and time restrictions.

2.5.1. Final Inspection Findings

Below is quoted what is considered factual evidence from the Blue Water Recoveries Ltd's report of 3 November 1999:

"Starboard Side Damage: This image shows the best overall detail of damage incurred along the full starboard side of the LEROS STRENGTH. These interpretations have been made after numerous viewings of the ROV video, which allowed correlation of specific damage seen on the video with the interpreted image.

A common form of damage evident in both the sonar image and video are buckles to the starboard shell plating. At least four buckles have been identified. Moving from the stern to the bow these buckles include: 1) a minor buckle just forward of the #4 mast house, 2) another minor buckle underneath the spot where the #2 derrick has toppled aft, 3) a more severe buckle slightly forward that is associated with heavy unidentified debris, and 4) by far the most severe buckling at about the position of the #1 derrick. This latter buckle is essentially a 90-degree fold in the shell plating and it appears that it is the result of the "accordion effect" when the ship impacted the seabed.

Forward of the 90-degree buckle the sonar image shows about an 8 metre discontinuous gap in the shell plating. The damage to this area is very heavy and the generally poor quality ROV video does not allow a good identification and

understanding of the damage. Forward of the 8-meter gap the starboard bow begins at the break of the forecastle, as confirmed by the ROV video. The video also shows a large scale 90-degree bend in the shell plating where the name LEROS STRENGTH is painted. This large deformation in the shell plating is also evident in the sonar imagery. The remainder of the starboard bow forward is also very heavily damaged".

Technical difficulties, time and weather did not permit a good sonar image of port side. Hence the Blue Water Recoveries Ltd's comments are limited to starboard side.

2.6. The Geology of the Wreck Site in relation to the Condition of the Wreck

After the Final Inspection, the Norwegian Maritime Directorate initiated preliminary contacts with the Geological Survey of Norway, the Norwegian Hydrographic Offices and the Institute of Marine Research. Subsequently these institutions communicated with Blue Water Recoveries Ltd. to clarify various issues related to the geology of the site of the wreck. This information is important for a complete understanding of the condition of the wreck on the seabed. A complete quotation of Blue Water Recoveries Ltd's chapter on the geology is therefore given in the following.

"Very little was known about the geology of the wreck site at the time the Final Inspection was being conducted. The sidescan sonar imagery showed the seabed to be mostly flat and featureless except for the occasional and isolated patch of glacial erratic (ice-born boulders), and shallow scars presumably made by fishing nets being dragged over the seabed. The patches of glacial erratics had a remarkably similar appearance to potential wreck debris and were initially interpreted as such. Video footage taken by the Scorpion ROV confirmed that the patches consisted of well-rounded boulders lying loose amongst the surface sediments. The exposed surfaces of the boulders were seen to be colonised by sponges of the family Geodiidae.

Further investigation into the geology of the wreck site was stimulated by questions about the nature of structural damage the hull would have suffered on impact with the seabed. To pinpoint the cause of the casualty it is necessary to separate any initial triggering damage from damage caused when the hull struck the seabed after it had already sunk. This has proved to be extremely difficult for the LEROS STRENGTH as the damage she has experienced is very severe and extensive. It is also possible that any initial damage could be masked by more serious impact damage occurring at the same place on the hull. As a result of these complications and because of the limited amount of information that could be collected during the Final Inspection, it is virtually impossible to separate any initial damage from impact damage at this time. For example, the section of the port bow that appears missing in the sonar imagery and can't be identified in the ROV video could have either been completely damaged by impact with the seabed such that it is hidden from view under the mud or other debris (most likely scenario), or this section could have become detached prior to impact with the seabed (least likely scenario). This missing section was not found in the vicinity of the wreck.

The severity and extent of impact damage to the hull will vary with a number of factors, the primary ones being: a) the forward momentum of the vessel as it strikes the seabed, b) the striking angle of the hull, c) the shear strength and thickness of the upper sediment layer, d) the corresponding depth of a hard rock surface, and e) the

strength and condition of the hull. This discussion shall be solely limited to the geological factors, namely c) and d).

Whilst impact with one of the surface patches of glacial erratic could conceivably lead to a certain amount of damage, it is felt that the patches are too small and far too infrequent to account for the extensive amount of structural damage observed. No glacial erratics were seen close to the wreck in either the side –scan sonar images or ROV video. The nearest likely glacial erratics to the wreck was a small patch located approximately 200 metres to the South of the wreck off the port side.

The impact of the wreck with the seabed had the result of ploughing the loose sediments aside and at the same time it generated a shock wave of energy that greatly disturbed a large surrounding area of sediments. This area of disturbed sediments can be clearly seen in the side-scan sonar images as a sort of “halo zone” of alternating dark and light sonar reflections. This is a typical feature of shipwreck impacts witnessed by the Consultant (David L. Mearns) in locations where there is sufficient loose sediment to be affected this way.

In this case, the area of disturbed sediments is an irregular shaped zone that extends approximately 48 metres ahead of the bow, 92 metres off the port side, 54 to 98 metres off the starboard side and at least 60 metres behind the stern. Off the starboard aft quarter the halo zone could extend to as much as 140 metres away. The final two “correct scale” sonar images shown in Section F illustrate the extent of the halo Zone. The irregular pattern of black/white patches that characterise the halo zone represent mounds of sediment, as high as 2 to 3 metres above the intervening troughs, that have been kicked up by the ship’s impact.

No data is available on the shear strength of the upper sediment layer although at the surface the sediment was observed to be made of non-cohesive muds and fine sand. It is doubtful that this sediment layer offered much resistance to the hull as it ploughed its way through to its final position, and thus the damage attributable to it should be negligible. While the wreck appeared to be deeply buried in the sediment nearly up to the level of the upper deck, high resolution seismic reflection data collected relatively close to the wreck’s position suggests that the sediment layer is limited to a thickness of 1 or 2 metres.

The data, provided by the Geological Survey of Norway, consists of a widely spaced grid of Geopuls Boomer seismic profiles. The nearest profile passes roughly 1 km from the wreck’s position (refer to the following track charts). Raw and interpreted profiles of the nearest seismic line No. 9503051 are included herein for comparison. The interpreted profile suggests that the wreck may be located in an area where there is no appreciable accumulation of sediments and there exists a harder sea-bottom just below the surface which shows evidence of ice-berg scour marks. The surface sediment overlying this hard-consolidated surface would thus appear to be just a relatively thin covering layer of just a couple of metres thick.

Should this trend hold true, the wreck would surely be lying directly on the hard surface. Importantly, this shallow surface, depending on its hardness, could be the cause of significant impact damage to the hull. The impact damage could be to such an

extent that the hull, hidden from view beneath the sediment layer, has been heavily crushed and flattened”.

3. Conclusions from the inspection of the wreck

3.1. Structural findings

In general, there is good conformity between the observations made during the Preliminary and the Final Inspections.

The more important findings of the Final Inspection which confirm the Preliminary Inspection are:

- The vessel is substantially submerged in the seabed, virtually to the upper deck. The wreck is more or less upright with the bow pointing west (260°).
- The “flight” path was probably a continuation of the nose-down-condition at the surface and the vessel most likely hit the seabed with the bow first. The size and form of the “halo-zones” strengthen this assumption not so much forward and aft as the form of the sediment ripples created by the shock waves.
- The buckles, which are shown on sketches made subsequent to the Preliminary Inspection, are confirmed for at least four locations.
- The sonar “photograph” has confirmed that one area of SB side shell plates is missing i.e. for hold no 1. In chapter 2.3.1 this was given as hold no. 2 (&3) which was a report mistake since the missing plates on a sketch were given as hold no 1.

The Final Inspection did not provide additional information neither on the missing side shell plates on port side (ref. chapter 2.3.1) nor on the missing bulkhead between holds nos. 1 and 2.

3.2. General comments

The Final Inspection was intended to confirm the Preliminary Inspection and hopefully provide further conclusive facts. In general, the Final Inspection was executed according to the survey strategy described in chapter 2.2.

Several good sonar runs did provide useful information about the likely sequence of events and the condition of the wreck. LEROS STRENGTH has been very severely crushed and distorted, and the damage is most likely accounted for by the geology of the wreck site. As detailed in chapter 2.6 it is highly probable that LEROS STRENGTH hit the seabed where the upper sediment layer is limited to a thickness of 1 - 2 m. This conclusion is supported by both data provided by the Geological Survey of Norway and by the high resolution seismic reflection data recorded by Blue Water Recoveries Ltd.

As the thin upper layer probably consists of non-cohesive mud and sand and the seabottom just below is very hard, this would cause a significant impact damage when the hull hit the seabed, and explain why the hull structure possibly has been

compressed in accordion fashion and why there is only 1-2 m from the seabed to the upper deck.

The question arises as to whether a strong, well-maintained ship could have become crushed and flattened to this extent. To the knowledge of the Norwegian Maritime Directorate, there is no experience data available on this issue, and although it may be possible to run computer simulations, so many assumptions would have to be made as to render any conclusions of little value.

During the Final Inspection of the wreck and also during the subsequent studies of the video recordings and sonar pictures, one was on the lookout for any signs of implosions/explosions within the ship's structure having occurred during the sinking. Such implosions/explosions can only occur when compartments remain with strong and intact boundaries down to the depth required for collapse, which is between about 25 and 100 m. No sign of such implosion/explosion mechanism was detected during the underwater inspection of LEROS STRENGTH. Although no definite conclusions can be drawn from these observations, they put a question mark on the condition of the ship prior to the sinking.

During the Preliminary Inspection some minor objects in the wreckage field were recorded and the Final Inspection revealed three unidentified pieces of wreckage – probably of steel and of the following approximate sizes: 15 m x 3 m, 9 m x 4 m and 11 m x 4 m. None of the above objects appear significant for the understanding of what happened.

As summarised in chapter 2.5, the Final Inspection unfortunately failed to provide a complete sonar “map” of the wreckage field and also failed to present a good sonar “photograph” of the port side of the vessel and its upper deck.

Many hours of video recordings of the wreck and the surroundings were made during the Final Inspection, but the quality could have been better. It was planned to use a high quality specialist video camera provided by Blue Water Recoveries, but it turned out that this equipment could not be fitted to the Scorpion ROV of KNM Tyr.

Summing up the underwater inspections, the results were not providing the answers one was hoping for when making the decision to conduct these inspections. As summarized above, a combination of technical problems, bad weather and limited time available can partly explain the limited success of these missions. The question therefore remains if significantly more substantial information related to the causes of the sinking of LEROS STRENGTH could be provided by carrying out *further* attempts. In relation to this question, the following views from the representative of the company (Blue Water Recoveries) which provided equipment and technical assistance during the Final Inspection may be quoted: “After reviewing all this information again, I am again reminded how difficult it will be to try to determine the cause of the sinking. The wreck is heavily damaged from one end to the other (I still find this surprising) which makes the job extremely difficult to isolate the triggering event. A subsequent investigation would require many days of the highest quality video investigations to possibly come up with the answer. In our limited time we never made a very good inspection of the immediate 150 meters radius around the wreck

where more clues may be found. There are also other ways of making sense out of the shattered hull such as three-dimensional sonars. ...”

Thus, the possibility can not be ruled out that additional information on the causes of the sinking may be revealed by carrying out further underwater investigations using even more sophisticated equipment than used so far. On the other hand, there is no guarantee that the “final answers” to the sinking of LEROS STRENGTH would be found even if new efforts far exceeding what has already been done, could be arranged. Taking into account the amount of work involved so far and the time and money spent on completing what has been done up to now, NMD has concluded that we are not able to justify further efforts in relation to this accident.

Prior to the underwater inspections of the wreck of LEROS STRENGTH, NMD had very limited experience with such investigations. One of the lessons learnt by carrying out these inspections has been that the amount of work involved - and the difficulties having to be sorted out during the process - far exceed what we expected from the outset. We have also learnt that tasks like this will be dependent upon good luck (like weather conditions) to a large extent. Furthermore, even if you do have good luck in many respects, you may still not succeed due to the prevailing circumstances (like the wreck being severely damaged after the sinking).

However, after a serious accident there is no doubt that an underwater inspection of a wreck may - in many cases - be able to provide information unobtainable by other means/methods. The investigations of the wreck of DERBYSHIRE are clearly such an example, even if the costs involved for those investigations were very high. Therefore, even if the underwater inspections of LEROS STRENGTH were not as successful as we had hoped, NMD is nevertheless of the opinion that similar attempts should still be *encouraged* in relation to future accidents.

4. Classification matters and statutory matters related to structural integrity

While sailing under Cyprus flag, the ship's classification society has been delegated authority to perform all statutory surveys of LEROS STRENGTH.

4.1. Introduction and summary up to and including Special Survey no. 3

The vessel was built as a bulk carrier to the rules and under supervision of American Bureau of Shipping (ABS). The following class notations were assigned by ABS: + A1, E, + AMS, Bulk Carrier “strengthened for the carriage of heavy cargoes, certain holds may be empty”.

The newbuilding was delivered on 21 July 1976 and named Benetnasch. She later changed name to Delena, then to Ena and finally to LEROS STRENGTH when she was taken over by Lamda Sea Shipping Company Ltd., Lemesos, Cyprus, in September 1993. During this period and until mid 1996, The American Bureau of Shipping was responsible for classification matters.

One year after delivery the vessel had some modifications done to the aft part of the fore peak tank during the guarantee dry-docking. This was done because sister vessels experienced fractures, and the modification was reported a success.

According to available information, the ship traded without special damage or wastage being reported to the cargo holds for the first 10 years, i.e. up to Special Survey no 2.

At Special Survey no 3 some wastage and thinning of internals were reported, however, nothing that seemed out of proportion for a 15-year-old vessel. It is noted that the Classification Society apparently did not specify the extent of this condition. However, this Special Survey was prior to the introduction of Enhanced Survey Programme, which introduced requirements to positive reporting, and this remark is therefore considered an observation only.

After the Special Survey no 3 it is noted that the vessel was subject to an accelerated rate of corrosion. This is concluded because of the condition during the Annual Survey described below in section 4.2.1 and 4.2.2., and the grave situation in August 1994 when the surveyor withdrew the Load Line and Safety Construction Certificates.

4.2. Summary from Annual Survey 1992 until leaving ABS class in mid 1996

4.2.1. Annual Survey 1992:

This Annual Survey was commenced 04/92 in Mobile, U.S.A., and was not completed until 06/92 in Tampico, Mexico. Several condition of class were initially issued, some of which were of rather serious nature. These related to the main deck plating, the upper fore peak tank and all topside water ballast tanks.

The Annual Survey was credited in Tampico but no mention was made of any repairs in response to the condition of class concerning accelerated wastage to the transverse bulkhead between top wing tanks nos. 3 & 4. In the documentation received by NMD, there are no indications that the specific repairs ("renewed as original") required by the surveyor in Mobile to be done to the high fore peak tank, were completed prior to crediting this Annual Survey. Furthermore, no repairs seem to have been done to the wasted and holed internals in way of most of the top wing tanks. It is also worth noting that the available documentation indicates that the required thickness readings were not taken.

At the start of this Annual survey, the conditions of class related to the upper fore peak tank were required rectified prior to crediting Annual Survey. However, this recommendation was subsequently overruled by another surveyor who deferred these repairs to the Intermediate Survey.

4.2.2. Annual and Intermediate Survey 1993:

The annual survey started 07/93 in Necochea, Argentina, and wastage was found to new areas such as hatch coamings, hatch covers and ventilators. The annual survey was completed together with the Intermediate Survey in Callao, Peru, 09/93. The deficiencies identified at the beginning of the annual survey were apparently put right (no positive narrative). Finally, almost 1 ½ years after the condition of class regarding the bulkhead between nos. 3 and 4 top wing tanks and the doublers in the fore peak tank were put in order – no mention of the other repairs needed in the fore peak tank.

4.2.3. Annual Survey 1994:

Based on an ABS Survey Status for the Intermediate Survey it is assumed that this Annual Survey window was from 28 February 1994 to 31 August 1994. The ship was presented for survey in August 1994 barely within the window, and the attending Rotterdam surveyor *withdrew* the Full Term Load Line and Safety Construction Certificates until the vessel undertook satisfactory repairs.

The seriousness of the situation is documented in the ABS report in which expressions like "throughout topside tanks evidence of excessive thinning" of various important steel members, and for cargo holds nos. 1, 4 & 5 there were "hold frames found partially detached from shell plate due to excessive corrosion". As for required class action this was narrated as "*inspection of all cargo holds, thickness gauging and major repairs are required to the satisfaction of attending surveyor before crediting Annual Survey Hull*". The report from Rotterdam is not specific regarding which parts of the structure that needed "major repairs", but the accompanying description of deficiencies indicate that such repairs were at least required for many topside ballast tanks, for some of the frames in the upper fore peak tank and for some of the frames in cargo holds no. 1, 4 and 5. Furthermore, the surveyor required close-up inspection of cargo hold no. 1 in Gdansk to establish whether the vessel was "able to proceed to repair port (Cadiz, Spain) or should be stopped and commence with immediate repairs".

The ship proceeded from Rotterdam to Gdansk and then finally to Bilbao where the Annual Survey was credited 09/94, one month outside the survey window. There are no indications in the available documentation that the repairs in Rotterdam and in Gdansk were done under supervision of a class surveyor. It is of considerable concern that the Gdansk surveyor in retrospect made remarks about repairs in the Top Wing Tanks that "dimensions and profiles different from original" and that the repairs "can NOT be considered permanent" and were recommended re-examined during the Special Survey. Again the picture is unclear, as there are several cases of non-reporting about defined deficiencies *possibly* being rectified. By then, the Enhanced Survey Programme had been in effect for more than a year and should have guaranteed positive reporting.

The surveyor in Gdansk issued conditions of class concerning cargo hold no. 1 and top wing tanks to be effected prior to completion of Special Survey no. 4. Since some of these conditions of class were of serious nature and since the Special Survey was approx. 1 ½ years away, one may question the soundness of this judgement.

It is of paramount importance to the safety of a bulk carrier that the side shell frames are soundly attached to the shell. Detached shell frames and grooving effects were reported in Rotterdam, and it is of considerable concern that there are no positive reports that these deficiencies were corrected in Gdansk or in Bilbao. The same applies to "frames found partially totally wasted" in the upper fore peak tank, as also reported in Rotterdam. It is also of concern that the Gdansk surveyor listed a number of top wing tank internals which were substantially corroded when the ship left, and which are not referred to in the report from Bilbao. *Formally* it is possible to conclude that this Annual Survey was successfully credited in Bilbao, but this seems to have been

achieved as a result of lengthy deferrals of - or overlooking - important surveys and repairs.

4.2.4. Annual Survey 1995:

The annual survey in 1995 was carried out in Piraeus, Greece, in March 1995. It is noted that the partial and total wastage of internals and frames in upper fore peak tank as reported in Rotterdam, were still not documented as put right by the Owner.

It is also noted that there is no detailed positive reporting about repairs to cargo holds nos. 1, 4 & 5. However, all cargo holds were cleaned, descaled by water-jet blasting and painted. Some of the conditions of class given in Bilbao in September 1994 were further expanded and again deferred to Special Survey no. 4.

4.2.5. Summary of the period 04/91 – 06/96

Below are comments on classification matters related to the period after the Special Survey no 3, and prior to changing class to RINA:

The *topside ballast tanks* were recurrently described as problem areas from Special Survey no. 3 onwards. During the Annual Surveys expressions like “wasted” and “holed” as well as “excessive wastage” are used for the topside tanks.

The *upper fore peak tank* is mentioned in various survey reports. During the survey 08/94 in Rotterdam “partial and total wastage” of internals was concluded. Despite surveys in Gdansk and Bilbao 09/94 the badly wasted tank internals are not mentioned at all, and the previous condition consequently not confirmed corrected. The same applies to the annual survey in Piraeus 1995.

Detached side shell frames with evidence of grooving was reported in Rotterdam 08/94 for *cargo holds nos. 1, 4 & 5*. Subsequent class reports are not specific about these important items, and it is not possible to conclude when, where and whether repairs were temporarily done by reinforcements by Owner’s riding crew.

Thus the documentation indicates that the concerns of the Rotterdam surveyor in August 1994 were not fully dealt with by the Gdansk and Bilbao surveyors who overlooked or deferred apparently badly needed upgrading to the Special Survey. The structures mentioned are, either alone or in combination with each other, vital to preserve the structural integrity of a bulk carrier. The Rotterdam surveyor also recommended that all cargo holds should be inspected, thickness gauged and *major repairs* effected before crediting Annual Survey Hull, which was already overdue. Despite being surveyed as recommended and despite diminution of side shell frames up to 24 %, there are no positive records of repairs to the cargo holds.

The International Association of Classification Societies has issued a Unified Requirement Z 13, for Voyage Repairs and Maintenance. Revision 1 was valid from 1995. The main objective of Z 13 is that repairs, which affect or may affect classification, are to be planned in advance on a mutual basis. Procedures and the extent of proposed repairs and the need for surveyor's attendance during the voyage are to be discussed and agreed. A mutual meeting Owner / Class is recommended to

ensure the continued effectiveness of the structure at sea and verification of acceptable materials and consumables.

As far as we are aware, there is no positive documentation verifying that this Unified Requirement was adhered to. One would have expected a growing alertness within the classification society during this period and the surveillance should in consequence have cracked down on unauthorised riding crew repairs, which can be detrimental to safety. These comments are underlined by the critical remarks by the Gdansk surveyor (ref. section 4.2.3) about the quality of work done by the riding crew.

On 8 May 1996 the Owners of LEROS STRENGTH requested 3 months extension of the Special Survey no. 4 (20 years), due 31 May 1996, for commercial reasons. This was refused by the ABS due to the many outstanding conditions of class. This resulted in actions by the shipowner to change classification society for the ship; see below.

4.3. Transfer of Class and Reporting of Changes in Class Status (TOCA)

“Transfer Of Class Agreement (TOCA)” was first initiated by the International Association of Classification Societies (IACS) in '86. During the years several revisions have been done, and revision no. 5, effective from 1 July 1995, was applicable when the Owners of “LEROS STRENGTH” changed its class in June 1996.

TOCA is considered by the marine industry as an important instrument to ensure that class changes are made in a proper and controlled manner, so as to prevent that class changes can result in a ship being able to “escape” from recommendations given by the previous classification society.

As noted earlier, on 8 May 1996 the Owners of LEROS STRENGTH requested 3 months extension of the Special Survey no. 4 (20 years), due 31 May 1996, but this was refused by ABS due to the many outstanding conditions of class. According to information from ABS, the class was suspended when the ship arrived at its first port of call in early June 1996. According to the TOCA documentation, the date for the formal withdrawal of class in ABS, was 26 September 1996. There is a difference between “suspension” and “withdrawal” of class, but according to ABS, LEROS STRENGTH was “disclassified” on arrival at its first port of call after 31 May 1996.

The Owners’ “Notice of Authorization” requesting classification transfer to RINA, the gaining Society, is dated 11 June 1996 which is eleven days after the Load Line, Pollution Prevention and the Safety Construction Certificates ceased to be valid. On 12 June 1996 the losing Society, American Bureau of Shipping, was informed by RINA, the gaining Society, about the Owners decision to effect a transfer, which is in accordance with the TOCA requirements. The Flag State, Republic of Cyprus, was informed the same day (12.06) by the losing Society, and on 14 June 1996 by the gaining Society.

The first part of the surveys related to Class Entry into RINA was carried out between 14 and 21 June 1996 in Cartagena, Colombia. After these surveys, the attending surveyor did not issue an Interim Certificate of Class and no new statutory certificates, but solely a “Certificate of Technical Fitness”.

The vessel then sailed from Cartagena via Barranquilla for unloading and finally to Curacao for drydocking and survey. During this voyage the ship sailed *without* a valid Load Line Certificate, Pollution Prevention Certificate or Safety Construction Certificate.

The reports from Curacao indicate that interim class and interim statutory certificates were issued 22 July 1996, valid until 30 November 1996.

The TOCA agreement includes quite detailed instructions regarding information to be exchanged and the time allowed. As a control measure for the losing Society the gaining Society shall within one month from issuing the Interim Certificate of Class, "advise the losing Society of the date of issuing this Certificate and confirm the date, location and action taken to satisfy each overdue survey, overdue recommendation and overdue condition of class, issued against the subject vessel".

According to the TOCA documentation from RINA, the date for issuance of the Interim Certificate of Class was 22 June 1996. However, according to other documentation this certificate was issued on 22 July 1996. RINA has later confirmed that the latter date is correct, and describes the former date as a "clerical error".

However, Part B of Form G was not sent by RINA to the losing Society before 11 October 1996, which is significantly later than required by TOCA (one month).

We have noted that in this case there was no report from the gaining to the losing Society about "Final Entry into Class", ref. Part C of Form G. According to RINA, the explanation is as follows: "... The Final Entry [into RINA class] has never been formalized by RINA. This is because the vessel sunk before approval by RINA Classification Committee of the vessel's file. Submission of the file to the Classification Committee was delayed because, at that time, some of the drawings requested by the TOCA procedure were not yet available at the RINA Head Office."

4.4. Hull Special Survey no 4

4.4.1. Introduction to Special Survey

The Special Surveys which are carried out at five-year intervals are intended to confirm whether the structural integrity is in accordance with the Classification Requirements and - when relevant - to specify necessary upgrading so that the hull remains fit for another five year period.

The Enhanced Survey Programme (ESP) became effective as a classification requirements from 1993 (1 July for most societies). ESP was later adopted by IMO by Resolution A.744(18), and was made mandatory for bulk carriers (and tankers) subject to the SOLAS Convention from 1 January 1996 (SOLAS Reg. XI/2). The Enhanced Survey Programme expands and emphasises the survey requirements for all periodical Hull Surveys, i.e. Annual, Intermediate and Special (Renewal) Surveys. This stricter survey regime requires i.a. positive reporting and traceability, and was applicable to LEROS STRENGTH as from the Intermediate Survey when Lamda Sea Shipping Company Ltd., took over as new Owners.

The success of a Special Survey, which is considered a challenging task for old ships, is dependant on good planning, execution, reporting and final quality control by the Classification Society Regional or Head Office.

4.4.2. Planning /Survey Programme

IMO Resolution A.744(18) requires that the Owner in co-operation with the classification society in advance of the Special Survey works out a Survey Programme. There is a mandatory minimum extent of survey planning to be worked out, and some of the main advantages should be:

- a mutual understanding between the Owner and the Society about the extent and the prerequisites for surveys, e.g. necessary staging and cleaning of areas to be inspected
- definition of high risk areas
- improved quality of surveys and better yard specifications

With a letter dated 16 September 1997 the Norwegian Maritime Directorate received from RINA what was termed a "complete E.S.P Survey report file". However, this binder did not comprise a Survey Programme, which must be considered as a vital document prior to the Special Survey.

4.4.3. Execution

As noted earlier, the first part of the surveys related to Class Entry into RINA was carried out between 14 and 21 June 1996 in Cartagena, Colombia. Following these surveys, the attending surveyor did not issue an Interim Certificate of Class and no new statutory certificates, but solely a "Certificate of Technical Fitness", which has no legal status in relation to IMO Conventions. As far as we are aware, the surveyor neither advised his Head Office about his actions, nor the Cyprus Flag Administration. It is not clear from the documentation received whether any repair were carried out prior to the issue of the "Certificate of Technical Fitness," but the certificate itself only refers to "a *general* examination of the hull" and other vital items.

The vessel then sailed from Cartagena via Barranquilla for unloading and finally to Curacao for drydocking and survey, where the vessel arrived in early July. During this voyage the ship thus sailed *without* a valid Load Line Certificate, Pollution Prevention Certificate or Safety Construction Certificate. In fact these certificates had been invalid since 31 May 1996 when the ship was en route from Bhavnagar, India, to Cartagena.

The documentation received for the repairs and surveys carried out between 13 June in Cartagena and 22 July 1996 in Curacao is not very detailed in all respects, and some of the information seems contradictory. Furthermore, there is no clear information neither on the total amount of survey work involved to complete these tasks, nor on procedures and methods that were used. However, the survey documentation includes a statement by the surveyor making reference to the recommendations given by ABS in three separate survey reports, which says that "these recommendations have been dealt with". Nevertheless, from the available documentation it is difficult to establish

with certainty to what extent (all) previous recommendations were properly dealt with, prior to issuing new certificates.

NMD does not have detailed information on the qualifications and service record of the surveyor attending these extensive surveys. It is noted with concern, however, that instead of using RINA's exclusive surveyors (14) in the Central America a surveyor was sent from Piraeus, Greece, for this survey. The following explanation is given by RINA: "At the time of the Special Survey, no exclusive RINA surveyor skilled for a first entry survey were appointed in Central America. The nearest offices (Fort Lauderdale and Buenos Aires) could not lend a skilled surveyor for this kind of survey for such a long time."

We note RINA's explanation, but add the following general comment: The selection of attending surveyor(s) should be totally at the discretion of the Classification Society. This should be a basic requirement in order to preclude any possibility of improper influence on surveyors from shipowners.

In relation to the above, we also note with some concern that on those RINA forms where the signature of two persons are required, for the Special Survey no. 4 the *same* person has signed both places; i.e. both as "The surveyor" and as "The Head of the Branch Office". The following comment is given by RINA: "The same person signed the report twice because he was both the surveyor and the Head of the Office. This particular situation does not impair the report verification procedure because RINA scheme provides 100% verification of the survey reports through the fleet services department located in the Head Office." NMD notes this explanation, but there is a significant difference between verification done *during* a survey compared to verification done solely of the survey documentation, and at another place a considerable time after the actual survey. It should also be noted that according to RINA "The special survey report was received by the Head Office the day of the foundering and immediately processed"; i.e. the verification took place more than 6 months after the survey.

4.4.4. Thickness Measurements

A. General comments

For an old ship thickness measurements are a very important supplement to visual close-up examinations, and are therefore given a separate section in this report. IMO Resolution A.744(18) also highlights the significance of thickness measurements and gives detailed requirements for the extent of measurements, procedures to be followed, reporting and certification of approved companies.

As noted in relation to the selection of surveyor for the task, it is again noted with some concern that a thickness measurement Company based in Greece was chosen for a job to be done in Central America, and a technician flown in from Greece. At the time of this Special Survey (07/96) this Company was approved by five major Societies (ABS, BV, DNV, GL, LR) but not by RINA. The following comment is given by RINA: "Companies approved by IACS Members are considered as being equivalent to those certified by RINA. Therefore they are accepted to take measurements on vessels classed with RINA:"

IMO Resolution A.744(18) has an Appendix 1, termed General Particulars, which state the requirements to *the first page format* of a thickness measurements report. On this first page of the RINA form there is no space for "Qualification of operator". Furthermore, according to the "Marine Accident Report" on this casualty produced by Cyprus authorities, the technician "did not hold any form of certification from any Class Society".

IMO Resolution A.744(18) and the International Association of Classification Societies Unified Requirements (Z.10.2) contain identical requirements for the areas (extent) that are to be measured at Special Survey no. 4. Both the extent and the formats used by RINA for reporting seem to be acceptable.

As for the actual readings, it is observed that for bottom & shell plating, inner bottom and lower hopper plating, and for transverse bulkheads between cargo holds, *no* readings exceed a reduction of 10 %. The figures are unexpectedly low, and it is difficult to accept that the measured thickness can be representative for a vessel being 20 years old.

RINA has given the following comment to the above viewpoints: "It has to be noted that in most cases the thickness measurements report shows a blank box where a structure has been replaced, since the original thickness has been restored. Therefore, the report does not give the situation of thickness reduction before repairs, but only after repairs (therefore the figures seem better than expected)."

NMD feels a need for questioning the above comment. Firstly, we have to point out that the main purpose of thickness measurements is to determine the general and local levels of corrosion, and it is therefore difficult to see the point of taking measurements on items *after* they have been renewed. In this regard, paragraph 2.1.2 of IMO Resolution A.744(18) on ESP may also be quoted: "As part of the preparation for the enhanced survey, the thickness measurements and survey programme should be dealt with in advance of the enhanced survey." Furthermore, since the total amount of steel being renewed was rather low, it is difficult to understand that the whole range of thickness measurements results could be as good as reported, even if the measurements *were* taken after the repairs were completed.

Below comments are given on a few selected areas.

B. Transverse bulkheads and cargo holds

Problems with the cargo holds of LEROS STRENGTH have been repeatedly reported. As noted in section 4.2.3 the Rotterdam surveyor's in August 1994 required "major repairs" to various items before crediting Annual Survey. During completion of this Annual Surveys in Bilbao in September 1994 it was issued a condition of class that all cargo holds be descaled, gauged, cropped and renewed as necessary prior to Special Survey no. 4 being credited.

Thus, there seems to be a contradiction between the survey reports preceding the Special Survey no. 4 and the Special Survey thickness readings which show only moderate wastage, and the highest recorded diminution is 8.2 %.

C. Side Shell Frames

When the Load Line and Safety Construction Certificates were withdrawn in Rotterdam in August 1994 the surveyor *reported detached frames with grooving effect in cargo holds nos. 1, 4 & 5 – a potentially very serious condition*. As far as we are aware, there is no class documentation indicating that these defects were ever corrected prior to Special Survey, and any possible repairs by Owner's riding crew were not supervised by the class. Even the Special Survey reports do not positively confirm that all these deficiencies were corrected.

In cargo hold no. 1 there were only 20 measuring points in the 10 % - 12.5 % diminution range, one 31.3 % and one 33.1 %. According to the reports we have had access to, only three entire frames were renewed, three lower or upper parts were renewed and eight brackets were renewed.

Thus also for the side shell frames we have to question the results of the thickness measurements and the subsequent (limited) renewals, compared to earlier conditions of class given to these items.

D. Hatch Covers

The thickness readings - as reported - must be considered excellent. Very few diminutions were over 10 % and the highest one was an encouraging 12.2%.

This "evidence" contrasts with reports from sailors referred to in the Marine Accident Report by Cyprus, who maintain that the covers were causing continuous problems and were constantly under temporary repair.

Furthermore, as noted in section 4.5.1, during a Port State Control in Rotterdam 13 August 1996, i.e. *less than one month* after the Special Survey, LEROS STRENGTH was detained for, among other deficiencies, serious problems with hatch no. 3. It was later established that some of the hatch covers were impossible to repair.

Taking into account that the thickness measurements one month earlier of these hatch covers showed an average diminution of 5 %, clearly these measurements can not have been correct.

4.4.5. Summary: Status at completion of Special Survey no. 4

As noted earlier, interim class certificates and interim statutory certificates were issued on 22 July 1996, valid until 30 November 1996. According to the documentation, there were no remaining recommendations at that date. However, as a general comment the amount of steel renewals reported in connection with this survey appears rather low in relation to the outstanding recommendations prior to Special Survey no. 4.

A. "Condition Evaluation Report"

The International Maritime Organization's Resolution A.744(18), Annex 7, defines a special format for the "Condition Evaluation Report". This format is designed to give

persons with legitimate interests a quick review of Special Surveys and the report is required to "be kept on board for the lifetime of the ship".

RINA's format for the Condition Evaluation Report is consistent with Resolution A.744(18). As for the data specific to LEROS STRENGTH, it is noted that the Head Office in Genova did not approve the Special Survey until 10 February 1997, i.e. two days after the foundering and more than 6 months after completion of the Special Survey. Although some delay in approval is acceptable due to the extensive volume of Special Survey data, which sometimes comes from various locations, this time period seems excessive.

B. Cargo holds

A condition of class was issued at Bilbao in September 1994 that all cargo holds were to be descaled, cleaned and internals to be examined and measured prior to Special Survey being credited.

An ABS survey report from March 1995 state that cargo holds nos. 1 through 5 were "cleaned, descaled by water-jet blasting and painted". There is, however, no documentation that the cargo holds were thickness measured and repaired for "grooving & pitting" prior to Special Survey. Grooving can develop into a very serious problem and had now been developing for cargo holds nos. 1, 4 and 5 since August 1994 in Rotterdam. The narrative from the Special Survey in Curacao refers to "some grooving" being restored in hold no 1. It is consequently worrying that nothing is stated about the gravity, extent and method of "grooving & pitting" repairs in no. 1 hold. Furthermore, holds nos. 4 and 5 are not mentioned at all and must be assumed left "as is".

C. Top Wing Tanks

The top wing tanks have been subject to a series of conditions of class from the start of the Annual Survey 1992 in Mobile, USA, up to and including the condition of class imposed in March 1995 at Piraeus – this latter condition of class was still effective at the Special Survey. It is not possible to relate (check) the narrative for Special Survey repairs to the conditions of class since these are very general. The wording of the many conditions of class clearly indicate serious deficiencies and the only ABS survey report which is reasonably accurate down to individual steel members is the one from Gdansk dated 8 September 1994.

What is clear, however, is that the conditions of class are consistent in referring to *all* top wing tanks, while the repairs at Special Survey are mostly part renewals and only refers to some of these tanks. The total amount of steel replaced, as also commented by the Republic of Cyprus, must be considered low. It follows therefore that sufficient upgrading may not have been carried out during this Special Survey.

D. Fore peaks

At the time of the Special Survey there was no active condition of class related to the fore peaks despite several previous conditions of class and obscurity as to when, how and to what extent repairs were made to the upper fore peak.

However, the RINA surveyor has ticked off both the upper and lower fore peak as acceptable both for coating and structural conditions.

4.5. Classification matters from Special Survey no. 4 until foundering

4.5.1. Detention in Rotterdam August 1996

With reference to the comments in section 4.4.1, a Port State Control less than one month after a vessel has passed a Special Survey should normally not create any problems for the vessel.

However, when LEROS STRENGTH was inspected by the Port State Control in Rotterdam 13 August 1996, serious defects were discovered in various areas, and the ship was detained. In the following a summary is given of the major defects related to structural matters.

A. Steel Details

Miscellaneous steel structures such as stiffeners on hatch coamings, bulwark on the main deck and an electric cable pipe was termed "corroded through".

According to the Port State Control officer's report, the aggregate effect could not be tolerated. The bulwarks were commented upon (as approved) in the Special Survey report, and the measured thickness' were within acceptable limits.

B. Hatch covers hold no. 3

Among the deficiencies giving rise to the detention, the problems with hatch no. 3 were among the most serious. As agreed with the Flag State, LEROS STRENGTH was allowed to sail one voyage directly to Piraeus for repair, with a maximum time limit of 15 days. *The existing load Line and Safety Construction Certificates issued at Curacao 22 July 1996 were withdrawn and cancelled by the Republic of Cyprus.* RINA was directed to revalidate the vessel's certificates.

In Greece it was confirmed that some of the hatch covers were unrepairable, and we quote information received from the Port State Control Co-ordinator in Rotterdam: "It has transpired that it will not be possible to complete the necessary repairs to four out of the six pontoon covers of the no. 3 cargo hold hatchway. The extent of deterioration of the pontoons in question is such that meaningful repairs can not be effected and thus the Owners have decided to fabricate new pontoons".

This contrasts strongly with the fact that the average measured diminution of the said hatch covers during the Special Survey one month earlier, was 5 %. In a case like this it seems likely that the surveyor could have drawn the correct conclusions about the need for major renewals without the supplement of ultrasonic thickness measurements. This indicates that the thickness measurements - which in general are supposed to document the possible *need* for repair - in this case may have served as an excuse for not requiring repairs. The seriousness of the matter is further underlined by the fact

that the RINA surveyor in Rotterdam also had to request that "some additional doublers were fitted" to hatch covers hold nos. 3, 4 and 5.

There is not much more to add except that cargo hatch covers and coamings were accounted for (i.e. surveyed, partly repaired and approved for a new period of 5 years) in the following RINA documents:

- Report for first classification survey 21/0
- Checklist for Load Line Surveys
- Record of Conditions of Assignment
- Maintenance Checklist for Cargo Ships

The results of the Port State Control in Rotterdam strengthen the impression that the quality of the survey work done during Special Survey no. 4 and the associated thickness measurements performed, can not have been up to the standards required for such work - at least in *some* of the areas being vital for the safety of a ship.

4.5.2. Itca, Greece, September 1996

The Conditions of Class imposed by the RINA surveyor as a result of the Port State Control intervention, were reported as being rectified.

All cargo holds were high-pressure water washed but not descaled. Holds nos. 3, 4 & 5 were completely recoated with Epoxy paint and holds no. 1 & 2 were touched up.

4.5.3. Point Lisas, Trinidad, November 1996

As noted earlier, all certificates issued in Curacao in July 1996 (i.e. the Load Line Certificate, the Safety Construction Certificate, the Safety Equipment Certificate, the Radio Certificate and the MARPOL Annex I certificate) were "Interim" with validity only until 30 November 1996. These interim certificates were *extended* by RINA in Point Lisas, Trinidad, until 30 April 1997, on the basis of instructions from the RINA Head Office, and a statement from the Master that he did not know of "any damage of any kind onboard the vessel affecting class". The certificates being extended relate to statutory matters *additional* to classification matters. The statement from the Master should therefore have been broader than written.

Taking into account that no outstanding recommendations remained, one may query why full term certificates were not issued to LEROS STRENGTH prior to expiry of the Interim certificates. The following explanation is given by RINA: "The issuance of the first set of full term certificates after a first entry survey is subject to the approval of the vessel's classification file by the Classification Committee. The vessel foundered before being submitted to the Classification Committee. This is the reason why the vessel was provided with Interim Certificates."

5. Conclusions

5.1. Knowledge and theories on the causes of the sinking of LEROS STRENGTH

When Norwegian Authorities decided to become actively involved in the investigations into the sinking of LEROS STRENGTH, the main objective was to attempt to contribute to establishing the direct causes - and hopefully also the underlying causes - of this tragic accident. If the causes could be established, this could possibly be a basis for proposing new/revised regulations or procedures related to bulk carriers, thereby - in the longer term - hopefully contributing to preventing similar casualties in the future.

As described in this report, the involvement of NMD and personnel/companies engaged by us in these investigations has mainly consisted of carrying out various underwater inspections and subsequent studies of the resulting video recordings and sonar photographs of the wreck and the surroundings. Our involvement has also included a study of documentation from two classification societies regarding the surveys of the vessel in the years preceding the sinking.

We have to conclude that our efforts have unfortunately not enabled us to identify with certainty the specific direct cause of this accident. However, from other available information it is possible to identify the direct cause in *general* terms, which was clearly "ingress of water into the fore part of the ship". This seems evident from the information given by the ship's captain in his short radio telephone conversation with the RCC/Stavanger immediately prior to the sinking, when he reported "my bow is under the water". He later added "all the forepart up to hold number one is under the water".

More details on the situation just prior to the sinking can be found in the "Marine Accident Report" on LEROS STRENGTH written by The Department of Merchant Shipping in Cyprus. As part of their investigation they initiated an independent study of the stability and of the longitudinal strength of the vessel at the time of departure from Murmansk and at the time of her loss. This study concluded, "it is highly probable that when the Master was in contact with the RCC Stavanger *the vessel's forepeak, no.1 and no.2 cargo holds were flooded*".

It seems probable that water has ingressed progressively into the forward compartments during the night and that the Captain first became aware of the gravity of the situation when the daylight broke (Sunrise occurred at 07.36 a.m., and the telephone conversation started at 07.50 a.m.).

One can speculate as to *how* and *where* water had ingressed into both the forepeak and cargo hold nos. 1 and 2, and possibly also other tanks etc in the foreship. There are a number of potential leakage paths that could lead to this scenario. One possibility would be leakage through detached areas of shell plating of the forepeak and/or the shell plating of one (or both) of the two most forward cargo holds. Other possibilities would be leakage through cargo hatches, soundingpipes, ventilators, etc. It may be argued that leakage through the cargo hatches does not seem very likely, because the hatch covers must have been visible to the captain at the time of his telephone conversation: Therefore, *if* he had seen damaged or missing hatch covers, it seems

likely that he would have included such information when describing the situation to the RCC.

If the leakage started through detached areas of shell plating, just a single compartment would be filled initially, unless the detached shell plating was boundary to more than one compartment. As already noted - based on the calculations performed by Cyprus - three main compartments were most likely water filled at the time of radio contact between the Master and RCC/Stavanger. This indicates that the leakage could have started as detached shell plating causing leakage into one - or possibly two - compartments. After water filling up to a certain level in this/these compartment(s), the combination of water pressure and sloshing on an adjacent transverse bulkhead could then have exceeded the strength of this bulkhead, which would then break down thus resulting in water filling of a third compartment.

Two transverse bulkheads are suspect in these scenarios; i.e. the bulkheads between cargo holds no. 1 and 2, and the bulkhead between cargo hold no. 1 and the fore peak tanks. Prior to IMO adopting a new SOLAS Chapter XII on "Additional Safety measures for Bulk Carriers" in 1997, it was established that the strength of transverse bulkheads between the cargo holds of many existing bulk carriers was not sufficient to withstand water filling of an adjacent cargo hold. Casualty statistics showed that the bulkhead between holds no. 1 and 2 was particularly vulnerable, and IMO decided to introduce new mandatory strength requirements on this bulkhead for existing bulk carriers. However, these requirements were introduced after the sinking of LEROS STRENGTH, and would furthermore not have been applicable to this vessel because of the length limit of 150 meters for Chapter XII. It is therefore not unreasonable to expect that the bulkhead between holds no. 1 and 2 would break down if this casualty started with leakage into hold no.1.

The other suspect bulkhead is the collision bulkhead, which is designed to be particularly strong. As noted earlier, the condition of the fore peaks had been subject to various recommendations in the past. Even if there were no active conditions of class after the Special Survey, the available documentation is not at all clear regarding the extent of repairs having been performed. Thus it is hardly possible to exclude the possibility that also the collision bulkhead *could* have collapsed due to water filling and sloshing if the leakage started through the shell plating into either the fore peak or the cargo hold no. 1.

The radio telephone conversation between the Master and the RCC was cut off very suddenly. One possible explanation could be sudden power failure within the ship. Another - and possibly more likely explanation - would be that something sudden and dramatic happened to the ship shortly after the radio conversation started.

Again there could be various possible scenarios causing the situation of the ship to rapidly change for the worse. Considering the prevailing weather conditions (westerly gale/strong gale and wave heights up to 4 meters) and the trim of the vessel due to filling of one or more compartments, it is quite conceivable that a high wave could have crushed down on the foreship and pressed the foremost hatch cover(s) into their respective cargo holds. If the cargo holds were only partially filled prior to this, these holds could then be filled very rapidly and the ship, having already lost most of its reserve buoyancy, would sink immediately. This scenario is not unlikely as cargo

hatch covers have traditionally been designed to withstand only low water heights - the International Load Line Convention of 1966 requiring covers to withstand only 1.75 m of water as a minimum, and the hatch covers LEROS STRENGTH were probably weakened by age.

Another possibility could be that one more transverse bulkhead suddenly collapsed; i.e. the bulkhead between cargo holds no. 2 and 3 thus leading to water filling also of hold no. 3. Taking into account that hold no. 3 was loaded with cargo, this would significantly reduce the pressure on the transverse bulkhead caused by water filling of hold no. 2 compared to an empty hold. Nevertheless, the possibility of sudden collapse of the transverse bulkhead between holds no. 2 and 3 can not be ruled out.

The underwater inspections did not provide clear indications on which of the above scenarios are most likely to have occurred. As noted earlier, the inspections of the wreck established that the transverse bulkhead between holds no. 1 and 2 could not be seen, but no information was established on the bulkhead between holds no. 2 and 3. It was established that the hatch covers of holds no. 1, 2 and 3 were all missing. These observations "fit" with various possible scenarios described above, but do not provide clear answers because e.g. the hatch covers may have disappeared *after* the sinking started.

However, according to the calculations done by Cyprus, it seems very likely that three separate compartments (i.e. the fore peak, cargo hold no 1 and cargo hold no. 2) of LEROS STRENGTH were water filled just prior to the actual sinking, and that water filling of a compartment number four *may* have started when the sinking begun. Therefore, even if it is not possible to establish the actual sequence of events from ingress of water started until the actual sinking of LEROS STRENGTH, these indications on water ingress into various compartments of the ship must in sum place a big question mark on the condition of the ship during her last voyage. The weather conditions had been quite bad during the voyage from Murmansk which started 6 days earlier, but the weather conditions were not extreme. As far as we know, no vessel other than LEROS STRENGTH ran into real problems because of the weather conditions in the areas where the voyage took place. Taking into account that the investigations into the sinking of LEROS STRENGTH have not established any other *external* factors than the weather that can explain the circumstances significant for progressive water ingress and subsequent sinking, it must therefore be concluded that the structural integrity of the ship during this voyage, can not have been up to the required standards.

5.2. The structural condition of LEROS STRENGTH prior to the sinking

The study that NMD has done of the available information on surveys etc during the years prior to the sinking, has given a rather confusing picture of the structural condition of LEROS STRENGTH during this period of approximately 5 years. As clearly indicated by much of this documentation, it has been quite common to *defer* the rectification of a number of weaknesses/problems/defects from the time of detection (e.g. during one of the yearly surveys) until the "special", i.e. the renewal survey which takes place every fifth year. This practice of numerous deferrals may certainly be criticised, but can possibly be defended *provided* certain important conditions are fulfilled including the following:

- Deferrals must only apply to items/weaknesses which do not compromise the structural integrity of the ship, and
- All such deferrals - as well as all other weaknesses/problems/defects - must be thoroughly rectified at the Special Survey.

An important question is therefore: Were the second of the above conditions fulfilled in relation to the 4th Special Survey of LEROS STRENGTH? Again the situation is rather confusing: According to the available information there were no outstanding recommendations in relation to any of the ship's certificates, and the thickness measurements carried out also indicated that the structural integrity of the ship was sound. Therefore, if the answer were to be given based solely on a study of the documentation at the time of completion of this Special Survey, the answer would clearly be yes.

But the above answer is in stark contrast to the results of the Port State Control in Rotterdam less than one month after the completion of the Special Survey. The ship was detained with serious defects in various areas, including severe structural problems regarding one hatchcover in particular, and other hatch covers and hatch coamings in general. There is no possibility that these defects could have been absent one month earlier. Therefore, it must be concluded that the documentation from this Special Survey can not have given a complete and accurate description of the structural condition of the ship. One possible explanation could be that due to a human error the hatch covers had been overlooked in this case. Although highly regrettable, human errors occasionally *do* occur, and may cause even *serious* problems to be overlooked. However, in the case of the hatch covers of LEROS STRENGTH such a possible human error must have been complemented by a *second* error - human or technical - because the visual examinations were supplemented by thickness measurements *also* indicating that no significant problems existed. In relation to the case of these defective hatch covers, this *possible* explanation does not seem very likely.

There are clear indications in the available documentation that the hatch covers of LEROS STRENGTH *were* subject to extensive repairs after the Port State Control in Rotterdam. But the report from the PSC in Rotterdam does not indicate that any cargo holds or ballast tanks were controlled during this inspection. A concern is therefore the following: Taking into account that the survey results and the thickness measurements clearly did not provide a correct picture of the condition of the hatch covers, could the results from the Special Survey of *other* vital structural elements be equally misleading?

In relation to the above question, it is worth noting that as a result of the gloomy results of the PSC in Rotterdam, a representative from Cyprus Authorities subsequently suspended a number of the ship's certificates and issued recommendations which included the following: "Verification of the tightness of the upper forepeak tank and all top side tanks including tightness of the collision bulkhead and of the watertight bulkheads between adjacent tanks." These recommendations were deleted a few weeks later, and trading certificates reissued. One can hope that the items covered by these recommendations were satisfactorily dealt with at that time, but doubt still exist on the actual condition of all *other* items vital to the structural integrity of LEROS STRENGTH. As stated earlier, the various realistic casualty

scenarios described previously in relation to the prevailing conditions, does not “fit” with a ship being in a fully acceptable structural condition, which is the picture given by the available documentation on surveys, measurements and repairs in the months prior to the accident.

5.3. Recommendations

Nothing can be done in relation to the actual sinking of LEROS STRENGTH and its tragic consequences. All parties having had a role in relation to this ship or having a particular interest in this accident, can hopefully agree that priority should now be given to consider relevant lessons which may be learnt from this accident and the related circumstances, rather than concentrating on attempting to identify parties to blame.

Our study of the documentation relating to surveys, measurements and repairs of LEROS STRENGTH in the years prior to the casualty, clearly indicates that improvements are needed in various respects. Generally speaking, many of the problems relate to inadequate reporting. As an illustration, the following question has arisen on numerous occasions: Has a given item identified as suspect or defective at a previous survey now been *repaired* or has it now been *completely neglected/overlooked/forgotten*? In relation to this subject, we can say from the outset that many of the recommendations listed in the following may - to a large extent - seem self-evident. Taking into account that the Enhanced Survey Programme (ESP) was established approximately 8 years ago and has been frequently improved during this period, it is also rather surprising that basic principles ensuring adequate reporting from surveys are not already fully implemented.

Recommendations based on lessons learnt from the LEROS STRENGTH accident, are listed in the following:

- All survey reports should comply with the following requirements:
 - Include a clear description of *which compartments* of the ship that have been surveyed.
 - Include a clear description of *which structural elements* that have been surveyed within each compartment, and what type of survey (“overall” or “close-up”) was done.
 - Include a clear description of the *condition* of each individual structural element surveyed, including - when relevant - a clear identification of *which items* that require specific types of repair.
 - The principle of “negative reporting only” seems to be accepted in many cases. In accordance with this principle, reporting can be limited to the identification of those items having been identified as *defective* during a survey. All items not mentioned will be assumed as “surveyed and found OK” in accordance with this principle, and can therefore not be separated from “items overlooked/forgotten during the survey”. The principle of

“negative reporting only” should therefore be generally banned from survey reporting.

- Standard terminology for accurately describing the seriousness and extent of problems/defects identified during surveys should be agreed, and made mandatory for all survey reports.
- Whenever a surveyor is of the opinion that repairs are required, each item to be repaired must be identified separately on a numbered list. Whenever repairs are carried out, this must be documented by making specific reference to all items on this list.
- It is not uncommon that a given survey is “split” between two or more survey stations. In such cases it is very difficult to ensure that the job in total will be adequate in all respects. Therefore, additional measures seems necessary:
 - Consideration should be given to introducing specific restrictions; ideally to *prohibit* a given survey to be split between different survey stations.
 - Alternatively, whenever further/supplementary surveys are required in order to *complete* a given survey, the remaining items to be dealt with must be clearly identified on a numbered list. When the remaining surveys are carried out, this must be documented by making specific references to the list from the previous survey.
- All repairs of items relevant to the structural integrity of a ship must be planned beforehand in co-operation with a surveyor from the classification society, and when carried out also be inspected and approved by a surveyor. Documentation on all such repairs must be available as part of the survey documentation.
- Whenever a surveyor is of the opinion that it is acceptable to *defer* any repair previously required by *another* surveyor, such decision should not be left to the discretion of this (last) surveyor alone. Only the head office should be authorised to make this type of decision.
- Even if the classification society of LEROS STRENGTH rejected the application for a 3 months extension of the Special Survey no.4, *in practice* the owners were able to continue trading for almost 2 months after expiry of the certificates, because of their decision to change to another classification society. It seems that owners have come to expect that applications for such 3 months extensions will *normally* be accepted, and such extensions are interpreted as permissions to continue trading beyond the due dates. This practice is clearly in violation of the intention as well as the actual wording of the relevant SOLAS regulation. This subject should be brought up in IMO and/or IACS, to put an end to this unsound practice.
- Renewed consideration should be given to making SOLAS Ch. XII applicable also for bulk carriers with a length of less than 150 m.

- For ships above a certain age (15 or 20 years), consideration should be given to requiring a surveyor from the Flag State to actively supervise (parts of) the Special Surveys related to structural integrity. Alternatively, attendance from a second surveyor from the ship's classification society could be required. As a third alternative, attendance from a second surveyor from another recognised classification society could be required.
- Additional requirements should be introduced on transfer of class:
 - All outstanding recommendations from the losing society should be required rectified prior to the ship being permitted to transfer to another classification society.
 - Alternatively, the losing society should be required to urgently supply the gaining society with all documentation relevant to describe the condition of a ship, including survey history and historical documentation regarding recommendations.
 - Additionally, when a periodical survey is due, no transfer of class should be allowed until the complete survey has been carried out by the *losing* society with satisfactory results.

We recognise that some of the above recommendations are covered - partially or fully - by existing regulations and procedures, and possibly in procedures being amended for the time being. However, experience has shown that new and stricter measures are needed to ensure full compliance during all surveys of ships. For some of these subjects there may be a need for introducing sanctions on violations, in order to effectively ensure compliance.
