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LESSONS LEARNED AND SAFETY ISSUES IDENTIFIED FROM THE ANALYSIS OF MARINE SAFETY INVESTIGATION REPORTS

Report of the Correspondence Group on Analysis of Marine Safety Investigation Reports

ANNEX 1

LESSONS LEARNED FROM MARINE CASUALTIES

1 EXPLOSION

Very serious marine casualty: Explosion in tank, causing fatality

What happened?

A 700 GT chemical tanker had discharged a cargo of base oil. En route to the next port, the vessel was performing tank cleaning operations. Prior to tank cleaning, there was no flushing of cargo tanks and pumps carried out by the crew.

Concurrently with the tank cleaning, the Chief Engineer performed a welding operation on the ventilation duct of one of the cargo tanks. The welding caused ignition of the cargo vapours in the ventilation duct, which caused an explosion in the cargo tank. Three crew members working in the vicinity suffered injuries, including the Chief Engineer. The Chief Engineer succumbed to his injuries as a result of the explosion.

Why did it happen?

Prior to the commencement of tank cleaning operations, the ship's crew did not flush the cargo tanks and pumps. During the tank cleaning operations, the base oil remaining in the cargo pumps likely sprayed onto the cargo tanks, became airborne in the ventilation duct, and vaporized. This vapour subsequently ignited when welding was conducted on the duct, causing the explosion.

There was no procedure in the company's safety management system (SMS) to ensure that tanks were flushed to remove previous cargo contents prior to tank cleaning.

The hot work procedures as per the company's SMS were not complied with. The advice of the second Engineer on the dangers of welding during tank cleaning operations was disregarded, due to the belief that the base oil was a high flash point cargo, that the area to be welded was small and that the job would be over quickly. None of the crew on board stopped the task, although it was deemed to be dangerous considering the tank cleaning operations.

What can we learn?

- Flushing of cargo tanks, etc., prior to tank cleaning should be part of the work

procedure when cleaning tanks after unloading petroleum products.

- Crew members should be instructed to conduct gas-free operations after preparing ventilation lines through which cargo pumps will be ventilated.

- Hot work procedures must be properly followed to ensure the safety of the ship and its crew.

- No task should be allowed to continue if Risk Assessments have not been properly conducted with a view to minimise the risk.

- When a crew member becomes cognizant of an unsafe condition, act, error, or omission or a lack understanding that could result in an undesired result, the crew member must take measures to stop work together with the master and safety officer, if time is available, or independently if time is unavailable.

Who may benefit?

Seafarers, shipowners and operators.

2 COLLISION

Very serious marine casualty: Collision resulting in fire, sinking and multiple fatalities

What happened?

An 85,000 GT oil tanker and a 40,000 GT bulk carrier were involved in a collision during the dark hours of the evening. The oil tanker was carrying 100,000 MT of condensate.

The oil tanker was on a northerly course while the bulk carrier was on its starboard bow proceeding on a south-westerly course. Prior to the collision, each vessel was aware of the presence of the other.

The bow of the bulk carrier collided with the starboard hull of No.2 and No.3 ballast tanks of the oil tanker, breaching the cargo tanks. The collision resulted in the cargo of condensate catching fire, which then led to explosions on board and subsequently resulted in the sinking of the oil tanker and the loss of all of its 32 crew. The bulk carrier suffered extensive damage to the bow as well as to the accommodation and structure as the result of being stuck to the burning oil tanker before it separated.

Both vessels were being navigated under the charge of their respective Third Officers assisted by an able seafarer (deck) as the lookout. The Third Officer of the bulk carrier had just taken over the watch from the Chief Officer prior to the collision. The officer of the oil tanker seems to have influenced the lookout's knowledge with his own erroneous perception of the situation.

Why did it happen?

The oil tanker's watchkeeping officer perceived the bulk carrier as a small vessel and appears to have believed that smaller vessels were to give way to big vessels like the oil tanker. The officer did not take action when the lookout advised him to do so.

The bulk carrier's watchkeeping personnel had not noticed the oil tanker's presence up until the time of collision, nor the flashing signals given by the oil tanker, and they relied on the AIS as the sole means of collision avoidance. There were inadequacies in the bridge watch handover procedures on the bulk carrier.

Neither vessel complied with the requirements of Rule 5 of the COLREGS to maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions, and did not make a full appraisal of the situation and of the risk

of collision. Both vessels failed to comply with the requirements of Rule 7 of the COLREGS to use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists.

There was also a non-compliance with other COLREGS, i.e. Rule 16 (Actions by give-way vessel – by the oil tanker), Rule 17 (Actions by Stand-on vessel) when the two vessels were in a crossing situation.

What can we learn?

- All vessels must use all available means to assess risk of collision and take appropriate collision avoidance actions as required by COLREGS
- AIS alone should not be used for assessing risk of collision. Proper use of radar equipment for systematic observation is important to avoid decision-making based on assumptions and scanty information.
- Safety of navigation should be the primary responsibility of watchkeeping officers to ensure the safety of vessels under their charge while taking into account surrounding traffic conditions
- Companies should encourage a lower the authority gradient to allow crew to speak up and raise concerns when information or advice is disregarded by higher-ranking officers.

Who may benefit?

Seafarers, shipowners and operators.

3 FIRE

Very serious marine casualty: Fire in a cargo hold and total loss

What happened?

As the 2,000 GT cargo ship, with a master and ten other crew members aboard, was waiting to begin loading of waste metal and other miscellaneous scrap at a berth, a fire broke out in the aft cargo hold.

The vessel foundered during fire-fighting operations and became a total loss. An oil spill occurred, but there were no fatalities or injuries.

Why did it happen?

A fire that broke out in the scrap loaded into the aft cargo hold spread because fire-fighting by water-spraying was ineffective and appropriate fire-fighting methods using the vessel's carbon dioxide fire-extinguishing system were not employed.

The master did not think of using the carbon dioxide fire-extinguishing system. He did not have experience of fire drills for a fire in the vessel's cargo holds and information was not shared between the vessel and the shipowner regarding effective fire-fighting methods.

The sprayed water was blocked by the scrap's surface layer and did not reach the fire's origin.

It is fairly likely that a spark created by contact between metal objects, a battery, or similar was the source of the fire, and that the source ignited combustible material.

Lessons we can learn

- Masters shall build a thorough system for appropriate and efficient fire fighting in

case of fire in consultation with the stevedoring company by considering and determining appropriate fire-fighting methods in accordance with the cargo's characteristics beforehand and by conveying this information to the stevedoring company.

- Masters shall pay full attention to the following points regarding fire-fighting methods for fires within piled scrap:

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  - Fire fighting by water-spraying may not be effective because the sprayed water can be blocked by the scrap surface layer and not reach the fire's origin.

  - Insulation material and other combustible items with low specific gravity may float in a burning state even when the water level in the cargo holds rises from continuous water-spraying and continue to burn on the water's surface.

  - Fire fighting using carbon dioxide fire-extinguishing system is effective.

  - When a vessel has multiple cargo holds, measures such as immediately closing and sealing the hatch covers of cargo holds other than the cargo hold with the fire shall be taken to prevent a fire's spread.

- Masters shall provide reliable information on fire-fighting equipment aboard their vessel to the fire-fighting organization.

- Shipowners shall provide thorough instruction to masters of their vessels to unfailingly execute the measures described above and shall also implement training in accordance with the measures

- Shipowners shall fully understand cargo characteristics and communicate information on those characteristics to vessels scheduled for cargo-handling. Shipowners shall also build a thorough system for appropriate and efficient fire fighting on board vessels by checking the fire-fighting equipment on those vessels and comprehending the appropriate fire-fighting methods.

- Fire-fighting organizations shall study more effective fire fighting by taking into account the specific nature of fires on scrap-carrying vessels.

- Masters and shipowners shall implement measures as soon as possible to control oil, such as closing air vents and setting up oil fences, whenever the danger of an oil spill from a vessel arises.

- Whenever there is a danger of an oil spill from a vessel, the port management body shall consider the measures to control the oil taken by the master and owner of the vessel and, as necessary, implement measures to control the oil, such as setting up an oil fence, as soon as possible.

Who may benefit?

Seafarers, shipowners, fire-fighting organizations, port managers.

4 GROUNDING

Very serious marine casualty: Grounding and total loss

What happened?

While moored at a berth, the 1,800 GT cargo ship was subjected to wind and waves occurring with the approach of a typhoon. Her mooring ropes broke and she drifted within the port. She subsequently attempted to move out of the port using her engine; however, ship manoeuvring became difficult and she ran aground on wave dissipating blocks of the breakwater on the opposite bank of the berth.

The ship's engine-room and other areas flooded and she became a total loss. However, there were no fatalities or injuries among her crew.

Why did it happen?

The vessel drifted within the port because her mooring ropes broke and, although she attempted to head out of the port using her engine, she was subsequently subjected to wind and waves, ship manoeuvring became difficult, and she drifted and ran aground on wave dissipating blocks.

She was subjected to wind and waves that expedited the hull's motion, as she was using mooring ropes with reduced strength due to fatigue degradation and age degradation, and consequently the load applied to the mooring ropes exceeded their strength.

Although he added mooring ropes, the master's use of multiple mooring ropes of different diameters together and mooring of the ship with ropes made slack contributed to the breaking of the mooring ropes.

Lessons we can learn

- For the use of mooring ropes, masters must conduct appropriate maintenance inspections, must not use ropes that have lost strength from degradation, and must not use ropes of different diameters together.
- Regarding the berth mooring method in heavy weather, masters must appropriately add mooring ropes so that load is distributed evenly.
- When heavy weather attributable to a typhoon or other phenomenon is predicted, masters must:
    - Strive to accurately ascertain and predict weather and sea conditions.
    - Accurately ascertain port characteristics.
    - Quickly execute necessary heavy-weather countermeasures, including considering evacuation.
- Masters must be wary of becoming overconfident in their own abilities and experience and of easily adopting an optimistic view based on assumptions resulting from habit, even in ports where they have extensive experience entering and leaving.

- Management companies must fully provide notification concerning the points mentioned above to masters and crew members on the ships they manage, using examples of past accidents that have occurred in the port for illustration.

- Management companies must provide further professional training that addresses the use of inappropriate mooring methods — namely, mooring with slack mooring ropes — and have their masters and crew members act accordingly.

Who may benefit?

Seafarers, ship managers.

5 FLOODING AND FOUNDERING

Very serious marine casualty: Engine-room flooding and foundering

What happened?

A 1,200 GT general cargo ship, which was carrying iron slag on a cabotage voyage in good weather conditions, raised a Mayday call through VHF Channel 16, stating that its engine-room was flooding and that the ship gradually sinking. The Master then ordered his crew to launch the rescue boat to abandon the sinking ship. A containership navigating in the vicinity responded to the Mayday call and successfully rescued all 10 crew members from the rescue boat. The 10 crew members were later transferred to a Coast Guard boat.

As a result of the flooding, the general cargo ship sank and was declared a total loss.

There was no oil pollution, crew injury or death arising from the incident.

Why did it happen?

The 1984-built general cargo ship had carried out periodic maintenance and repair of the sea water pipelines (pipe, valve, seal, gasket) in the engine-room during dry-docking.

Hull areas below the waterline were also blasted and painted, and 42 anodes were renewed.

The result of the underwater plate thickness measurement had showed no appreciable diminution in the thickness of the steel plate; hence, no bottom plate steel renewal was made.

However, considering the age of the vessel, it was postulated that corrosion, decay and failure in the sea water pipelines may have been contributory to the flooding.

The Chief Engineer had noted during his shift that the bilge alarm in the engine-room had been activated when it reached the set level, and he had pumped out the bilges. He had also given instructions to the Duty Engineer to check the bilge level at the beginning of each shift.

The Duty Engineer was working in the engine-room workshop when he received the bilge water alarm. He acknowledged the alarm, but he did not immediately investigate the source of the bilge water alarm. Later, when realising that the bilge alarm light had kept blinking, he went down to check the engine-room bilges, joined by the Chief Engineer.

They were however not able to identify the source of the flooding, as the water level had risen above the engine floor plate. At this level, it was also impossible to start the bilge pump. To prevent damage, the Chief Engineer stopped the main engine, went up to the bridge, and apprised the Master of the situation in the engine-room.

The Master subsequently raised a Mayday call through VHF Channel 16, and ordered his crew to launch the six-person capacity rescue boat for abandoning the ship. The general alarm was not rung, and he also did not give instructions to his crew to close all water-tight compartments before abandoning the ship.

The rescue boat was launched, and all 10 crew were mustered and they boarded the six-person capacity rescue boat. One crew member abandoned the ship without wearing his life jacket.

What can we learn?

- Pay particular attention to mechanical, structural or material failure due to the ship's age. Particular attention should be given to the seawater pipelines in older ships due to the higher probability of developing corrosion, decay and failure which could contribute to flooding.

- Keep effective engine-room watch and control. The Duty Engineer should not be distracted from performing his main engine watchkeeping duty. When he first received the alarm, the Duty Engineer was in the engine-room workshop. Immediate and prompt action at the first instance in identifying the source of the flooding would have provided sufficient time for mitigation actions to be taken.

- The importance of conducting regular and periodic training and drills. Had regular and periodic training and drills been done on board, the Master would have rung the general alarm and would have given instruction to close the water-tight compartments. The Master would also have ordered the launching of the 16-person life raft instead of the six-person rescue boat for the 10 crew members to abandon ship. The crew too would have been drilled to close the water-tight compartments, and to assemble at the Muster Point with their life jackets appropriately worn. Ringing the general alarm would also have made the crew more aware of the situation and the closing of the water-tight compartments would have slowed down the rate of sinking.

Who may benefit?

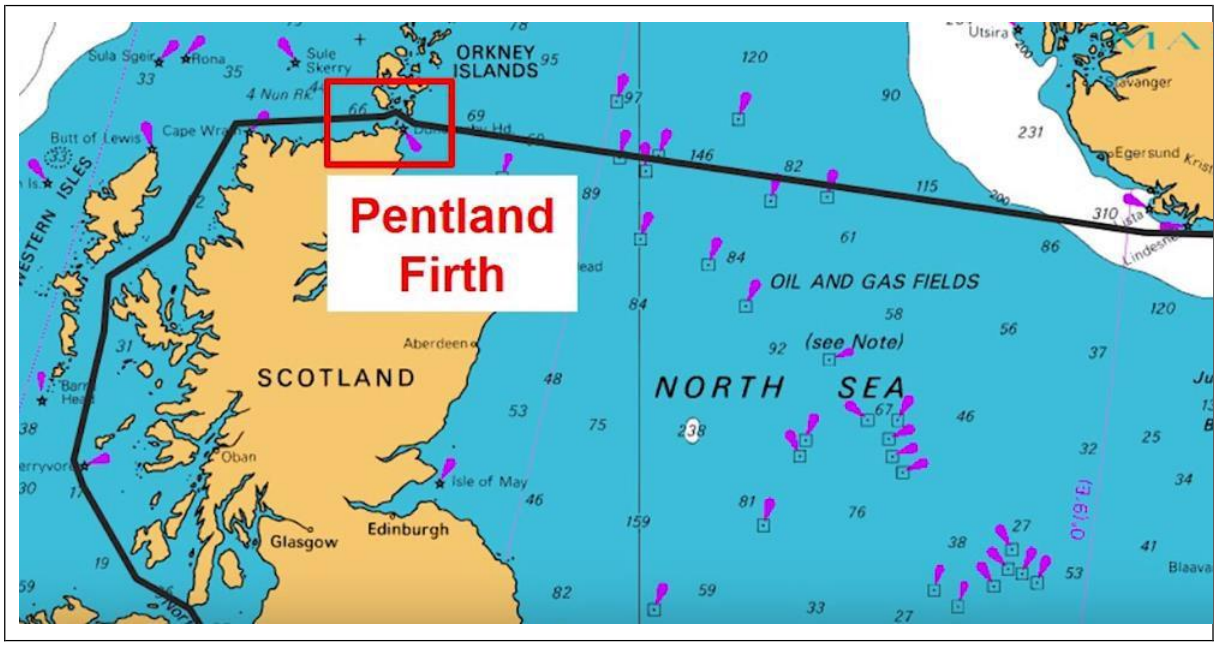
Seafarers, shipowners and operators, flag Administrators.

6 CAPSIZE AND SINKING

Very serious marine casualty: Capsize and sinking with loss of lives

What happened?

A cement carrier, loaded with about 2,100 tonnes of cement in bulk, departed with the intention to take the ship north around Scotland through the Pentland Firth.



As the ship crossed the North Sea, the weather deteriorated significantly, reducing the ship's speed and delaying its anticipated time of arrival.

Once inside the Pentland Firth, a crossing ferry sighted the cement carrier upright, making slow headway and pitching heavily into the large waves.

The fully laden cement carrier capsized in extremely violent sea conditions while transiting the Pentland Firth. The rapid nature of the capsize had denied the crew any opportunity to raise a distress call or to abandon the ship in a controlled manner.

Twenty-five hours later, a roll-on roll-off passenger ferry sighted its upturned hull and raised the alarm.

An extensive search followed but regrettably none of the eight crew was found, presumably all had perished.

Why did it happen?

- Although there is insufficient evidence to determine the cement carrier's exact stability condition at the time of the capsize, there were shortcomings in its stability management. The ship was found to have been loaded improperly, not in accordance with procedures for loading cement cargoes, potentially increasing its vulnerability to capsize.

- The investigation found that the ship capsized when it encountered violent storm conditions created by a strong tidal stream and opposing gale force winds. This combination of factors created treacherous sea conditions that were impassable to small vessels. The ship had slowed down to reduce the effect of pitching and pounding in the heavy seas, but this had led to the loss of steerage control and probable capsize to port.

- The capsize itself was likely exacerbated by a shift in the cement cargo when the ship heeled beyond 30°.

- Such extremely violent storm conditions were predictable and are commonly experienced. The onboard decision to enter the Pentland Firth was a result of insufficient passage planning and underestimation of the sea conditions.

- The master's decision to transit the Pentland Firth at that time was probably influenced by actual or perceived commercial pressures and his personal determination to succeed.

- The cement carrier was put to sea with significant shipboard safety deficiencies relating to its rescue boat launching arrangements and bilge pumping system in the void spaces beneath the cement cargo holds.

- The rapid nature of the capsize denied the crew the opportunity to broadcast a distress message or the chance of a controlled abandonment. The emergency position indicating radio beacon (EPIRB) was probably released from its housing but then became trapped in the upturned hull and therefore did not float free to the surface or transmit.

What can we learn?

- Six hours on/six hours off watchkeeping routine in short coastal trading cargo vessels can generate high levels of fatigue. Additional problems will almost certainly increase the hours of work and disrupt normal working routines.

Deteriorating sea conditions will adversely affect the quality of sleep. Thus, there was a significant risk of crew suffering the effects of fatigue, affecting the outcome of decisions.

- Six of the eight crew members were serving on board the ship on their first contract. As a result, the crew had limited collective experience, and this would have increased the master's operational burden and reduced the level of support available to him, and made it more difficult for the crew on their first contracts to challenge the master's decisions regarding the operational conduct of the vessel.

- The investigation has identified that industry and commercial pressures at all levels of management and oversight of this ship had an impact on the ship's operations. These factors would inevitably have had an effect on the master's decision-making and on his willingness to accept higher levels of risk to achieve his goals.

- Owners and masters have the pivotal role of embedding and promoting a strong safety culture among their crews. If they do not take a positive approach to safety management, then it is likely their crew will adopt similar attitudes, and a poor safety culture will result. Learning lessons from less serious marine incidents or near misses can significantly improve safety awareness and help promote safety culture.

- Passage planning requires that all hazards are taken into account and avoided; the extraordinarily violent and fatal sea conditions were predictable, well-documented in nautical publications, and could have been avoided.

Who may benefit?

Seafarers, shipowners and operators, flag Administrators.

7 Fire

Very serious casualty: Engine-room fire resulting in one fatality

What happened?

A suction dredger was dredging for a cargo of sand approximately 12 miles off the coast when a fire occurred in the engine-room. The watchkeeping engineer, who was the sole occupant in the engine-room, was using an angle grinder to attempt to repair a leak in a low-pressure fuel return line on the main engine fuel system while the engine was running. The fire started when high-energy sparks from the angle grinder ignited the atomised fuel from the leak and the diesel-soaked overalls he was wearing.

The engineer managed to escape the engine-room and was evacuated by helicopter to a hospital, where he later died because of serious burn injuries.

The intensity of heat and smoke prevented the crew from making a direct attack on the fire, so they activated the fixed CO_2 fixed fire-fighting system in the engine-room and provided boundary cooling, which was successful in extinguishing the fire.

Why did it happen?

- The brackets securing the low-pressure fuel lines had loosened in service due to corrosion and vibration, allowing fretting to occur and a hole to develop in a fuel line.

- The flag regulator had not promulgated the IMO circular, which recommends 6-monthly inspections of low-pressure fuel lines. The operator's planned maintenance system did not require inspection of low-pressure fuel lines, nor had the generally poor condition of the low-pressure fuel system been detected through the Classification Society surveys.

- The use of an angle grinder was not included in the operator's list of hot-work activity, and consequently a work permit was not routinely issued for any time a portable grinder was used.

- The presence of atomised fuel coupled with the wicking effect of the engineer's diesel-saturated coveralls resulted in an extremely flammable garment susceptible to ignition by sparks from the angle grinder.

- Although the severity of the engineer's injuries was such that any action taken by the crew was unlikely to have saved his life, the crew's actions were not consistent with best medical advice.

What can we learn?

- It is important that surveyors, ship operators and ships' crew routinely inspect low-pressure fuel systems in accordance with IMO guidance to ensure that the systems remain fit for purpose at all times.

- The high-energy sparks generated by abrasive wheels during grinding and cutting operations (including portable angle grinders) contain sufficient energy to ignite flammable substances, and this should therefore be recognized and treated as hot work activities.

- Working alone in hazardous workspaces should ideally be avoided, but at least be managed by an effective communication system that ensures the safety of the worker.

- Coveralls worn in engine-rooms or any area where there is a risk of fire should be made from fabric of low flammability, but regardless of the fabric used, this does not provide assurance against ignition and flame-spread, particularly when contaminated by flammable substances.

- It is important that injured persons be treated by persons trained to the appropriate medical standards and that the best medical advice is followed.

- At the same time as managing the risk of hypothermia, it is important that cooling of extensive burns be undertaken without delay, particularly within the first 30 minutes.

- Any response to a fire or other emergency must be fully coordinated in accordance with good industry practice and shipboard procedures.

- Once a fixed CO2 fire-extinguishing system has been activated, the room in which the plant is located should not be entered without first checking that the atmosphere inside the room is safe.

Who may benefit?

Seafarers, shipping owners and operators, surveyors, flag Administrations.

8 Fall overboard

Very serious casualty: Crew member dies when falling overboard onto

bunker barge What happened?

A containership was exchanging containers in a sheltered port. A bunker barge was moored alongside the ship transferring about 700 metric tonnes of fuel oil on board the ship via a six-inch-diameter bunker hose. The bunker hose had been lifted on board using the ship's stores crane and connected to the ship's bunker manifold. The weather was fine with light winds. The ship was stable at the berth and the deck in the area of the bunker manifold was dry and free from contaminants.

The bunker hose passed through a section of the ships rail where the top bar of the rail could be removed, allowing the bunker hose to rest on a round bar to prevent chaffing and kinking. During bunkering, the hose was further supported from above by a strop connected to the ship's stores crane.

Once bunkering was complete, an engine-room wiper and a fitter were tasked with disconnecting the bunker hose from the bunker manifold. The wiper and the fitter together removed seven of the eight bolts securing the bunker hose flange to the ship's manifold. The fitter then grabbed the bunker hose under his right arm while the wiper removed the last bolt. As soon as the flange disengaged from the last bolt, the hose swung outboard pulling the fitter towards the ship's rail, whereupon he lost his balance and toppled through the opening where the bunker hose had passed through the rail. The fitter fell several meters to the deck of the bunker barge below, and was fatally injured.

Why did it happen?

The head of the ship's stores crane, from which the bunker hose was suspended, was positioned out towards the ship's rail instead of directly above the bunker manifold, which resulted in the bunker hose swinging out towards the ship's rail once it had been disconnected.

What can we learn?

- It is important when working with suspended loads to remain vigilant to the factors that will cause the load to shift.

- A safety line is an effective way of controlling suspended loads that may be liable to shifting unexpectedly.

Who may benefit?

Seafarers.

9 Foundering

Very serious marine casualty: Foundering due to hull-to hull interaction

What happened?

An 11 m work boat was acting as the lines boat assisting the berthing of a 68 m, 1,000 GT motor tanker. With the ship underway, the work boat was manoeuvred close in to the ship's bow in order to retrieve a mooring line. In this position, the hull-to-hull interaction forces caused the work boat to turn across in front of the ship's bow. The resulting collision capsized the work boat. Both occupants made it safely clear and suffered only minor injuries.

Why did it happen?

The work boat was manoeuvred in very close to the moving ship to aid the retrieval of the mooring line. In this position, close to the ship's hull, the coxswain of the work boat underestimated the interaction forces acting between the two vessels.

What can we learn?

- Interaction forces between two moving vessels can be sufficiently large to seriously affect the manoeuvrability of either or both vessels. This is particularly important for small vessels when manoeuvring close to a larger vessel, as the forces can quickly cause a dangerous situation to arise.

- Masters and coxswains of all vessels, including port service vessels and work boats, should be fully aware of and trained in the dangers associated with hull-to-hull interaction.

Who may benefit?

All vessel crew members including port service providers.

10 Fatality

Very serious marine casualty: Crew member falling overboard onto wharf below

What happened?

On a 123 m long, 5,300 GT chemical/oil tanker, an able seaman was fatally injured while throwing rubbish from the ship's second deck into a rubbish container on the wharf 8 m below. The able seaman was in the area reserved for life-raft stowage and launching, protected only by two chains strung across the opening in the handrails. He lost his balance, and as the chains were insufficient to restrain him, he fell over the side onto the wharf below.

Why did it happen?

The risks associated with the task had not been sufficiently well assessed and preventative

measures to guard against a fall from height were not implemented.

The chains in place protecting a gap in the handrails were insufficient to provide protection if leant or fallen against. The gap was more than two metres longer than it should have been. This had escaped notice since the ship was built.

What can we learn?

- All shipboard activities should be considered from a risk management perspective.

- All work near the ship's side needs to be assessed in regard to the dangers of falling from height. This accident highlights how flexible barriers such as chains may be insufficient to prevent or arrest a fall.

- The risks involved in seemingly routine tasks can be perceived to be lower when the tasks are undertaken with a degree of autonomy, freedom of choice and are thought to be within one's own control. A positive illusion of control is established where the risk is underestimated and a person is therefore more willing to accept the risk and exposure to hazards.

Who may benefit?

All seafarers, shipowners and operators, surveyors.

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