Marine Safety Investigation Unit

Transport Malta

SAFETY INVESTIGATION REPORT

201407/018 REPORT NO.: 15/2015 July 2015

DECK CARGO BARGE *AMT EXPLORER*

Capsizing while under tow
off the South Southwest coast of Sardinia
03 July 2014

SUMMARY

On 04 July 2014, the Marine Safety Investigation Unit (MSIU) was informed that on 03 July 2014, at about 0509 (LT), the deck cargo barge *AMT Explorer* had capsized while under tow from Naples, Italy to Bremerhaven, Germany.

The barge was under an unmanned tow, carrying a cargo which consisted of a sub-sea cable. As a result of the accident, *AMT Explorer* suffered structural damages. Moreover, her cargo was lost at sea and has not been recovered.

On the basis of the available documentary evidence, the safety investigation established that the immediate cause of the capsizing was the flooding of water into a number of water ballast tanks.

The MSIU has issued four recommendations to the owners designed to ensure the safe operation of the deck cargo barge when under tow, with respect to voyage planning and watertight integrity.

AMT Explorer

FACTUAL INFORMATION

Vessel

AMT Explorer, a 5814 gt barge was built in 1984 by Austin & Pickersgill, UK and is registered in Malta. She is owned by Augustea Maritime Transportation Ltd. and is classed by Lloyd's Register.

Charterers advised that following a period of 'in-house' management, the technical management of the barge was passed to another company on 02 September 2013. The charterers explained that whilst the management system implemented on board was not a conventional one, due to the barge being unmanned during voyages, there was a close relationship via emails between the officer in charge on board the barge, the loading (offshore) superintendent, and the management company's Technical Department.

The charterers also advised that the technical managers were in the process of populating a planned maintenance system, which had been implemented on board since January 2014.

The barge's length overall is 91.72 m, has a moulded breadth of 30.48 m and a loaded draught of 6.17 m. Her depth is 7.62 m and has a summer deadweight of 13980 mt at a corresponding freeboard of 1184 mm.

The barge has 22 water ballast tanks, arranged in two pairs on each side of a continuous longitudinal bulkhead, which runs from forward to aft. The maximum water ballast capacity is 17,932 m^3, corresponding to 18,380 metric tonnes (Figure 1).

AMT Explorer is a dumb barge[1] and the only Statutory certificates issued were the International Oil Pollution Prevention Certificate, the International Load Line Certificate, the International Anti-Fouling System Certificate and the International Air Pollution Prevention Certificate. All Statutory certificates were valid.

Departure stability condition

On 03 July 2014, the barge was engaged in the carriage of a sub-sea cable on an international voyage. *AMT Explorer* left the port of Pozzuoli in a stable condition. She had 22.9 mt of gas oil on board and 7372.1 mt of ballast water. Upon departure, all ballast tanks were slack, bar inner ballast tank no. 1 port, outer ballast tank no. 1 port, and outer tank no. 1 starboard. Ballast tanks nos. 4 were empty.

The trim and stability information at departure is summarised in Table 1. The mean freeboard was calculated to be 1.91 m. Due to its trim by the stern, the minimum freeboard was at the aft perpendicular (1.43 m).

Table 1: Stability Information

Criteria	Required	Actual
Initial metacentric height (GM)	0.150 m	11.291 m
Area up to 30°	0.07 m*rad	0.90 m*rad
Area between 30° and 40°	0.03 m*rad	0.27 m*rad
Righting lever (GZ) at 30°	0.200 m	1.84 m
Angle of max. GZ	15°	20°
2nd intercept range	40°	>40°
Wind heel reduction in freeboard	0.956 m	0.073 m
Trim	0.97 m	
Draft at Forward Perpendicular	5.22 m	
Draft at Aft Perpendicular	6.19 m	
Mean draft	5.71 m	
Draft at Aft Mark	6.10 m	
Draft at Centre Mark	5.66 m	
Draft at Forward Mark	5.34 m	

[1] A dumb barge has no propulsion system.

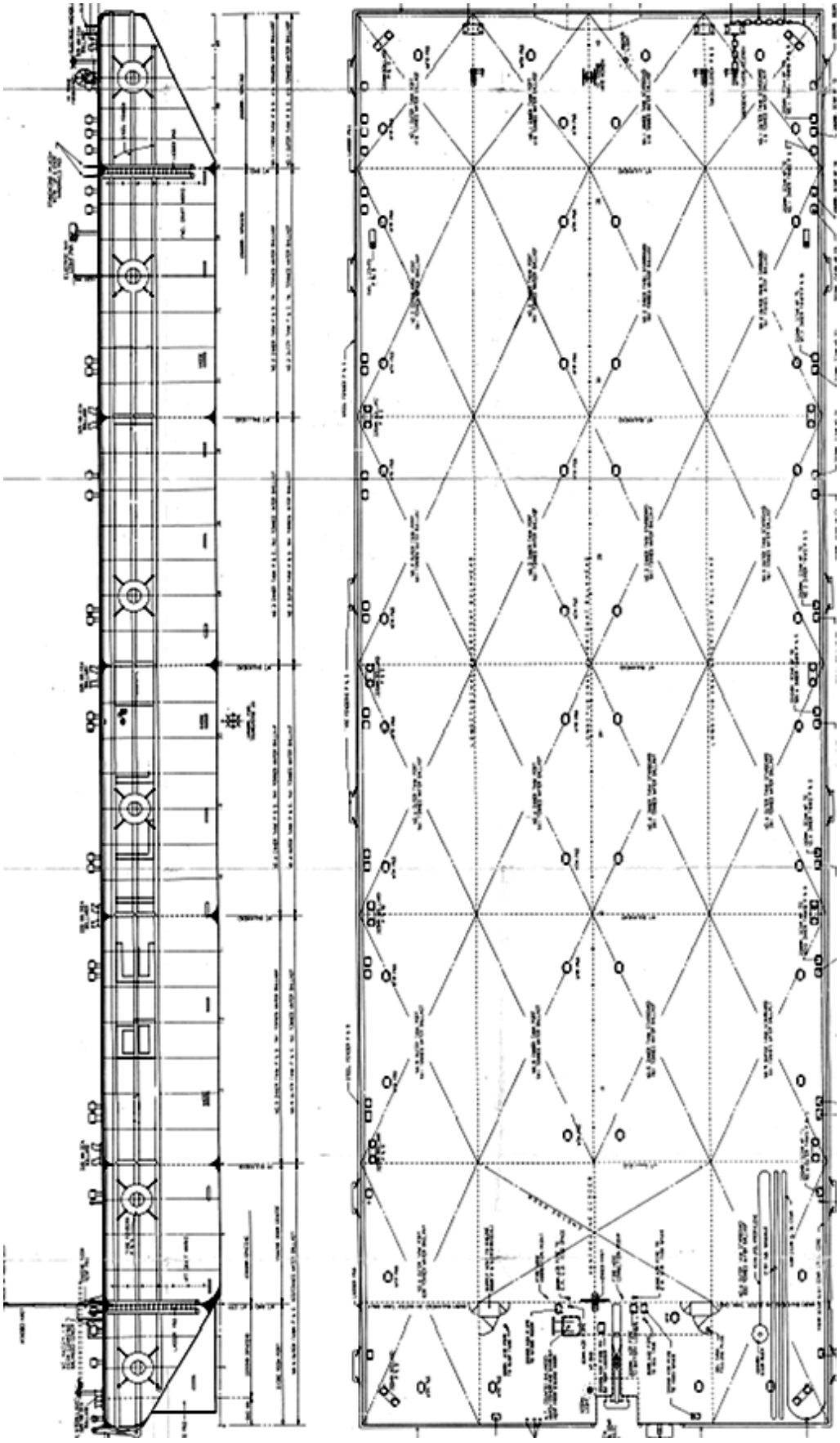

Figure 1: *AMT Explorer* General Arrangement Plan

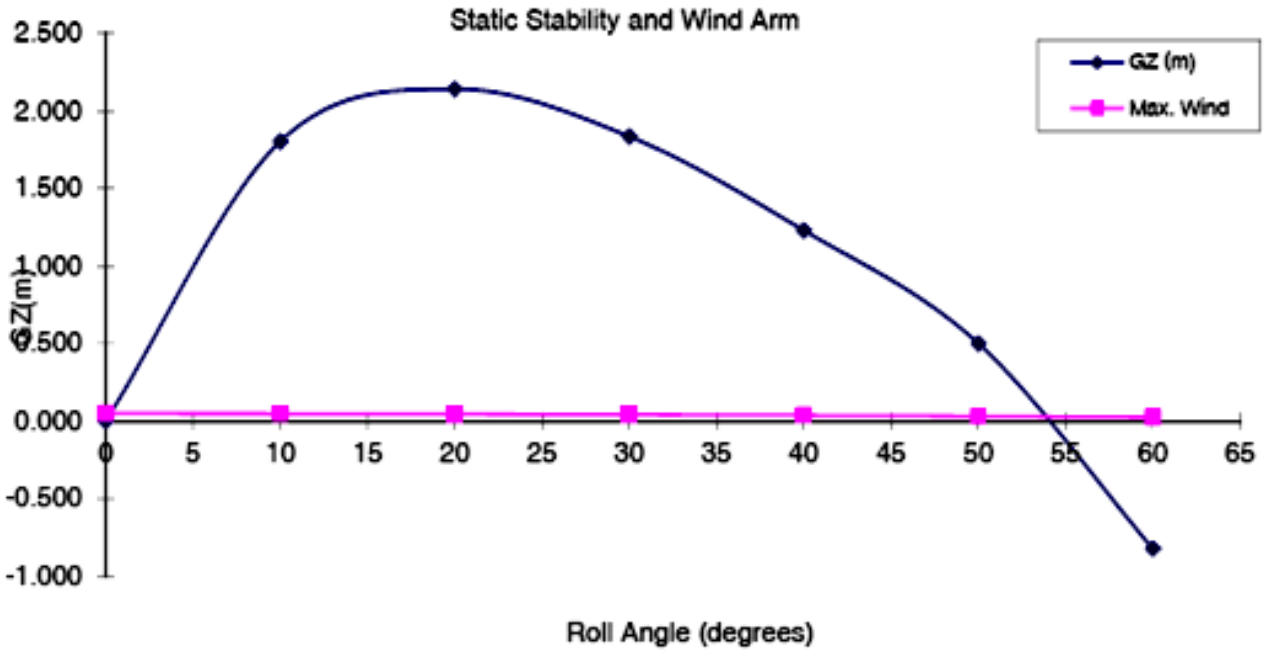

Figure 2: GZ curve (departure condition)

In this departure condition, the roll period of the barge was 7.08 s. Figure 2 shows the static stability and wind arm curve.

Environment

The maximum wind encountered during the voyage was Easterly force 7 whereas the sea state was North Northeast and rough (maximum wave height was approximately 3.5 m)[2]. It would seem that the vessel had been encountering adverse weather conditions since the night of 29 June 2014, until it eventually capsized.

It was reported that the significant wave height was 2.4 m at about 0500 on 03 July 2014 (which was approximately the time of the accident)[3].

Narrative[4]

AMT Explorer was chartered to carry a carousel sub-sea cable of 4400 metric tonnes (project cargo) and 897.42 metric tonnes of project equipment for a total weight of 5297.42 metric tonnes[5].

The tow commenced on 25 June 2014, at about 0700. One tug boat had been contracted to tow *AMT Explorer*. The (unmanned) tow left the port of Pozzuoli, Italy to Bremerhaven, Germany. AIS data showed that the initial speed of the tow was about 4.5 knots.

Until 01 July 2014, the voyage seemed to be uneventful and on 02 July, at about 2042, the tow altered course to starboard to pass South of Sardinia. Since morning, the crew on board the tug boat had been noticing what appeared to be a list to port side[6].

[2] The MSIU has conflicting evidence on the maximum wave height with other documentary evidence reporting 2.7 m during the tow.

[3] The charterers confirmed that these conditions were not forecast on departure from Pozzuoli.

[4] Unless otherwise indicated, all times are local (UTC+2).

[5] A correction weight factor of 64.40 metric tonnes was considered in the trim & stability calculation.

[6] Fresh information provided to the MSIU indicated that the tug boat master had erroneously stated "morning" and that it was only during the evening that he became concerned with the tow.

In order to compensate for the port list, at about 1948, the tug boat master decided to adjust and shorten the tow line in an attempt to counteract the trim by the head and the list to port side. It was also noticed that the barge was shipping green seas from her port side (Figure 3). The perception from the tugboat was that the freeboard on port side forward was 0 m.

Seeing this situation, at about 2042, the master decided to alter course to the closest port of call, which was Cagliari in Sardinia, about 110 nautical miles away.

Figure 3: Green seas shipped on the open deck from port side

The developing situation was communicated to the charterers at about 2135.

An another email was sent to the managers when the tow was in position 38° 18.6'N 007° 44.2'E. In his email, the tug boat master provided an update of the situation and requested urgent help, reporting that the list to port side was increasing and that the situation was critical.

About an hour later, at about 0509, the tug boat master confirmed that the tow had been released and that the barge had capsized although still afloat (Figure 4). Soon after capsizing, the barge started to drift at about 1.2 knots. It was estimated that in this position, her freeboard aft was about 1.5 m and 1.0 m forward.

Figure 4: *AMT Explorer* after capsizing under tow

Although the project cargo and most of the project equipment were lost, no injuries and pollution were reported.

Salvage operation and parbuckling

SMIT Salvage was contracted under an LOF contract by the charterers to conduct the salvage. *NOS Aries* was hired in by SMIT Salvage and deployed with an eight-man salvage team and dive equipment to the casualty site. During this period, the tug boat remained on site to report on the position and condition of the barge.

Eventually, *AMT Explorer* was connected to *NOS Aries* and was towed to Sardinia for an initial dive survey. A full dive survey was then carried out on 15 July 2014 in Piombino, Italy (Figures 5-6), prior to the commencement of parbuckling operations by the salvors.

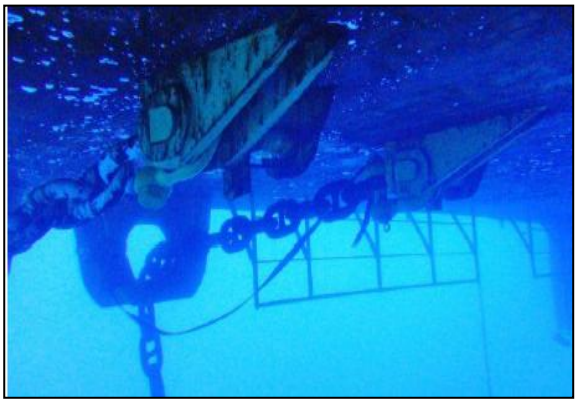

Figure 5: Towing gear (capsized barge)

Figure 6: Vent pipes (capsized barge)

The parbuckling operation was successfully completed during the first week of August 2014 (Figures 7 and 8). *AMT Explorer* was subsequently towed to a shipyard in Malta for permanent repairs.

Figure 7: *AMT Explorer* connected to the parbuckling slings

Figure 8: *AMT Explorer* in the process of correcting the port heel (looking aft)

Reported damages
A Lloyd's Register surveyor went on board on 01 August 2014 to carry out consultancy services *i.e.*:

- a general examination of the barge afloat, following the parbuckling and the de-ballasting operations;
- confirmation of watertight integrity;
- confirmation of suitability for towage; and
- confirmation of repair activity.

At the time of the survey, the barge was floating at a draft which was well below the summer waterline. Ballasting operations were still in progress and coordinated by the salvors.

The watertight integrity survey was limited to the accessible spaces. The gunwale was found torn in way of outer starboard ballast tank no. 4. It is the understanding of the safety investigation that this damage was caused by the parbuckling operation. The damage measured 800 mm by 600 mm.

Following the capsizing, various deck mounted fixtures, such as the cable loading turret, were found to have become detached from their deck securing points and lost; with the deck plating found locally fractured in way of water ballast tank no. 3 centre. All air vents were found either missing or blanked at deck level[7]. A number of water ballast tank manhole covers were found missing.

The class survey had also found that the auxiliary machinery in the engine-room had to be re-commissioned and water ballast tank no. 3 port bulkhead and associated under-deck longitudinals were buckled.

[7] The air vents and vent piping were removed during the parbuckling operation.

Towage to the repair yard
On 14 August 2014, a 'Fitness to be Towed Certificate' was issued for a single voyage to the shipyard. Weather restrictions were imposed on the tow[8].

ANALYSIS

Aim
The purpose of a marine safety investigation is to determine the circumstances and safety factors of the accident as a basis for making recommendations, and to prevent further marine casualties or incidents from occurring in the future.

Cooperation
During the course of the safety investigation, the MSIU had a number of challenges. Out of necessity, the parbuckling operation interfered with the evidence, some of which may have been altered during the process. It is acknowledged, however, that all efforts were made to preserve the status of the barge as much as possible.

Obtaining evidence was challenging, even considering that this accident involved a dumb barge which was operated in a very different way from conventional SOLAS vessels. During the course of the safety investigation, various requests for information were made by the MSIU, a number of which did not yield positive results[9].

[8] Wind strengths of force 6 or less on the Beaufort scale, associated with sea states sufficiently moderate to ensure that green seas were either not shipped at all or else shipped at infrequent intervals.

[9] It has to be submitted that a detailed document from the charterers with important evidential material was only received on the last day of the consultation period.

Source of water ingress and flooding scenarios

Documents made available to MSIU indicated that the conditions of the ballast tank vents and other vents were in good condition and not considered to have contributed to the accident.

The MSIU was informed of a missing vent for outer ballast tank no. 2 port, which appeared to have stripped threads, possibly due to either wave action or during the actual capsizing. It was therefore not excluded that this may have contributed to the down-flooding into the ballast tank and contributed to the subsequent capsizing (if its loss was primarily due to wave action).

A likely source of water ingress was through the manhole covers. The manhole covers were secured using two strong-backs, each tightened with a single bolt (Figure 9).

Figure 9: A manhole cover showing on bolt on each strong-back

Pictures made available to the MSIU indicated that there was a potential issue with the watertight integrity of as much as 47 manhole covers. These were found to be missing (16), not watertight (16), or not airtight[10] (15).

[10] During the salvage operation, it was noticed that a number of manhole covers had gaps in way of the sealing faces. These were considered not to be watertight. In other water ballast tanks, the diver's exhaled air bubbles leaked through the sealing faces of the manhole cover. These were considered not to be airtight.

Most of the manhole covers were found to be deformed to various degrees (Figure 10).

Figure 10: Deformation (set-down) of one of the manhole cover by about 4 to 5 mm

Indications of widespread corrosion on the manhole covers' sealing faces were also evident (Figure 11) and a potential source of water ingress due to the unevenness created by the flaking material.

Figure 11: Corrosion on the sealing face

It was also very probable that the flaking material would have compromised the tightening effectiveness of the sealing manhole cover (Figures 12 and 13).

Figure 12: Flaking material due to corrosion, compromising a watertight arrangement

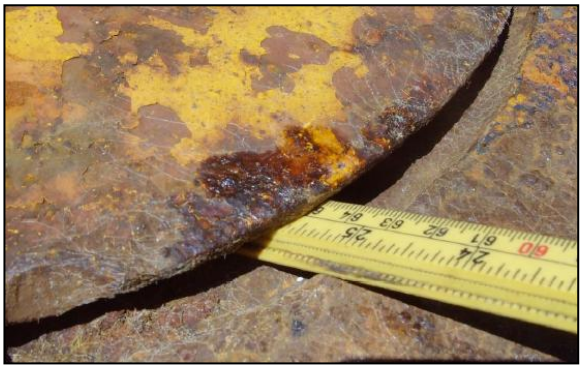

Figure 13: Carpenter ruler (3*3 mm) inserted in a gap between the manhole cover and the sealing face

It has to be specified that the tightness of the cover may have been also compromised due to displaced rubber seals on a number of covers, which were found after the parbuckling operation (Figures 14 and 15).

Figure 14: Displaced rubber seal inside a ballast tank

Figure 15: Another displaced rubber seal inside a ballast tank

The MSIU, however, was unable to confirm whether the rubber seals were displaced before the accident, during the course of the accident or post-accident as a result of the salvage work.

Expanding foam (Figure 16) and silicone (Figure 17) was also used on many sealing faces with the neoprene gasket in bad condition, although the MSIU was not able to determine whether this was applied before this particular voyage.

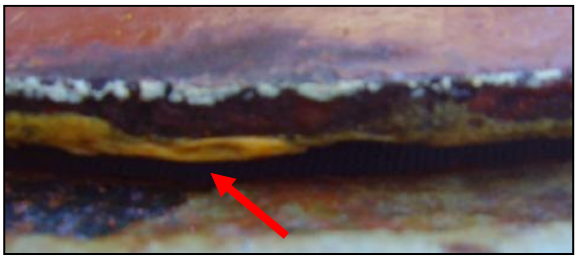

Figure 16: Traces of expanding foam

Figure 17: Silicone applied to the sealing faces

Most of the manhole covers which were not watertight were located forward to amidships and on the port side of the centre line. Figure 3 showed that green seas were being shipped from the port side.

Maintenance

During the course of the safety investigation, the MSIU was provided with a copy of the Charter Party[11]. The Charter Party addressed the maintenance and the operation of the barge. The owners stated that in accordance with the relevant clause of the Charter Party, the charterers were responsible to maintain the barge, her machinery, appurtenances, and spare parts in a good state of repair, in efficient operating condition and in accordance with good commercial maintenance practice.

The charterers communicated a different position. They advised that the owners were involved in the carrying out of structural strength analysis of the condition of the barge in conjunction with Lloyd's Register in January 2014. They also claimed that the owners had visited and selected the location for the next dry-docking and were emailed with queries on the scope of the work for the dry-docks, which included replacement of steel within the ballast tanks.

It was also claimed by the charterers that the owners had communicated their intention to visit the barge together with a Lloyd's Register surveyor to determine the scope of inspection of the ballast tanks for the special survey. For the charterers, this was indicative that the maintenance of the structural condition was not an 'onus' which had to be borne by them.

It is outside the MSIU's remit to analyse commercial documents from a legal perspective. It would seem, however, that the interpretation of who had the maintenance responsibility led to a situation where a maintenance protocol was not developed in an unequivocal manner. The MSIU, however, believes that the legal interpretation of the charter party is secondary in terms of safety.

What is a primary concern for safety is correct and effective maintenance because this is one of the critical processes to ensure reliability. Figures 18-19 show the condition of a number of strong backs, which were wrongly fitted – a situation which could have contributed to a number of manhole covers (35 kgs) being lifted off.

Figures 18-19: Manhole covers with wrongly fitted strong backs

Figures 20-21 are a representation of the strong backs as designed and as fitted.

[11] The Baltic and International Maritime Council (BIMCO) Standard Barge Bareboat Charter Party (Bargehire 94).

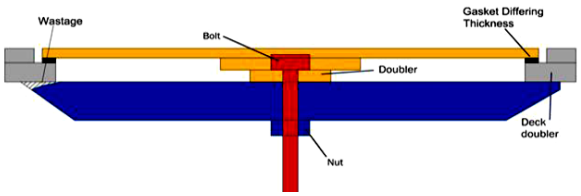

Figure 20: Strong back as designed

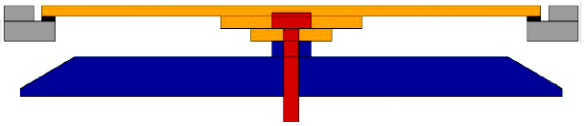

Figure 21: Strong back (incorrectly fitted)

The lack of adequate oversight from any of the two parties is evident to the safety investigation. The physical condition of the manhole covers and other structural areas of the barge strongly suggest that the way maintenance data was used, did not prevent an incorrect diagnosis of the structural condition.

It may well be that owners did not have maintenance data in hand (for whatever reason). It could also be that the charterers had limited domain-specific knowledge, while the 'new' technical managers were still in the process of populating a planned maintenance system. What is evidently clear, however, is that the barge was engaged in a commercial activity at a time when the manhole covers, a critical fitting on the barge, may have not been part of an effective (preventative and corrective) maintenance plan.

Safety management system and flag State inspection regime's relation to maintenance

It was acknowledged that the barge had a valid Class certificate and was issued with Statutory certificates. Documentary evidence suggested that the barge was inspected once by the flag State Administration on 16 December 2011 before the barge was registered under the Malta flag. These regimes would necessitate preventive maintenance tasks to be executed at pre-defined periods.

Being a non SOLAS vessel, however, *AMT Explorer* was neither inspected regularly by the flag State Administration, nor did she have a conventional safety management system implemented on board. This is significant because there is a strong interaction between maintenance, safety and its management, given that the main purpose of maintenance is the prevention of significant deterioration of the barge (in this case), which in turn can jeopardise safety.

Safety and maintenance management concepts and policies should interact in a seamless manner – highlighting the flow of information with respect to prevention and corrective maintenance, but also incident correction and accident recovery.

Charterers confirmed that maintenance specific to the sealing arrangements of the manhole covers was identified and in progress. However, as indicated elsewhere, taking into consideration the actual physical state of the manhole covers at the time of the accident, it would seem that the lack of a proactive safety management philosophy, even if a conventional management system was not a requirement, had a significant effect on the way the situation evolved on board the barge.

Towage conditions and the prevailing weather conditions

On 28 June 2014, a Towage Approval Certificate was issued for a single voyage from the port of Arco Felice to either Bremerhaven or another suitable port in the North of Germany. The Certificate was issued subject to eight conditions, four of which were directly related to the weather conditions. One of the conditions was the avoidance of adverse and stormy weather as assessed by the tug master.

The scope of the Towage Approval Survey and Certification was to approve the tug and inspect the main and emergency towing arrangement. The MSIU was also informed that other surveyors had visited the barge prior to previous voyages. Although this information could not be confirmed, it was also stated that their visit on board would not have been with the scope of inspecting the structural condition of the barge.

Further to this Certificate, the MSIU did not have any reference to the conditions of the manhole covers on the *AMT Explorer*.

It has already been stated that the adverse weather conditions had started since 29 June 2014. Considering the course taken by the tug, since 29 June until the day of the accident, the barge was exposed to head seas and green water from the port quarter.

It has to be acknowledged, however, that South of Sardinia, the tug boat master would have had very limited options with respect to avoiding prevailing adverse weather conditions.

The MSIU has requested confirmation for the weather routing, if any, and on the passage plan in order to establish what factors had been taken into consideration when the route was selected. The scope was to determine what weather forecasts were obtained before and during the voyage, actions taken by the tug boat, limitations which the tug boat crew had and any actions taken once it was determined that the barge may have encountered problems.

No information was provided on the weather routeing. The passage plan did not include detailed information, except for the minimum necessary (charts used, pilots and lighthouses, way points and related information). The document was generic with five main points listed on the traffic in close proximity of the convoy, reporting to local authorities, attention to the tow line and deteriorating weather conditions. The passage plan also included a list of nine ports of refuge, including Cagliari in Sardinia.

The purpose of a passage plan was to ensure that there was a positive control over the safe navigation of the tug boat and the barge at all times. The document, which was made available, however, neither included the foresight of potential problems and a strategy to minimise risk, nor contingency plans, such as alternative routes and emergency anchorages.

The way the risks were analysed before the trip and during the actual situation therefore remained unclear to the MSIU.

The actual time when the problems on the barge were identified also became unclear following the correction made by the tug boat master with respect to this time. It is very probable that since none of the tug boat crew members could board the barge, they would not have had an accurate indication of the magnitude of the risks involved.

Capsizing

On the basis of the available evidence and stability calculations, it is very likely that the cause of the flooding was due to significant water ingress into the slack and / or empty ballast tanks, through missing and / or dislodged manhole covers.

Free-surface effect was a phenomenon, which was considered by the safety investigation. Although free-surface effect leads to a reduction in the effective metacentric height, it was not considered to be critical enough to compromise the GM value of the barge[12]. Thus, although the shifting of the ballast water due to free-surface effect would have had a small contributing effect on the capsizing, it was

[12] *Vide* Table 1. The actual GM on departure was 11.291 m.

not considered that it would have been significant.

Calculations clearly indicated that the flooding of three water ballast tanks (*i.e.* no. 2 port, no. 3 port and no. 4 port) would have sufficed for *AMT Explorer* to capsize[13].

However, in addition, it had to be taken into consideration that the down-flooding rate must have been high enough to cause the capsizing within 214 hours, *i.e.* the duration of the tow from the port of departure until the accident happened[14].

Leakage of water though ballast tank vents was not considered to be an actual cause, although reference has already been made to outer ballast tank no. 2 port, which was found with a missing forward vent and which could have contributed to down-flooding into the ballast tank. Neither was flooding through the ballast system considered to be a potential source since no issues with the system were identified following the parbuckling operations.

The source of water ingress was therefore narrowed down to the manhole covers. Considerations were made on the possibility of the down flooding through gaps around the perimeters of the manhole covers. Although different simulated scenarios did not provide perfectly identical results, water ingress through displaced / missing manhole covers was a common finding. Moreover, the displacement of manhole covers due to sloshing pressures acting on the covers was not excluded and considered to be a potential source of water ingress.

[13] A specific focus was made on these three tanks due to the direction of the encountered seas.

[14] Actually, the time available would have been even shorter since the barge did not encounter adverse weather immediately upon departure.

CONCLUSIONS

1. The immediate cause of the capsizing was determined to be progressive flooding of slack water ballast tanks;
2. The condition of the manhole covers indicated a general ineffective maintenance regime;
3. The water ingress was the result of missing manhole covers which may have been potentially washed overboard, deformed covers and severe corrosion, preventing a watertight fit;
4. The lack of a proactive safety management philosophy, even if a conventional safety management system was not a requirement, had a significant role in the way the situation evolved on board the barge;
5. The passage plan neither included the foresight of potential problems and a strategy to minimise risk, nor contingency plans, such as alternative routes and emergency anchorages;
6. Initially, the list to port side and the gradual loss of freeboard did not raise any extraordinary concern.

RECOMMENDATIONS

Augusta Maritime Transportation Ltd. is recommended to establish mechanisms to:

15/2015_R1 verify that a passage plan has been prepared to ensure positive control over the safe navigation of the barge at all times;

15/2015_R2 ensure that the passage plan is adequate enough to foresee potential problems and plans a strategy to minimise risk, taking into consideration contingency plans;

15/2015_R3 prepare a maintenance schedule, comprising the manhole cover, securing nuts, and gaskets to ensure that the watertight integrity is not compromised at any stage of the commercial activity;

15/2015_R4 ensure that all manhole covers are watertight prior to departure and that they are well secured for the duration of the sea passage.

SHIP PARTICULARS

Vessel Name:	*AMT Explorer*
Flag:	Malta
Classification Society:	Lloyd's Register
IMO Number:	8405892
Type:	Deck Cargo Barge
Registered Owner:	Augusta Maritime Transportation Ltd.
Managers:	Not applicable (No ISM Managers)
Construction:	Steel
Length Overall:	91.72 m
Registered Length:	87.78 m
Gross Tonnage:	5814
Minimum Safe Manning:	Not applicable
Authorised Cargo:	Solid

VOYAGE PARTICULARS

Port of Departure:	Pozzuoli, Italy
Port of Arrival:	Bremerhaven, Germany
Type of Voyage:	International
Cargo Information:	4400 metric tonnes (project cargo) and 897.42 metric tonnes of project equipment
Manning:	Not applicable

MARINE OCCURRENCE INFORMATION

Date and Time:	03 July 2014 at about 0509
Classification of Occurrence:	Serious Marine Casualty
Location of Occurrence:	Approx.: 38° 18.6'N 007° 44.2'E
Place on Board	Ballast tanks
Injuries / Fatalities:	None
Damage / Environmental Impact:	None reported
Ship Operation:	Under tow
Voyage Segment:	Transit
External & Internal Environment:	Wind was Easterly, force 7, and the sea state was North Northeast and rough (maximum wave height was approximately 3.5 m).
Persons on board:	Not applicable