Report on the investigation of

the fatality on board

passenger cruise ship

Saga Rose

in Southampton, England

on 11 June 2008

Marine Accident Investigation Branch
Carlton House
Carlton Place
Southampton
United Kingdom
SO15 2DZ

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Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

The MAIB wishes to acknowledge the contribution to this investigation made by the Bahamas Maritime Authority and to thank it for its co-operation and support.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AB	-	Able seaman
ABP	-	Associated British Ports
COSWP	-	Code of Safe Working Practices
DNV	-	Det Norske Veritas
EDS	-	Entry into dangerous spaces regulations
EEBD	-	Emergency Escape Breathing Device
FSS	-	Forensic Science Service
GT	-	Gross Tonnage
IMO	-	International Maritime Organization
MAIIF	-	Marine Accident Investigators' International Forum
MCA	-	Maritime and Coastguard Agency
OOW	-	Officer of the Watch
OS	-	Ordinary Seaman
PSSC	-	Passenger Ship Safety Certificate
SCBA	-	Self Contained Breathing Apparatus
SMS	-	Safety Management System
UHF	-	Ultra High Frequency
UTC	-	Co-ordinated Universal Time
VTS	-	Vessel Traffic Service

All times in this report are UTC (+1)

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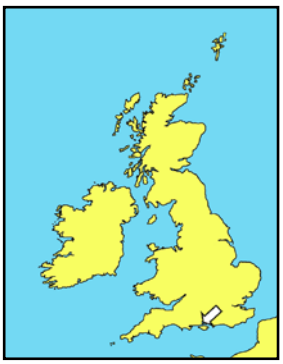
Saga Rose



SYNOPSIS

On 11 June 2008, a motorman found an experienced petty officer lying at the bottom of a ballast tank on board the passenger cruise ship *Saga Rose* while the ship was visiting Southampton, UK. The petty officer was the vessel's second bosun who had been sent to the tank to determine whether it contained fresh or salt water. The motorman raised the alarm and then returned to the scene and entered the tank to help the petty officer, who was a close friend. The motorman then also collapsed.

The onboard emergency response team quickly arrived with breathing apparatus, and the local emergency services were called to assist. The motorman was successfully revived and evacuated from the tank, but the second bosun died before he could be recovered.

The second bosun was instructed to test the water in the tank on the assumption that the tank was full and the water was within easy reach from outside the tank. As a result, a permit to work was not deemed to be necessary. However, the tank contained only a small amount of water and the second bosun entered it despite being aware of, and practised in, the vessel's procedures for entering enclosed spaces. The atmosphere inside the tank contained insufficient oxygen to sustain human life due to the corrosion of the tank's steel structure.

This is the sixth fatality in an enclosed space that the MAIB has investigated since September 2007. In view of these, and many other fatalities occurring in similar circumstances worldwide, the MAIB issued a Safety Bulletin in July 2008. The bulletin made recommendations to the Maritime and Coastguard Agency (MCA), ship owners, managers and other industry bodies and organisations aimed at improving the identification of potentially dangerous spaces, and the identification of measures to reduce this unnecessary loss of life. No further recommendations have been made in this report.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *SAGA ROSE*

Vessel details

Registered owner	:	Saga Shipping Ltd., Folkestone, Kent
Port of registry	:	Nassau
Flag	:	Bahamas
Previous names	:	Sagafjord, Gripsholm
Type	:	Passenger liner
Year of build	:	1965
Classification	:	Det Norske Veritas (DNV)
Length overall	:	188.88 metres
Breadth	:	24.49 metres
Gross tonnage	:	24,474
Design passenger capacity	:	587

Accident details

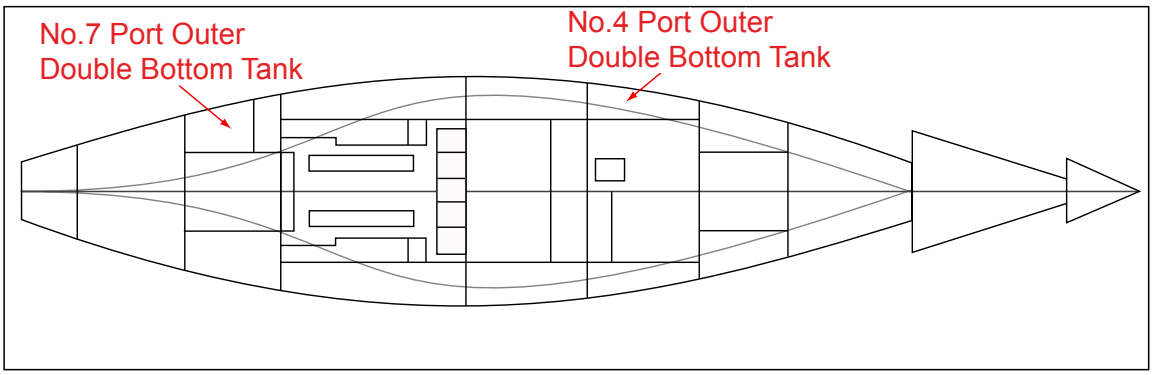
Time and date	:	1425 on 11 June 2008
Location of incident	:	Berth 101, Southampton, UK
Crew on board	:	363
Fatalities / injuries	:	One fatality / one injury
Damage	:	None

1.2 NARRATIVE

1.2.1 Tank inspection

Saga Rose arrived at berth 101 in Southampton at 0700 on 11 June 2008. During the course of the port visit, a number of tanks were opened to allow various inspections. After lunch, an able seaman (AB) and an ordinary seaman (OS) removed the manhole covers of No 4 port and starboard outer double bottom tanks **(Figure 1)**. The ratings then reported the completion of the task to the second bosun, who was securing the manhole covers to No 7 port and starboard outer double bottom tanks. They also informed the second bosun that the port tank contained water and the starboard tank contained grit. At about 1340, the AB also informed the bosun, who was overseeing the loading and offloading of passengers' luggage, that the tanks were open. The bosun relayed this information by telephone to the staff captain, who was in the ship's technical office. The bosun had initially tried to contact the staff captain by UHF radio, but was unable to do so because of poor radio reception.

Figure 1



Extract of vessel's tank plan

In response, the staff captain asked what was inside the tanks and, if water, whether it was fresh or salt. After further difficulties with radio reception, the bosun contacted the second bosun and was advised that there was grit in the starboard tank and water in the port tank.

This information was again relayed to the staff captain, who was now on the bridge discussing the contents of the ship's tanks with the safety officer and a Det Norske Veritas (DNV) surveyor. He next spoke with the bosun by radio at 1405, when the bosun confirmed that the port tank contained water. The staff captain responded by saying:

> *"Okay, let me know when you have tasted it"*

He then left the bridge to attend a safety management audit meeting.

At about 1410, the bosun located the second bosun in the purifier room **(Figure 2)** and told him of the requirement to determine whether No 4 port outer double bottom tank contained fresh or salt water. The second bosun said he would

Figure 2

The purifier room

Figure 3

Entrance to the cofferdam (view from the purifier room)

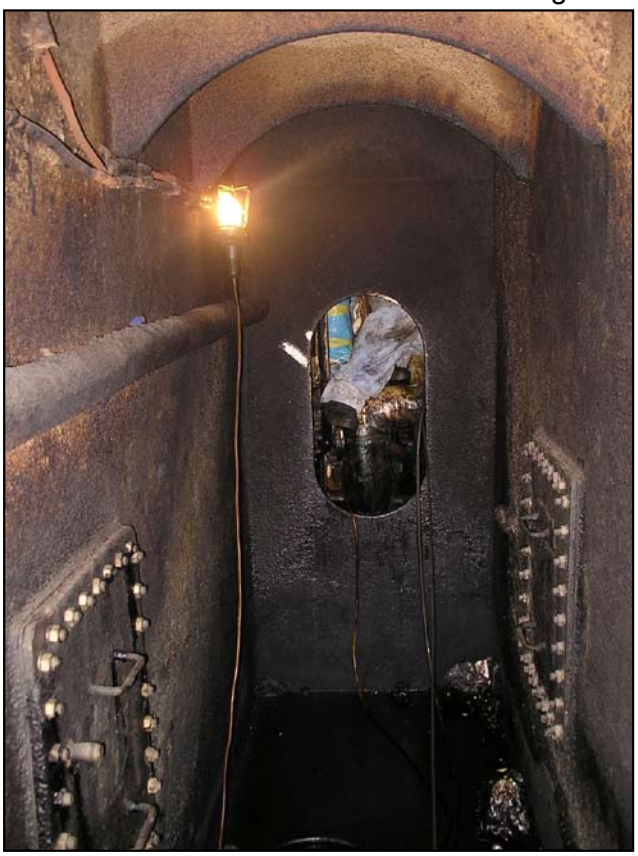
find out by putting his finger in the water and tasting it. The bosun questioned whether this was safe considering that some double bottom tanks contained sewage. The second bosun replied that the sewage tanks were “far” from No 4 port.

The second bosun then climbed through the lightening hole leading from the purifier room into the open cofferdam in which the manhole access to No 4 port was sited **(Figures 2 and 3)**, while the bosun went to No 4 starboard to confirm its contents. When the bosun returned to the purifier room a few minutes later, he went to the entrance to the cofferdam to locate the second bosun. He could not see or hear him, and when he called, there was no reply.

The bosun was too large to fit through the lightening hole, so he went to the boiler room and asked the watchkeeping motorman, who was of slimmer build, to go into the cofferdam to find out if the second bosun was still in there.

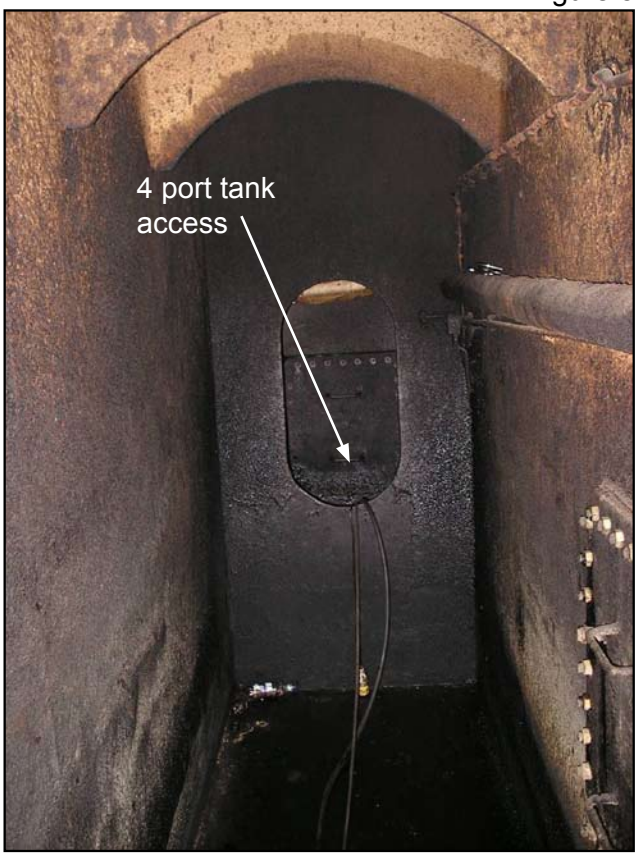
The motorman slid down into the cofferdam and looked down into the tank **(Figures 4, 5, and 6)**. He saw the second bosun was unconscious at the foot of the ladder. He was lying face up, with one of his legs passing between two of the ladder’s lower rungs **(Figure 7)**. The motorman immediately alerted the bosun, who ordered him to get out of the cofferdam. The bosun and the motorman then went to the engine control room from where the bosun informed the officer of the watch (OOW) on the bridge, by telephone, that the second bosun was unconscious in No 4 port outer tank.

Figure 4



Entrance to the cofferdam (view from cofferdam)

Figure 5



Cofferdam with tank access

Figure 6

No.4 port outer double bottom tank manhole

Figure 7

Reconstruction of the position of the second bosun

1.2.2 Onboard reaction

The OOW immediately initiated a “code bravo” on the crew alarm panel. This was made at 1423 and alerted the ship’s rapid response team via a bleeper system. The OOW then made a general broadcast instructing the team to go to No 4 port tank in the engine room.

Meanwhile, the motorman told a mechanic what he had seen, and the two men decided to go to the tank. They entered the cofferdam and the motorman climbed down the ladder but, as soon as he took a breath and tried to lift the bosun, he collapsed. By now, an AB had joined the mechanic in the cofferdam, and they both immediately returned to the purifier room to await help.

The rapid response team, which included the staff chief engineer, the safety officer, and the ship’s service engineer, arrived in the purifier room within minutes and were equipped with conventional Self Contained Breathing Apparatus (SCBA) plus a two cylinder airline breathing system on a trolley connected to two positive pressure face masks **(Figure 8)**. The team were joined by the staff captain at about 1427, who ordered the OOW to issue a “code alpha” to alert the ship’s medical team. At 1428, the fleet director of operations, who was on the bridge with the master, dialled 999 on his mobile telephone and alerted the emergency services ashore.

Figure 8

BA trolley set

The safety officer and the staff chief engineer slid down into the cofferdam and were then passed three SCBA sets and the two masks from the trolley set. The safety officer put on one of the trolley masks and the staff chief engineer an SCBA. They then crawled through the cofferdam, carrying the rest of the emergency equipment to the tank entrance.

The safety officer entered the tank. The motorman was slumped across the second bosun at the base of the ladder and, although semi-conscious, he was confused. The second bosun was unconscious; he was not displaying any visual signs of life and his eyes were glazed and half closed and his mouth was open. The safety officer put the second mask from the rescue trolley on the motorman's face, with the valve set to 'free-flow'. The staff chief engineer then passed down an SCBA set and mask and the safety officer placed the mask over the second bosun's face; the valve was again set to 'free-flow'. Assisted by the staff chief engineer from above, the safety officer then tried to lift out the motorman, but without success, even when a rope was passed under the motorman's arms. The safety officer realised that the recovery of the two men

could not be achieved quickly and, as the air from the second bosun's SCBA set was now exhausted, he replaced it with his own mask set to 'free-flow'. He then climbed back up into the cofferdam.

At this point, the motorman began trying to rip the SCBA mask from his face, so the staff chief engineer positioned a forced air ducting tube that had been fed into the cofferdam, over the motorman's head. As he did so, the motorman's mask came off. The staff chief engineer continually talked to the motorman and poured water over his head to keep him cool. The motorman gradually appeared more responsive and, over the next few minutes, and with help and encouragement from the staff chief engineer and the safety officer, he managed to pull himself upright against the ladder. He slowly climbed the ladder and as soon as his shoulders were through the manhole, the motorman was pulled out of the tank and taken from the cofferdam into the purifier room where the first of the shore fire and rescue teams had just arrived. The motorman was then taken to a local hospital.

1.2.3 Shore assistance

When the fleet director of operations called the emergency services, he passed the berth number, the ship's name and the type of emergency. A fire and rescue team arrived at the nearest dock gate within 5 minutes and, although the gate officials were unaware of the emergency, there was no delay in allowing them through.

On arrival at the berth, the rescue team were taken to the ship's main passenger gangway, where they were met by a member of the crew and taken to the purifier room. They were given little information as to the type of emergency or where it was within the ship, and no general or safety plans of the vessel were provided. Once in the purifier room, the rescue team's radio communications with its shore command were poor.

The rescue team entered the cofferdam wearing SCBA at 1525, and assessed the second bosun to be deceased shortly before 1600. The limited room available, the possibility of contaminated air and low oxygen levels, and the high temperatures experienced, hampered the removal of the second bosun from the tank, which was not completed until 1910.

1.3 MEDICAL EXAMINATIONS

The postmortem examination of the second bosun concluded that the cause of death was consistent with hypoxic hypoxia, or asphyxiation due to insufficient oxygen being available to the lungs. The postmortem report also concluded:

> *The unusual distribution of bruising along the comparatively protected underside of the left arm and armpit would tend to support a scenario in which the deceased man reached into the tank and then slid and tumbled in.*

No drugs or poisons were detected in the blood or urine of the second bosun, or in the blood of the motorman, which was tested soon after he arrived at the local hospital.

1.4 BACKGROUND TO THE TANK INSPECTIONS

Saga Rose had 31 double bottom tanks, which had a variety of uses, and their contents included: fuel oil, fresh water, engine drains, sewage and ballast. Between 28 May and 3 June 2008, DNV surveyors visited the vessel to survey equipment and spaces, including a number of oil and ballast tanks, as part of the periodic inspection requirements for the vessel's Passenger Ship Safety Certificate (PSSC). Before leaving, the surveyors requested that three double bottom tanks, which had not been inspected, be made available when the vessel visited Southampton on 11 June 2008. The tanks were: No 5 port inner double bottom tank, which was an oily bilge tank, and No 4 and No 7 port outer double bottom tanks, which the DNV Class Status Report and onboard records indicated were permanently filled with ballast. No 4 port outer double bottom tank had last been inspected during the vessel's dry docking in Southampton on 19 April 2005.

Due to the potential requirement to empty and then refill No 4 and No 7 tanks with fresh water, the staff captain decided that it would not be possible to complete an inspection of these tanks in Southampton. However, as there was conflicting evidence regarding their contents and, as the tanks could not be sounded because their sounding pipes were blocked, the staff captain decided to open the tanks after the vessel's arrival solely to identify whether they were filled with fresh or salt water, or grit. The classification society's inspection of No 5 port inner tank, which would be opened by the ship's engineering staff, would continue as planned.

The staff captain and safety officer inspected the accesses to No 4 and No 7 port tanks to identify and assess potential risks. They decided there were none, and that the opening of the tanks did not require permits to work. The staff captain instructed the chief officer to oversee the opening of the two ballast tanks and, with the safety officer, to accompany the DNV surveyor during his inspection of No 5 port inner tank.

Shortly after the vessel's arrival in Southampton, the second bosun and an AB started to remove the nuts securing the manhole covers of No 7 port and starboard outer tanks. The chief officer went to the engine room just before 1000 to find out how the work was progressing and found the job was taking longer than expected because the manhole nuts were corroded and very tight.

At about 1030, the chief officer and the DNV surveyor donned paper boiler suits and rubber boots in preparation for the inspection of No 5 port inner double bottom tank. The required safety equipment was assembled, the tank

atmosphere checked, and both the permit to work and the enclosed space entry checklist forms were completed, signed and dated. The safety officer stood-by outside until the two men had completed the inspection.

At about 1130, the chief officer, safety officer and surveyor went to No 7 port outer tank, where the second bosun was waiting, having removed the manhole cover. The safety officer looked inside the tank and found it to be full of water. He dipped his finger in, and by tasting, confirmed it to be fresh water. The chief officer instructed the second bosun to replace the manhole cover of No 7 port and to remove the cover on No 4 port inner tank after lunch. He then arranged for more men to help with these tasks. Although the nuts securing the manhole cover to No 7 starboard tank were removed, this work had been undertaken in error and the tank was not opened.

The chief officer informed the staff captain that No 5 port had been inspected and that No 7 port was full of fresh water, which he had confirmed by tasting. The chief officer then went to his cabin to rest as he was scheduled to be on watch at 1600. The safety officer, who was leaving the ship in Southampton, commenced a handover with his relief and assisted with familiarisation training for crew joining the vessel.

1.5 NO 4 PORT OUTER TANK

No 4 port outer double bottom tank was 2.5m wide and 20m long with a maximum depth of 1.7m, and it had a capacity of 44 cubic metres. About 10cm of water covered the tank bottom. The tank was serviced by a vertical natural air vent to the ship's side, a suction/filling pipe sited in the engine room, which was blanked off, and a sounding pipe which was blocked. The tank's steel structure was coated with a preservative, but this had broken down and the structure was heavily corroded.

Samples of the corroded tank structure and sediment from the tank bottom were sent to the Forensic Science Service (FSS) for testing and analysis, but no toxic substances were identified. As the tank's atmosphere was purged during the rescue, it was not possible to determine if any harmful gases had been present at the time of the accident.

Access into the tank was through a single tank top manhole fitted with a steel cover secured by 22 nuts and bolts. The manhole access was oval shaped, but the steel cover was rectangular with dimensions of 800mm x 600mm **(Figure 6)**. Following the accident, the manhole cover gasket was found lying in the tank bottom under the discarded breathing apparatus and airlines used during the rescue.

The manhole was at the far end of a 5 metre open cofferdam **(Figure 5)** which was accessed through a lightening hole from the purifier room **(Figures 3 and 4)**. The cofferdam was situated between two heated fuel oil service tanks and

the temperature in the cofferdam was between 40º and 50ºC. Illumination was provided by a light with a wandering lead, and, other than for access to the double bottom tank, this space was not normally entered.

1.6 THE CASUALTIES

The second bosun was a Filipino aged 43. He had regularly sailed as an AB on *Saga Rose* between 1992 and 2000. He was then promoted to second bosun, and had occasionally acted as the bosun when the ship's regular bosun was on leave. The second bosun had regularly opened tanks for inspection and had signed permits to work and enclosed space entry forms on numerous occasions. He had returned from leave on 15 April 2008.

The motorman was also a Filipino, and was a close friend of the second bosun. He had regularly sailed on the vessel for over 10 years and, as the opening of engine room tanks was one of his regular duties, he was familiar with the vessel's permit to work system.

1.7 ONBOARD PROCEDURES

1.7.1 Permits to work

The vessel had a permit to work system for entry into enclosed spaces, which was complied with by ship's staff; permits were not required for the opening of tank access covers. Following the opening of a tank, it was normal procedure for the officer supervising the work to attend and to complete a permit to work and an enclosed space entry form. Permits had been issued during previous tank entry operations, including the entry into No 5 oily bilge tank during the morning of 11 June 2008. A permit to work was not considered necessary for the work carried out on No 4 and No 7 ballast tanks because the tanks were only being opened to identify their contents. Entry into the tanks was not intended.

1.7.2 Drills

The crew was periodically exercised in simulated rescues from enclosed spaces. The company Safety Management System (SMS) required the drills to be completed at least once every 6 months. The last drill took place in April 2008.

1.7.3 Equipment

Meters were on board the vessel to detect the presence of Hydrogen Sulphide H2S and carbon monoxide, and to analyse the oxygen content. All of the meters were in date for calibration.

1.7.4 Communications

Portable UHF radios were used on board *Saga Rose* for communication between key personnel. The crew had regularly experienced difficulty with poor reception during routine operations and emergency drills but, although

disruptive, had generally managed to work around the problem. On the day of the accident, the bosun found it necessary to move from the main deck to a lower deck to communicate effectively with the second bosun in the engine room.

1.8 ENTRY INTO DANGEROUS SPACES (EDS) REGULATIONS

1.8.1 Merchant Shipping (Entry into Dangerous Spaces) Regulations 1988

The Regulations apply to United Kingdom (UK) ships and other nations' ships while they are in a UK port. The regulations define "dangerous space" as:

> *Any enclosed or confined space in which it is foreseeable that the atmosphere may at some stage contain toxic or flammable gases or vapours, or be deficient in oxygen, to the extent that it may endanger the life or health of any person entering that space.*

The Regulations require that: entrances to unattended dangerous spaces be secured against entry; procedures for entry into dangerous spaces are laid down and observed; drills are periodically carried out; and that equipment for testing dangerous spaces is carried where entry into a dangerous space might be necessary.

1.8.2 Duties under the Entry into Dangerous Spaces (EDS) Regulations

- The employer shall ensure that procedures for ensuring safe entry and working in dangerous spaces are clearly laid down; and
- The master shall ensure that such procedures are observed on board the ship
- No person shall enter or remain in a dangerous space (except in accordance with safe procedures)
- In fulfilling their duties under these regulations, the employer, master and any other person shall take full account of the principles and guidance contained in the Code of Safe Practice for Merchant Seamen (COSWP)[1].

1.8.3 Drills

The EDS regulations require the master to ensure that drills simulating the rescue of a crew member from a dangerous space are held at intervals not exceeding 2 months, and that a record of such drills is entered in the official logbook. This applies to tankers of 500 GT and over, and to any other ship of 1000 GT and over.

1.8.4 Atmosphere testing equipment required

The EDS regulations require the employer to ensure that each ship, where entry into a dangerous space may be necessary, shall carry or otherwise have available an oxygen meter and such other testing device as is appropriate to

[1] The COSWP is published by the MCA, and is mandatory for UK ships. Regulations place a duty on the ships' operators to ensure that sufficient copies of the COSWP are carried on every ship to which the regulations apply, based on the number of workers on the ship.

the hazard likely to be encountered in any dangerous space on board. The regulations also require that masters ensure that the oxygen meter and any other testing device provided on board are maintained in good working order and, where applicable, regularly serviced and calibrated according to the manufacturers' recommendations.

1.9 PORT EMERGENCY RESPONSE PROCEDURE

Embarked pilots provide masters of ships visiting the port of Southampton with documentation which requests that, in the event of an emergency on board when alongside, the port's vessel traffic service (VTS) is informed in addition to the local emergency services. The VTS then advises security personnel at the access gates, and arranges for the emergency vehicles to be escorted to the berth as necessary. The VTS also places the port's emergency response staff on alert to assist if required. The master of *Saga Rose* was not aware of this procedure.

The Hampshire Fire and Rescue Service regularly visits Southampton port to familiarise itself with the port area and to identify the inherent risks on each vessel type.

1.10 SAGA SHIPPING LIMITED

Saga Shipping Limited, based in Folkestone, UK, is both the owner and operator of *Saga Rose*. In addition to *Saga Rose*, the company operates her sister ship, *Saga Ruby,* and a smaller cruise ship, *Spirit of Adventure*. All of the vessels are usually manned with European officers and Filipino crew. The company has owned and operated *Saga Rose* since 1998, and many of her crew had regularly sailed on board the vessel since then.

1.11 SIMILAR ACCIDENTS

Since September 2007, the MAIB has completed two other investigations into accidents in which a total of five seafarers died in enclosed/confined spaces:

- On 23 September 2007, three experienced seamen died inside the chain locker on board the emergency response and rescue vessel *Viking Islay*. The first two were overcome while tying off an anchor chain to prevent it from rattling in the spurling pipe. The third to die was the first rescuer who entered the chain locker, wearing an Emergency Escape Breathing Device (EEBD). He was soon constrained by the device and removed its hood. All three men died as a result of the lack of oxygen inside the chain locker caused by the ongoing corrosion of its steel structure and anchor chain.

- On 18 January 2008, two seamen collapsed in a store on board the general cargo ship *Sava Lake*. The chief officer entered the store to try to rescue the men, but was soon forced to leave when he became short of breath and his vision narrowed. The two seamen had been

asphyxiated. The store was adjacent to the vessel's forward cargo hold containing 'steel turnings'. To allow for the drainage of sea water and the removal of cargo residue, the bellows pieces on the cargo vent trunk either side of the cargo ventilation fan motor, located in the store, had been cut. This allowed a path for the air from the self-heating cargo, to enter the store. When tested, the air in the cargo hold contained only 6% oxygen.

Co-incident with these investigations the Marine Accident Investigators' International Forum (MAIIF) identified a large number of fatalities in the shipping industry worldwide which were related to work in confined or enclosed spaces, and considered that the occurrence of such accidents was increasing. Accordingly, in October 2007, MAIIF tasked its representative from Vanuatu to research the incidence of this type of accident with a view to the submission of a paper to the International Maritime Organization (IMO). By July 2008, responses from 18 administrations had identified 120 fatalities and 123 injuries resulting from entry into confined spaces since 1991. These statistics do not include the fatalities on board *Sava Lake* or *Saga Rose*.

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 THE HAZARD

The findings of the postmortem examination of the deceased, the FSS analysis of the tank sediment, and the absence of drugs and poisons in the blood of the second bosun and motorman, clearly indicate that the second bosun died as a result of a lack of oxygen inside No 4 port outer ballast tank. Given that the motorman was seen to collapse almost immediately after entry, it is highly likely that the oxygen content of the atmosphere inside the tank was between 6% and 8% **(Table 1)**, which was insufficient to sustain human life.

Table 1

Asphyxia – Effect of O_2 Concentration	
O_2 (volume %)	**Effects and Symptoms**
18-21	No discernible symptoms can be detected by the individual.
11-18	Reduction of physical and intellectual performance without the sufferer being aware.
8-11	Possibility of fainting within a few minutes without prior warning. **Risk of death below 11% vol**
6-8	Fainting occurs after a short time. Resuscitation possible if carried out immediately.
0-6	Fainting almost immediate. Brain damage may occur, even if rescued.

Effect of oxygen concentration

It is almost certain that the oxygen depleted atmosphere developed through the corrosion of the tank's steel structure. The tank had probably been empty since it was last inspected in April 2005, and the steel structure would have corroded in the following 3 years due to its exposure to moist air. The oxidising or rusting process would have consumed the oxygen within the tank and, as the tank was fitted with a single natural air vent, any mixing of fresh air with the tank's atmosphere would have been minimal.

2.3 TANK ENTRY

Although the postmortem report concluded that the bruising to the underside of the second boson's left arm supports the scenario of him reaching into the tank, sliding and tumbling in, this was unlikely in view of the extremely limited room available adjacent to the manhole **(Figures 5 and 6)**. It is more plausible that he descended the ladder, and then reached towards the water at the tank bottom with his left hand while holding onto the ladder with his right hand. Once his head was inside the tank, he would have quickly lost consciousness and collapsed onto the protruding frame at the tank bottom **(Figure 6)**, with his left arm extended. This scenario is also consistent with the position in which his body was found **(Figure 7)** and the absence of other injuries which would have been likely had he fallen 1.7m, head first into the tank.

The second bosun went to No 4 port tank with the specific intention of tasting the fluid in the tank to establish whether it was fresh or salt water. He was probably expecting the tank to be full, or nearly full, but when he saw that the level of water in the tank was very low, it is apparent that he climbed down into the tank to complete the task, despite knowing that it should not be entered without a permit to work and the implementation of the vessel's enclosed space entry procedures. Why he chose to enter the tank is not clear, however complacency and a perception that he would only need to enter the tank for a few seconds are likely to be factors that influenced his decision.

2.4 THE RESCUE

2.4.1 The motorman

The motorman's decision to enter the tank after raising the alarm was undoubtedly an instinctive reaction to help his close friend. However, although well intended, the motorman's action not only placed his own life at risk, but also doubled the task faced by the ship's rescue team and therefore reduced the likelihood of a rapid evacuation of the second bosun.

2.4.2 The rapid response team

It is evident that from when the OOW was informed of the second bosun's collapse, the ship's internal procedures worked very efficiently. The response team assembled in the purifier room within about 3 minutes, and the safety officer and the staff chief engineer were quick to enter the space with ample breathing apparatus. In this respect, the supply of air that was provided by the trolley system **(Figure 8)** was particularly beneficial in view of the small and awkward nature of the accesses into the cofferdam and tank. It was not surprising that once in the tank, the safety officer was unable to lift the virtual dead weight of the motorman. However, the provision of air through a BA mask and then via a duct, revived the motorman sufficiently to enable him to get himself onto the ladder. There is no doubt that the actions of the response team saved the motorman's life. Therefore, although the ship's personnel had not completed drills in rescuing a crew member from dangerous spaces at

the frequency required by the EDS regulations (being a Bahamian registered vessel, they were not required to do so), this does not appear to have adversely affected the response of the ship's crew on this occasion.

2.4.3 Shore emergency services

Although the fire and rescue team were not fully appraised of the nature or location of the emergency, or given copies of the ship's plans immediately on arrival, which could have potentially compromised the effectiveness of their response, they were escorted directly to the purifier room, and their involvement in the rescue of the second bosun was not unduly delayed. Unfortunately, when the team first entered No 4 tank, at 1525, the second bosun had been unconscious for over 1 hour, and his chances of survival were negligible, despite the supply of air to his face provided from the trolley BA system.

2.5 THE SCOPE AND CONTROL OF THE TASK

The objective of opening No 4 and No 7 port outer ballast tanks was to determine their contents. This was to be done visually from outside the tanks; there was no intention of entry. However, it is apparent that after the tanks were opened, the objective of the work was extended to include the testing of the water they contained.

As No 7 port outer tank was full of water, the safety officer was able to obtain a water sample without difficulty. When the bosun reported to the staff captain that No 4 port outer contained water, the staff captain assumed that it was also full. He was not advised otherwise, and it would be unusual for a permanent ballast tank to be virtually empty. Therefore, when the staff captain asked for the water in the tank to be tasted, he expected this to be done from a position outside the tank.

There are a number of factors which contributed to the breakdown in communications which led not only to the staff captain's assumption that No 4 port outer tank was full of water, but also to the erroneous opening of No 4 and No 7 starboard outer tanks. In particular, the opening of the tanks was conducted during a busy port visit. Consequently, the chief officer was unable to oversee the task through to its completion because he had to rest in preparation for his watch later in the day, the two safety officers were changing over and busy conducting crew familiarisation training, and the staff captain's attention was divided between the tank inspections and a safety management audit. Without the continuous oversight of a responsible officer and, with a reliance on the use of UHF radio, which was known to be unreliable in key areas such as the engine room, the scope for misunderstanding and a lack of co-ordination was increased considerably.

2.6 EFFECTIVENESS OF PROCEDURES AND TRAINING

The second bosun on board *Saga Rose* was fully familiar with the vessel's procedures for entry to an enclosed space. Indeed, he had followed the procedure on numerous occasions during his time on board. It is not known why he ignored them on this occasion. A lethal atmosphere within an enclosed space is not usually readily apparent, and there are few aspects of personal safety on board ships that have received more attention than the importance of following the correct procedures. However, it is clear from this case and the many other cases identified by MAIIF, that the number of deaths in this area is unacceptably high. Therefore, the need for further action to improve seafarers' knowledge and appreciation of the risks involved, and compliance with onboard procedures, is compelling.

2.7 PERMANENT BALLAST TANKS PRACTICES

Records held on board *Saga Rose* and by DNV indicated that No 4 port outer tank was a permanent ballast tank and was filled with water. In fact, the tank was almost empty and had probably been for a number of years despite the classification society's requirement for them to be full when at sea. Although it is common practice to regularly sound all tanks in a vessel, regardless of whether they are empty or full, this was not the case on board *Saga Rose.* Otherwise, the onboard records would have been accurate and it is highly unlikely that No 4 port tank would have been allowed to remain empty for so long, given its intended contribution, albeit small, to the vessel's stability.

Furthermore, both the safety officer and the second bosun were content to orally test the contents of No 7 and No 4 port tanks respectively. In view of the possibility that the tanks might have held sewage at some stage during the vessel's life, and the fact that the tanks had almost certainly not been opened for several years, this was not a healthy practice. Although there was no evidence of harmful substances in these tanks, it would have been far safer and hygienic to use a sample pot and hydrometer.

2.8 PORT EMERGENCY PROCEDURES

Southampton port covers a large area with many berths and has a number of access points. It is therefore essential that in the event of an emergency on board a visiting vessel, the emergency services are able to proceed to the appropriate berth with the minimum delay. In this case, although *Saga Rose* was a regular visitor to Southampton, her master was not aware of the need to inform the VTS of the developing emergency. Fortunately, this did not impede the rapid response of the fire and rescue service, which highlights the benefits of its frequent familiarisation with the port's layout and facilities.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES

3.1.1 Safety issues identified during the investigation, which have resulted in recommendations

1. The second bosun entered the ballast tank, the atmosphere of which contained insufficient oxygen to sustain human life, despite being fully aware of the vessel's procedures for entering enclosed spaces. [2.2, 2.3]

2. The motorman's attempt to rescue the second bosun was undoubtedly instinctive and well intended. Nevertheless, he put himself into serious danger and ultimately hindered the recovery of his friend. [2.4.1]

3. The need for further action to improve seafarers' knowledge and appreciation of the risks involved with entry into enclosed spaces and compliance with onboard procedures is compelling. [2.6]

3.1.2 Safety issues identified during the investigation, which have not resulted in recommendations but have been addressed

1. The objective of opening the ballast tank was to see what was inside, but was later extended to include the testing of the water. When the staff captain ordered the water to be tested he was not aware that the tank was virtually empty. [2.5]

2. Without the continuous oversight of a responsible officer, and with a reliance on the use of UHF radio, the scope for misunderstanding and a lack of co-ordination was increased considerably. [2.5]

3. The records of the contents of the vessel's permanent ballast tanks were inaccurate. [2.7]

4. The tasting of the contents of the ballast tanks to determine if they contained salt or fresh water was not a healthy practice. [2.7]

5. Although *Saga Rose* was a regular visitor to Southampton, her master was not aware of the need to inform the VTS of the emergency on board. [2.8]

SECTION 4 - ACTION TAKEN

4.1 THE MARINE ACCIDENT INVESTIGATION BRANCH

The MAIB has issued Safety Bulletin 2/2008 **(Annex A)**, which included the following recommendations:

2008/145 **Ship owners and managers, and industry bodies and organisations** are recommended to:

- Identify and implement measures aimed at improving the identification of all dangerous and potentially dangerous spaces, and increasing compliance with the safe working practices required when working in such compartments.
- Individually and collectively raise the awareness of the continuing high incidence of fatalities of seafarers working in enclosed spaces.

2008/146 **The Maritime and Coastguard Agency** is recommended to:

Co-sponsor with the Maritime Administration of Vanuatu and other concerned administrations a submission to the IMO aimed at raising the awareness of the number of fatalities on ships which have occurred in enclosed spaces, and highlighting the need for measures to be identified which will reduce this unnecessary loss of life, such as the identification and marking of all potentially dangerous spaces.

4.2 SAGA SHIPPING LIMITED

The vessel's owner has:

- Reviewed and re-written its permit to work system, which includes pre work checklists and risk assessment.
- Employed a risk assessment trainer to undertake risk assessment training on board its vessels.
- Developed training modules focussing on the risks of tank entry, enclosed spaces, and other high-risk areas.
- Amended its SMS to reflect the EDS requirements for the frequency of drills.
- Provided BA trolley sets to all its vessels.
- Briefed and discussed the lessons learned from this accident and the risks of enclosed spaces with all engine and deck crew on board its vessels.

4.3 THE MARITIME AND COASTGUARD AGENCY

Following the accident, MCA surveyors verified the contents of a large number of the vessel's double bottom tanks.

4.4 ASSOCIATED BRITISH PORTS (ABP) SOUTHAMPTON

The port authority has undertaken to produce an information card detailing the action it recommends a master takes in case of an emergency on board which requires external assistance. The card will be supplied to all vessels entering the port of Southampton.

SECTION 5 – RECOMMENDATIONS

In view of the actions already taken and the recommendations made in Safety Bulletin 2/2008, no further recommendations are considered necessary.

Marine Accident Investigation Branch
January 2008