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The Test House (Cambridge) Ltd
Granta Park, Great Abington
Cambridge CB1 6AL
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Att: David Ellin

Oslo, 25th August 2003

RE: Damage investigation

Refer to your draft report sent by e-mail 11th June 2003.
Reference is made to the scope of work enclosed to the contract dated 29th April 2003:

Discussion/conclusion

2.1 Item (1b) Main Engine Forward Starboard Side Power Take Off (PTO) Unit

Quote from the report: "The damage apparent at this engine location is, therefore, thought to have occurred in two separate events. In the first event the PTO unit mounting and engine casing (both grey cast iron) suffered brittle fractures in response to an upwardly directed bending moment, which had also resulted in upward bending of the top cover plate. The downward bending of the joints four retained studs and associated stripping of the nuts then occurred in a later event."
Additional quote: " Ductile bending of the steel cover plate also appeared contemporary with fracture of the bolted PTO unit joint, and had similarly resulted from an upwardly directed force. "

The commission asks for a more precise proof of the conclusion that the upwardly directed bending moment occurred before the downward bending. Is it possible that a seabed grounding causes these two forces?

2.2 Item (1d) Camshaft Drive Chain – (Timing Chain)

Quote from the report:" It was concluded that no fractures were apparent in the recovered chain length, and that plate detachment and damage had probably resulted

from a combination of post casualty corrosion of the pins riveted ends and removal damage."
Please note that prior to the dismounting of the chain and the chain wheel, the chain was observed in the bottom of the engine, covered by hard seabed products and semi-cemented pebbles. The chain was at that time not in position at the chain wheel; refer to figure 13 in the Norwegian expert evaluation. The chain wheel was heavily damaged on the part of the radius sticking out of the engine block; refer to the picture mentioned above and enclosed picture no. 1 taken by the commission represented by Bård Meek-Hansen during an examination 04.07.2003.

The commission does not find any remarks in the report showing that the chain was not in a position at the chain wheel prior dismounting, and do not find any remarks about the heavy damages at the chain wheel. The commission is uncertain if the information above has been taken into consideration during your examination of the damage, and wants this accounted for in the final report.

2.3 Item (1g) Starboard Side Engine Block

Quote from the report:" The upper starboard side engine block included a fabricated rectangular shaped steel charge air distributor with bolted inlet connection and cover plates." Further quotes:" The charge air distributor had suffered inward bending of the lower aft longitudinal bolting face (figures 9 and 10) and inwardly bending of the aft three vertical stiffeners (figures 9 and 10)" and "The charge air distributor cover plates had been secured by bolts of approximately 8mm diameter, and all were seen to have fractured close to the bolting face."
The commission finds that the remains of the studs commented in the report belongs to the securing of the charge air distributor to the engine block, not to the securing of the covers for the charge air distributor. After examinations compared with drawings from the engine manufacturer, it looks for the commission as the charge air distributor is removed from the engine block
The conclusion in the report seems to be based on the fact that only the charge air distributor covers are missing. We ask for your point of view on this matter.

Moreover, the commission can not find in the report the size and direction of the force causing the missing charge air distributor and charge air cooler, including if this could have been caused by the seabed grounding, refer to the scope of work, exhibit A, point 5 and point 1g in exhibit B.

Figure 10 in the report shows that the aft and lower part of the air intake to the engine is heavily bended down. Examinations carried out 04.07.2003 indicate a deflection off about 16 mm, se enclosed picture no. 2. The commission does not find this damage evaluated in the report, refer to the scope of work, exhibit A, point 5.

Quote from the scope of work, exhibit B, 1g: "Aft end of starboard engine block damaged." This damage was presented during survey 28.04.2003. The commission does not find this damage evaluated in the report, refer to the scope of work, exhibit A, point 5.

2.4 Top of Main Engine – Valves and Rocker Gear

Quote from the report:" The engines rocker covers and rocker gear was also absent from the top of the engine at the time of inspection (figure 16)."

The commissions examination 04.07.03 exposed that 5 of 6 fuel injection pumps were missing and the belonging securing bolts were more or less gone, see enclosed picture no. 4. In addition all of the securing of the charge air bends to the cylinder head were teared off, se enclosed picture no. 5 and drawing from the engine manufacturer.

The commission asks for an evaluation whether the missing parts on top of the engine are caused by a load and/or circumstances connected to the quality of the materials. A seabed grounding to be evaluated if it is concluded with a load.

2.5 Item (1h) Cover for the Aft end of the Camshaft Drive

Quote from the report:" The camshaft aft drive cover plate had been secured with six studs (figure 18). "

It is pointed out by the commission that the cover plate described in the report and figure 18, is the inspection cover to the crankshaft and the flywheel, not the camshaft. The damage pointed out in exhibit B, point 1h, is therefore not handled with in the report.
You are requested to correct this in the final report.

2.7 Items (2a/2b) Front Starboard and Starboard Frame Damage

The commissions examination 04.07.2003 and enclosed pictures 3-4, indicate that starboard flange at the steel floor 1, 2 and 3 counted from the front, are cut off close to the brace. Reference is made to figure 35 in the report showing flange no.2 counted from the front. Compared to port side approximately 12-15 cm is missing per brace., se enclosed picture no. 5-6.
The commission asks for the circumstances to be evaluated, refer to the scope of work exhibit A, point 5.

2.8 Item (3) Propeller

Quote from the report:" The current position of the hydraulically actuated push rod would suggest that the propeller had been pitched to thrust to stern. It is, however, more likely that with loss of hydraulic power, the current position of the actuator and

push rod reflected their reaction to impact of the number 1 blade with the sea bed, rather than reflecting the propellers pitch setting immediately preceding the casualty."

The hydraulic system for adjustment of the propeller pitch is a closed system, as fare as the commission know. In a closed system it is not possible to move the pull rod when the valve is closed, even if the hydraulic pump is stopped.

The commission asks for the conclusion to be proofed more precisely based on this information.

2.9 Item (4a) Keel Plating – Aft Damage

The commission emphasized during the survey and the meeting in Harstad 28-30th April 2003 that the damage in front of the main engine should be evaluated. It was also pointed out that some of the videos dispatched for the desktop study, showed this specific damage prior to the recover of the damaged items from the seabed.

The commission asks for the circumstances to be evaluated, refer to the scope of work exhibit A, point 5.

2.11 Item (6) Rudder Stock

Quote from the report:" The stock bar exhibited bending of its bottom end, in a forward to aft direction (figure 46)."
Further quotes:" The rudder blades lower aft corner exhibited ductile bending through an angle approaching 180°, (figures 44 and 45), which was judged to be most unusual."
Further quotes from the Norwegian expert evaluation, chapter 3.6, page 14:" The bolt (guide pin) for the lower support of the rudder is missing."

The commission asks for an evaluation whether the above mentioned damages could have been caused by the same load or different loads. The size and direction of the load(s) to be estimated, and a seabed grounding to be accounted for, refer to exhibit A, point 5.

3. SUMMARY

Quotes from the report, page 12-14:

- "Casualty related damage to the engine and engine room foundation plates was confined to the starboard side, and was at its most severe at the front end of the engine." og "The foundation plate damage aft of the engine was, however, significantly less severe than was the case along the engine side."
- "The forces associated with damage to the engines starboard side, cylinder head and ancillaries were all judged to be of a magnitude which could be suitably accounted for by a direct collision of the engine with the seabed.

- “The fractures apparent in the cast iron turbine casing and cover-plate appeared typical of brittle overload fractures in cast iron. The estimated fracture forces were again of an order of magnitude which could have been generated by impacting of the engine with the seabed.”
- ” It, therefore, appears more likely that the damage resulted from casualty related collision of the number 1 propeller blade with the seabed.
- ” The 180° bending of the aft blade corner appeared most unusual, and can only be reasonably explained by a scenario including the blade grounding and then folding over itself. The reported presence of pebbles under the fold would also tend to support a seabed grounding scenario. The estimated force necessary to effect the damage was relatively small and could conceivably have been generated by the vessels engine and steelwork mass.”
- ” Bending damage to the aft end of the keel by way of the lower rudder bearing pin hole location was also thought to have resulted from casualty related seabed grounding damage, and was thought likely to be directly associated with the rudder grounding damage.
- “The inherent low strength and brittle nature of such materials, coupled with their insensitivity to shock, bending and tensile loadings would suggest that the fracture load was quite low, and well within the loadings which could have been generated by a collision of the engine with the seabed.”

It is concluded in the report, see the above quotes, that many of the damages individually could have been generated by a collision of the engine with the seabed. It is supposed that the loads exposed to the engine during a seabed-grounding scenario will vary, depending on how the seabed-grounding occurred. Could the different damages seen in connection have been caused by a seabed-grounding? The commission asks for a description of how the seabed-grounding could have occurred, based on the damages and loads (size and direction) pointed out, including a calculation of the load sizes and directions, distributed across the engine, shaft and propeller, together with an evaluation saying if the calculated forces was big enough to cause the reported damages.

If the seabed-grounding could have occurred in many different ways, the commission asks for the above calculations and evaluations to be carried out also for these alternatives.

The commission asks for information about the rate of descent and hardness of the sea bottom used in the calculations, and the appreciation for selection of these parameters, refer to the scope of work, exhibit A ” The rationale, assumptions and methods used to reach any partial or final conclusion of the report should be described in detail. “

Quotes from the scope of work, exhibit A, point 3: ”Examine the damages on the parts described in the table enclosed. Carry out a quality assurance of the description (see 1b) based on the results from the examination. The result from this quality assurance to be a separate part of the report.”
The commission does not find this handled in the report, and request this to be corrected in the final report.

The above mentioned questions and comments to be worked into the final report. If this is not possible, we ask for the reason in writing.

Final report to be send to the commission as soon as possible and not later than 15th September 2003. If some additional time is needed, please inform in writing.

Yours sincerely

Brit Ankill

Bård Meek-Hansen