Casualty Investigation Report CA 094

CEC PACIFIC

Crane Failure on 26th July 2005 at Zanzibar

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Summary

On 26th July 2005 the Isle of Man registered heavy lift vessel "CEC Pacific" was discharging a barge, carried as deck cargo, into the sea at Zanzibar when one of the vessel's cranes catastrophically failed causing it to topple into the water.

The only injury was to the crane driver who escaped once the crane was in the water and was back at work on light duties the following day.

The barge was consequently found to be of a weight significantly greater than the declared weight meaning that the crane was operating outside its design parameters. This report examines the events leading up to the incident, the incident itself, and an analysis of why this incident occurred.

CEC PACIFIC AFTER NUMBER 2 CRANE FAILURE

A draft copy of this report was circulated to interested parties and where appropriate their comments have been incorporated in this report.

1 CEC PACIFIC DESCRIPTION

1.1 The CEC Pacific is a general cargo vessel built in 1992 with two 50 tonne cranes designed for self loading and discharge of heavy lifts. These are also capable of being twinned to lift up to 100 tonnes within a specified radius. The ship's principle dimensions are 80.69 metres LOA and 2815 GT. The vessel is also fitted with a dedicated ballast system controlled from the bridge to assist with heavy lift handling.

1.2 The ship trades world wide and on this occasion was fixed to perform two voyages from Tio in Eritrea to Zanzibar. When the incident occurred the vessel was at the discharge port for the first voyage.

1.3 The ship is staffed by Filipino officers and crew, all of whom have been with the Company for a number of years and are trained and familiar in the operation of heavy lifts.

2 NARRATIVE OF EVENTS

2.1 On the 10th July 2005 the Vessel commenced loading general cargo at the finger jetty at Tio for the first of two voyages. On the morning of the 15th July the vessel moved off the pier to an anchorage to enable the loading of two barges directly from the sea, the first having a declared weight of 26.5 Tons and the second having a declared weight of 43.9 Tons.

2.2 The first barge was loaded in the tween deck without incident. The hatch was then closed and the hatch lid prepared to load the second barge onto it.

2.3 The second barge took four attempts to load. On the first attempt the barge listed to port so it was lowered back into the water and re-slung.

2.4 On the second attempt the barge was down by the stern so it was once again lowered to the water and re-slung.

2.5 On the third attempt the barge was lifted out of the water by approximately 1 metre before the cranes would not heave any more. The barge was then lowered back to the water. At this point the ships staff suspected that the barge weighed more than the declared 43.9 Tons.

2.6 The Master contacted the Technical Managers with his concerns and they advised the vessel to leave the barge behind and sail without it. The Charterers' (Clipper Elite Carriers) then contacted the Master who, after some discussion, agreed to try again.

2.7 On the fourth attempt the load was re-slung and the vessel successfully loaded the barge on board on the hatch lid at 2300. During the loading the barge was observed to twist back and forth. The vessel then departed the anchorage at 2359.

2.8 On the passage to Zanzibar the ships staff inspected the cranes and all appeared to be in order.

2.9 The vessel arrived at Stone Town anchorage, Zanzibar, after a sea passage of 10 days, at 0630 on the 26th July 2005. At 0716 the pilot boarded and the vessel anchored at 0750. The intention was to discharge the barge from the hatch lid into the sea and then to go alongside to discharge the remaining cargo onto the quay.

2.10 At approximately 0800 the Captain and the Chief Officer held a safety meeting for all staff involved with the heavy lift to talk through the plans, including the required ballast operations. Shortly after this the crew unlashed the barge and prepared the lifting strops while the Chief Engineer prepared the ballast system. These strops were the same ones used during loading; the only alteration was the insertion of one extra shackle at the forward end to assist levelling off the load as it had been loaded with a trim of approx 25 degrees by the stern. These strops are used for heavy lift operations only and are fully certified. Once the barge was prepared the crew stood down to wait for the stevedores to arrive.

2.11 At around 1000, 12 stevedores arrived on board, met the Chief Officer, and discussed who would be driving the cranes. It was agreed that the ship's staff would drive the cranes, the Chief Officer would be in charge on deck and the stevedores would be assisting with the two tag lines.

2.12 At this time the Chief Officer advised the ship's staff to get into their positions. One Able Seaman was in each of the two cranes and the Second Officer on deck assisting with the tag lines and advising the stevedores what they could wrap the steadying lines around. All staff were properly trained and had experience with the Company for a number of years working with heavy lifts.

2.13 At 1020 the Chief Officer advised the Master that they were ready to start the lift. The Master contacted the Engine room to ensure that the ballast was lined up and that they were standing by. The Chief Engineer confirmed that the ballast system was ready.

2.14 The Chief Officer confirmed with the crane drivers that from now on all communications from him would be via hand signals.

2.15 The weather conditions during the operation were perfect and within all acceptable limits. The wash from the nearby ferries had no effect on the vessel.

2.16 The Chief Officer gave the instruction to No. 1 crane (forward) to take the weight shortly followed by No. 2 crane (aft). Next the barge was lifted much the reverse of when it was loaded with the last point of contact on the hatch lid being the aft starboard side of the barge.

2.17 Once the barge was approx 20cm above the hatch cover the forward end of the barge swung slowly to port while the aft end swung slowly to starboard.


Stern of barge starting to swing to starboard

2.18 The Chief Officer instructed both cranes to stop, followed shortly after by an instruction to No. 1 to “turn in a bit” to correct the twist and for No. 2 crane to heave up to bring the barge level. This resulted in the barge being approx 50 cm above the hatch cover.

2.19 At about this time the Master contacted the Engine room and requested that they started transferring ballast from the port side to the starboard side. The engine room confirmed this. This ballast shift was to counter the weight of the barge as it was swung over the port side to ensure that the ship stayed as near level as possible.

2.20 The Chief Officer then gave the instruction to start swinging out the barge slowly. This was done and the instruction was given to stop when the outboard side of the barge was in line with the coaming. This was in order to give the ballast time to catch up. After approx 10 seconds the forward end of the barge started twisting outboard. As the vessel started to list to port the Master instructed the cranes to stop and requested the Engine room to pump ballast faster. This request was not acknowledged by the engine room.

Forward end of barge twisting outboard

2.21 The forward end of the barge continued to twist outboard and as it did so the vessel's list to port increased until the angle of list was approximately 10 degrees. It was at this time that both cranes started to be dragged outboard by the combination of list and the weight of the barge.

Vessel listing to port as barge swings over the side rail

2.22 Tag lines were used to try and control the swing and consisted of narrow diameter mooring ropes (approx 45mm). The only places that they could safely be wrapped around were the pad eyes on the side of the hatch coamings. There was a minimum of three men on each line and from the video coverage of the incident it can be clearly seen that there was no effective use of these tag lines.

Vessels list increasing as cranes being dragged outboard by the weight of the barge. Note forward tag line, tight but not holding

2.23 As the barge continued to swing outboard the forward line appeared to be tight as this had been wrapped around a pad eye as discussed above. However this also proved to be ineffective as it did not check the swing.

2.24 Both crane drivers heard a metal on metal sound coming from the slew bearings of both of the cranes. Both No. 1 and No. 2 crane drivers attempted to correct the slewing motion outboard by moving the control sticks over to the opposite direction (inboard). This had no effect.

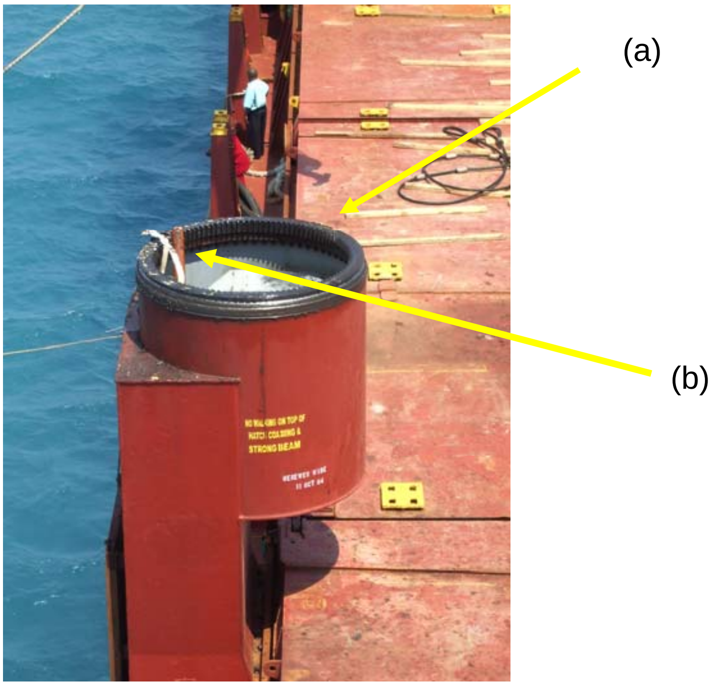
Moments before cranes ordered to slack the barge into the water

2.25 When the load was suspended over the water, the Master by VHF handheld radio and the Chief Officer by hand signals, instructed both cranes to lower the barge down into the water. No. 1 crane did this until the barge was in the water and the hoist wire was slack. At the same time as the order was given to lower the barge into the water the driver of No. 2 crane, on being unable to correct the adverse slewing, and on hearing a metal on metal grinding sound, pressed the emergency stop and the crane powered down.

Last image before No 2 crane detached. No.1 crane slacking to water.

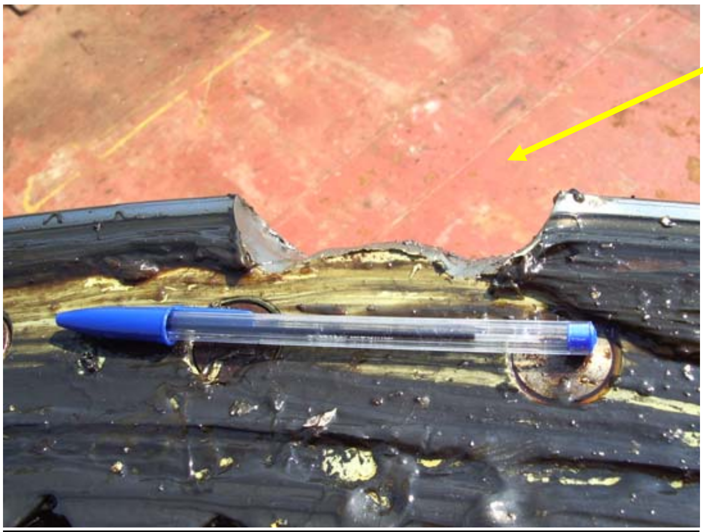
2.26 Once all the weight was off No. 1 crane due to the barge being lowered into the water, more weight was transferred on to No. 2 crane. The weight on the crane proved too great causing the slew bearing to fail catastrophically.

2.27 No 2 crane sheared at this bearing and toppled into the sea with the driver still in the cab.



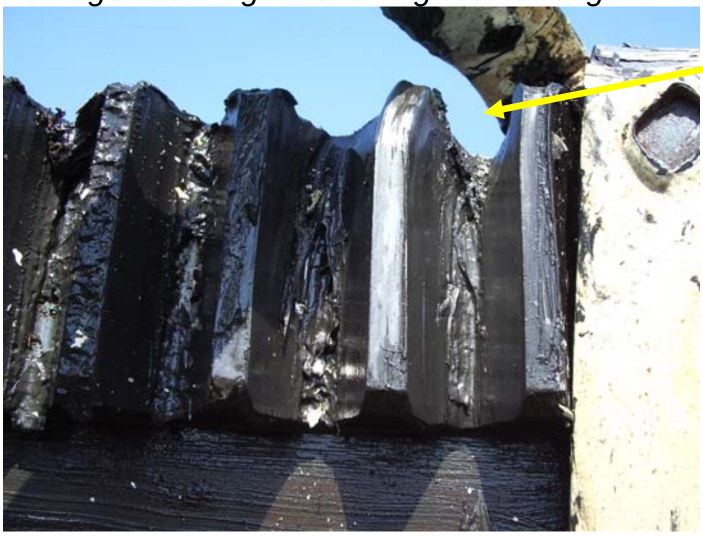
Number 2 crane pedestal after the incident

(a)



Damage to slew gear showing area through which bearings had torn

(b)



Damage to slew gear showing bent slewing gear

2.28 The crane sheared off the pedestal at the slew ring (see images above). Investigation of the incident demonstrated that this was the single point of failure on the crane. The driver was able to exit the cab via the pedestal while submerged, but before the crane hit the seabed sealing off this escape route.

2.29 No 1 crane driver, at the same time exited his crane via the usual route inside the pedestal for fear of his crane also falling into the sea.

2.30 No. 2 crane driver was back at work the following day on light duties having sustained minor bruises.

Final resting place of Number 2 crane in the sea, supported on the barge

3 COMMENTS AND ANALYSIS

3.1 Shipboard Cranes

3.2 The vessel is equipped with two Hagglund MTT multi-purpose slim type cranes, type GPS 630-2518.5/509.25, Serial numbers 721-736/797-800 manufactured in 1991. The cranes are used for cargo handling.

3.3 The cranes have a lifting capacity of 50 tonnes at a radius of 9.25 metres decreasing to 25 tonnes at a maximum outreach of 18.5 metres using a four reeving[1] and two reeving arrangement respectively. They also have auxiliary winching facilities 6.3 tonnes at 17.8 metres outreach.

3.4 There is no facility for operating the cranes together through a master and slave arrangement. During the loading and discharging both cranes were used in a tandem lift being driven independently. This is an acceptable mode of operation.

3.5 The CEC Pacific is designed for the type of weight as presented. The vessels maximum lifting capacity is 100 tonnes when the cranes are twinned and the lift remains within the 50 tonnes SWL radius, but for this lift it was not possible to remain within the 9.25 metre radius. The barge was outside the limits for the reach of the cranes to remain within the 50TONNES limit which, as the weight was presented, would not have caused any concerns.

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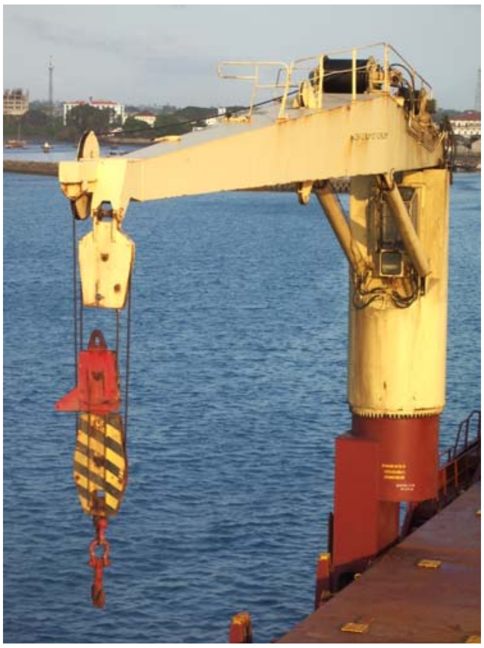

Number 1. Crane

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[1] Reeving: Number of parts of wire passing between two blocks.

4 Weight of the barge

4.1 The barge is part of a floating pontoon with the trade name of “flexifloat” that was delivered to the vessel in four sections. Each section consists of separate compartments joined together with cleats. The barge which was attached to the cranes when the incident occurred was made up of 2 x Quadrafloats and 1 x Duofloat joined together by cleats.

4.2 The declared weight of the barge was 43.9 Tons.
43.9 Short Tons = 39.8 metric tonnes
43.9 Long Tons = 44.6 metric tonnes

4.3 As the vessel works in metric tonnes the vessel assumed the weight to be 43.9 tonnes. Had the weight been expressed in Long Tons then this would have been equivalent to a weight of 44.6 tonnes, still within the crane limits. The ships staff were working on the load for each crane to be 22 tonnes and therefore within the limits of the outreach.

4.4 Four barges were loaded.
The only information provided by the charterers’ on these barges was as follows:

Ex. Harbour	Description	No.	Weight Tons	Volume cbm
Eritrea	1 x Quadrafloat & 1 x Duofloat	1	26.5	118.89
Eritrea	1 x Quadrafloat & 1 x Duofloat	1	26.5	118.89
Eritrea	1 x Quadrafloat & 1 x Duofloat	1	26.5	118.89
Eritrea	2 x Quadrafloat & 1 x Duofloat	1	43.9	237.77

4.5 The first three that were loaded were described as a 1 x Quadrafloat & 1 x Duofloat with a declared weight of 26.5 Tons. Two of these were loaded in the lower hold while the third was loaded into the tween deck. The fourth and last to be loaded was described as 2 x Quadrafloat & 1 x Duofloat with a declared weight of 43.9 Tons.

4.6 The first three had nothing added on their decks.

4.7 The last barge had the addition of 2 x hydraulic power packs, 1 x windlass, 1 x anchor and two steel plates to square off the barge. The vessels staff assumed that all this was included in the weight of the barge as declared by the charterers’’.

4.8 The last barge, by means of a makers plate on its side, appears to be manufactured by Robishaw Engineering of Houston, or possibly by their former licensee in Holland. From the dimensions of the barge as measured locally they appear to be 2 x S-70 Quadrafloats and 1 x S-70

Duofloat. This has been confirmed by Robishaw Engineering. Whether these were manufactured in either of the two factories the weights would not deviate significantly from the initial design. The weights from the design sheet are as follows:

S-70 Quadrafloat: 35,600 pounds = 16.15 tonnes

S-70 Duofloat: 18,900 pounds = 8.57 tonnes

4.9 This would put the weight of the barge arrangement (not including the power packs, winch, steel plates and anchor) as follows:

(16.15 x 2) + 8.57 = 40.87 tonnes

4.10 This ties in approximately with the charterers'' declared weight of 43.9 Tons.

4.11 After the event the only way to positively determine the actual weight of the barge was to perform a draught survey. This was carried out after the incident and witnessed by four parties, namely: Graig Ship Management; Owners P + I; Charterers' P + I and MMSI (Charterers Machinery and Hull insurers) on 14th August 2005. *(See appendix 1*).

4.12 At the time of the draught survey the barge had been recovered, repaired and then pumped out. This damage, which had been repaired, had been sustained when the crane landed on it after toppling off the vessel. The result of the draught survey showed that the weight of the barge at the time of discharging was approximately 64tonnes. This is well in excess of the declared weight by the charterers' at 43.9 Tons. This weight includes items on the barge such as two power packs, a winch, 2 x steel deck plate extensions, but does not include any weight of water which may have been already in the barge itself at the time of loading and discharging.

4.13 Subsequent to the incident the charterers' advised verbally to Graig Ship Management that there was 5 cm of water in the barge before it was loaded. As there is no confirmation of where the sounding was taken and the barge was loaded after it was floating at an angle of list there is no way of determining actually how much water was present in the barge.

4.14 It has been calculated from the draught survey that the actual weight of the barge, including all the additional items was 64 tonnes. This is in excess of the declared weight by approximately 20 tonnes. As discussed further on in this report this discrepancy between the declared weight and actual weight had the effect of changing the lift from one which the cranes were designed for, to one outside their design capabilities.

4.15 Analysis of the stability after the incident has shown that the vessel has sufficient stability to load and discharge the barge safely, and that lack of stability was not a cause of the incident or a factor.

5 Loading the Barge

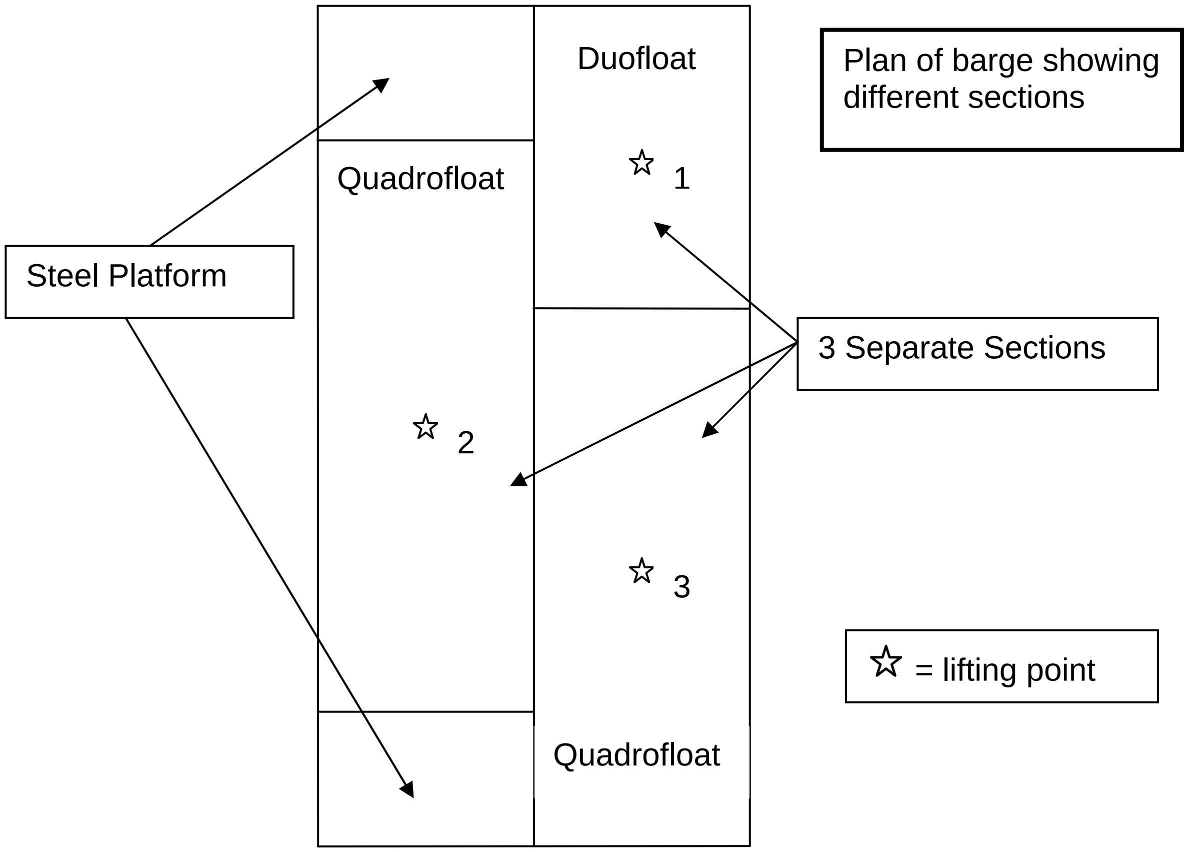
5.1 The cranes were rigged in 50 tonne mode and plumbed over the barge ready for a dual lift. On the information supplied by the charterers' the ships staff were working on the weight of the barge being 43.9 tonnes. This would mean that each crane would bear a weight of approximately 22 tonnes and all stability calculations were based on this. As the barge had no marked centre of gravity or weight marked on it, it was only an assumption that the barge's weight would be evenly distributed between the two cranes.

5.2 On top of the barge there were two hydraulic power packs, a winch, two steel extension plates and an anchor as can be seen on the picture following, taken at the load port of Tio prior to lifting it on board.

Barge alongside vessel at Tio prior to being loaded

5.3 Duofloats utilise a single watertight compartment. Quadrofloats also utilise a single watertight compartment unless otherwise specified as an option at the time of the build. There is no way of determining if these barges had this option or not.

5.4 The barge was lifted direct from the sea using the only available lifting points while it was against the ships side as the image overleaf.



5.5 The first attempt

Crane No. 1 was attached by a double strop to lifting point 1 (See diagram above for locations) while Crane No. 2 was attached using two strops to lifting points 2 and 3. The barge listed to port when lifted so it was decided to rearrange the strops.

5.6 The second attempt

Crane No. 1 was attached to lifting points 1 and 2 using two strops and Crane No. 2 was attached to the Lifting points 2 and 3 using two strops. The barge lifted but was trimmed too far down by the aft end so it was decided to rearrange the strops.

5.7 The third attempt

Crane No. 1 was attached to lifting point 1 and 2 using two strops while Crane No. 2 was attached to lifting point 3 using a double strop.

The cranes lifted the load approx 1 metre from the water, at which point the cranes would not hoist any more.

5.8 It was at this point that the ship's staff thought that the barge may be overweight. The Master contacted Graig Ship Management (GSM) to advise that he could not heave up the barge and that it appeared to be uneven in weight. GSM advised the Master to leave the load at Tio. Shortly afterwards the Master received a call from the Charterers' (Clipper Elite Carriers) and after some discussion the Master agreed to try again. There was no means for the vessel to verify the weight as the cranes were not fitted with strain gauges and the vessel does not carry any load cell links.

5.9 <u>The fourth and successful attempt</u>

Crane No. 1 was attached to lifting point 2 using a double strop while Crane No. 2 was attached to lifting points 1 and 3 using two strops. The barge was successfully brought on board although it was noted by several of the ships staff that the load was twisting back and forth during the process. The barge was landed on the hatch cover stern first due to the fact it was trimmed at an angle of approx 25 degrees. See photograph on the next page.

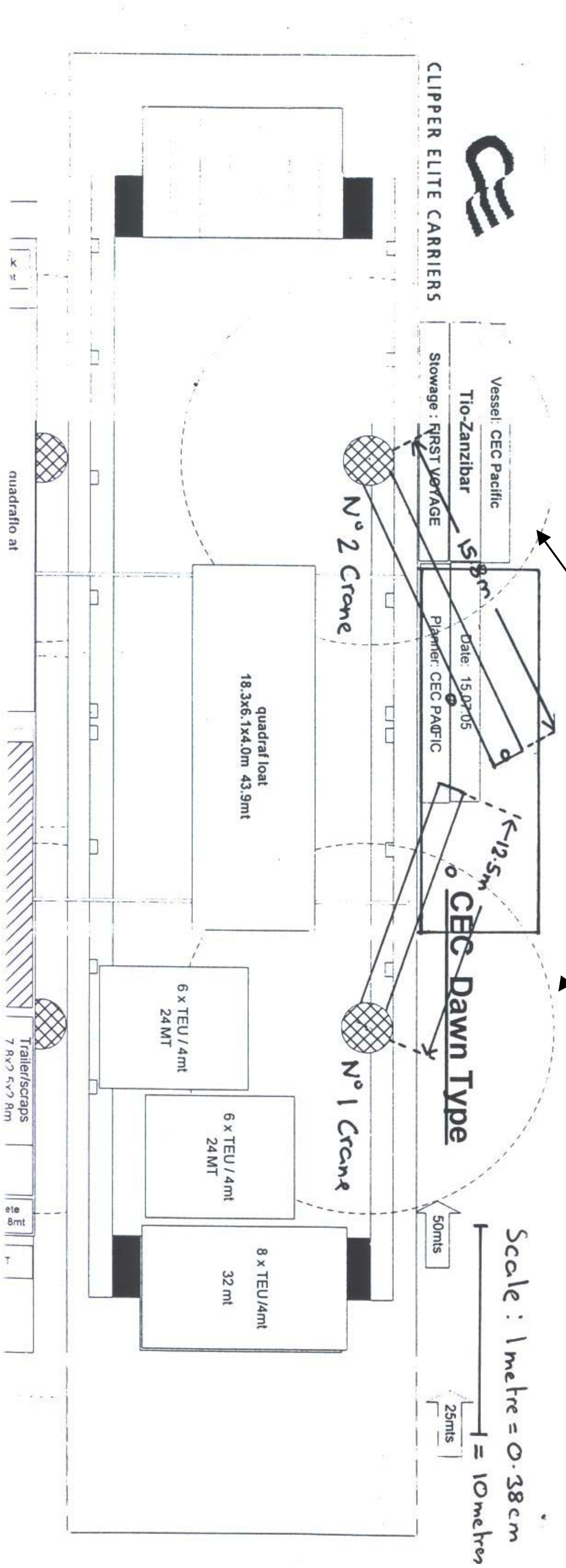
Loading the barge on board at Tio

5.10 After loading the barge the Master thought that there may have been water in the barge causing it to sway. This was not followed up on board. There is no explanation for the motion of the barge during loading, but it is considered possible that water in the barge might have been moving about as it was lifted, causing variations in the centre of gravity position. This may have produced this twisting effect which was also evident as it was lifted during discharge. The evidence of water and extra weight, being in the barge, is not available but this observed movement is a strong indicator of its possible presence.

5.11 During loading, the load on each crane has been calculated as follows, based on the information gathered at the draught survey: (See *Appendix 1* for the draught survey and *Appendix 3* for the calculation of weights on each crane).

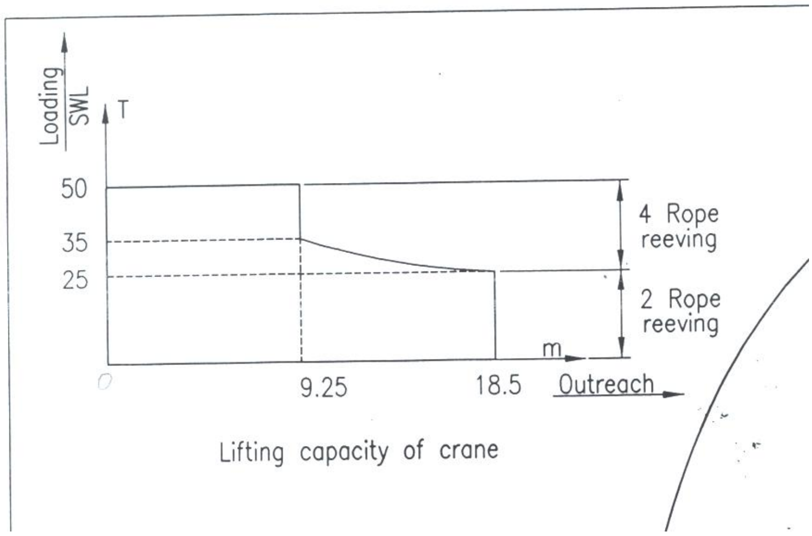
Crane No 1: 34.84 tonnes
Crane No 2: 33.92 tonnes

5.12 As loading of the barge took place while it was at the side of the ship, the outreach of the cranes would have been as shown on the scale drawing on the next page.



Scale diagram taken from the load computer on board the vessel with the author's diagrams superimposed on top in order to determine the outreach. Scale 1 metre = 0.38 cm.

Limit of outreach for 50 tonne SWL



SWL Scale

5.13 Using the manufacturer's scale from the crane handbook above:

No. 1 crane outreach 12.5 m. SWL at this point = 29 tonnes.
Actual weight on crane = 34.8 tonnes. **20% overload**.

No. 2 crane outreach 15.8m. SWL at this point = 26 tonnes.
Actual weight on crane = 33.9 tonnes. **30% overload**.

5.14 After three attempts at lifting the load there should have been enough evidence for the crew to suspect that the barge was over weight and beyond the limits of the cranes. However, any concerns the crew may have had about the weight of the barge were not acted upon or followed up. In planning for the discharge of the barge no consideration appears to have been taken about the barge being over the declared weight, and possibly outside the limit of the cranes.

6 Crane Maintenance

6.1 The cranes were maintained using the TM Master system for issuing and recording all the routine maintenance tasks to be carried out on the cranes. The Chief Engineer was responsible for the mechanical, hydraulic and electrical checks while the Chief Officer was responsible for the greasing and lubrication. The maintenance is carried out in accordance with the manufacturer's handbook.

6.2 No. 1 Crane (Forward)

6.2.1 *Lubricating turning/lifting gear*: This is performed monthly. July 2004 a technician from Macgregor, the crane manufacturers, conducted a full inspection of the cranes and submitted the results to Graig Ship Management. In January 2005 a hydraulic leak was reported from a hydraulic ram. By March 2005 this description had gone from "good" before the leak to "bad" during the leak and onto "acceptable" after the leak, right up to when the incident occurred, suggesting that the leak had been reduced but not stopped entirely. This was deemed to be acceptable to the ship's staff.

6.2.2 *Hydraulic Oil Analysis*: This is performed annually with nothing untoward reported to the vessel. On the 10th July 2005 approximately 40 litres of fresh hydraulic oil was added to the crane hydraulic tank prior to loading the barge. On the 25th July this was once again checked prior to discharge and the level in the tank was still the same so no more oil was added.

6.2.3 C*heck Crane and Controls*: This is performed yearly with nothing untoward reported.

6.2.4 *Crane Limits:* No records available.

6.3 No 2 Crane (Aft)

6.3.1 *Lubricating turning/lifting gear*: This is performed monthly with nothing untoward reported in the maintenance log. July 2004 a technician from Macgregor conducted a full inspection of the cranes and submitted the results to Graig Ship Management.

6.3.2 *Hydraulic Oil Analysis*: This is performed annually with nothing untoward reported to the vessel.

6.3.3 *Check Crane and Controls*: This is performed annually with nothing untoward reported with the exception of a deformed cab window which would not close properly.

6.3.4 *Crane Limits*: March entry read "N/A" (Not Applicable). April: no records available. May: "Job not done". June: "job done 21/06/05". It has not been possible to determine why the record states N/A for the March inspection or why for April no records are available. However in June the Crane Limit check is recorded as being completed on 21/06/05. There are several reasons why the checks might be omitted, some valid, some not so, but it is certainly a fault in the record keeping.

6.4 It is clear that checking of crane limits was not carried out routinely although other routine aspects of crane maintenance appear to have been attended to on a regular basis. It may be the case that this check has been left out at times when the cranes are not expected to be used for heavy lifts for a period. Nevertheless the records are uninformative and unhelpful for a new crew, for example, who might seek to understand the crane maintenance status. If there was a decision to omit this test, for whatever reason, it should be stated in the records. It was also the case that Number 2 crane actually lifted a weight which was about 30% over its design limits. While there is no direct evidence to support this, the fact strongly suggests that the crane limits were not correctly set. Subsequent investigation with the manufacturers has confirmed that the limits are set by the manufacturer and then sealed. It was not possible to determine if these seals were still intact at the time of the incident.

6.5 It was also discovered that the record of crane tests and certificates for the wires were found to be incomplete on board the vessel.

7 Operational limits of the cranes

7.1 The cranes on board are Hagglund MTT Type: GPS 630-2518.5/509.25.

7.2 They have two modes of operation, 25 Tonne and 50 Tonne. The change between these two modes is facilitated by moving the middle block at the crane head[2] to achieve either a 2 rope reeving for the 25 tonne mode or a 4 rope reeving for the 50 tonne mode. There is no requirement to switch over anything in the cab when changing modes. The crane can also operate as a union purchase[3] when single reeved in combination with the auxiliary winch and this has a SWL of 12.5 tonnes. See diagram on next page.

When in 50 tonne mode the maximum outreach is 9.25 metres.

When in 25 tonne mode the maximum outreach is 18.50 metres.

7.3 The crane hoist limits work on hydraulic pressure and the requirement of the vessels planned maintenance system is that they are inspected monthly. These limit checks follow the crane manual instructions but have been shown to be erratic in frequency as per section 5 of this report.

7.4 It would appear that the crane limits were in fact working up to a degree. This was demonstrated during the loading operation as the hoist winch was unable to lift the barge on the first three attempts as it is designed to. To override these limits a deliberate action would have to be made and there is no evidence suggesting this occurred.

7.5 The cranes have an operational limit of 2 degrees for trim of the vessel and a limit of 5 degrees for the heel of the vessel. During the loading and discharging operation the trim was under 2 metres and therefore within the design parameters of the crane with regard to trim at all times. However as soon as the vessel exceeded 5 degrees of list this was beyond the operational limits of the slew brakes which were not able to hold, resulting in the cranes' being dragged out over the side of the vessel by the weight of the barge.

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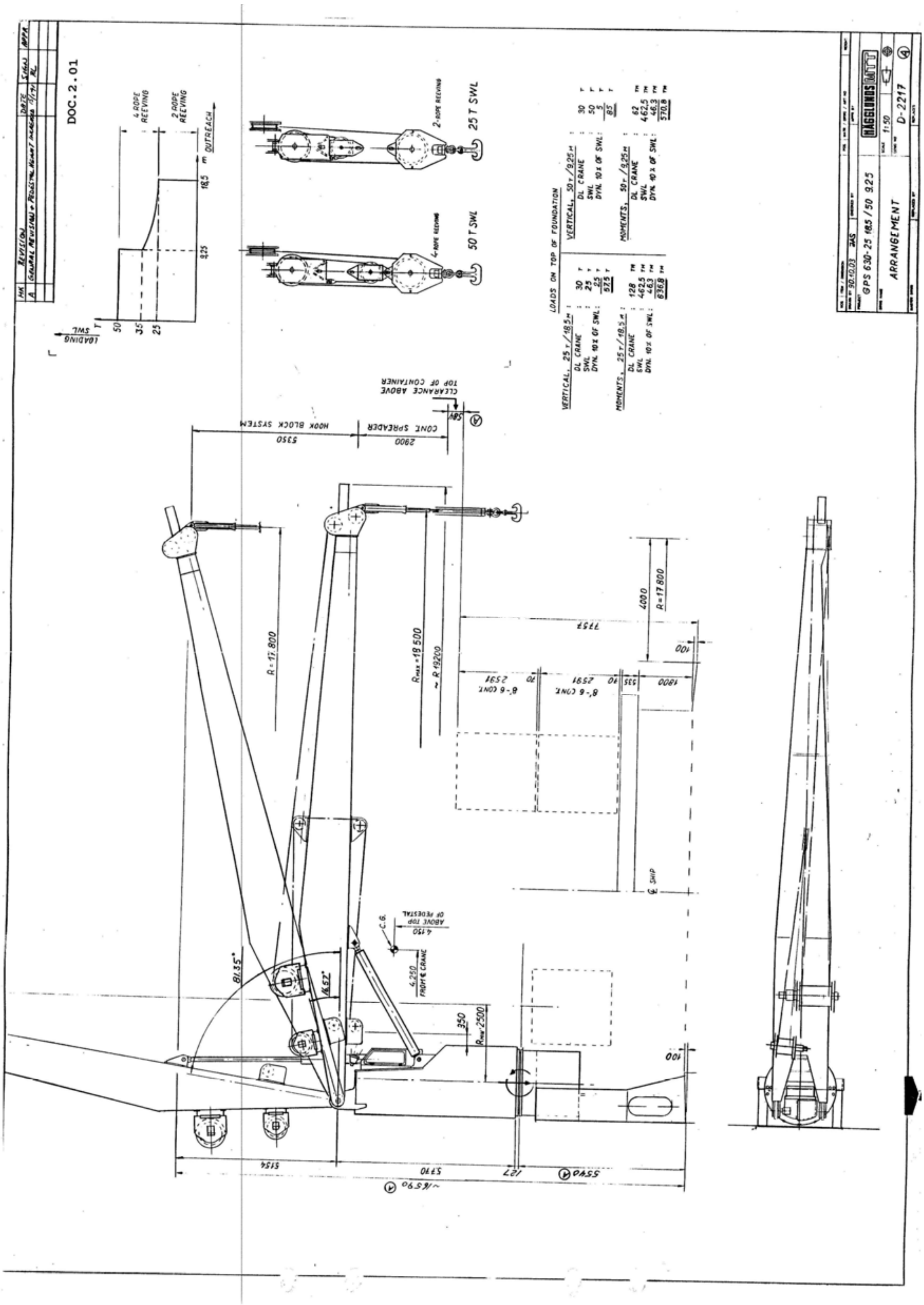
[2] Crane Head: Furthermost point of a cranes jib from the cab.

[3] Union Purchase: Two cranes, each independently plumbed with their hooks joined to provide a single lifting point. The combination of hoist/lower action of these two hoist wires provides the lift and athwartship motion of the lift and thereby a rapid transfer for light loads.

7.6 Once the damaged crane had been recovered from the seabed and replaced on the vessel, a representative from Crawford Technical Services was appointed by Graig Ship Management to attend and compile a report. In conclusion to this report it was stated that the cranes main “jib appeared to be distorted due to a considerable overload”.

7.7 In conclusion, the ship’s staff were presuming the weight of the barge to be the weight declared to them by the charterers’ and as such prepared their outreach load calculations accordingly. As the barge was in fact much heavier than the declared weight the crane was in fact operating outside its design parameters. This was exacerbated by the list of the vessel as the barge swung out over the side and the sudden extra load experienced on No. 2 crane when No. 1 crane lowered its share of the barge load into the water, and as such No. 2 crane failed catastrophically.



Crane Schematic

8 Mode of Failure

8.1 The crane sheared off the pedestal at the slew ring.

8.2 This could only occur if the crane was either operating outside the design capabilities or if there was a deterioration in the slewing gear.

8.3 Once the crane's jib was recovered from the water it was observed to have large areas of buckling consistent with an excessive overload. 2/3^{rds} of the crane's superstructure was also observed to have buckled consistent with overloading. With this nature of damage the crane would have failed at some point and on this occasion the point of failure was the slew bearing.

8.4 If the slew bearing was defective then this would have failed prior to the buckling of the cranes superstructure.

9 Planning the discharge operation

9.1 Having loaded the barge and suspected that it may be overweight there is no evidence to suggest that this suspicion was followed up on board. The discharge plan was made assuming that the barge still weighed 44 tonnes. This ignores the evidence presented during the loading process that indicated a load in excess of what was expected.

10 Handling of heavy lifts

10.1 Graig Ship Management are involved with heavy lifts on a regular basis, and as such the ISM system has a generic information procedure for heavy lifts covering all classes of vessels in the fleet, '*Handling of Heavy Lifts, Form CHL 067*' (See *appendix 4*). This form was utilised during both the loading and discharging of the barge.

10.2 The following observations in the checklist can be made:- (The text in italics refers to the text of the checklist and the normal text is the observation).

10.3 <u>Loading</u>

10.4 *Tandem lifts are only to be carried out in daylight due to risk of crane jibs colliding* – The barge was finally loaded on board at 23:00 on the 15th July. Sunset on this day was 18:50 so the final loading was carried out during darkness.

10.5 <u>Loading and Discharging</u>

10.6 *Check centre of gravity and lifting points are marked on the cargo unit* – The centre of gravity was not marked on the barge and the Master expressed his concern about this to the Technical managers during the phone call after the first three failed loading attempts. It became apparent on lifting the barge that the centre of gravity of the unit was not where it was expected to be. The barge had three lifting points.

None of these were marked but the relevant box on the Safety Management Checklist, CHL 067, was checked off.

10.7 *Check lifting points are adequate* – There were no more lifting points available on the barge. Staff commented on this matter once the barge was lifted.

10.8 Loading

10.9 *Crew members involved in the operation are to be adequately rested, minimum of six hours* – records indicate that the ship's staff were not properly rested on the day the barge was loaded on board at Tio.

10.10 Loading and Discharging

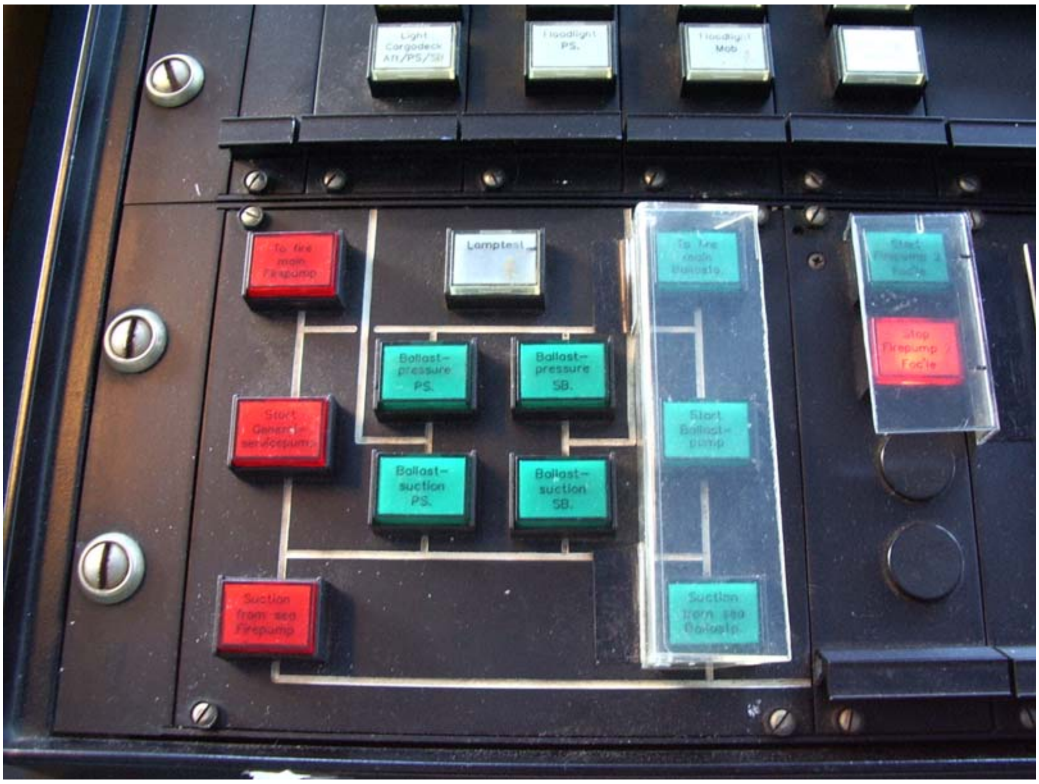
10.11 *Heeling tank on the crane side to be approximately 100% capacity, other side to be empty, for rapid transfer* – This is in contradiction with the working practice on board where both heeling tanks are half full before a heavy lift cargo operation commences.

11 Ballast Management

11.1 Ballast procedures on heavy lift ships is key to ensuring that the vessel remains upright, within the crane limits and lifts are transferred safely. To achieve this the ballast transferred is directly proportional to the distance a weight is moved horizontally, the ballast being transferred at a similar rate to the transverse shift of the lift. Control should be a simple operation controlled by a single person.

11.2 The CEC Pacific has two heeling tanks, Wing Water Ballast (WB) Tank 1 Port and Wing WB Tank 1 Starboard. Each tank has a capacity of 238.4 m^3. The ballast valves are situated at the forward bulkhead of the Engine Room. Situated on this bulkhead is an inclinometer which can be read easily from the position of the valve controls.

11.3 On the bridge the remote ballast transfer controls are located over to the port side of the forward consule (see image on following page). The inclinometer is set on the aft bulkhead nearer to the centre line of the vessel and behind the consule. This would mean that when operating the ballast controls the operator, in this case the Master, would constantly have to look over his shoulder to view it. In reality the Master would be looking forward to determine which way the vessel was listing and would have full control of ballast operations during heavy lifts. A visual appreciation of the heel angle against a horizon is, in any case, equally effective in a dynamic situation such as the load or discharge operation.



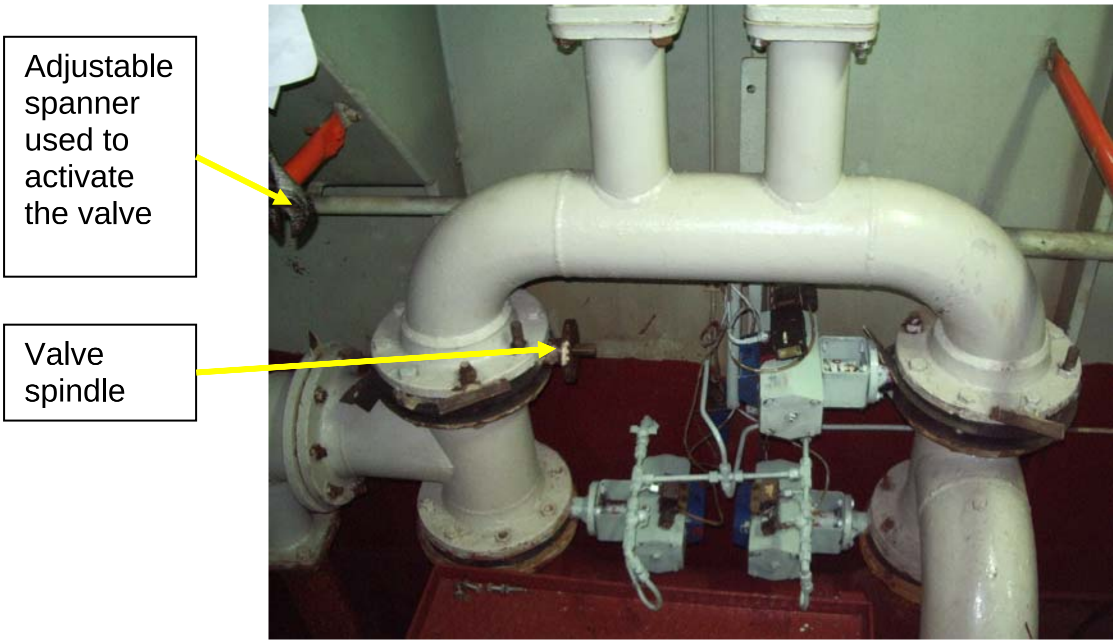
Remote ballast control panel on the Bridge

11.4 The remote ballast controls on the CEC Pacific had not been in use for some time and the accepted practice on board was to follow the procedure detailed below using a chain of communication to the Engine Room:

- The Master is in control of the ballast, in liaison with the Chief Officer on deck by means of a hand held radio, during heavy lift operations.
- The Chief Engineer stands by in the Engine Control Room (also referred to as the switchboard room) with the Second Engineer at his side.
- The Master contacts the Engine Control room with instructions such as “transfer ballast from port to starboard wing tanks”.
- The Second Engineer then goes to the ballast pump flat, sets the valves and switches on the ballast pump. The Second Engineer then remains at the ballast controls. It takes approximately 15 seconds for the engineer to get from the control room to the ballast flat, and a further 5 seconds to set the valves and begin transfer.
- An Oiler then positions himself between the ballast flat and the Engine Control Room should more orders need to be relayed between the Second Engineer and Chief Engineer who do not leave their posts.

11.5 In order to enable the remote ballast controls to operate as the ship had been originally designed one of the pneumatic activator rods that had been removed would need to be replaced (the current arrangement is that this has been removed and the spindle is turned with an adjustable spanner, see image below). Some of the indicator bulbs on the bridge panel would also need to be replaced and the system fully restored and tested to remote operation.

11.6 As the spindle requires an adjustable spanner to operate the valve this demonstrates that the system is not “as designed” and should not be operated in this way. The current arrangements mean that the engineer has to activate the pneumatic valves from the mimic board in the ballast flat and then remember to activate the one valve that has had its actuator removed by hand.



11.7 The ballast system allows for two pumps to be used. In practice one pump only is used and this has a capacity of 150 cubic metres/hour which is deemed sufficient by the ship’s staff considering the size of tanks. The time taken from receiving an instruction from the bridge to actually starting ballast was measured as being approximately 20 seconds. To get the second pump (General Service Pump) on line and pumping ballast requires a further 20 seconds.

11.8 With the current ballast set up on board the vessel it was not possible for the Master to influence the ballast quickly enough to react to the rapidly developing situation. In the event, the speed of events was so quick, as the barge carried away over the vessels port side, that the rate of change of list would have been faster than the capabilities of the ballast system, even if both pumps had been running.

11.9 Although the system of controlling ballast on board this vessel had lapsed from a designed system to one of a “make-do” system, it would not have contributed to the incident. However this lack of quick interaction between the ballast and demonstrates the ineffectiveness of the system used on the CEC Pacific.

11.10 The fact that the second order was not received by the Chief Engineer to increase the ballast transfer speed reinforces the above conclusion. If the system was used as designed then the Master would have been able to start the second pump and increase the transfer rate within seconds.

11.11 It is also noted that checklist CHL 067 is described as being guidelines only. The purpose of a checklist is that it provides a series of steps that must be undertaken in performing an operation.

11.12 Two anomalies stand out:

- Why has the Centre of Gravity check box been checked off as complete, when there was no way of knowing what the Centre of Gravity of the barge was?

- The checklist refers to the preparation of the ballast tanks before a loading and discharge operation. If the CEC Pacific had planned the lift as per the checklist then the port side heeling tank would be approximately 100% full while the starboard side would be empty. This would maximise the effect of the ballast as the vessel would have been pumping from a tank with maximum head to one with no head, ensuring that the pumps would be operating at their most efficient. Also this would ensure that the vessel had a greater quantity of ballast to transfer rather than limiting the operation to transferring a maximum of 50%, as opposed to the ability to transfer 100% of the contents of the heeling tanks.

11.13 The CEC Pacific used one ballast pump only as this was deemed sufficient by the staff on board at the time. However, if two pumps had been used from the start this would have doubled the transfer rate giving more effective weight transfer to counteract what was happening with the lift.

11.14 If the ballast was arranged as per the checklist, and both pumps used from the start of the operation, then the combination of 11.12 and 11.13 would have ensured that the transfer capacity would have been in the region of four times as effective as that used on the day. However, due to the speed of the events it would still not have been effective at preventing the incident.

11.15 The control of the lift was compromised by the following factors:

- The vessel was operating only the single ballast pump so limiting the speed of ballast transfer.
- Both heeling tanks were 50% full instead of one side being 100% and the other empty. Due to the hydrostatic heads in both tanks, this

reduced the pumping capacity of the pump as well as reducing by half the amount of ballast that could have been transferred.

- The semblance of control of the ballast system and thereby the heavy lift operation was hindered by the time lapse created by the ship's manual ballast operation. This time lapse was due to messages being passed from one person to another instead of one person having direct control over the ballast system while watching the lift in progress.

12 Crane Emergency Stop Button

12.1 This button is situated in the crane cab. See picture below:

No. 1 crane controls showing emergency button.

12.2 When this button is pressed all power is cut to the crane and can only be restored by switching it back on in the Engine Room.

12.3 On hearing the metal on metal sound and seeing things go out of control the crane driver did what he believed to be the correct line of action and also as per the instructions in the cab, see picture above.

12.4 It can be concluded that the crane toppled off the vessel as a direct result of the majority of the barges weight transferring to a single crane when the power to this crane had been switched off. Had the crane not been locked then the situation may have been different. In most situations when machinery or situations are appearing to get out of control the normal cause of action is to press the Emergency Stop button, however on this occasion pressing the Emergency Stop button exacerbated the situation. The only way, in this situation, of reducing the stress on the crane would be to lower away the load to the water. As the Emergency Stop button prevented the lowering mechanism, this was not possible. Even if it would have been possible to restart the crane (This has to re-started from the switchboard room in the Engine Room) it would have been unlikely that there would have been enough time to lower the barge into the water before the crane became catastrophically overloaded.

13 Conclusions

13.1 It is concluded that:

13.2 The crane failed as a direct result of lifting a weight that exceeded its Safe Working Load (SWL) at the radius of the lift.

13.3 The ship's crew were presented with information by the charterers' that declared the weight of the barge to be 44 Tonnes which was within the Safe Working Load limits for the two cranes working together. The true weight was 64 Tonnes which was in excess of the SWL at the radius of operation.

13.4 The crew had evidence that the weight may have been excessive during the loading operation but allowed themselves to be persuaded to carry on anyway.

13.5 Maintenance records for the cranes were poorly kept and do not show that monthly checks on the crane's limit settings were carried out.

13.6 The technical specification of the cranes was such that it should not have been possible for the cranes to lift the weight of this barge.

13.7 The ship's designed ballast control system had been allowed to fall into disrepair while the crew managed with a temporary manual arrangement. This slowed the operation of ballast management and reduced the ship's capability to handle heavy lifts safely and properly. While it did not contribute directly to this incident the temporary nature of the ship's ballast control system should mean a reduction in the stated capability of the ship to handle heavy lifts until such time as it is restored.

14 Recommendations

14.1 **The Isle of Man Marine Administration should;**

- Ensure that this report is circulated as widely as possible to all those who may have an involvement in heavy lift operations.

14.2 **The ship's managers should;**

- Consider the carriage of load links on board the vessels so that weights of lifts can be verified on board.

- Reinstate the ballast system to "as designed" so that one person is in immediate control of the heavy lift ballasting arrangements.

- Urgently review planned maintenance records and the conduct of planned maintenance in their ships with a view to ensuring that records are effective and that procedures are being fully carried out.

- Review shipboard generic guidance on heavy lifts, including clear guidelines on dealing with lifts which are not marked with a centre of gravity or weight and which do not have effective lifting arrangements.

14.3 **The ship's charterers' should;**

- Consider supplying load links with project cargoes.

- Ensure that all loads are correctly represented to vessels.

Appendix 1

Draught Survey on barge

RESULT OF THE JOINT SURVEY HELD IN ZANZIBAR HARBOUR ON 14TH AUGUST 2005 TO DETERMINE THE DISPLACEMENT TONNAGE OF:-

FLEXI-BARGE NICKLAS (2 x Quadrafloat and 1 x Duofloat) BEING PART OF CARGO CARRIED BY "CEC PACIFIC" FROM ERITREA TO ZANZIBAR 15 TH JULY 2005 TO 13TH AUGUST 2005.

- AT THE TIME OF THE SURVEY THE BARGE WAS FLOATING AND TIED UP ALONGSIDE THE QUAY IN ZANZIBAR.
- THE BARGE HAD BEEN SALVAGED HAVING SUNK IN THE HARBOUR.
- THE SURVEY WAS CARRIED OUT AT 0820 HOURS ON 14TH AUGUST 2005.

THE DISPLACEMENT OF THE BARGE AT THE TIME OF SURVEY IS SAID TO BE :-

OBSERVED DISPLACEMENT:	72.134	METRIC TONNES
LESS INTERNAL WATER :	15.9637	METRIC TONNES
ACTUAL DISPLACEMENT OF BARGE......	56.171	METRIC TONNES

TO DETERMINE THE WEIGHT OF THE BARGE ON 26TH JULY 2005 AT THE TIME OF DISCHARGE FROM THE CEC PACIFIC AT ZANZIBAR ANCHORAGE, THE FOLLOWING WEIGHTS MUST BE ADDED TO THE ABOVE DISPLACEMENT TONNAGE:-

2 X POWER PACKS WEIGHING 2.7 METRIC TONNES EACH	5.4	M.T.
2 X STEEL DECK PLATES MISSING AT SURVEY TIME PLUS SUNDRY HANDRAILS, STEEL LADDERS ETC.	2.5	M.T.
ESTIMATED AMOUNT OF WATER	UNKNOWN	
TOTAL ADDITIONS	7.9	M.T.
TOTAL WEIGHT OF BARGE AT TIME OF DISCHARGE	**64.07**	**M.T.**

SIGNED:

.................(R.Wade) on behalf of Graig Ship Management

.................(Emmanuel Thomas) on behalf of Robmarine (Owners P and I)

.... (B.Ekama) on behalf of East Africa Maritime (Charterers P and I)

.................(P.Van Os) on behalf of MLQS (For MMSI)

As observer only

2/4

BARGE DISPLACEMENT CALCULATION

UNIT	Location	Barge height	Freeboard	Draft	Mean Draft	MEAN		
							Density	1.025
							Waterplane Area	
Q1	F 1 P	2130	1155	975				
	F 1 S	2130	1180	950	962.5			
	2P	2130	1180	950				
	2S	2130	1218	912	931			
	3P	2130	1253	877				
	3S	2130	1348	782	829.5		Beam	3.02
	4P	2130	1430	700			Length	12.18
	4S	2130	1452	678	689		Waterplane area	36.7836
	MEAN OF MEAN OF MENS				**0.853**		**Displacement**	**31.37641** cuMetre
							AT s.g. 1.025	32.16082 metric Tonnes
Q2	F 1 P	2130	1253	877				
	F 1 S	2130	1245	885	881			
	2P	2130	1376	754				
	2S	2130	1386	744	749		Beam	3.02
	3P	2130	1515	615			Length	12.18
	3S	2130	1506	624	619.5		Waterplane area	36.7836
	MEAN OF MEAN OF MEANS				0.749833333		**Displacement**	**27.58157** cuMetre
							At s.g. 1.025	28.27111 Metric tonnes
D1	F 1 P	2130	1430	700				
	F 1 S	2130	1452	678	689			
	2P	2130	1510	620				
	2S	2130	1515	615	617.5		Beam	3.02
	3P	2130	1550	580			Length	6.06
	3S	2130	1580	550	565		Waterplane area	18.3012
	MEAN OF MEANS OF MEANS				0.623833333		**Displacement**	**11.4169** cuMetre
							At s.g. 1.025	11.70232 Metric Tonnes

FREE WATER OBSERVED WITHIN BARGES

Q1 Sounding 0.23 m @ 0.445m and 0.230m diagonally opposite centre lifting point
Mean Sounding : 0.675m
Wedge Calculation 0.675m/2 X 3.02m X 12.18m = 12.41447 At s.g. 1.025 12.72483 metric tonnes

Q2 Sounding 0.01m outboard 1m abaft Centre line 7.09m from high side
Trim 0.26m
0.10/7.08 X 12.18m = 0.1718

Wedge calculation: 0.178/2 X 12.18 X 3.02 = 3.159711 At s.g. 1.025 3.238704 metric tonnes

G.S.M.

For Owner

East Africa Maritime (on behalf Charterers)

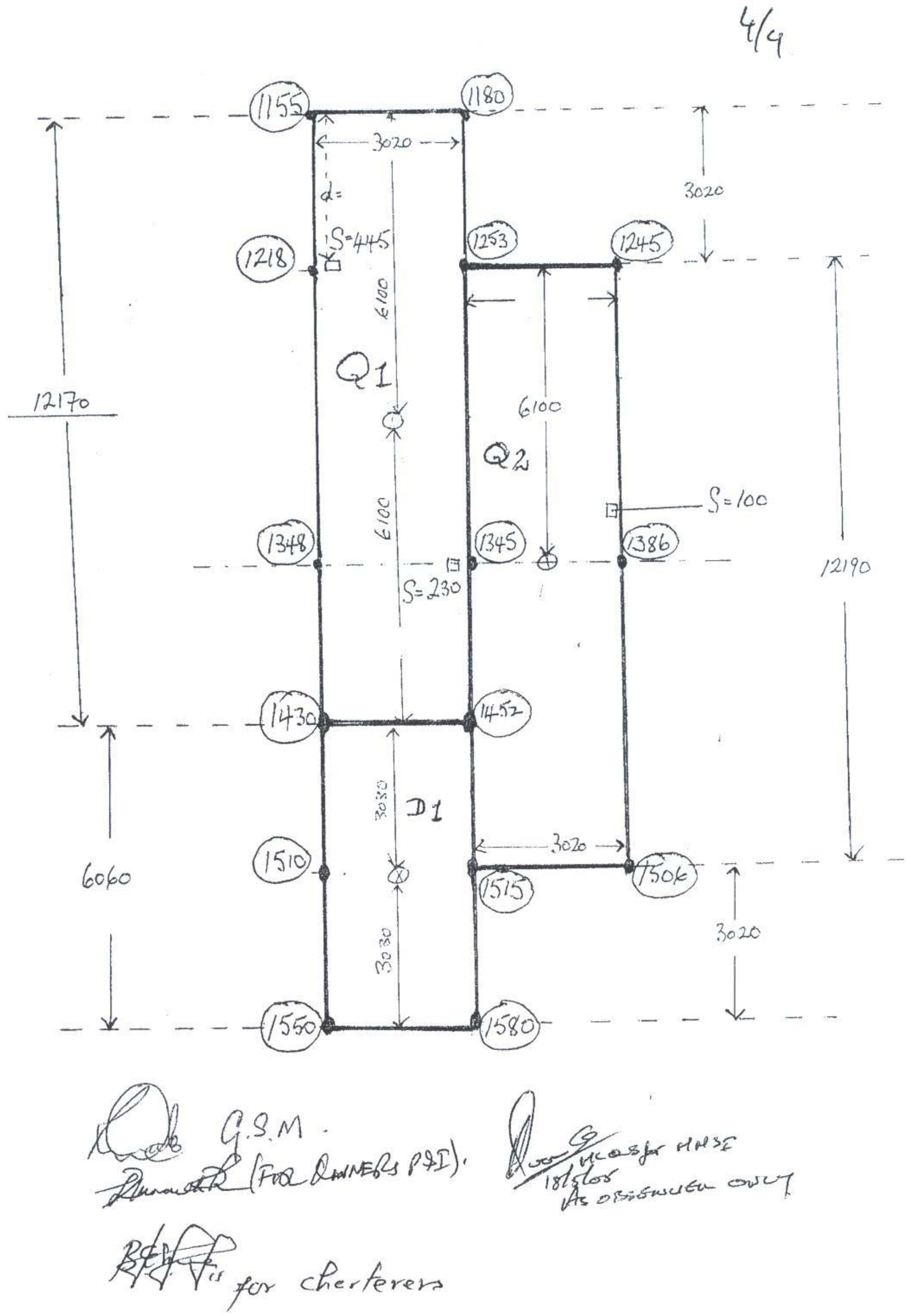
14/8/05 as observer only

3/4

WEIGHT OF UNITS

Q1	Weight of barge weight of water Weight of BArge	32.16082 12.72483 19.43599 Metric tonnes	
Q2	Weight of barge weight of water Weight of BArge	28.27111 3.238704 25.0324 Metric tonnes	
D1	Weight of Barge	11.70232 Metric Tonnes	
Total Displacement of unit		56.17072 Metric tonnes	
Power Packs		5.4 Metric tonnes	(As per weigh bridge)
Steel Deck plates - Ends		2.5 Metric Tonnes	(Allowance - weight unknown)
WEIGHT OF UNIT AT TIME OF LIFT		**64.07072 Metric Tonnes**	**(Excludes any possible water in lift at time of shipment)**

[illegible] - G.S.M.
[illegible] - ROBMARINE (FOR OWNERS P&I).
[illegible]
for Charterers
[illegible]
MLOS for [illegible]
As OBSERVER only


4/4
1155
1180
3020
3020
1218
1253
1245
S=445
6100
Q1
12170
6100
Q2
S=100
1348
1345
1386
6100
S=230
12190
1430
1452
3030
D1
3020
1510
6060
1515
1506
3030
3020
1550
1580
G.S.M.
(FOR OWNERS P&I).
for charterers

Appendix 2

Arrival Zanzibar

M/V CEC Pacific K/S DMK Storebaelt
IMO no.: 9000778
W25 Spl.ADB Voy.1st Arrival from TIO to ZANZIBAR Date: 26.07.05

GRAIG

DEADWEIGHT SUMMARY

	Weight t	pcs.	LCG m	TCG m	VCG m	S.Corr. m
20' CONTAINERS	320	44	52.95	-0.37	7.11	
40' CONTAINERS	0	0	0	0	0	
CONTAINERS	320	44	52.95	-0.37	7.11	
GENERAL CARGO	537	6	44.32	-0.00	4.62	
GRAIN	0		0	0	0	
CREW & STORES	80		33.03	0.00	10.63	0.000
MARINE DIESEL	104		29.73	-1.26	2.22	0.181
GAS OIL	31		44.76	-0.53	1.61	0.031
FRESH WATER	29		2.18	0.57	6.61	0.003
WATER BALLAST	1207		39.85	-0.19	2.26	0.014
MISCELLANEOUS	15		10.10	-2.53	2.47	0.008
CRANE LOAD	0		0	0	0	
DEADWEIGHT	2322		41.41	-0.22	3.81	0.237
DEADLOAD	0		0	0	0	
LIGHTWEIGHT	1518		35.10	0.35	6.69	
DISPLACEMENT	3840		38.91	0.00	4.95	0.237
DW RESERVE	1820					

HYDROSTATICS & STABILITY

						Seawater	1.025	t/m^3
Draught AP	4.98	m	GM solid	1.56	m	KMT	6.51	m
Draught M.	4.34	m	Correction	0.24	m	LCB	40.74	m
Draught FP	3.70	m	GM fluid	1.33	m	LCF	39.36	m
Trim	1.28	m	GM req.	0.17	m	TPC	10	t/cm
Air Draught	23.70	m	Heel	0.2	°PS	MPC	55	tm/cm
Propp.Ratio	120	%	Rollp.	10.9	sec.	(Values above for trim=0)		

STRENGTH SUMMARY

Bay no.	From AP	Shear Forces t	% of permiss. Seag.	Harb.	Bending Moment tm	% of permiss. Seag.	Harb.	Torque Moment tm	% of permiss. Seag.	Harb.
-19	0.000	81	9	9	102	3	4	-27	-2	-2
-19	6.500	333	38	38	1455	42	30	-58	-4	-4
-19	13.000	375	22	22	3850	73	54	34	2	2
19-17	19.500	213	8	8	5776	82	60	90	6	6
17-15	26.000	74	2	2	6705	81	56	150	10	10
15-13	32.500	-14	0	0	6891	83	58	187	12	12
13-11	39.000	-122	4	4	6432	78	54	157	10	10
11-09	45.500	-202	6	6	5356	65	45	126	8	8
09-07	52.000	-233	7	7	3940	48	33	93	6	6
05-03	58.500	-179	5	5	2532	33	21	104	7	7
03-01	65.000	-103	4	4	1643	28	17	116	8	8
01-	71.500	-119	7	7	1039	26	15	90	6	6
01-	78.000	-94	11	11	271	12	6	53	4	4
01-	84.500	-12	1	1	-23	9	1	15	1	1
Maximum :		392	38	38	6897	83	60	193	13	13
Position (m) :		11.05	6.5	6.5	31.71	31.7	18.9			31.200
Bays :		-19	-19	-19	15-13	15-13	19-17			15-13

OW ANCHOR

MASTER

A. D. BENBINUTO
CHIEF OFFICER

easeacon
page 1/1

26 July 2005
07:06:16

Arrival Zanzibar

M/V CEC Pacific K/S DMK Storebaelt
IMO no.: 9000778
W25 Spl.ADB Voy.1st Arrival from TIO to ZANZIBAR Date: 26.07.05

TANKS

Compartment	Max.W. t	Max	S.Corr m	%	Volume m^3	Sp.Gr. t/m^3	Weight t	LCG m	TCG m	VCG m
CREW & EFFECTS	50.0	N	0.000	60.0	30.0	1.000	30.0	7.80	0.00	10.00
STORES AFT	100.0	N	0.000	20.0	20.0	1.000	20.0	20.48	0.00	11.00
STORES MID	100.0	N	0.000	0.0	0.0	1.000	0.0	0	0	0
STORES FORE	100.0	N	0.000	30.0	30.0	1.000	30.0	66.63	0.00	11.00
CREW & STORES			0.000		80.0		80.0	33.03	0.00	10.63
MDO DB No 4 C	99.7	N	0.073	50.2	58.8	0.850	50.0	44.20	0.00	0.35
MDO DB No 5 C	139.4	N	0.106	14.3	23.5	0.850	20.0	25.40	0.00	0.10
SETTLING TK 1 S	12.2	N	0.000	98.4	14.1	0.850	12.0	7.47	-3.90	6.32
SETTLING TK 2 S	12.2	N	0.000	98.4	14.1	0.850	12.0	13.98	-3.90	6.32
MDO DAY TK S	10.6	N	0.001	89.6	11.2	0.850	9.5	10.70	-3.85	6.20
MARINE DIESEL			0.181		121.8		103.5	29.73	-1.26	2.22
DB GO TANK 3 C	41.4	N	0.030	58.9	28.7	0.850	24.4	55.25	0.00	0.45
GO DAY TANK S	3.8	N	0.000	68.4	3.1	0.850	2.6	-2.28	-0.60	8.75
GO OVERFLOW TK	14.0	N	0.000	0.0	0.0	0.850	0.0	0	0	0
GO SETTL. TK S	4.3	N	0.001	81.4	4.1	0.850	3.5	6.54	-4.15	4.33
GAS OIL			0.031		35.9		30.5	44.76	-0.53	1.61
FRESHWATER TK P	19.6	N	0.001	84.2	16.5	1.000	16.5	2.18	4.10	6.61
FRESHWATER TK S	19.6	N	0.001	63.8	12.5	1.000	12.5	2.18	-4.10	6.61
FRESH WATER			0.003		29.0		29.0	2.18	0.57	6.61
FOREPEAK TK	144.0	N	0.008	50.0	70.2	1.025	72.0	78.62	0.00	2.66
DB WB TANK 1 C	40.2	N	0.000	100.0	39.2	1.025	40.2	70.22	0.00	0.71
L WB TANK 2 P	79.7	N	0.000	100.0	77.8	1.025	79.7	62.33	3.77	1.70
L WB TANK 2 S	79.7	N	0.000	100.0	77.8	1.025	79.7	62.33	-3.77	1.70
DB WB TANK 3 P	61.0	N	0.000	100.0	59.5	1.025	61.0	51.06	4.78	0.66
DB WB TANK 3 S	61.0	N	0.000	100.0	59.5	1.025	61.0	51.06	-4.78	0.66
DB WB TANK 4 P	65.1	N	0.000	100.0	63.5	1.025	65.1	37.70	4.87	0.65
DB WB TANK 4 S	65.1	N	0.000	100.0	63.5	1.025	65.1	37.70	-4.87	0.65
L WB TANK 5 P	157.0	N	0.001	79.0	121.0	1.025	124.0	23.83	5.61	1.76
L WB TANK 5 S	157.0	N	0.000	100.0	153.2	1.025	157.0	23.79	-5.78	2.32
WING WB TK 1 P	244.3	N	0.002	52.4	124.8	1.025	127.9	44.55	6.55	3.16
WING WB TK 1 S	244.3	N	0.002	53.2	126.8	1.025	130.0	44.56	-6.55	3.19
AFTERPEAK C	144.1	N	0.000	100.0	140.6	1.025	144.1	2.49	0.00	4.64
WATER BALLAST			0.014		1177.4		1206.8	39.85	-0.19	2.26

A. D. BENBINUTO
CHIEF OFFICER

easeacon
page 1/2

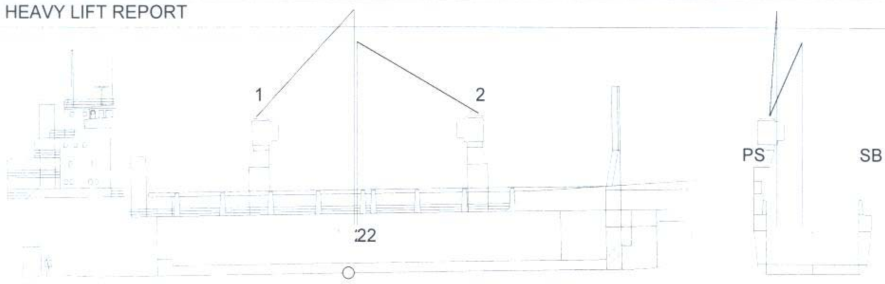
26 July 2005
07:07:00

Prior to ballast transfer

M/V CEC Pacific K/S DMK Storebaelt
IMO no.: 9000778
W25 Spl.ADB Voy.1st Arrival from TIO to ZANZIBAR Date: 26.07.05

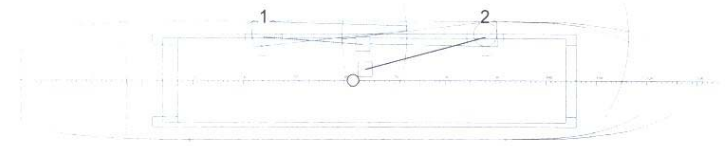
GRAIG

HEAVY LIFT REPORT



Discharge Load

Started ballast transfer



Distance between hooks 3.21 m

No	Hook	SWL	Reach	Load	Luffing	Slewing	Long.Pos.	Transv.Pos.	OutReach	LCG	TCG	VCG
		t	m	t	Degr.	Degr.	m	m	m	m	m	m
1	1	30	12.83	22	46	-4	12.80	-0.90	0.00	41.40	4.60	33.21
2	1	30	16.03	22	30	-165	-15.50	-4.10	0.00	41.70	1.40	29.11

HYDROSTATICS & STABILITY

						Seawater	1.025	t/m^3
Draught AP	5.01	m	GM solid	1.22	m	KMT	6.50	m
Draught M.	4.39	m	Correction	0.23	m	LCB	40.73	m
Draught FP	3.76	m	GM fluid	0.99	m	LCF	39.31	m
Trim	1.25	m	GM req.	0.18	m	Immersion	10	t/cm
Air Draught	23.67	m	Heel	-0.1	°SB	TrimMom	55	tm/cm
Propp.Ratio	121	%	Rollp.	12.6	sec.	(Values above for trim=0)		

PORT / DATE : ~~TIO~~ ZANZIBAR / 31 July 2005

MASTERS SIGNATURE : ______________________

A. D. BENBINUTO
CHIEF OFFICER

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Prior to ballast transfer

M/V CEC Pacific K/S DMK Storebaelt
IMO no.: 9000778
W25 Spl.ADB Voy.1st Arrival from TIO to ZANZIBAR Date: 26.07.05

GRAIG

TANKS

Compartment	Max.W. t	Max	S.Corr m	%	Volume m^3	Sp.Gr. t/m^3	Weight t	LCG m	TCG m	VCG m
CREW & EFFECTS	50.0	N	0.000	60.0	30.0	1.000	30.0	7.80	0.00	10.00
STORES AFT	100.0	N	0.000	20.0	20.0	1.000	20.0	20.48	0.00	11.00
STORES MID	100.0	N	0.000	0.0	0.0	1.000	0.0	0	0	0
STORES FORE	100.0	N	0.000	30.0	30.0	1.000	30.0	66.63	0.00	11.00
CREW & STORES			0.000		80.0		80.0	33.03	0.00	10.63
MDO DB No 4 C	99.7	N	0.072	50.2	58.8	0.850	50.0	44.20	0.00	0.35
MDO DB No 5 C	139.4	N	0.105	14.3	23.5	0.850	20.0	25.40	0.00	0.10
SETTLING TK 1 S	12.2	N	0.000	98.4	14.1	0.850	12.0	7.47	-3.90	6.32
SETTLING TK 2 S	12.2	N	0.000	98.4	14.1	0.850	12.0	13.98	-3.90	6.32
MDO DAY TK S	10.6	N	0.001	89.6	11.2	0.850	9.5	10.70	-3.85	6.20
MARINE DIESEL			0.178		121.8		103.5	29.73	-1.26	2.22
DB GO TANK 3 C	41.4	N	0.030	58.9	28.7	0.850	24.4	55.25	0.00	0.45
GO DAY TANK S	3.8	N	0.000	68.4	3.1	0.850	2.6	-2.28	-0.60	8.75
GO OVERFLOW TK	14.0	N	0.000	0.0	0.0	0.850	0.0	0	0	0
GO SETTL. TK S	4.3	N	0.001	81.4	4.1	0.850	3.5	6.54	-4.15	4.33
GAS OIL			0.031		35.9		30.5	44.76	-0.53	1.61
FRESHWATER TK P	19.6	N	0.001	84.2	16.5	1.000	16.5	2.18	4.10	6.61
FRESHWATER TK S	19.6	N	0.001	63.8	12.5	1.000	12.5	2.18	-4.10	6.61
FRESH WATER			0.003		29.0		29.0	2.18	0.57	6.61
FOREPEAK TK	144.0	N	0.008	50.0	70.2	1.025	72.0	78.62	0.00	2.66
DB WB TANK 1 C	40.2	N	0.000	100.0	39.2	1.025	40.2	70.22	0.00	0.71
L WB TANK 2 P	79.7	N	0.000	100.0	77.8	1.025	79.7	62.33	3.77	1.70
L WB TANK 2 S	79.7	N	0.000	100.0	77.8	1.025	79.7	62.33	-3.77	1.70
DB WB TANK 3 P	61.0	N	0.000	100.0	59.5	1.025	61.0	51.06	4.78	0.66
DB WB TANK 3 S	61.0	N	0.000	100.0	59.5	1.025	61.0	51.06	-4.78	0.66
DB WB TANK 4 P	65.1	N	0.000	100.0	63.5	1.025	65.1	37.70	4.87	0.65
DB WB TANK 4 S	65.1	N	0.000	100.0	63.5	1.025	65.1	37.70	-4.87	0.65
L WB TANK 5 P	157.0	N	0.001	79.0	121.0	1.025	124.0	23.83	5.61	1.76
L WB TANK 5 S	157.0	N	0.000	100.0	153.2	1.025	157.0	23.79	-5.78	2.32
WING WB TK 1 P	244.3	N	0.002	50.0 47	119.2	1.025	122.2	44.54	6.55	3.08
WING WB TK 1 S	244.3	N	0.002	57.0 50	135.9	1.025	139.3	44.57	-6.56	3.31
AFTERPEAK C	144.1	N	0.000	100.0	140.6	1.025	144.1	2.49	0.00	4.64
WATER BALLAST			0.014		1180.9		1210.4	39.87	-0.27	2.27

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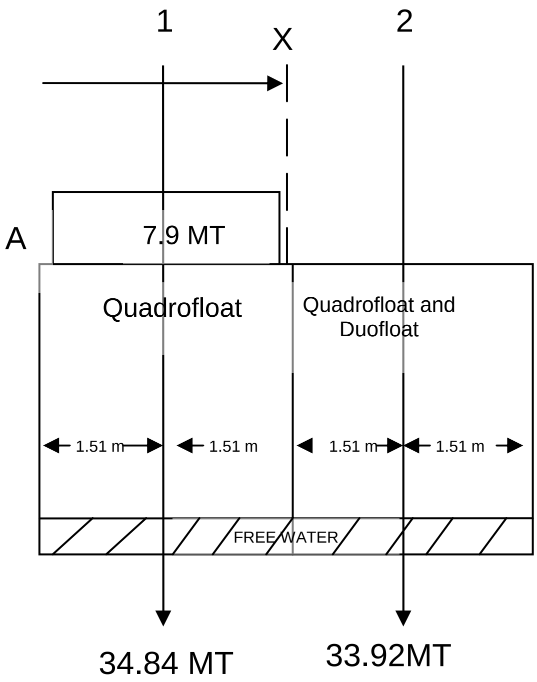
Appendix 3

Weight on each crane during loading



Free water in Quadrofloat

(assuming 5cm sounding)

12.19 x 3.02 x 0.05 x 1.025 = 1.89 MT

Free water in Quadrofloat and Duofloat

18.23 x 3.02 x 0.05 x 1.025 = 2.82 MT

Weight of winches = 7.9 MT

Weight of Quadrofloat = 25 MT

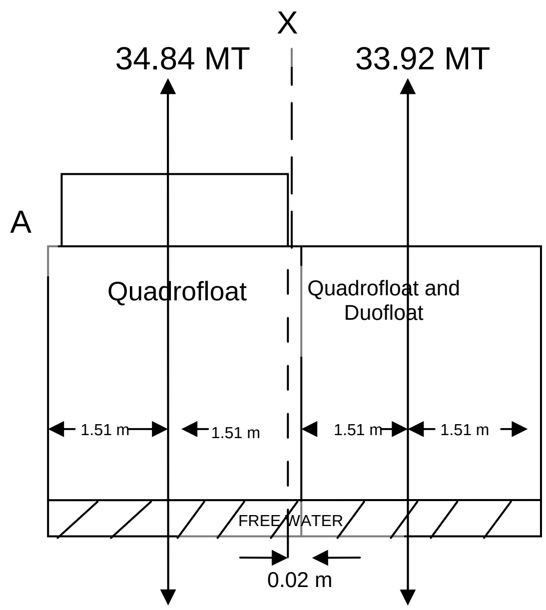
Weight of Quadrofloat and Duofloat = 31.15 MT

Taking moments about A

34.79 x 1.51 + 33.97 x 4.53 = 68.76 x X

52.53 + 153.88 = 68.76 x X

X = 3.0m



Taking Moments about X

1.53 x $ = 1.49 (68.76 - $)

1.53 x $ = 102.45 – 1.49 $

1.53 x $ + 1.49 X $ = 102.45

3.02 X $ = 102.45

$ = 33.92 MT = weight on Number 2 crane

To determine weight on Number 1 crane

68.76 MT – 33.92 MT = 34.84 MT

Appendix 4

Graig Ship Management Ltd.	Shipboard Procedures - Checklists		SBPC 67
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HANDLING OF HEAVY LIFTS CHL 067

The loading and discharging of heavy lifts requires thorough preparation and all crew members involved must act as a team. The Master is to take overall charge of the operation, appointing a designated crane signalman and an officer in charge of ballast operations. The following guidelines shall be followed:-

General

- Tandem crane operations are only to be carried out in daylight due to the risk of crane jibs colliding. ☑
- Cranes and wires to be thoroughly checked. Limits set for intended operation. ☑
- Condition and capacity of spreaders, shackles and slings to be checked, SWL to be adequate for planned weights. All equipment to be certified. ☑
- Check centre of gravity and lifting points are marked on cargo unit. ☑
- Check lifting points are adequate. ☑
- Check packaging and lashing points are suitable for handling, stowage and sea carriage. ☑
- Briefing meeting to be held to ensure that all crew members are aware of their duties and procedures. ☑
- Signals and orders between signalman (Chief Officer) and crane operators to be agreed at briefing. Orders over portable radios are to be given clearly and separately in English in order that all parties are able to monitor instructions. Examples of orders as follows: "Crane No.1 swing slow to your right. Crane No.1 Stop. Crane No.2 boom up." ☑
- Crew members involved in the operation to be adequately rested, minimum of six hours. ☑
- Stability calculated to ensure adequate GM throughout operations. ☑
- Master to check and verify stability calculation. ☑
- Tank Top/Tween Deck/Deck loading per square metre ascertained and required dunnage in place. ☐
- Ballast transfer procedure agreed by Master and officer in charge of ballast operations. ☑
- Communication between deck and ballast control checked. ☑
- Chief Engineer to supervise ballast operation. If Chief Engineer is busy with maintenance the Master may delegate another Officer provided he is certain that Officer is fully familiar and experienced with the ballast transfer procedure. ☑
- Double bottom tanks to be full or empty, no free surface. If there is doubt then free surface to be allowed for in the stability calculation. ☑
- Heeling tank on the crane side to be at approximately 100% capacity, other side to be empty, for rapid transfer. ☑
- Verify accuracy of heeling tank remote sensors. If a sensor is non-operational or faulty then transfer of ballast to be verified by manual soundings. ☑
- Weather deck pontoons to be stacked ashore. If stacked on board to be no more than two high and secured against shifting in case of excessive list. ☑

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Moorings checked and adjusted. ☐

Gangway tended and lifted if necessary. If cargo unit is to be lifted or landed adjacent to gangway then gangway to be stowed during operation. ☐

No unauthorised personnel on deck during operation. ☐

Vessel to be maintained as near upright as possible during the operation by transferring ballast. In any case, the list is not to exceed 3 degrees. ☑

Tag lines to be fitted to cargo unit to control rotational movement. ☑

Crane hoist wires to be kept to the vertical during the operation ☑

Ballast procedure - loading. ☐

(For cranes fitted port side)
Take the minimum weight of the cargo with the crane(s) without lifting the unit.
Transfer ballast port to starboard until unit is clear of trailer or shore.
Lift unit until clear of hatch coaming and slowly swing inboard.
Transfer ballast starboard to port while swinging unit through fore and aft line of coaming. If necessary, stop swinging while transferring ballast to keep vessel upright.
Continue to transfer ballast starboard to port –until unit is above stowage position.
Lower unit into stowage position.

Ballast procedure - discharging. ☑

(For cranes fitted port side)
Lift unit with crane(s) from stowage position until clear of hatch coaming and slowly swing outboard while transferring ballast from port to starboard.
Continue transfer ballast port to starboard while swinging unit through fore and aft line of coaming until unit is positioned over trailer or shore. If necessary, stop swinging while transferring ballast to keep vessel upright.
Lower unit to position on trailer or shore.
Transfer ballast starboard to port to land unit.

COMPLETED BY:

Name (Print) A. D. BENBINTO Rank C/OFF

Signed [signature] Date 26 JULY 05

VERIFIED BY MASTER :

Name (Print) C. GALANGA Date 26/07/05

Signed [signature]