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MARINE ACCIDENT REPORT – B/W HAVFROST, SHIPBOARD OCCUPATIONAL ACCIDENT IN SINGAPORE 9 JUNE 2014

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This report has been translated into English and published by the Accident Investigation Board Norway (AIBN) to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photo of ferry on the Norwegian west coast: Bente Amandussen

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NOTIFICATION OF THE ACCIDENT

At 10:17 on 9 June 2014, the Norwegian Maritime Authority (NMA) notified the Accident Investigation Board Norway (AIBN) of an occupational accident that had occurred on board the gas tanker *BW Havfrost* previously the same day. *BW Havfrost* was moored beside the quay at Sembawang Shipyard in Singapore awaiting docking, when an ordinary seaman fell into a cargo tank and died. The AIBN decided to conduct a safety investigation into the accident, and two AIBN inspectors travelled to Singapore on 12 June to carry out shipboard examinations and interview the crew and personnel involved.

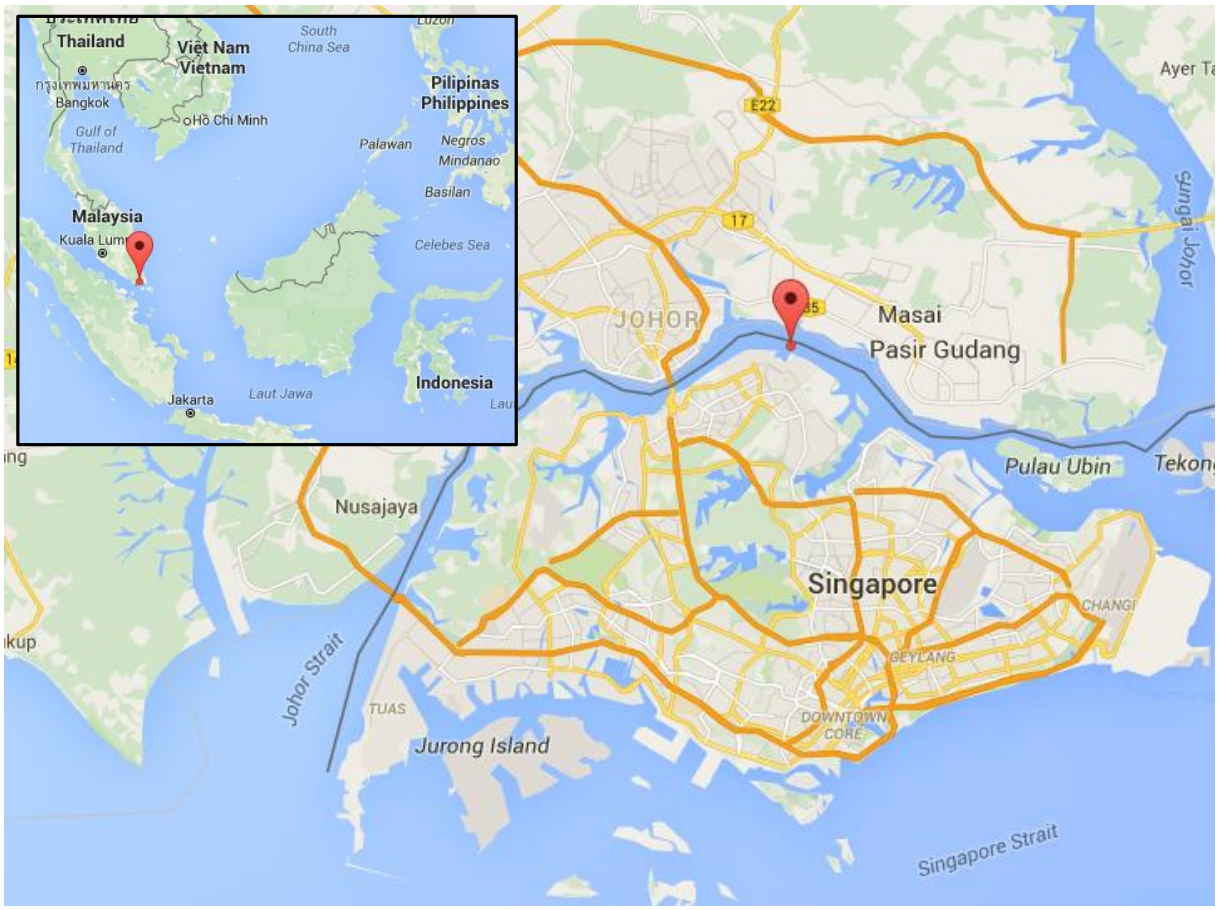

Figure 1: Sembawang Shipyard, Singapore. Map: Google Maps

SUMMARY

The accident occurred when the ordinary seaman entered cargo tank 4P to assist the bosun and an able seaman in retrieving a hatch cover that had fallen into the tank.

The day before the accident, the shipyard had issued an entry permit for the tank in question, on which it was indicated that adequate illumination had been provided and unsecured openings had been secured. However, during a tank inspection on the same day, the chief mate and deck trainee found that no lighting had been rigged up to illuminate the tanks. They also found that a hatch cover had become dislodged from the deck in the lower tank dome and fallen to the bottom of the cargo tank, leaving the maintenance hatch open and unsecured.

On the following day, the bosun, the able seaman and the ordinary seaman entered the tank, among other things to hoist up the hatch cover. The able seaman was the first to climb into the tank dome, followed by the bosun. These two were busy preparing the equipment they intended to use and had

their back to the entrance ladder when the ordinary seaman entered the tank as the last of the three. After a couple of minutes, the bosun wondered where the ordinary seaman had got to, and he therefore shone his light around the space in order to locate him. As the ordinary seaman was nowhere to be seen, the bosun went over to the open hatch and looked into the tank. He saw the ordinary seaman lying lifeless at the bottom of the tank.

When the crew were about to start the work in the tank, they were aware that no lighting had been rigged up yet. Portable work lights were available on board the vessel, and it would have been relatively easy to rig them up inside the tank while waiting for the yard to arrange illumination. Despite this, the crew chose to start the work using only the vessel's torches.

The ordinary seaman had spent time on deck in full daylight before he entered the tank. Research has shown that it can take as long as 30 minutes to adapt one's eyesight to the dark and establish night vision. Hence, the ordinary seaman would not have been able to adapt to the dark inside the tank in the short space of time that passed before he fell. The AIBN finds that the lighting conditions in combination with the failure to cordon off or place guardrails around the maintenance hatch were factors that contributed to the ordinary seaman's fall.

None of the three people who were to carry out the work in cargo tank 4P had entered this tank before, but the bosun and able seaman had previously entered similar tanks. The ordinary seaman was aware of the open and unsecured maintenance hatch when he entered the tank, but he did not know exactly where in the tank the hatch was located. He had never been inside a cargo tank before, and the AIBN finds that this contributed to increasing the risk of an accident.

The AIBN finds that the shipyard's failure to prepare the tank and its incorrect completion of the entry permit also contributed to increasing the risk of an accident. The shipyard has not answered the AIBN's inquiries about what measures it has implemented following the accident, but the shipping company has stated that it has conducted a follow-up process in relation to the yard, to address its procedures and safety management.

The shipping company has initiated several measures to improve the safety of the crew during yard stays, and therefore the AIBN will not issue any safety recommendations in connection with this accident.

1. FACTUAL INFORMATION

The factual information is mainly based on interviews with the vessel's crew and other employees of BW Fleet Management, and on documentation from the shipping company. Shipboard examinations were also carried out, including of the tank in question, as well as a reconstruction of the accident. Information about Sembawang Shipyard has mainly been obtained from the yard's website and available brochures etc. The shipyard has not answered the AIBN's inquiries.

1.1 Sequence of events

Figure 2: BW Havfrost. Photo: BW Maritime

BW Havfrost moored beside the quay at Sembawang Shipyard in the morning on 7 June 2014, at around 11:30 local time.

In a meeting with the shipyard at approximately 09:00 on 8 June, the vessel's representatives asked for a permit to enter tanks and enclosed spaces, as they considered it important to get started on work in these areas of the vessel.

The vessel received the above-mentioned permit at 10:43. It was indicated for each individual tank that adequate ventilation had been arranged, adequate illumination provided and unsecured openings secured. The chief mate and deck trainee then entered cargo tank no 4 on the port side (4P) to inspect it.

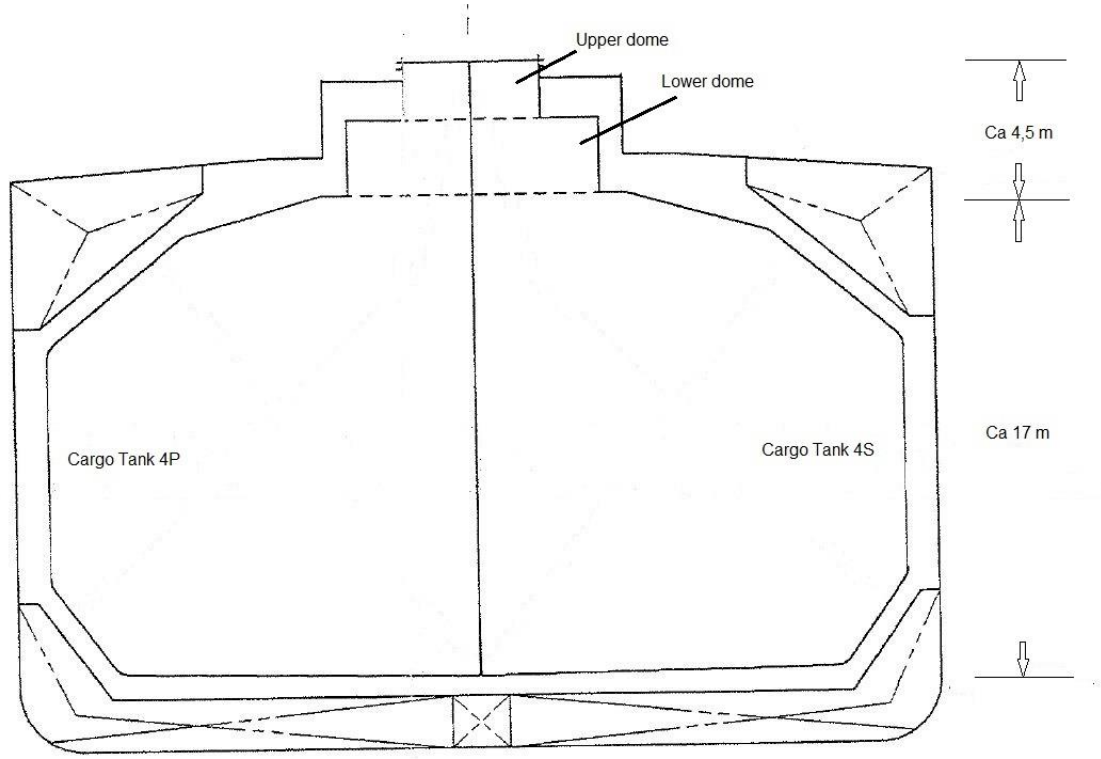

Figure 3: Schematic diagram of the vessel's cross-section at cargo tank no 4. Source: Drawing provided by BW Havfrost and edited by the AIBN

When the chief mate and deck trainee entered the tank, they found that no lighting had been set up inside. They therefore used their own lanterns. During the inspection, they found that a hatch cover had become dislodged from the deck in the lower tank dome and fallen to the bottom of the cargo tank, leaving the maintenance hatch[1] open and unsecured. The distance to the tank top was about 17 metres. They also found that the ventilation hose provided by the yard was coiled up on deck in the lower tank dome. The chief mate and trainee fed the end of the hose through the maintenance hatch to ensure that there was also ventilation inside the cargo tank itself.

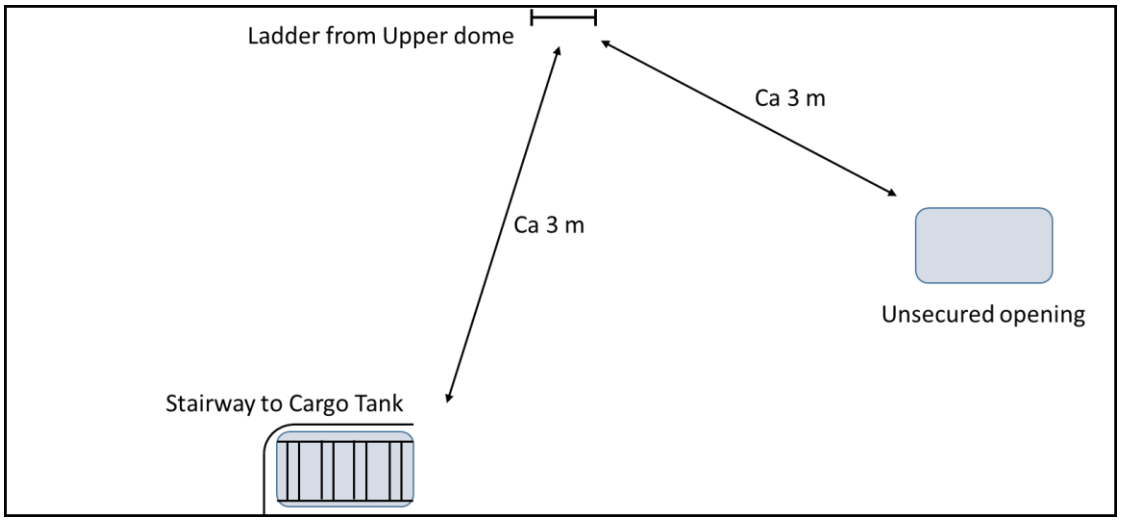

Figure 4: Schematic diagram of the deck in the lower dome. Illustration: AIBN

[1] The maintenance hatch had been arranged so that the cargo discharge pump could be hoisted up for maintenance purposes etc.

The chief mate decided that the work inside the tank would not start until the next day, as he wanted to have sufficient time and crew available to carry out the job. The vessel's master and shipping company's inspector were informed about the observations that had been made.

At the safety morning meeting that was held at 7:40 on 9 June, the chief mate issued the bosun with work orders for the day. The hatch cover that had fallen into cargo tank 4P was to be hoisted up, the pump sump was to be emptied and general maintenance carried out in the tank. The chief mate also told the bosun to be extra vigilant and careful on account of the open hatch. After the meeting, the bosun passed this information on to the able seaman and the ordinary seaman who were to assist with this job later that day. None of them had entered this tank before, but the bosun and able seaman had previously entered several similar tanks.

The daily meeting between the vessel and the shipyard was held at 09:00. On the part of the vessel, requests were put forward for better ventilation of the tanks, in addition to a permit to commence work in cargo tank 4P. The yard's representatives confirmed that they would arrange for better ventilation and they themselves pointed out that there was a lack of lighting in void spaces and enclosed spaces and that this would be arranged where needed. Concerning a work permit for the tank in question, they pointed out that the previously issued general entry permit for enclosed spaces also applied to cargo tank 4P.

After the coffee break at 10:00, the bosun, able seaman and ordinary seaman started lowering equipment into the tank dome. The hatch cover that had fallen into the cargo tank was to be hoisted up by means of a pulley that would be attached to a beam under the deck above the hatch. The equipment was prepared in advance outside the hatch on deck. The ordinary seaman stood watch outside by the hatch on deck.

The able seaman was the first to climb into the tank dome. He was not sure where the maintenance hatch in the deck was located, so he used his torch to get an overview. When he had located the hatch, he started to rig the equipment in the vicinity of the ladder that led down into the cargo tank. This was done at a safe distance from the unsecured opening.

The bosun followed close behind. He looked around to locate the opening in the deck before he went over to the able seaman. No lighting had yet been rigged up in the tanks, but both men carried lanterns and felt comfortable that these would provide sufficient light for the time being. Both men were working on preparing the equipment, with their back to the entrance ladder: see Figure 5 below.

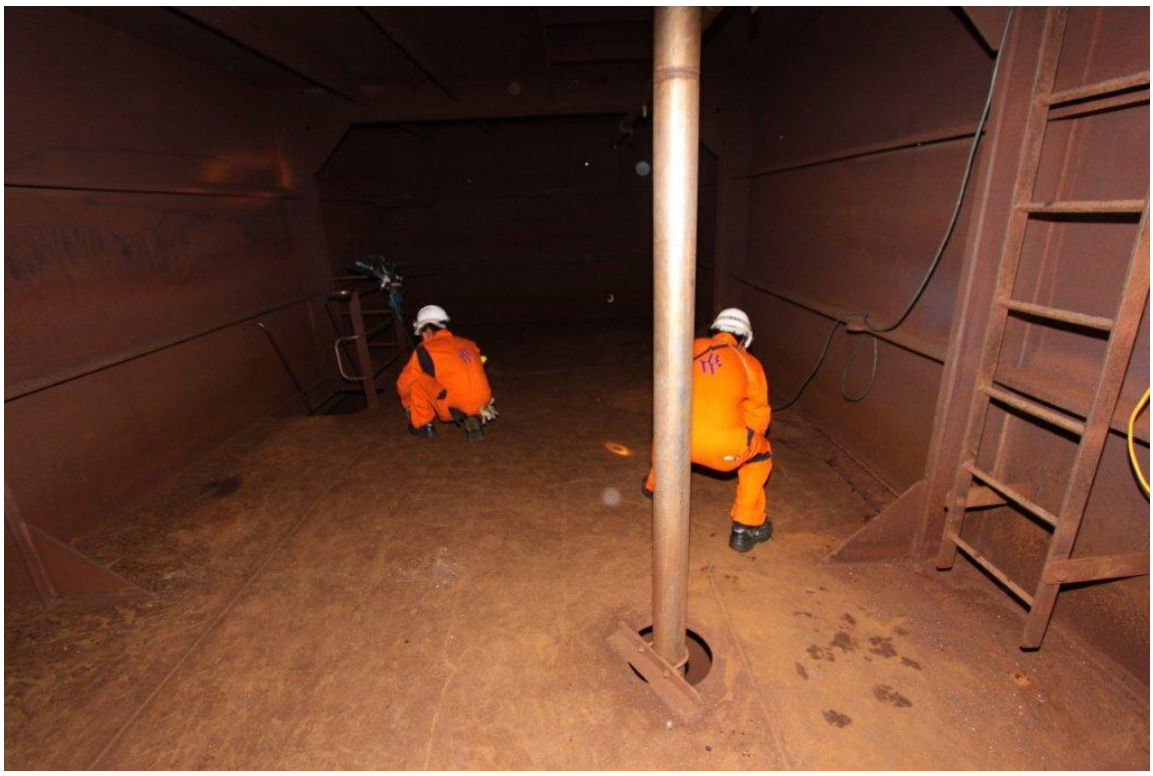

Figure 5: Photo from the lower dome. The approximate positions of the bosun and able seaman. Photo: Asker and Bærum Police

The deck trainee had meanwhile completed his tasks and was asked by the chief mate to relieve the ordinary seaman, so that the latter could assist the bosun and able seaman down in the tank. The ordinary seaman was carrying a hand-held torch when he entered the tank. At 10:40, the trainee radioed the chief mate with the message that he had taken over and that the ordinary seaman had started to climb into the tank.

The bosun also heard this message. The bosun heard the ordinary seaman as he started to climb down the ladder, but after one or two minutes he wondered where he had got to. He therefore shone his light around the space to locate the ordinary seaman. As the ordinary seaman was nowhere to be seen, the bosun went over to the open hatch and looked into the tank. He saw the ordinary seaman lying lifeless at the bottom of the tank. He called the able seaman who quickly climbed out of the tank to fetch a stretcher, while the bosun notified of the accident by radio. Neither the bosun nor the able seaman had seen the ordinary seaman come into the lower dome. The able seaman had just heard a thud, but had not given it any thought as he assumed that it came from some dropped tools or similar.

Figure 6: Photo from the lower dome. The unsecured opening can be seen at the far end. The guardrails were not in place at the time of the accident. The photo also shows the ventilation hose that had been fed into the tank through the unsecured open hatch. The red crosses indicate the approximate work positions of the bosun and able seaman. Photo: Asker and Bærum Police

The chief mate did not catch what was said in the radio message, but understood that something serious had happened. He called the trainee on the radio and told him that the ordinary seaman had fallen into the tank and needed help. The chief mate notified the vessel's master and the yard's safety manager, after which he entered the tank to assist in the rescue effort. Both members of the vessel's crew and personnel from the shipyard helped to get the ordinary seaman out of the tank and, by 10:50, they had brought him out on deck. First aid was administered immediately by medical personnel from the yard, until the ambulance arrived and the ambulance personnel took over. Shortly afterwards, while being transported by ambulance, the ordinary seaman was declared dead.

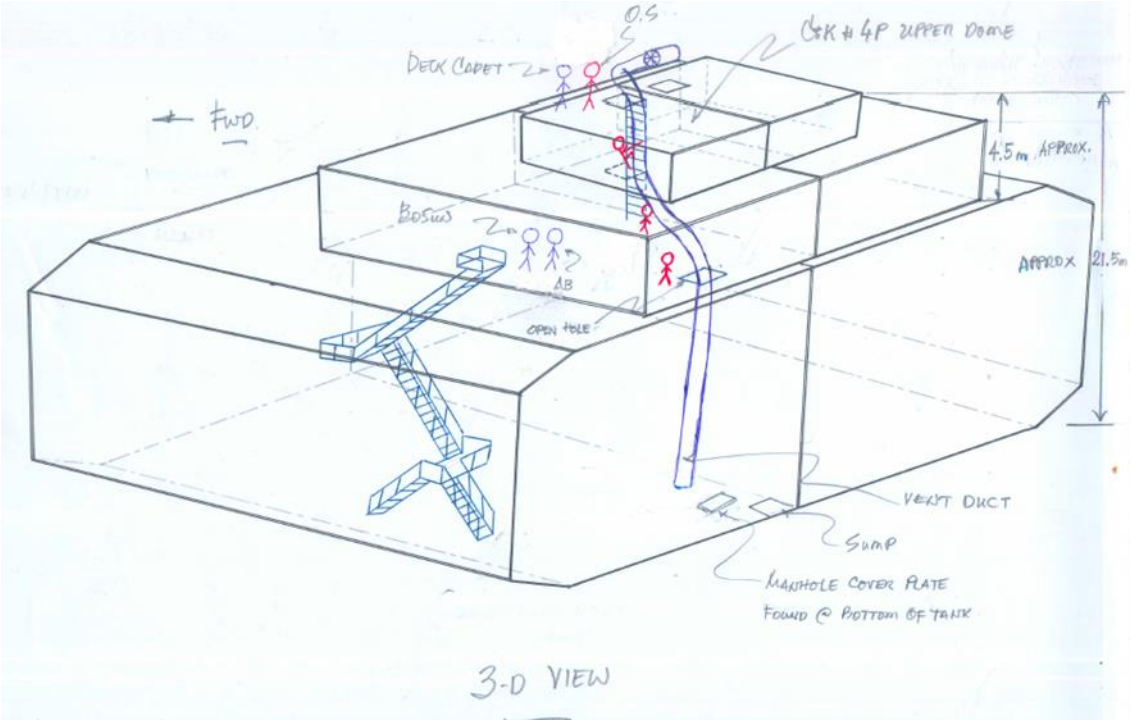

Figure 7: 3D drawing of cargo tanks 4S and 4P. The schematic diagram shows the positions and movements of the crew that were inside the tank at the time of the accident. Illustration: BW Havfrost

1.2 The yard stay

1.2.1 Challenges related to the yard stay

The transition from ordinary vessel operation to a yard stay can involve a number of challenges. There are tasks to be completed during a yard stay that are rarely or never performed at other times, such as inspection and maintenance of cargo tanks. The work to be performed during the course of a yard stay is normally divided between the vessel's crew, yard personnel, the yard's subcontractors and representatives of equipment manufacturers. All these people must be taken into consideration as regards safety, organisation and work performance. The division of responsibility and prioritisation of tasks can be challenging. There is a further transition from the vessel's own safety management system and procedures to the yard's procedures and safety requirements. Normally the pressure will also be on to finish in time.

1.2.2 Preparations for the yard stay

A routine docking of *BW Havfrost* at Sembawang Shipyard in Singapore had been scheduled for June 2014. The task of cleaning and preparing the vessel's ballast tanks had started already in early May. The bosun, able seaman and ordinary seaman were among those who had participated in this work, and they were used to work in enclosed spaces and in the light of headlights and torches.

After discharging the last of its cargo in Vung Tau in Vietnam on 31 May, the vessel set course for Singapore. On this voyage, it started the work of gas-freeing the void spaces and cargo tanks.

En route to Singapore, the master held a meeting for the entire crew, in which information was provided about the practical implications of a yard stay for both vessel and crew. In this meeting, there was a particular focus on safety.

BW Havfrost arrived at Singapore Explosive Anchorage on 6 June 2014. Chemists from Sembawang Shipyard boarded the vessel on the same day, carried out necessary measurements of the atmosphere in tanks and void spaces and declared the vessel to be gas-free.

1.2.3 Safety management in connection with the yard stay

BW Havfrost moored beside the quay at Sembawang Shipyard in the morning on 7 June 2014. The first safety and planning meeting between the vessel's management and the shipyard was held at 13:45 that same day. Among the things discussed at the meeting were health, safety and the environment (HSE), and a number of HSE documents were handed over to the vessel. Based on this, it was decided that the applicable procedures would be the yard's safety procedures and work permit system.

The master shared the HSE documentation with the chief mate and the chief engineer. After reviewing the documentation, he posted relevant parts of it on the shipboard bulletin board. A meeting with the crew was held in the evening, at which the master reviewed parts of the safety documentation received from the shipyard. He pointed out once again that a yard stay is materially different from following the day-to-day routines on board.

At the morning meeting at 7:40 on 8 June, the chief mate told the bosun what tasks were to be carried out in the course of the day, and that work in the tanks must wait until they received an entry permit from the yard.

During the yard stay, Vessel Safety Co-ordination Committee (VSCC) meetings were held on board on a daily basis, between personnel from the yard and the shipboard management team, including the shipping company's technical inspector. The topics of these meetings were planned jobs and HSE. The yard's standard minutes template was used to take minutes of the meetings.

In the VSCC meeting at 09:00 on 8 June, the vessel's representatives requested a permit to enter tanks and void spaces as they considered it important to get started on the work in these areas of the vessels as soon as possible. From the minutes of that meeting it is clear that ventilation was to be provided in all the cargo tanks and void spaces.

A little while later, at 10:20, the yard's safety officer held a safety meeting with the entire crew on board. Among other things, information was provided about the yard's safety procedures and work permit system.

At 10:43, the vessel was issued with an entry permit for void spaces. Even though the vessel had been issued with the necessary certificates and permits, it was decided to also use the vessel's own procedures for entry into enclosed spaces on this particular day. The crew therefore conducted a risk assessment before embarking on the inspection of cargo tank no 4. The inspector from the shipping company and the vessel's master considered this time-consuming double work as it was the shipyard's safety management system that was applicable, and they therefore decided that only the yard's system should be used from then on.

On the part of the vessel, requests were put forward for better ventilation of the tanks, in addition to a permit to commence work in cargo tank 4. The yard's representatives confirmed that they would arrange for better ventilation and they themselves pointed out that there was a lack of lighting in void spaces and that this should be arranged where needed. Concerning a work permit for the tank in question, they pointed out that the previously issued general entry permit for enclosed spaces also applied to cargo tank 4.

1.3 The vessel

BW Havfrost is a gas tanker of 34,946 gross tonnes, built by Kværner Govan in Glasgow in 1991.

The vessel has a length overall of 205 metres, a breadth of 32.2 metres and a moulded depth of 20 metres. *BW Havfrost* has eight cargo tanks (four on either side) with an aggregate volume of 57,180 cubic metres. The vessel carries liquefied petroleum gas (LPG), cooled to a temperature of -50 °C.

The ship is registered in the Norwegian International Ship Register (NIS) and classed by DNV-GL with class designation +1A1, Tanker for Liquefied Gas, ICE-C, E0, INERT, BIS (-50oC, 0.97/0.68t/m3, 0.25 bar).

All the vessel’s certificates were valid at the time of the accident. Most of the certificates were issued in 2012 and are valid until 2016. The vessel's Safety Management Certificate (SMC) was issued on 09 February 2014, valid until 16 March 2019.

The most recent survey of cargo tank 4P took place on 21 July 2011.

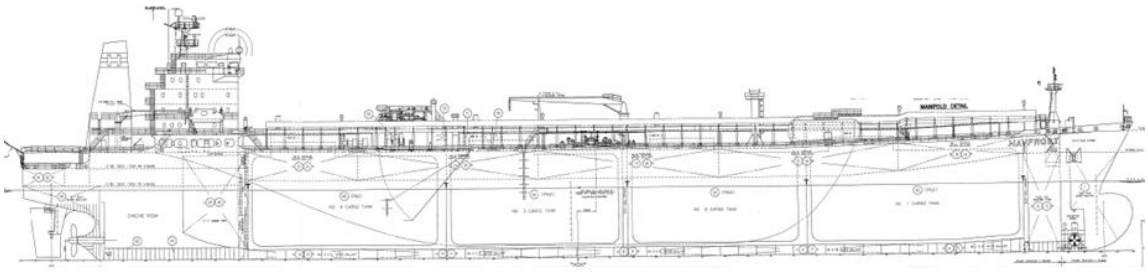

Figure 8: General arrangement (GA) plan drawing. Source: BW Havfrost

1.4 The crew

The master had been with the shipping company (Havtor – Bergesen – BW) since 1989, and he had been sailing as a master since February 2005. The master's first voyage on board *BW Havfrost* was in 2012.

The chief mate had been at sea for 19 years, 16 of which had been in the shipping company (Havtor – Bergesen – BW). He had been a chief mate since 2008, mainly on *BW Havfrost*'s sister ship. He had served on board *BW Havfrost* since March 2014. He had served on board other ships during several previous yard stays.

The bosun had been with the shipping company (Havtor – Bergesen – BW) for 25 years. He had served on board *BW Havfrost* since March 2014. This was his first time on board *BW Havfrost*, but he had previously worked on her sister vessels.

The able seaman had worked at sea for 14 years. He had been with the shipping company the whole time. He came on board in March, and this was his first voyage on *BW Havfrost*. He had no previous experience of this type of vessel.

The ordinary seaman who died was 22 years old, and this was his first sea voyage. He came on board as a deck hand in October 2013. He was described as full of initiative, a conscientious worker and a pleasant young man with great potential. When a position as ordinary seaman became vacant, he applied for promotion despite having spent only a short period on board. He completed some informal tests to prove that he was ready for promotion. After a shipboard evaluation and confirmation from the crew department, he was promoted to the position of ordinary seaman in February 2014.

The deck trainee was 20 years old and had served on board *BW Havfrost* since March 2013. This was his first sea voyage. He had two years of previous schooling from the Philippines, organised by BW.

1.5 The shipping company

1.5.1 BW Gas

BW Gas is part of the BW Group, which is primarily engaged in oil and gas transportation and floating offshore oil and gas production. The BW Group operates a fleet of 93 vessels.

BW Gas is a global gas transport player and, as of 2012, it had commercial responsibility for 47 gas tankers that mainly carried LNG and LPG.

BW Fleet Management is responsible for the technical management of all BW Gas's vessels.

1.5.2 The shipping company's safety management

The shipping company's safety management system (TQM – Total Quality Management) is a comprehensive system based on the International Safety Management Code (the ISM Code), and is intended to ensure compliance with national and international regulatory frameworks, the classification companies' rules, the oil companies' requirements and the shipping company's internal procedures.

1.5.2.1 *Procedure for risk assessment*

The shipping company's risk assessment procedure contains guidelines for the types of work to be risk-assessed, for the identification of hazardous work, for the frequency of risk assessments, risk classification, and how to reduce risk to an acceptable level in order to carry out the job in question.

1.5.2.2 *Procedure for safety meetings*

The shipping company has prepared a procedure for mandatory shipboard safety meetings. A daily safety meeting is to be held every morning between the chief mate and the bosun, to ensure that safety procedures are observed before carrying out the day's work.

1.5.2.3 *Dry Docking Guidelines*

The shipping company has an extensive manual for what should be done before, during and after docking of its vessels. Among other things, it contains information about how safety should be handled during docking. Docking entails dangers that do not usually arise during day-to-day operation. It is emphasised that safety during docking is controlled by the relevant shipyard's safety requirements, but that a yard stay does not entail any change in the vessel master's responsibility for safety.

1.5.2.4 *Procedures for entering enclosed spaces*

The shipping company's procedure for entering enclosed spaces has been established in order to ensure the safety of personnel who enter such spaces. It includes detailed descriptions of responsibility, entry permits, risk assessments, preparations and testing, but the information mostly concerns atmospheric conditions. The risk of falling is not mentioned and there is little focus on lighting. The entry permit includes a question on whether adequate illumination has been arranged.

1.5.3 Supervision of the shipping company and vessel

The most recent certification survey/classing of the vessel before the accident was carried out by DNV-GL in Fujairah in the United Arab Emirates on 25 April 2014. This was an intermediate survey, and no items were outstanding under official orders after the survey.

1.6 The shipyard

Sembawang Shipyard is situated on the north coast of Singapore. The yard is owned by Sembcorp Marine Ltd., and it offers expertise in repairs and conversion of most types of vessels. The yard has five docks with related facilities and a quay capacity of nearly four kilometres in total.

The AIBN has conducted only a limited investigation related to the shipyard.

1.7 Relevant previous accidents

The NMA's statistics show that, since 2003, a total of 100 accidents related to falls at the same level or to a lower level in cargo holds or cargo tanks have been registered on Norwegian ships. About 75 of these accidents resulted in more than 72 hours' absence from work, while 6 were fatal accidents. The AIBN has investigated or initiated investigations into the four fatal accidents that have occurred after 1 July 2008.

In one of these investigations (Rapport Marine 2011/03), the AIBN found that inadequate illumination of enclosed spaces and the absence of guardrails around openings constituted a risk of falling to a lower level. The AIBN therefore submitted a safety recommendation to the NMA:

> *Safety Recommendation MARINE No 2011/03T*
>
> *The IMO's recommendations for entering enclosed spaces focus primarily on the space atmosphere, and include a very detailed checklist which is recommended as a template for a shipboard procedure.*

The AIBN recommends that the Norwegian Maritime Authority work towards including references to other relevant procedures and guidelines in the IMO's recommendations for entering enclosed spaces aboard ships, for example for work at height.

The IMO's guidelines[2] have been revised since the above safety recommendation was issued, and address both access and illumination as follows:

6.3 The master or the responsible person should determine that it is safe to enter an enclosed space by ensuring that:

.1 potential hazards have been identified in the assessment and as far as possible isolated or made safe;

.4 the space has been secured for entry and properly illuminated;

1.8 Implemented measures

1.8.1 The shipping company

The shipping company has implemented a number of measures following the accident.

Among other things, it has prepared a description of the mandate and authority to be vested in a Safety Officer whose presence is required during all planned dockings. All inspectors will be re-trained in the docking manual, with a particular focus on crew safety.

It has also put greater emphasis on risk assessments and prepared a practical risk assessment exercise for the crew, to be conducted when the inspectors visit the vessels. This will also be used as a learning experience for the shipping company, on board the vessels and during officer conferences.

1.8.2 The Shipyard

The AIBN has requested, but not received any information from the shipyard about what measures, if any, the yard has implemented following the accident.

2. ANALYSIS

2.1 Introduction

The accident occurred when the ordinary seaman entered cargo tank 4P to assist the bosun and an able seaman in retrieving a hatch cover that had fallen into the tank.

As nobody observed the accident when it happened there is uncertainty about important details concerning the sequence of events. The ordinary seaman's exact movements and actions after entering the tank remain uncertain. The AIBN has been told, and assumes it to be the case, that the ordinary seaman was aware that there was an open maintenance hatch on the deck he stepped onto. It is also assumed that the deceased did not see the hatch before he fell into it. This leaves two important questions: Why did he not see the

[2] IMO Res. A.1050(27)

hatch, and why did he move towards it? In its consideration of the sequence of events, the AIBN will seek to clarify these questions as far as possible.

The fact that the hatch cover had fallen into the tank is also an important factor in relation to the accident. However, the AIBN does not consider the reason for the fallen hatch cover to be of any decisive importance insofar as it had been identified by the crew and that those who entered the tank prior to the accident knew about it. As far as the AIBN has been able to ascertain, nobody had entered the tank in question since 21 July 2011. There is reason to believe that the hatch cover was put back in place and fastened on that occasion. There is no obvious reason why the cover plate had come loose since then and fallen into the tank. Nor can the AIBN see that the reason can be ascertained with any material degree of certainty. The AIBN has therefore chosen not to investigate in any detail the possible circumstances that could have caused the cover plate could to come loose and drop into the tank.

2.2 Assessment of the sequence of events

Before the accident, Sembawang Shipyard had issued an entry permit for the tank in question, on which it was indicated that ventilation had been arranged, adequate illumination had been provided and unsecured openings had been secured. The day before the accident, the chief mate and deck trainee had inspected the tank and found that it was poorly ventilated, that it was without lighting and that there was an unsecured open maintenance hatch in the deck in the lower dome.

None of the three people who were to carry out the work in cargo tank 4P had entered this tank before, but the bosun and able seaman had previously entered similar tanks. The chief mate had explained to the bosun about the unsecured maintenance hatch in the deck, and the bosun had passed on this information to the other two crew members who were to enter the tank. The danger this entailed had been identified and was known to all three. The AIBN nonetheless finds that the failure to place guardrails around the maintenance hatch contributed to the ordinary seaman's fall.

Both the bosun and the able seaman had instinctively tried to find their bearings when they entered the space, so as to locate the open maintenance hatch as soon as they stepped off the ladder. They chose a position that they deemed to be at a safe distance from the hatch in order to prepare the equipment they intended to use.

The bosun overheard the trainee's radio message to the chief mate stating that the ordinary seaman was entering the tank. The ordinary seaman only had to climb about 4.5 metres down a vertical ladder, so the bosun soon got worried when there was neither sight nor sound of him. Based on statements by the crew, the AIBN assumes that less than two minutes passed from the time when the ordinary seaman entered the tank until he had fallen through the maintenance hatch.

When the ordinary seaman stepped onto the deck in the lower dome, his colleagues were less than three metres away with their back towards him and lanterns lit. The AIBN assumes that the ordinary seaman would have been able to locate his colleagues, as there was darkness in the rest of the dome. Furthermore, a ventilation hose had been placed along the very ladder that he used and onwards through the open maintenance hatch. Whether the ordinary seaman was aware that this hose went through the maintenance

hatch or thought that it continued down the ladder for entry into the cargo tank from the lower dome is uncertain.

The ordinary seaman had spent time on deck in full daylight before he entered the tank. Hence his eyes would not have had time to adapt to the dark inside the tank in the short space of time that passed before he fell. Research has shown that it can take as long as 30 minutes to adapt one's eyesight to the dark and establish night vision. That is why it is a requirement in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (the STCW Convention) that crew do not take over the bridge watch until they have adapted to the dark. Although the STCW Convention is of no direct relevance to the accident under consideration, this underlines the degree to which the ability to see is impeded during the first few minutes of moving from light to darkness. The ordinary seaman's torch had already been confiscated by the Singapore police when the AIBN arrived at the vessel and the AIBN has not been able to ascertain how well it worked at the time of the accident. The AIBN finds that the lighting conditions contributed to the ordinary seaman's fall.

The ordinary seaman did not approach his colleagues when he entered the dome, but moved in the opposite direction. It is impossible for the AIBN to ascertain why he moved as he did, but the fact that he had never been inside such a tank before may have contributed to making it difficult for him to find his bearings and he wanted to familiarise himself with his surroundings. Even though the AIBN cannot ascertain why the ordinary seaman moved towards the open hatch, it is likely that the risk of an accident increased as a result of his lack of experience of moving inside a cargo tank.

2.3 The shipyard's preparation of cargo tank 4P

The day before the accident, the shipyard had issued an entry permit for the tank in question, on which it was indicated that ventilation had been arranged, adequate illumination had been provided and unsecured openings had been secured. However, it turned out that none of these three factors had been adequately attended to. The crew stated that the way in which they found the ventilation hose in a coil on deck in the lower dome suggests that it had simply been dropped down from the hatch on deck. The AIBN finds it probable that nobody from the shipyard had climbed into the tank in question before the entry permit was issued.

The vessel's crew took their own measurements of the air quality inside the tanks, and even though the ventilation should have been arranged in a more satisfactory manner, the AIBN has no reason to assume that the air quality was poor or that this contributed to the accident. The AIBN finds it worrying, on the other hand, that the tank entry permit had been incorrectly completed. This exposed the vessel's crew to unnecessary risk when they first entered the tank for inspection purposes the day before the accident. It was the vessel's crew who discovered the unsecured opening and who decided, on an independent basis, to commence work in the tank on the following day, despite the fact that the condition of the tank was not as indicated on the papers issued by the yard.

The AIBN finds that the shipyard's failure to prepare the tank and its incorrect completion of the entry permit contributed to increasing the risk of an accident. The shipyard has not answered the AIBN's inquiries about what measures it has implemented following the accident, but the shipping company has stated that it has conducted a follow-up process in relation to the yard, to address its procedures and safety management.

2.4 Illumination of the cargo tanks

The day before the accident occurred, the chief mate and deck trainee had found that no lighting had been arranged in the tank in question. They had nonetheless completed an inspection of the tanks using the vessel's own torches. In the meeting with the shipyard on the following day, the chief mate raised the issue of inadequate ventilation, but, since the yard representatives mentioned that lighting would be arranged where needed, he assumed that this would also be arranged in the cargo tanks and did not address this topic himself.

When the crew were about to start the work in the tank, they were aware that no lighting had been rigged up yet. Portable work lights were available on board the vessel, and it would have been relatively easy to rig them up inside the tank while waiting for the yard to arrange illumination. Despite this, the crew chose to start the work using only the vessel's torches.

For several weeks before the yard stay, the bosun, able seaman and ordinary seaman had participated in the work of cleaning and preparing the vessel's ballast tanks. This work was done using headlights and torches. Hence, the three of them were used to working in enclosed spaces and without rigged illumination. This was one of the reasons why, on the day of the accident, they felt comfortable about performing work in the tank equipped with lanterns only.

The AIBN finds that the crew's decision to work in the cargo tank equipped with torches only, contributed to increasing the risk of an accident. The shipping company has initiated several measures to improve the safety of the crew during yard stays, and therefore the AIBN will not issue a safety recommendation on this point.

3. CONCLUSION

a) As nobody observed the accident when it happened there is uncertainty about the detailed sequence of events. The ordinary seaman's exact movements and actions after entering the tank remain uncertain.

b) The shipyard's tank entry permit indicated that ventilation had been arranged and adequate illumination of the tank provided, and that unsecured openings had been secured, even though this was not the case. The AIBN finds that the shipyard's failure to prepare the tank and its incorrect completion of the entry permit contributed to increasing the risk of an accident.

c) The ordinary seaman was aware of the open and unsecured maintenance hatch when he entered the tank, but he did not know exactly where in the tank the hatch was located. He had never been inside a cargo tank before, and the AIBN finds that this contributed to increasing the risk of an accident.

d) The crew was aware of the fact that lighting had not been arranged in the tank in question, but decided to perform the work equipped with torches only. Work lights were available on board the vessel, but they chose not to use them as they felt comfortable working in enclosed spaces using torches.

e) The AIBN finds that the lighting conditions in combination with the failure to place guardrails around the maintenance hatch were factors that contributed to the ordinary seaman's fall.

4. SAFETY RECOMMENDATIONS

The AIBN does not propose any safety recommendations as a result of this investigation.

Accident Investigation Board Norway

Lillestrøm, 14 June 2016

DETAILS OF THE VESSEL AND THE ACCIDENT

The vessel	
Name	*BW Havfrost*.
Flag state	Norway (NIS)
Classification society	DNV-GL
IMO number / call signal	8814768
Type	Gas tanker (LPG)
Build year	1991
Owner	Partrederiet Bergesen D.Y. Shipping DA
Operator/ Responsible for ISM	BW Fleet management AS
Construction material	Steel (double hull)
Length	204.93m
Gross tonnage	34,946
The voyage	
Port of departure	Vung Tau, Vietnam
Destination port	Sembawang Shipyard, Singapore
Type of voyage	International
Cargo	Ballast (gas-freeing)
Persons on board	26
Information about the accident	
Date and time	9 June 2014, 10:40 local time.
Type of accident	Fatal occupational accident
Place/position where the accident occurred	Quay SS08, Sembawang, Singapore
Place on board where the accident occurred	Cargo tank 4 port
Injuries/deaths	One crew member died
Damage to vessel/the environment	None
Vessel operation	Preparation for dry-docking
At what point of its route was the vessel	Alongside the quay (waiting quay)
Environmental conditions	Daylight