Report of investigation into the fatal accident on board the Hong Kong registered ship *"Saga Frontier"* at Antwerp, Belgium on 11 April 2015

The Hong Kong Special Administrative Region
Marine Department
Marine Accident Investigation Section

2y April 2016

Purpose of Investigation

This incident is investigated in accordance with the Code of the International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (the Casualty Investigation Code) adopted by IMO Resolution MSC 255(84).The purpose of this investigation conducted by the Marine Accident Investigation and Shipping Security Policy Branch (MAISSPB) of Marine Department, in pursuant to the Merchant Shipping Ordinance Cap. 281, the Merchant Shipping (Safety) Ordinance (Cap. 369), the Shipping and Port Control Ordinance (Cap. 313), or the Merchant Shipping (Local Vessels) Ordinance (Cap. 548), as appropriate, is to determine the circumstances and the causes of the incident with the aim of improving the safety of life at sea and avoiding similar incident in future.

The conclusions drawn in this report aim to identify the different factors contributing to the incident. They are not intended to apportion blame or liability towards any particular organization or individual except so far as necessary to achieve the said purpose.

The MAISSPB has no involvement in any prosecution or disciplinary action that may be taken by the Marine Department resulting from this incident.

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1. Summary

1.1 An accident happened onboard the Hong Kong registered general cargo carrier "Saga Frontier" (hereinafter referred to as *the Vessel*) in the bulk terminal No. Q1211 at Antwerp, Belgium on 11 April 2015.

1.2 While the semi-coke bulk cargoes in the No.4 cargo hold was being discharged, two stevedores and one bulldozer operator entered the forward stair trunk for entry of the No.4 cargo hold to sweep the cargo for facilitating the discharge operation. They had been overcome by the oxygen deficient atmospheres at the bottom of the stair trunk due to the oxygen consumption of semi-coke and collapsed.

1.3 Some minutes later, another stevedore entered the stair trunk to check why his colleagues did not exit from the bottom door of the stair trunk and enter into the cargo hold. He discovered the incident, and escaped at once from the trunk, then reported the incident to the duty officer on deck.

1.4 The three casualties were transferred by the gantry crane to the jetty and sent to a hospital for treatment. However, they were certified dead later.

1.5 The investigation revealed that the main contributory factors of the accident were as follows:-

- The stair trunk was categorized to be an enclosed space and it had not been provided with sufficient ventilation prior to the entry;
- No "enclosed space entry permit" was issued to certify the safe entry into the stair trunk;
- Stenciled warning signs "Ventilation before Entry" and "O_2 Depletion" at the entrance of the stair trunk were disregarded by the stevedores; and
- The officers did not follow the relevant guidelines to prevent unauthorized entry of enclosed space.

2. Description of the vessel

2.1 Particulars of Saga Frontier

Port of Registry :	Hong Kong
IMO No. :	9343510
Type of Vessel :	General Cargo Carrier
Year of Built :	2007
Built At :	Oshima Shipbuilding Co Ltd
Owner :	Saga Ship Holding (Norway) Ltd.
Length :	194.89 metres
Breadth :	30.50 metres
Depth :	16.4 metres
Gross Tonnage :	29758
Net Tonnage :	14440
Engine Power :	9510 kW
No. of Crew :	24
Management company	Anglo Eastern Ship Management Ltd

Fig 1: *"Saga Frontier"*

2.2 The vessel (see Fig. 1) is a double hull, ten-hold general cargo carrier. The cargo holds are separated by bulkheads with access stair trunks fitted with 2 straight stairways, 3 access doors and 3 landing points at different levels for accessing the cargo holds (see Fig. 2).

2.3 The vessel is fitted with two gantry cranes that run on fixed rails for cargo work.

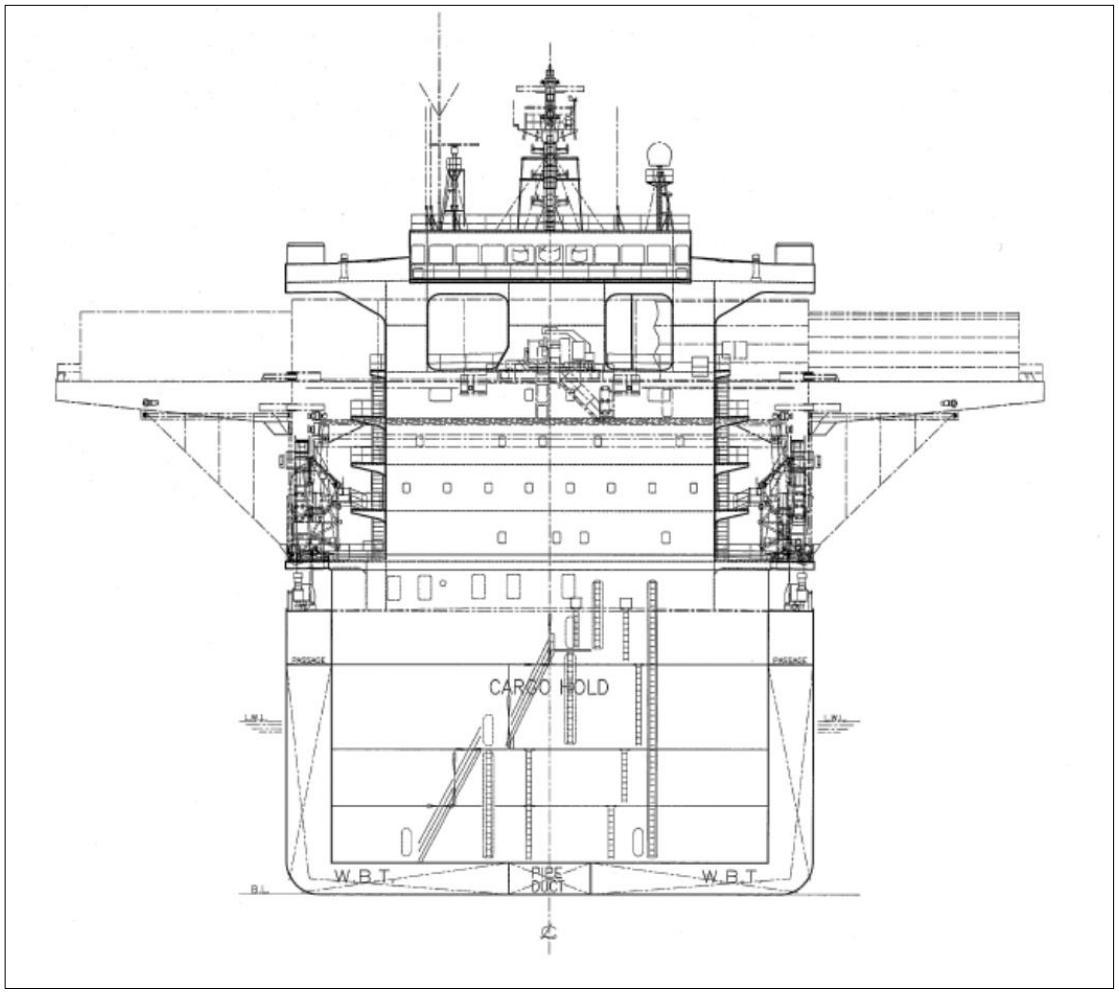

Fig 2: Cross section view of "*Saga Frontier*" (View from forward)

3. Sources of evidence

3.1 The master and crewmembers of the vessel

3.2 The management company of the vessel

4. Outline of events

(All time used are local time (UTC +2))

4.1 The Hong Kong registered general cargo carrier "Saga Frontier" (the *vessel*) completed the loading of cargoes and departed from Xingang, Mainland China for Antwerp, Belgium on 16 February 2015.

The vessel carried different types of cargoes, such as plywood, anodes, mineral etc., they were stowed as to the stowage plan (See Fig.3). Out of the ten cargo holds, only the No.4 cargo hold was stowed with 3,530 metric tonnes semi-coke in bulk. The deck cargo was the windmill blades.

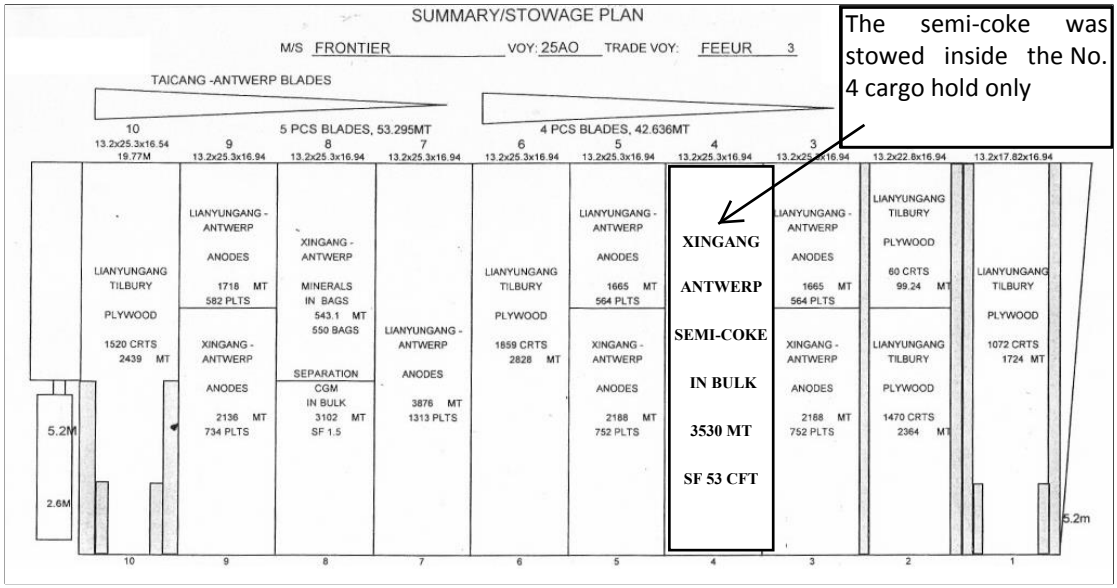

Fig. 3: Stowage plan of *the Vessel*

4.2 The *vessel* arrived at the bulk terminal in Antwerp on the morning of 10 April 2015. She was moored with starboard side alongside at about 1100. All deck cargo was finished discharging at about 1600 on the same date.

4.3 The chief officer ordered his crew to rig a grab to the No.1 ship gantry crane for discharging the cargo in No.4 cargo hold. A supercargo[1] advised the chief officer that the discharging of semi-coke would be started at about 2200 and a stevedore foreman would come on board at the same time.

4.4 Around 2100, the chief officer instructed the third officer to open the hatch covers of the No.4 cargo hold and the access hatch of the stair trunk on main deck for natural ventilation. He further instructed the third officer to

[1] Supercargo is the local agent organizing the stevedore to carry out cargo handling.

request the stevedore foreman to visit him for discussion of cargo work when he came on board. However, the stevedore foreman did not visit him afterwards.

4.5 Discharging work for No.4 cargo hold was started at about 2200 on 10 April 2015.

4.6 As the grab could not reach to the sides of the cargo hold to discharge the semi-coke, it was necessary to use a bulldozer to shovel the remaining semi-coke to the centre of the cargo hold for easy grabbing.

4.7 On 11 April, at about 1245, three stevedores and one bulldozer operator came on board to sweep and shovel the semi-coke. There was about 600 to 700 metric tonnes semi-coke cargo remaining. They noticed the illumination inside the stair trunk was not working properly, so they informed the deck watch keeper (i.e. an ordinary seaman) to rectify the lighting.

4.8 The ordinary seaman then went to the ship's office to check the light switch and requested the electrician for assistance.

4.9 Meanwhile, two stevedores and one bulldozer operator entered into the stair trunk for going down to the cargo hold. However, they were overcome by the oxygen-deficient atmosphere of the stair trunk while they were going down to the bottom of the stairway. Another stevedore entered the stair trunk to verify why they did not exit from the trunk and entering the cargo hold. On the middle way of the stair trunk, he found his three colleagues lying down on the bottom of the stair trunk. He managed to retreat from the stair trunk and cried for help.

4.10 The ordinary seaman on deck reported the duty officer of the incident immediately after he had heard the calling for help. The general alarm was raised and all crew mustered at the emergency station. The bosun wearing a self-contained breathing apparatus (SCBA) and two stevedores wearing emergency escape breathing devices (EEBDs), entered the stair trunk to rescue the casualties. They went down and open the bottom exit door to the cargo hold. Three casualties were moved to the bottom of the cargo hold through the bottom exit door.

4.11 Three casualties were unconscious. When they were lifted up by the gantry crane and transferred to a jetty, ambulance men applied first aids to them immediately. They were then sent to a hospital for treatment. Later, three casualties were certified dead in the hospital.

Fig. 4 - Three stevedores collapsed at the bottom of the trunk

5. Analysis

5.1 Working experience and training

5.1.1 The master of the *vessel* had had 28 years of seagoing experience. He obtained his master's certificate of competency in January 2000 and had sailed as a master for about 8 years. He had about 8 years of experience sailing on general cargo carriers. He had joined the *vessel* for about five months.

5.1.2 The chief officer had had 9 years and 10 months of seagoing experience. He had about 9 years of experience sailing on general cargo carriers. He obtained his class two certificate of competency in March 2013, had sailed at the rank of chief officer for about 6 months. He joined the *vessel* on 20 February 2015 until the accident happened.

5.1.3 There was no information about the training and experience in respect of the three deceased stevedores. It was probable that they were not aware of potential danger while entering the stair trunk which was an enclose space.

5.2 The environment inside the stair trunk

5.2.1 The stair trunk in question was a void space between No. 3 and No.4 cargo hold (Fig.4). There were three landing points respectively at above the first deck, second deck and bottom deck (tanktop), each of them provided with a steel door in the bulkhead opening into the No.4 cargo hold (Fig.2). These steel doors were not gas-tight, therefore the atmosphere inside the stair trunk could be affected by the atmosphere inside the cargo hold even though the steel doors were closed.

5.2.2 Before loading of the semi-coke cargo at Xingang, Mainland China, the three doors were closed and the bottom door sealed with tape from the inside of the stair trunk.

5.2.3 Semi-coke was produced from the raw coal after desiccated, dehydrated and dry distilled inside the carbonization furnace. It was an endothermic reaction. Most of the moisture and absorbed gases were removed from the raw coal. Carbon monoxide might produce during the chemical reaction causing oxygen depletion in cargo hold.

5.2.4 The hatch covers of No.4 cargo hold and the access hatch cover of the stair trunk were open at 2100 on 10 April 2015 for cargo discharging preparation

by natural ventilation.

5.2.5 The oxygen content in the normal atmosphere is 20.9%. When the oxygen content in the enclosed stair trunk dropped down to 15%, a person would feel of dyspnea, emotional instable and extreme tiredness. If the oxygen content was further reduced to 10%, fatal would occur in minutes. It was highly probable that the stevedores suffered from asphyxiation when they were entering into the stair trunk while the oxygen content was in a danger level, i.e. less than 10%.

5.2.6 The accident happened at about 1245 on 11 April 2015. The facts shown that the atmosphere inside the stair trunk was not safe for entry after about 15 hours of natural ventilation starting from 2100 on 10 April to 1245 on 11 April. Adopting a natural ventilation through hatch cover was not an effective way for ventilating a deep and narrow stair trunk. For better ventilation, positive forced draft fan should be applied in case of no sufficient time is allowed for natural ventilation.

5.3 Procedures for entry into the stair trunk

5.3.1 Prior to entry of the stair trunk, the crew should use multi-gas meter to check the contents of oxygen, carbon monoxide, hydrogen sulphide and hydrocarbon inside. If the readings are normal, the crew can go into the stair trunk and open the first steel door at the first landing point (i.e. first deck). They should repeat the same procedure until they reach to the bottom of the stair trunk.

5.3.2 The access hatch cover of the stair trunk had been opened for natural ventilation and there was no attendant or any barrier secured at the entrance (i.e. the access hatch) in order to prevent unauthorized entry. Also, despite stenciled warning signs "O_2 Depletion" and "Ventilation before Entry" on the top surface of the access hatch cover, the stevedores disregarded the warning signs, they entered into the stair trunk. Normally, the stevedores should check with ship's crew if there was any permit for entry.

5.4 Enclosed space entry

5.4.1 The stair trunk was categorized to be an enclosed space.

5.4.2 The stevedores entered the stair trunk without the enclosed space entry permit. The ship management company's Health and Safety Manual (HSM) contains extensive instructions and guidance regarding entry into

enclosed spaces. This guidance is incorporated into an enclosed space checklist.

5.4.3 Whenever entering into enclosed space, HSM stipulates for ventilation, of which forced draft ventilation is preferable, at least four air changes must took place before entry. If natural ventilation is the only possible choice, there should have sufficient number of opening to achieve effective natural ventilation for at least 24 hours. Since the stair trunk was not fitted with a fixed mechanical ventilation system, before the stevedores entered the stair trunk, the stair trunk was naturally ventilated through the opened access hatch for about 15 hours.

5.4.4 In accordance with the required procedure, the enclosed space entry permit should be issued by the chief officer, and countersigned by the Master. This double check procedure will confirm and safeguard the stair trunk to be safe for entry. However, the stair trunk had not been thoroughly ventilated, and the atmosphere had not been tested by multi gas meter before the stevedores entered into the stair trunk. (i.e. an enclosed space entry permit had not been issued for the entry into the stair trunk).

5.4.5 Even though there were stenciled warning signs "O_2 Depletion" and "Ventilation before Entry" at the entrance of the stair trunk, it did not alert the stevedores of the potential danger of the stair trunk. Also, the hatch covers of the No.4 cargo hold and access hatch were left open, it may be mistakenly believed by the stevedore to be safe for entry into the stairway.

5.5 Previous similar incident

5.5.1 There were a number of similar incidents happened regarding the potential danger of entry into enclosed space. Correct measures and action should be strengthened in order to prevent similar accident from happening again.

5.5.2 Firstly, the re-design or retro-fit work should be considered to be done onto this type of stair trunk ventilating system, i.e. the positive and forced draft ventilation system or a portable fan with extending air ducts are recommended.

5.5.3 Secondly, the authorized person onboard should enforce the procedures from the Health and Safety Manual, such as alert whichever party the potential danger of entry into enclosed space; gas free condition of the enclosed space; the issue of enclosed space permit ; dedicated or assigned

attendant guard at the entrance of enclosed space; continuous monitoring of atmosphere of the enclosed space.

6. Conclusions

6.1 At about 1245 hours on 11 April 2015, a fatal accident occurred on board the Hong Kong registered general cargo carrier "*Saga Frontier"* which moored alongside the bulk terminal No. Q1211 at Antwerp Belgium.

6.2 While the semi-coke bulk cargoes in the No.4 cargo hold was being discharged, two stevedores and one bulldozer operator entered the forward stair trunk for entry of the No.4 cargo hold to sweep the cargo for facilitating the discharge operation. They had been overcome by the oxygen deficient atmospheres at the bottom of the stair trunk due to the oxygen consumption of semi-coke and collapsed.

6.3 Some minutes later, another stevedore entered the stair trunk to check why his colleagues did not exit from the bottom door of the stair trunk and enter into the cargo hold. He discovered the incident, and escaped at once from the trunk, then reported the incident to the duty officer on deck.

6.4 The three casualties were transferred by the gantry crane to the jetty and sent to a hospital for treatment. However, they were certified dead later.

6.5 The investigation revealed that the main contributory factors of the accident were as follows:

- The stair trunk was categorized to be an enclosed space and it had not been provided with sufficient ventilation prior to the entry;
- No "enclosed space entry permit" was issued to certify the safe entry into the stair trunk;
- Stenciled warning signs "Ventilation before Entry" and "O2 Depletion" at the entrance of the stair trunk were disregarded by the stevedores; and
- The officers did not follow the relevant guidelines to prevent unauthorized entry of enclosed space.

7. Recommendations

7.1 A copy of the report should be sent to the master and the company of *the Vessel* advising them the findings of the investigation.

7.2 The company should ensure the master and all crew to strictly follow *the Vessel*'s procedures to control the entry into an enclosed spaces, in particular:

- To assign an entrance attendant or a barrier secured across the entry with an attached warning sign when the enclosed space is not sealed off or it has no enclosed space entry permit issued;
- To ventilate the enclosed spaces by positive forced draft ventilation in order to secure sufficient air change;
- To issue enclosed space entry permit after the risk assessment and gas free having been complied with; and
- To alert the involved parties the potential danger of entry into enclosed space (i.e. the stair trunk) before commencing of the cargo discharge.

7.3 A Hong Kong Merchant Shipping Information Notice is to be issued to promulgate the lessons learnt from the accident.

8. Submission

8.1 In the event that the conduct of any person or organization is commented in an accident investigation report, it is the policy of the Marine Department to send a copy of draft report to that person or organization for their comments.

8.2 The draft report was sent to the master and the management company of *the Vessel.*

8.3 A submission was received from the management company. The report was revised as appropriate.