Report of investigation into the fatal accident on board Hong Kong registered container carrier "*Seaspan Brilliance*" in Vancouver, Canada on 27 September 2020

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

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Purpose of Investigation

The purpose of this investigation, conducted by the Marine Accident Investigation Branch (MAIB) of Marine Department, is to determine the circumstances and the causes of the incident with the aim of enhancing the safety of life at sea and avoiding similar incidents in future.

It is not intended to apportion blame or liability towards any particular organization or individual except so far as necessary to achieve the said purpose.

The MAIB 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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Summary

On 27 September 2020, the Fitter of the Hong Kong registered container carrier "*Seaspan Brilliance*" (*the vessel*) at work in the engine room was seriously burnt when *the vessel* was berthed alongside for cargo operation in Vancouver, Canada.

After the exhaust side of the exhaust gas boiler (EGB) was cleaned, it was subject to a running test before putting back into service. During the running test, steam was found leaking from the water outlet valve of the EGB. The EGB was depressurized to allow the Third Engineer (3/E) and the Fitter to work on the leaking valve. They opened up the valve and reconditioned the parts. To assemble the valve, the 3/E used a rope to lower down the bonnet cover of the valve from above with the assistance of the Fitter who held another rope lashed to the bonnet stem from below to ensure alignment with the valve casing while lowering. Upon completion of lowering the bonnet to the valve casing, hot water suddenly gushed out of the bonnet joint of the reconditioned valve and scalded the Fitter underneath. The Fitter was sent to a local hospital for medical treatment but he died about one month later.

The investigation revealed that the crew members failed to follow the "Code of Safe Working Practices for Merchant Seafarers",[1] (*the Code*) to dissipate or isolate the thermal energy in the EGB together with the attached pipe resulting in hot water gushing out to scald the Fitter.

The investigation also identified that the crew members failed to strictly follow the risk assessment report to carry out the required control measures of the repair work; and that the crew members did not have sufficient safety awareness to apply good craftsmanship to control the potential fatal hazards when handling repair work.

1 "Code of Safe Working Practices for Merchant Seafarers" is a publication required to be carried on board Hong Kong ships pursuant to the Merchant Shipping (Seafarers) (Code of Safe Working Practices) Regulation (Cap. 478M).

1. Description of the vessel

Ship name	:	*Seaspan Brilliance* (Figure 1)
Flag	:	Hong Kong, China
Port of registry	:	Hong Kong
IMO number	:	9685334
Type	:	Container carrier
Year built, shipyard	:	2014, Jiangsu Yangzi Xinfu Shipbuilding, China
Gross tonnage	:	113,042
Net tonnage	:	59,440
Summer deadweight	:	115,173 tonnes
Length overall	:	336.95 metres
Breadth	:	48.2 metres
Engine power, type	:	58,100 kW, B&W 10S90ME-C9
Classification society	:	DNV-GL
Registered owner	:	GC Intermodal V Ltd
Management company	:	Seaspan Ship Management Ltd.

Figure 1 *The vessel*

2. Sources of evidence

2.1 The statements of the crew members of *the vessel*.

2.2 The information provided by the management company.

3. Outline of events

(All times are local time UTC - 7 hours)

3.1 After arriving in Vancouver of Canada at 2000 hours on 26 September 2020, *the vessel* proceeded to berth at 0118 hours on 27 September 2020 for cargo operations.

3.2 At 0745 hours on 27 September 2020, a toolbox meeting was held by the Second Engineer (2/E) to engine crew members (the crew members) to brief them on the safety procedures of the jobs going to be carried out in the engine room on that day, including the cleaning of EGB, the replacement of main engine fuel oil injection valves and the cleaning of purifiers.

3.3 After the meeting, the 3/E prepared to clean the EGB by stopping the auxiliary boiler (the boiler) and isolating the EGB from the boiler. The work done by the 3/E was cross-checked by the 2/E.

3.4 After the cooling down of the EGB, the 3/E opened the steam side ventilation cock and the exhaust side entrance manhole doors at the top and bottom of the EGB.

3.5 The 3/E, together with an oiler, operated a water jet gun to clean the tubes of the EGB from the exhaust side. When the cleaning work was completed, the 3/E restarted the boiler and initiated supply to the steam systems by resetting all the relevant valves into normal working position gradually as appropriate. At 1145 hours, the 3/E opened the isolation valves between the boiler and the EGB and started the circulation pump to test any abnormality of the EGB. During the test, steam leakage was found from the EGB water outlet valve (leaking valve). The 3/E then reported to the Chief Engineer through the 2/E.

3.6 At about 1215 hours, the work in the engine room was suspended and the crew members went for lunch. At 1300 hours, the crew members resumed the work in the engine room.

3.7 At 1330 hours, the 2/E assigned the Fitter to assist the 3/E in repairing

the leaking valve and held a toolbox meeting to brief the 3/E and the Fitter of the risks involved in the repair which required opening the leaking valve and renewing the joint packing inside.

3.8 Considering that the ambient temperature was around 12 degrees centigrade (°C), prolonged disruption of steam service system should be avoided to ensure smooth machinery operation and human comfort. As such the 3/E did not shut down the boiler which was at 4 bar steam pressure. Instead, he reduced the steam output from the boiler and stopped firing the boiler in order to allow the steam pressure to drop down slowly during the repair.

3.9 After isolating the EGB from the boiler by stopping the circulation pump and closing the isolation valves, the 3/E opened the steam ventilation cock of the EGB to release the steam inside. After releasing all the steam, the 3/E worked with the Fitter to open the leaking valve.

3.10 The bonnet cover of the leaking valve was removed and shifted to the engine room workshop by the 3/E for overhauling and re-conditioning. The casing of the leaking valve was reconditioned locally without disconnecting from the pipe line.

3.11 At about 1700 hours, the 3/E and the Fitter shifted the reconditioned bonnet cover from the engine room workshop to the side of the leaking valve casing and commenced to assemble the leaking valve by lowering down the bonnet cover to the valve casing using a rope from above. In the process of lowering the bonnet cover to the valve casing, the Fitter positioned himself under the leaking valve casing to control a rope which was lashed to the bonnet stem for assisting in aligning the bonnet cover to the leaking valve casing according to the instructions from the 3/E standing above.

3.12 When the bonnet cover successfully sat on the valve casing, hot water of about 50 to 60 liters in total suddenly gushed out of the joint between the bonnet cover and the leaking valve casing lasting for 5 to 6 seconds.

3.13 The Fitter was seriously scalded by the hot water. The Fitter

accompanied by the 3/E immediately went to the engine control room to receive first aid treatment. The Master was also informed to assess the injury of the Fitter.

3.14 The Fitter was then shifted to the ship's hospital for further medical treatment by shore medical staff on board.

3.15 At about 1810 hours the Fitter was sent to a local hospital by ambulance for medical treatment but he died in the hospital about one month later.

4. Analysis

Certification and experience

4.1 The Master had worked for the company for about 3 years. He had about 10 years of experience as a master and joined *the vessel* on 11 August 2020. He held a valid Class 1 Certificate of Competency (Deck Officer), which was revalidated on 20 December 2019 by the Government of Romania.

4.2 The C/E had worked for the company for about 4 years. He had about 16 years of sea experience and joined *the vessel* on 11 August 2020. He held a valid Class 1 Certificate of Competency (Marine Engineer Officer) issued by the Government of Ukraine on 9 September 2016.

4.3 The 2/E had worked for the company for about 6 years. He had about 4 years of experience as a second engineer and joined *the vessel* on 11 August 2020. He held a valid Class 2 Certificate of Competency (Marine Engineer Officer), which was revalidated on 1 January 2019 by the Government of India.

4.4 The 3/E had worked for the company for about 5 years. He had about 2 months of experience as a third engineer and joined *the vessel* on 22 September 2020. He held a valid Class 3 Certificate of Competency (Marine Engineer Officer) issued by the Government of India on 7 September 2017.

4.5 The Fitter had served the position as a fitter for about 8 years. He joined *the vessel* on 16 February 2020. He held a valid Certificate of Proficiency for Seafarers issued by the Government of India.

4.6 There were no abnormalities noted with regard to the certification and experience of the crew members concerned.

Fatigue, alcohol and drug abuse

4.7 There was no evidence to show that any crew members involved in

the accident, including the deceased, had suffered from fatigue at work or alcohol or drug abuse.

Cause of hot water gushing out

4.8 Prior to the repair, the water circulation was maintained between the EGB and the boiler at about 4 bar. It was estimated that the water temperature inside the EGB should be about 150°C.

4.9 At 1145 hours when the 3/E started to test the EGB, the crew members found steam leaking out from the bonnet cover joint of the leaking valve.

4.10 To stop the steam leakage, the crew members had to overhaul the leaking valve and replace the joint gasket of the bonnet cover. Before the overhaul, the 3/E isolated the pipe of the leaking valve by stopping the circulation pump and closing the isolation valves between the EGB and the boiler in order to allow the EGB to cool down and de-pressurize gradually. The 3/E also stopped firing the boiler but still allowed the main steam valve of the boiler to keep open by closing one turn only. Therefore, the steam heating system was still running.

4.11 The water inside the EGB was not drained for the valve repair. After de-pressurizing the EGB, the 3/E and the Fitter removed the bonnet cover of the leaking valve for re-conditioning the bonnet stem in the engine room workshop for about an hour. The leaking valve casing remained in connection with the boiler piping system. When the leaking valve was opened, no hot water or steam was observed gushing out of the leaking valve casing although the hot water inside the pipe was not drained. During the repair period which lasted for more than one hour, the steam pipe was found misty inside with hot water in a calm state.

4.12 When the 3/E lowered down the bonnet cover with the Fitter's assistance from below the valve seat, the steam pipe was closed again

with air trapped inside. The flash steam[2] generated by the hot water in the steam pipe built up pressure under the bonnet cover. This sudden increase of pressure induced water turbulence with wave pulses to the pipe internal surface, including the bonnet cover. Consequently, hot water of about 50 to 60 litres gushed out through the unbolted bonnet cover for about 5 to 6 seconds and splashed on the Fitter resulting in the serious scalding of the Fitter.

Risk assessment and control measures

4.13 Section 20.10 of *the Code* stated that when critical equipment was to shut down, risk assessment should be carried out to address any alternative back-up arrangement, any necessary modification in operational procedures as a result of the equipment being taken out of service, and any additional safety procedures.

4.14 As stated in the shipboard risk assessment report, steam might gush out under the repair procedures. As such, additional control measures had to be done to lower the risk level which included warning notices to be displayed at remote locations, slippery surfaces to be cleaned up, nobody should be present around the leaking valve during opening the valve and personal protective equipment had to be worn and checked.

4.15 However, the following control measures as recommended in the risk assessment report were not done or had not been carried out thoroughly, resulting in the accident:

(a) Instead of cooling down the boiler, the boiler was maintaining steam supply at a low rate throughout the repair period. Had the boiler been cooled down, the thermal condition inside the leaking valve would be stable and the gush of hot water might be

2 High-temperature condensate (water) contains an excess of energy preventing it from remaining in liquid form at a lower pressure. The result is that the excess energy causes a percentage of the condensate (water) to flash.

avoidable or happened at a lesser extent.

(b) The additional control measures that required nobody to be present around the leaking valve during opening the valve should also be applied to crew when they attempted to fit back the bonnet cover. An alternative arrangement such as lowering the bonnet cover by using chain block could be arranged to help the crew to stay further away from the fitting of the repaired bonnet cover, but this was not done in this case.

(c) The additional control measures also required additional personal protective equipment to be worn and checked. However, the crew did not put on additional insulated overalls as a last resort to protect body from hot water gushing out.

4.16 It was deduced that the risk assessment discussion in the toolbox meeting was ineffective. The crew members failed to fully understand the potential risks and follow the safe working plan before the repair work.

Safety issues when handling steam systems

4.17 For the maintenance of machinery, *the Code* has provided the guidelines under Section 20.5 of Chapter 20 "Work on Machinery and Power Systems" which stipulates that when working on steam-operated machinery or pipework, including those with heated water under pressure, both steam and exhaust valves should be securely closed, the valves locked or tied shut or some other means employed to indicate that the valves should not be opened. Such guidelines were meant to ensure that the thermal energy would be dissipated or isolated before proceeding to repair work.

4.18 In this case, however the crew members failed to dissipate the thermal energy in the EGB and the pipe line and the leaking valve. The EGB was only de-pressurized through the steam ventilation cock but the EGB was still full of hot water and flash steam.

4.19 In general, the following precautionary measures should be taken as good craftsmanship when handling steam systems:

(a) No boiler and the attached piping or fittings should be opened for inspection or repair until adequate arrangements such as blanking off or valves being locked shut have been made to prevent any backflow of steam or working fluid.

(b) When the bonnet cover was lowered onto the valve casing, the crew should stand at a safe zone either away from the leaking valve or protected by a barrier in between in order to reduce the chance of scalding by steam or hot water splashing out.

4.20 However, none of the above precautionary measures had been carried out properly.

Actions taken by the company after the accident

4.21 After the accident, the management company introduced a permit-to-work system in the shipboard safety management system for working on hot fluid system. This is to enhance the safety on board by following a set of predefined safety procedures to ensure that any repair work on hot fluid system is free of accumulated hot fluid. Crew members assigned for hot fluid system repair work are required to don personal protective equipment.

5. Conclusions

5.1 On 27 September 2020, the Fitter of *the vessel* was seriously burnt by hot water when *the vessel* was berthed alongside for cargo operation in Vancouver, Canada.

5.2 The Fitter was working with the 3/E on the leaking valve of the EGB which was de-pressurized but was still full of hot water and flash steam. After re-conditioning the parts of the leaking valve, the 3/E used a rope to lower down the bonnet cover of the leaking valve with the assistance of the Fitter who stood below the valve casing whilst holding another rope lashed to the bonnet stem. Upon placing the bonnet cover on the leaking valve casing, hot water suddenly gushed out of the bonnet joint of the repaired valve and scalded the Fitter underneath. The Fitter was sent to a local hospital on the same day, but he died about one month later.

5.3 The investigation revealed that the crew failed to follow *the Code* to dissipate or isolate the thermal energy in the EGB and the attached pipe resulting in hot water gushing out to scald the Fitter.

5.4 The investigation also identified the following contributory factors leading to the accident:

(a) The risk assessment had not been thoroughly discussed in the toolbox meeting to draw sufficient attention of the crew to comply with the control measures of cooling down the boiler; and that nobody is allowed to be present around the leaking valve during opening; and additional personal protective equipment should be worn.

(b) The lack of safety awareness to apply good craftsmanship to control the potential fatal hazard of hot water gushing out when handling repair work on steam system.

6. Recommendations

6.1 The management company of *the vessel* is recommended to:

(a) issue notice/circular to draw the attention of their masters, officers and crew members to the findings of the investigation; and

(b) enhance training on board to improve crew members' safety awareness of the potential hazards of working on hot fluid systems.

6.2 A Hong Kong Merchant Shipping Information Note should be issued to promulgate the lessons learnt from the accident.

7. Submission

7.1 The draft report, in its entirety, was sent to the shipowner, ship management company and master of *the vessel* for their comments.

7.2 During the consultation period, comments from the management company and the master of *the vessel* were received and the report had amended as appropriate.