Marine Safety Investigation Unit

Transport Malta

SAFETY INVESTIGATION REPORT

201604/038 REPORT NO.: 07/2017 April 2016

MV *Azamara Quest*
Fire in the engine-room
In position 19° 51.7' N 068° 31.8' E
27 April 2016

SUMMARY

On 27 April 2016, at about 1330, the staff chief engineer heard one of the crew members shouting in the engine-room. He made his way to the workshop in order to investigate what had happened. At the other entrance to the workshop, the staff chief engineer was informed that there was a fire on one of the diesel generators.

The staff chef engineer hurried towards the diesel generator room and from the inside, he observed a dark orange fire under the turbocharger of diesel generator no. 2, on the B-bank side.

The fire was brought under control within a few minutes, limiting the damage to the immediate surroundings of the turbocharger.

The immediate cause of the fire was identified to be a pressurised fuel oil leak from a loose fuel oil pipe flange.

On the basis of the actions taken by the Company, the MSIU did not issue any recommendations following the safety investigation.

MV *Azamara Quest*

FACTUAL INFORMATION

Vessel

Azamara Quest was built by Chantiers del Atlantique, San Nazaire, France in 2000. As a passenger cruise liner, she was fitted with 351 cabins and could carry a total of 702 passengers and 372 crew members. She was previously named *Delphin Renaissance* and later, her name was changed to *Blue Moon* before being named by the current owners *Azamara Quest*. The vessel is classed by Lloyd's Register of Shipping and managed by Royal Caribbean Cruises Ltd. The vessel is registered in Malta.

Engine-room and machinery spaces

Azamara Quest is powered by diesel electric propulsion. The propulsion plant consists of four Wärtsilä 'Vasa 32', 12-cylinder V-type, four-stroke medium speed diesel engines, each developing 4,650 kW at 720 RPM to give a total available power of 18,600 kW. These units are installed with the flywheel end facing forward and connected at the forward end to a shaft. Each shaft penetrates the forward bulkhead of the diesel engine-room and drives an alternator situated in the generator propulsion motor room. The alternators supply power to all the ship's services and the two main electric propulsion motors.

The propulsion motors are situated in the generator propulsion motor room, immediately forward of the four alternators. They are rated to 6,750 kW at 175 RPM and drive the propellers via two shafts that run aft between the two alternators on each side, back through the bulkhead to the diesel engine-room and between the two diesel generators (DGs). The shafts then run through the aft engine-room bulkhead to the propellers.

The aft boundary of the diesel engine-room is formed by a watertight bulkhead and aft of this is an evaporator room on deck no. 1 (the lowest deck). Above this, *i.e.* on deck no. 2, are the engine-room workshop and a selection of other service spaces. A power operated sliding watertight door leads into the engine-room through this bulkhead at deck no. 2 level. The door is on the centreline and faces a lobby with access from both the stairwell down from deck no. 3 and the workshop to port side.

The forward engine-room bulkhead is a main vertical zone bulkhead separating Zone 4 from Zone 5. It is penetrated by a sliding watertight door at deck no. 1 between the engine-room and the space forward (the generator propulsion motor room). This is the only direct opening between the diesel engine-room and the generator propulsion motor room.

DG exhaust gases are continuously monitored for smoke by an obscurity meter that records data in the engine control room (ECR), and additionally by a camera on the funnel, with a screen fitted over the main console in the ECR.

On either side of each DG is an exhaust gas turbo charger located at the aft end. The exhaust outlets from each cylinder lead to an exhaust header, positioned over the top of the engine between the two cylinder banks, taking the exhaust along the top of the engine to the respective turbo charger.

The two exhaust lines are enclosed in an insulated metal box running along the top of each engine, protecting them from contact with flammable materials. The normal temperature of the exhaust gas headers is in the region of 400 °C. The auto ignition temperature of the fuel oil used in the engines is about 220 °C.

The engine banks are labelled A and B. A-bank is the starboard side bank of cylinder units (looking towards the turbo charger end). The cylinder units are numbered 1 to 6 on either bank, with no. 1 at the forward end and no. 6 at the turbo charger end.

Engine-room manning

The engine-room is manned on a 24 hour basis. The officer of the watch (OOW) is normally a duly certificated second engineer, assisted by a motorman and a wiper. The watches are based on the conventional 4-on, 8-off watch system. The chief engineer is responsible for the operation of the engine-room and its associated machinery. He is supported by the staff chief engineer, who looks after the routine day-to-day planned maintenance. The staff chief engineer is assisted by a third engineer and three fitters.

Planned maintenance

The Company's procedures in chapter 4, AMOS / Maintenance, of its safety management system (SMS) provided comprehensive guidance to the engine-room staff. The staff engineer had a very detailed job description, which included:

- ensuring that the vessel is maintained in a safe and efficient condition;
- supervising and controlling maintenance as required by the chief engineer;
- maintaining pollution prevention equipment, fixed fire fighting system, and life saving equipment mechanical parts as per manufacturer's instructions; and
- ensuring that a high standard of cleanliness and appearance is maintained for the:
  - engine-room;
  - steering gear flat, machinery areas, and associated equipment;
  - accommodation areas where machinery was fitted;
  - discussing and coordinating efforts with the staff captain when the maintenance involved deck machinery, hull and equipment; and
  - ensure that appropriate entries are made into AMOS.

The planned maintenance system operated by the Company provided the user with information on the required upcoming maintenance, recorded all undertaken planned maintenance jobs, and had a searchable historical maintenance log function.

Environment

The wind was Northerly, force 4, and the sea state was smooth. Visibility was good. Air temperature was recorded at 29 °C and the sea water temperature was 26 °C.

Narrative[1]

On 26 April 2016 at 2200, *Azamara Quest* departed Mumbai, India with 588 passengers. The vessel was bound for Muscat, Oman. Until 27 April 2016, the voyage was uneventful.

During the early afternoon, the staff chief engineer was working forward of the engine-room workshop on deck no. 2, in way of the crew elevator landing area. Together with two other crew members, he was securing spare pipes, which were stored in the area.

At about 1330, the staff chief engineer heard one of the crew members shouting. He made his way to the engine-room workshop to investigate what had happened. At the other entrance to the engine-room workshop, the staff chief engineer saw one of the motormen shouting that there was a fire on DG no. 2. At that point, he also observed that the motorman was closing watertight door no. 216.

[1] Unless otherwise stated, all times are local.

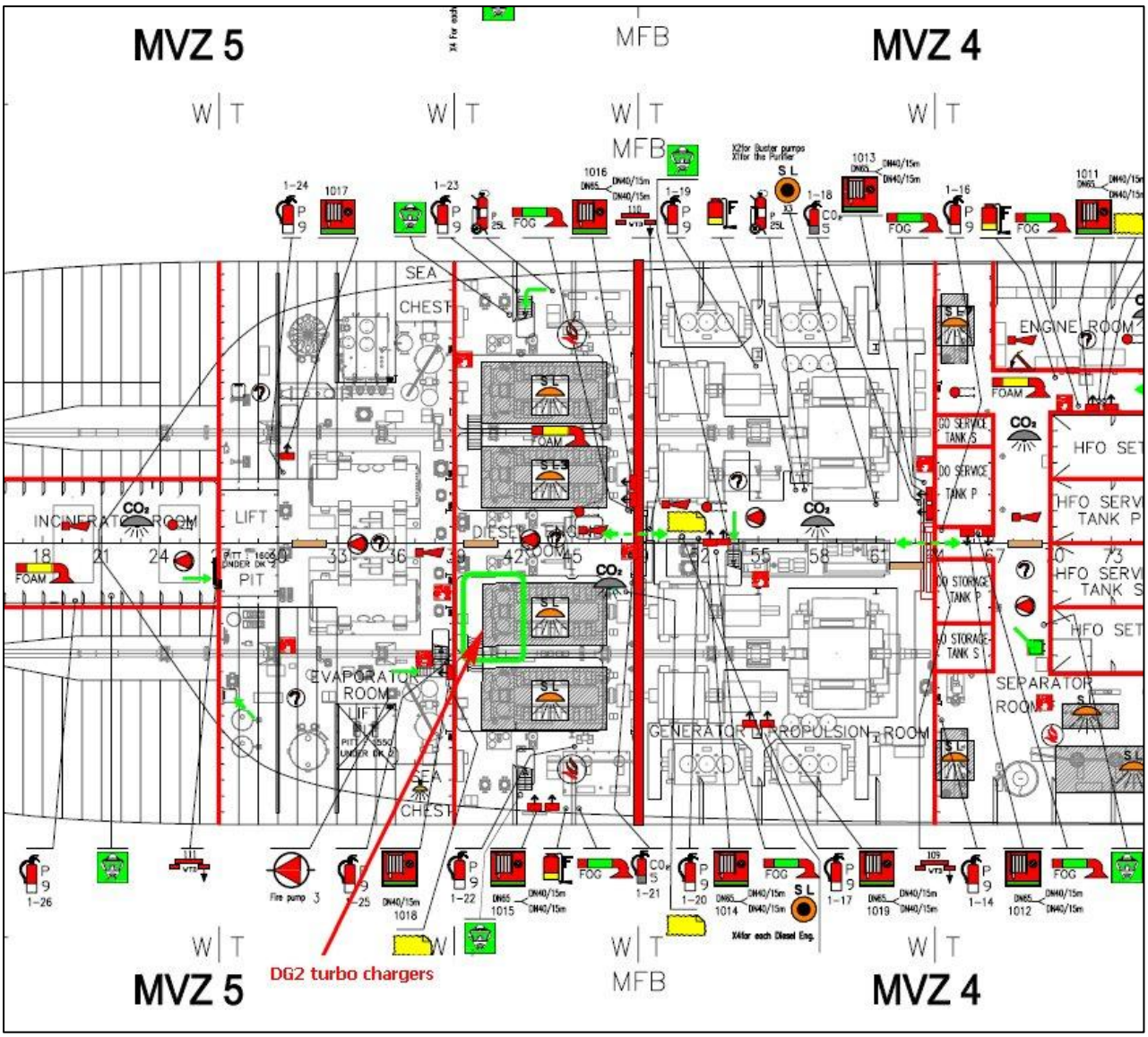

Figure 1: Part of the engine-room's general arrangement plan, showing the location of the fire in way of DG no. 2 turbo charger casing

The staff chef engineer hurried towards the DG room through watertight door no. 216, which was still not completely closed.

From the inside, the staff chief engineer saw a dark orange fire below the turbocharger casing on DG no. 2, in way of the prime mover's B-bank (Figure 1). At the time, there was little smoke and he could still see well within the space.

The staff chief engineer walked back through the watertight door, forward of the electrical workshop, to activate the ultra fog and water mist systems. In the meantime, the watertight door was also closed completely as the staff chief engineer pressed the relevant buttons for the ultra fog for DG nos. 1 and 2 and the water mist for DG no. 2 to be released.

He then hurried to the ECR and informed the OOW of the fire on DG no. 2. The OOW confirmed that he had also acknowledged the alarms from the ultra fog system[2]. The fuel oil quick closing valve (QCV) for DG no. 2 was also closed.

[2] The alarms in the engine control room would have confirmed that the ultra fog system had activated and released successfully.

In order to stop the starboard fuel oil feed and booster pumps units completely, the engineers had to stop DG no. 4 (fuel oil to this generator was supplied by the starboard fuel oil booster pump).

During the course of the fire fighting operation, the staff chief engineer noticed that there were no alarms on the water mist system. In fact, further verification revealed that the water mist system had actually not released, which necessitated the staff chief engineer to release it locally.

The feed and fuel oil booster pumps units were stopped but by that time, the fire had already been extinguished and there were neither signs of naked flames nor of smoke.

Reported damage

A survey by the Classification Society was carried out on 01 May 2016 in Dubai, UAE. The damage, which was limited to DG no. 2, included:

1. the control block SMU 3-3 exposed to fire;
2. the main bearing no. 7 sensor cable burnt; and
3. the exhaust line flexible joints on A-bank to the turbocharger inlet exposed to fire.

All the affected items were replaced prior to the vessel's departure.

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.

Immediate cause of the fire

The immediate cause of the fire was found to be a pressurised fuel oil leak on the fuel oil supply line to the high pressure fuel oil pumps. The fuel oil leak was in way of a connecting flange on the A-bank side of the A-B set pipe. The top left Allen bolt was found completely loose and had actually fallen out of place. The remaining three Allen bolts were also loose.

Figure 2: Missing Allen screw

The MSIU did not have access to the Allen bolts and therefore, a metallurgical analysis was not carried to determine whether there was any damage to the threads.

It has to be pointed out, however, that the safety investigation ruled out any potential problems (say, damaged thread) with the missing Allen bolt, given that the three other bolts were also found loose.

Engine-room records collected during the course of the safety investigation indicated that the last maintenance on the pipe was carried out on 21 April 2016 (Figure 3).

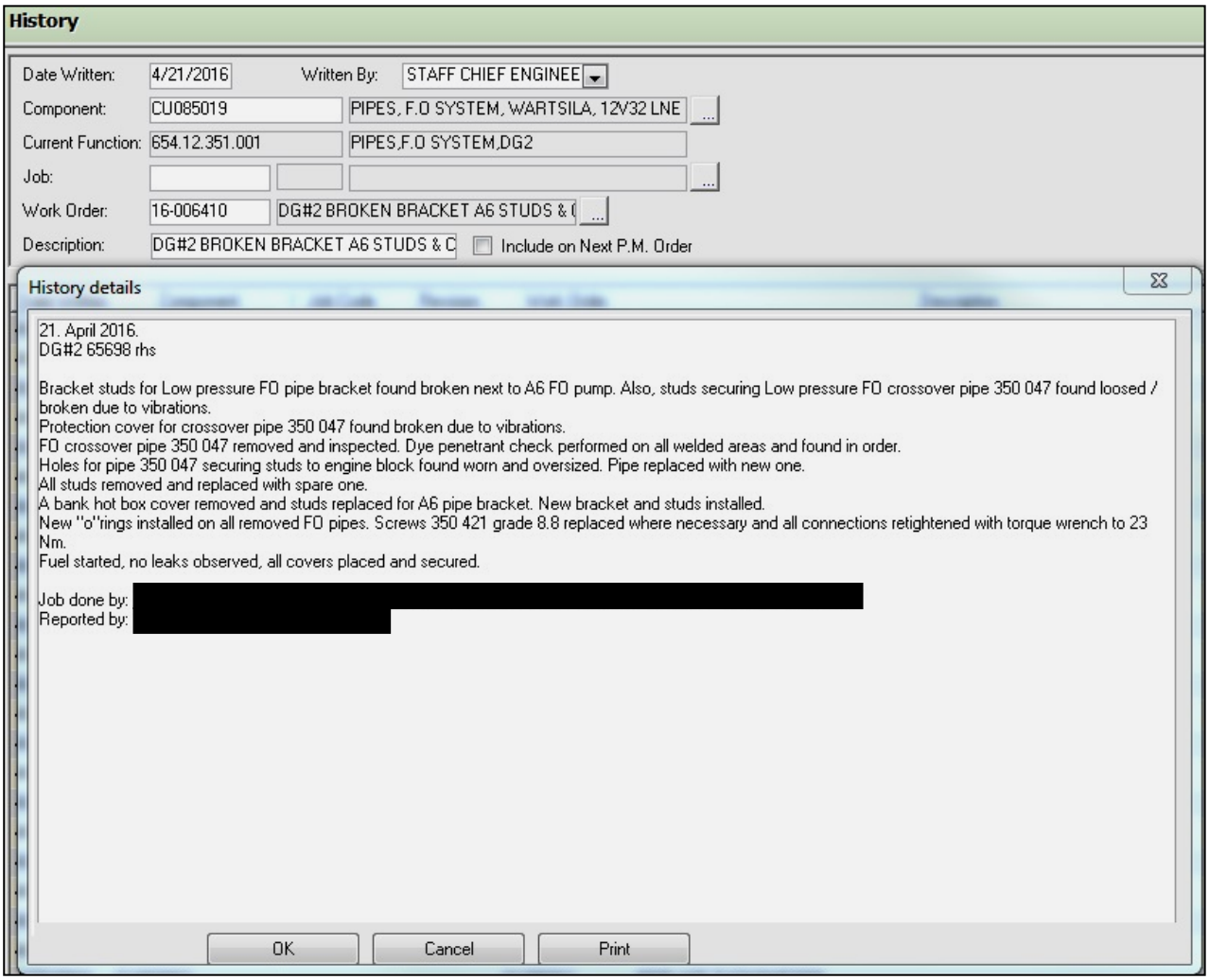

Figure 3: AMOS history report (screen dump)

The task was actually 'breakdown' maintenance after the engineers noticed a broken pipe bracket and a loose bolt on the bracket.

The absence of damages to the thread of the Allen bolt may be suggestive that there were no anomalous operations of the pump, which could have caused the loosening of the bolts. While the safety investigation noted that the maintenance history in Figure 3 showed that the bolts had been tightened to the torque recommended by the manufacturer (23 Nm)[3], it was not excluded that actually a lower torque may have been applied, thus allowing for vibration to loosen the bolts.

Taking into consideration that the prime mover had only been working for a total of 39 hours from the time it was maintained until the fire, it was considered possible that actually vibration was a major contributing factor to the loosening of the four Allen bolts, fitted in somewhat awkward positions.

Fire prevention barrier system

It has been confirmed that the prime mover had always been fitted with protection covers to prevent leaking fuel oil from reaching hot surfaces (Figure 4). Despite this, a closer inspection revealed that fuel oil

[3] The four Allen bolts were not fitted with spring washers since these were not mentioned in the manufacturer's manual.

had sprayed at a pressure of 8 bar, underneath the protective cover, penetrated through the gaps in the exhaust lagging screen, reached the exhaust pipe and auto ignited.

Figure 4: Protection covers in way of the fuel oil lines

It would appear that these gaps had never been detected during the regular maintenance on the DG; however, it has to be stated that this would have been a difficult task, if not an impossible one, given the narrow and small spaces involved.

Fire protection barrier system

Further to the above, the four DGs were protected by an ultra fog system. Initially, the vessel was fitted with a water mist system but a new ultra fog system had been fitted during *Azamara Quest*'s last dry dock in April 2016, replacing the water mist system.

During the course of the safety investigation, it transpired that the staff chief engineer operated successfully the ultra fog system but had to release the water mist system locally by opening the zone solenoid valve and start the water mist pump manually.

It would appear that the staff chief engineer tried to activate the water mist system by pressing the (blue) release buttons (Figure 5). It has been clarified, however, that the (blue) water mist release system buttons had been integrated in the new ultra fog system as manual call points during the vessel's latest dry docking earlier during the month of April.

Figure 5: Blue buttons below the ultra fog system

Notwithstanding this matter, the safety investigation concluded that it had no effect on the containment and extinguishing of the fire, given that the staff chief engineer had already taken the necessary and timely actions by activating the ultra fog system and shutting down the fuel oil supply to the affected prime mover.

CONCLUSIONS

1. The immediate cause of the fire was found to be a pressurised fuel oil leak on the fuel oil supply line to the high pressure fuel oil pumps;
2. It was not excluded that actually a lower tightening torque had been applied when the system was last maintained, thus allowing for vibration to loosen the bolts after a relatively short period of running time;
3. Vibration was a major contributing factor to the loosening of the four Allen bolts;
4. Despite the protection covers, a closer inspection revealed that fuel oil had sprayed at a pressure of 8 bar underneath the protective cover, penetrated through the gaps in the exhaust lagging screen, reached the exhaust pipe and auto ignited;
5. The gaps in the protective screen had never been detected during the regular maintenance on the DG because of the narrow and small spaces involved;
6. The ultra fog system had been operated successfully;
7. The staff chief engineer took the necessary and timely actions by activating the ultra fog system and shutting down the fuel oil supply to the affected prime mover.

SAFETY ACTIONS TAKEN DURING THE COURSE OF THE SAFETY INVESTIGATION[4]

Although the covers had been installed as per maker's design, the Company fitted SOLAS splash tape on the affected flange and pipe as an added protection barrier system (Figure 6).

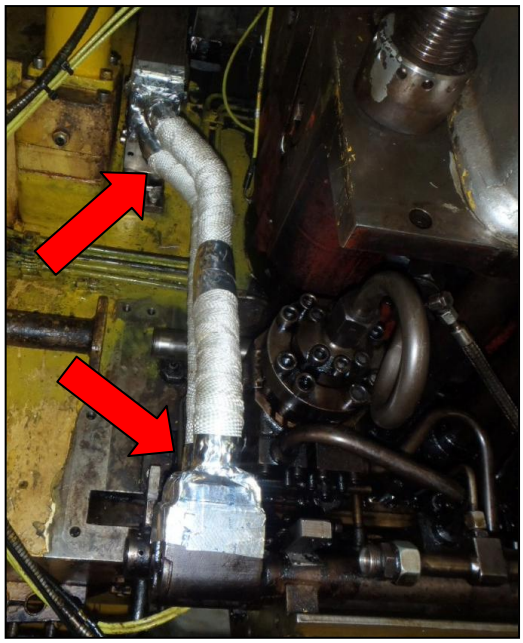

Figure 7: Splash tape fitted after the fire

Moreover, the Company replaced the (blue) release buttons on the water mist system with red call buttons to avoid any confusion (Figure 8). The Company has also addressed this issue through its crew familiarisation procedure.

Figure 8: New call points in red casings

[4] **Safety actions should not create a presumption of blame and / or liability.**

SHIP PARTICULARS

Vessel Name:	*Azamara Quest*
Flag:	Valletta
Classification Society:	Lloyd's Register of Shipping
IMO Number:	9210218
Type:	Passenger
Registered Owner:	Azamara Quest Inc.
Managers:	Royal Caribbean Cruises Ltd.
Construction:	Steel
Length Overall:	181.00 m
Registered Length:	157.85 m
Gross Tonnage:	30277
Minimum Safe Manning:	21
Authorised Cargo:	N/A

VOYAGE PARTICULARS

Port of Departure:	Mumbai, India
Port of Arrival:	Muscat, Oman
Type of Voyage:	International
Cargo Information:	N/A
Manning:	413

MARINE OCCURRENCE INFORMATION

Date and Time:	27 April 2016 at 13:31
Classification of Occurrence:	Serious Marine Casualty
Location of Occurrence:	19° 51.7' N 068° 31.8' E
Place on Board	Engine-room
Injuries / Fatalities:	None reported
Damage / Environmental Impact:	None reported
Ship Operation:	On passage
Voyage Segment:	Transit
External & Internal Environment:	The wind was Northerly, force 4, and the sea state was smooth. Visibility was good. Air temperature was recorded at 29 °C and the sea water temperature was 26 °C.
Persons on board:	1001