Report of investigation into the fire explosion on board the Democratic People’s Republic of Korea registered container ship “Kum Song 8” at position 22° 18.131’N 114° 04.329’E in Hong Kong on 20 November 2012
**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 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 to wards 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. At about 08:50 hrs on 20 November 2012, a fire explosion happened on board the Democratic People’s Republic of Korea registered general cargo/container vessel Kum Song 8 while she was mooring in the Western Anchorage No.1 at position 22° 18.131’N 114° 04.329’E.

1.2. At the time of the accident, the Chief Engineer and the Engineer Officer were transferring diesel oil from the starboard diesel oil storage tank to the port heavy oil storage tank using a portable electrical submersible pump with the manhole covers of the two fuel oil storage tanks left opened during the transfer.

1.3. It is deduced from the available evidence that the cause of the fire and explosion accident was due to ignition of the flammable vapour by electric sparks generated at the socket of the portable power extension cable, when the power supply to the portable submersible pump was interrupted by disconnecting the power plug from the socket. Fire was started at once as flammable vapour was ignited by electric sparks and it started at the position near the diesel oil storage tank. The fire flashed back inside the tank and generated a great pressure, which forced a flame of burning vapour out into the store room. The fire flame died down after flammable gas was depleted. Apart from some tools in the store room were burned, the store room sustained no fire damage.

1.4. The Chief Engineer and the Engineer Officer, who were staying in the vicinity of the fire were engulfed by flame. Their work clothes were burned and the Chief Engineer and the Engineer Officer sustained serious skin burns of about 50% and 90% respectively. At about 09:40 hrs, Marine Police and Fire Services Department launches arrived at Kum Song 8. The two injured persons were sent to the hospital for treatment by the Government Flying Services.

1.5. The Chief Engineer was repatriated back home for treatment on 6 December 2012. The Engineer Officer was later certified dead in the hospital in Hong Kong on 21 December, 2012.

1.6. Investigation into the accident revealed the following main contributing factors:-

a) Safety awareness of engineer officers was poor when handling fuel oil transfer within the space where oil vapour could be trapped and electric sparks from the interrupted power supply to the portable pump could be generated during operation;

b) Chief Engineer of Kum Song 8 was not familiar with the fuel oil specification requirements for the main engine and the ship management company did not
investigate and solve the root cause of the problem which could be resolved by heating up the heavy oil to a temperature that could be burnt by the main engine;

c) the Chief Engineer and Engineer officers on board were not familiar with fuel oil piping system which had been designed for internal transfer of fuel oils between the port and starboard fuel oil storage tanks; and

d) without assessing the risk, the ship management company did not object the Chief Engineer to use the inappropriate arrangement of using a portable electrical submersible pump for transferring diesel oil to mix with the heavy oil for use by the main engine.
Description of the vessel Kum Song 8

Flag : Democratic People’s Republic of Korea
Port of Registry : NAMPHO
IMO No. : 8810384
Call Sign : HMYT7
Type : General Cargo/ Container Ship
Keel Laid Year : 1988
Gross Tonnage : 1,485
Deadweight : 2,399
Length (Overall) : 77 m
Main Engine : 1 x NIIGATA 6M31ATE/1400PS
Engine Output (M.C.R.) : 1,029 kW
Cruising speed : 11.0 knots
Classification Society : Korea Classification Society
Shipbuilder : Miura Shipbuilding Co., Ltd. Japan
Registered Owner : Hong Kong Myunghae Group Limited
Management Company : Korea Jamaedo Shipping Co
Minimum manning : 11

Fig. 1 – Kum Song 8
3 Sources of evidence

3.1 Statements from the Master and crews of Kum Song 8;
3.2 Weather report provided by the Hong Kong Observatory
3.3 Information furnished by the Maritime Administration, DPR Korea and statement of the Chief Engineer upon consultation of the draft report.
Outline of events
All times are local time GMT + 8

4.1 At about 08:30 hrs on 12 November 2012, *Kum Song 8* (the *vessel*) departed from the port of Dalian, China after discharging all of its cargo and sailed to Hong Kong under ballast condition.

4.2 At 17:30 hrs on 19 November 2012, the *vessel* arrived at Hong Kong and moored in the Western Anchorage No.1, approximate position 22° 18.131’N  114° 04.329’E. It was scheduled to load 30 containers in Hong Kong.

4.3 At 18:30 hrs on the same day, the *vessel* received 25 tons of heavy oil from a bunker barge into the port storage tank (Fig. 2). Prior to taking the bunker, there was about 7 tons of heavy oil inside that tank.

4.4 At about 08:30 hrs on 20 November 2012, the Chief Engineer and the Engineer Officer started opening the manhole covers of the port and starboard fuel oil storage tanks (Fig. 3) and lowered an electrical submersible pump hanged to the end of a rope into the starboard diesel oil storage tank to transfer diesel oil into the port heavy oil storage tank for mixing.

4.5 The process took about 20 minutes and was completed at 08:50 hrs. At the completion of the transfer and mixing of fuel oils, the Chief Engineer instructed the Engineer Officer to stop the process by disconnecting the electric plug of the pump from the socket of the power extension cable. When the Engineer Officer took out the electric plug from the socket, an explosion occurred and followed by the fire incident.

4.6 The work clothes of the Chief Engineer and the Engineer Officer were burned. They took off and threw their work clothes on the engine room platform while running out from the engine room up to the crew accommodation seeking for help. Both of them sustained serious skin burns.

4.7 Upon knowing the accident, crewmembers went down into the engine room and extinguished the fire of burning clothes with portable fire extinguishers. Apart from that, there was no fire inside the engine store room (Fig. 4).

4.8 The store room was partly charred by black smoke and sustained no structural damage. The insulation of the electrical power cable of the submersible pump was partly burned (Fig. 5). The damaged part of the power cable was cut by the crew after the incident and was thrown overboard. Some tools in the store room was slightly burned and/or blackened by the fire (Fig. 6).
The Master of the *vessel* used mobile phone to inform the local agent who called the Police about the incident. At about 09:40 hrs, Marine Police and Fire Services Department launches arrived at the *vessel*. The Chief Engineer and the Engineer Officer were sent to the Prince of Wales Hospital by helicopter of the Government Flying Services for medical treatment.

Fig. 2 – Diagram showing the position of the port and starboard fuel oil storage tanks inside the engine room

Fig. 3 – Manhole covers of port and starboard fuel oil storage tanks
Fig. 4 – General condition of the store room after the incident

Fig. 5 – Submersible pump used for transferring diesel oil
The Chief Engineer and Engineer Officer sustained serious skin burns of about 50% and 90% respectively. The Chief Engineer was repatriated back home for treatment on 6 December 2012. The Engineer Officer was later certified dead in the hospital in Hong Kong on 21 December, 2012. The autopsy of the Engineer Officer was waived on the application of the next-of-kin of the deceased.

At the time of the accident, the weather was fine with easterly wind of 19 km/hr. The sea state was slight.
5 Analysis

Certification and Experience

5.1 The vessel was manned by a total of 15 crew members consisting of the Master, two deck officers, Chief Engineer, Second Engineer, Electrical Officer, seven deck ratings and two engine room ratings, all were nationals of the Democratic People’s Republic of Korea.

5.2 The Master had 22 years of seagoing experience and worked as a master of ships for about 10 years. He possessed a Certificate of Competence as master on ships of gross tonnage between 500 and 3000 GT issued by the Maritime Administration, Democratic People’s Republic of Korea on 14 August 2009 valid until 13 August 2014. He signed on the vessel as a Master on 26 May 2011.

5.3 The Chief Engineer, who was injured in the incident, had 10 years of experience working on board ships and worked as a chief engineer for about 3 years. He possessed a Certificate of Competence as chief engineer officer on ships of propulsion power between 750 and 3000 kW issued by the Maritime Administration, Democratic People’s Republic of Korea on 12 March 2011 valid until 11 March 2016. He signed on the vessel as a Chief Engineer on 26 May 2011.

5.4 The Engineer Officer, who died in the incident, had three years of experience working on board ships. He possessed a Certificate of Competence as second engineer officer on board ships of propulsion power between 750 to 3000 kW issued by Maritime Administration, Democratic People’s Republic of Korea on 28 August 2011 valid until 27 August 2016. He signed on the vessel as an Engineer Officer on 11 October 2011.

Fuel oil storage tanks in the engine room

5.5 The engine room is located in the aft of the vessel with one set of main engine installed in the lowest level. One set of diesel generator was located on the port side of the main engine.

5.6 A corridor space athwartships of the vessel allocated for keeping tools and accessories was arranged on the forward upper platform of the engine room (hereafter called the store room, see Fig. 7). Below the deck of the store room were the port and starboard built-in fuel oil storage tanks for storage of heavy and diesel oil respectively (Fig. 8). These storage tanks were originally designed for storage of heavy oil only. According to the crew, the vessel required to use more diesel oil and therefore they made use the starboard tank for the storage of diesel oil.
Fig. 8 – Layout of the built-in oil tanks in the engine room

Entrance into the store room from the upper platform of the engine room

The store room looking to the port side of the vessel

Fig. 7 – The store room
5.7 The flush-deck manhole covers of the fuel oil tanks are located on the deck inside the store room. Two stool pieces, one for each tank and closed by a blank flange, are provided for taking soundings of the oil tanks (Fig. 9). There were no other sounding pipes for the storage tanks and the crew used to remove the blank flanges for taking soundings. At the time of the accident, the bolts and nuts for tightening the blank flanges were loosened to facilitate taking soundings of the fuel oil tanks during the transfer of diesel oil.

![Blank flange the stool-piece for taking sounding of storage tank](image9)

5.8 The capacity of the port heavy oil storage tank was 38 m$^3$. Heavy oil was transferred to the settling and daily service tanks, both were stand-alone tanks with a capacity of 0.95 m$^3$ located side-by-side on the port side of the upper platform in the engine room (Fig. 10). The daily consumption of heavy oil by the main engine was about 3.7 tonnes.

![Heavy oil settling tank and service tank](image10)
5.9 The capacity of the starboard diesel oil storage tank was 38 m$^3$. There were also two double-bottom diesel oil tanks located in the port and starboard side of the engine room, capacity of 4.89 m$^3$ and 8.24 m$^3$ respectively. A stand-alone diesel oil service tank with a capacity of 0.95 m$^3$ was also located on the port side of the upper platform in the engine room (Fig. 11).

![Fig. 11 – Diesel oil service tank](image)

5.10 The fuel oil piping system of the vessel is shown in Fig. 12.

![Fig. 12 – Fuel oil piping system](image)
Transfer of diesel oil from starboard storage tank to mix with heavy oil in the port storage tank

5.11 The vessel was normally traded between Democratic People’s Republic of Korea and ports in the northern part of China, such as Dalian, Qingdao. It was the first time that the vessel called Hong Kong.

5.12 The vessel experienced main engine problem back in April 2012 due to fuel viscosity too high. According to fuel viscosity – heating temperature graph in main engine operation guidance (Figure. 13), if heavy oil used on board ship could be heated to about 110°C, it would be possible to use as main engine fuel without mixing oils. But the problem was solved by mixing diesel oil with heavy oil. Since then, it became a normal practice on board the vessel to transfer diesel oil from the starboard diesel oil storage tank into the port heavy oil storage tank. There was piping system to enable such transfer operation, but the crew did not know about it. So it was done by means of a portable electrical submersible pump through the two manhole openings of the tanks, which are adjacent to each other.

![Fig. 13 – Fuel viscosity – heating temperature graph](image)

5.13 During docking repair of the vessel in China in July 2012, a screw pump was installed at the port side lowest deck of the engine room close to the bulkhead. The
pump drew heavy oil from the port heavy oil storage tank and discharged it back into the tank for circulation of fuel oil inside the tank. The pump would be started after diesel oil added into the heavy oil storage tank and with the two manhole covers closed. The screw pump was kept running during the voyage.

Fig. 14 – Screw pump for circulating heavy oil inside the storage tank

5.14 It is observed that the arrangement of the screw pump did not comply with SOLAS requirement in which there was no outlet valve fitted directly on the heavy oil storage tank (Fig. 14). Also, there is no evidence that the modification of the fuel oil system had been approved by the Classification Society.

5.15 The last time of transferring diesel oil into the heavy oil storage tank was carried out in the port of Dalian after receiving heavy oil into the storage tank and before ship departure. The vessel arrived in Hong Kong and received heavy oil in the night of 19 November 2012. The fuel oil characteristics of heavy oil received in comparison with main engine manufacturer are as follows:

<table>
<thead>
<tr>
<th>Fuel Characteristics</th>
<th>M/E Manufacturer Suggestion</th>
<th>Bunkering Fuel Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity cSt @40/50°C</td>
<td>13 ~ 16</td>
<td>180</td>
</tr>
<tr>
<td>Flash Point °C</td>
<td>80 ~ 120</td>
<td>70</td>
</tr>
<tr>
<td>Sulphur Content %</td>
<td>1.5 ~ 2.9</td>
<td>2.4</td>
</tr>
</tbody>
</table>

5.16 The Chief Engineer started to transfer diesel oil into the heavy oil storage in the morning of 20 November 2012. He and the Engineer Officer opened the adjacent manhole covers for the two tanks inside the store room and used the portable
electrical submersible pump, which was tied to one end of a rope and lowered into the diesel oil storage tank, to carry out the transfer. Approximately 2.5 m$^3$ of diesel oil was transferred from the starboard storage tank into the port heavy oil storage tank before the accident. According to the crew, the fuel oil circulating pump was not running at the time of the accident.

**The source of flammable vapour**

5.17 The manhole covers for the fuel oil storage tanks inside the store room were left opened so that the discharge hose of the portable pump inside the diesel oil storage tank could be put inside the heavy oil storage tank through the manholes. Flammable vapour evaporated and accumulated inside the storage tanks could have been expelled through the manhole openings and the stool-pieces into the store room during transferring of diesel oil. Neither forced nor natural ventilation was provided for the store room and there was no fire detector inside the room.

**Submersible pump, power extension cable and connection**

5.18 The electrical submersible pump used for the transfer of diesel oil was not of an explosion-proof type equipment. After the fire incident, the insulation material of the power cable for the submersible pump was burned out from its end connecting to the extension cable to the end near to the body of the pump. That part of the cable was cut off and threw overboard after the accident as claimed by the crew. The remaining part of the unburned cable, about 150 mm long, for the pump is shown in Fig. 15.

![Fig. 15 – The remaining part of the power cable of the submersible pump](image1)

![Fig. 16 – Power extension cable](image2)
The power extension cable was kept in a reel with its power socket and plug connector not designed for used in an environment with the present of flammable gas (Fig. 16).

**Probable cause of the fire explosion**

It is deduced from the available evidence that the cause of the fire and explosion accident was due to ignition of the flammable vapour by electric sparks generated at the socket of the power extension cable, when the power supply to the portable submersible pump was interrupted by disconnecting the power plug from the socket.

In view of the fire damage to the store room was not serious, it is determined that fire was started at position near to the diesel oil storage tank upon ignition of flammable vapour accumulated there by electric sparks. Fire occurred once flammable gas was ignited. The fire flashback inside the tank to generate a great pressure which forced a flame of burning vapour out into the store room. The fire flame died down after flammable gas was depleted (Fig. 17).

As there were not so many combustible materials stored inside the store room apart from the tools, the fire could not spread to the engine room.

The Chief Engineer and the Engineer Officer were staying in the vicinity of the manhole covers where they were engulfed by flame. Their working clothes were burned and consequently sustained serious skin burns.

![Diagram of probable cause of fire explosion](image-url)
5.24 The ship management company of the vessel should have been aware of the main engine fuel oil problem back in April 2012, which was solved by mixing the heavy oil with diesel oil. However, the management did not find out the root cause of that problem. They adopted the mixing operation as a routine practice on board the vessel without properly assessing the risk associated with it.

5.25 Chapter II-2 Regulation 15.2.5 of SOLAS 1981 Amendment applicable for ships constructed on or after 1 September 1984 and before 1 July 2002 required that – “every oil fuel pipe, which, if damaged, would allow oil to escape from a storage, settling or daily service tank situated above the double bottom shall be fitted with a cock or valve directly on the tank capable of being closed from a safe position outside the space concerned in the event of a fire occurring in the space in which such tanks are situated”. During dockyard repair of the vessel in July 2012, the ship management company installed a screw pump for circulating heavy oil inside the port heavy oil storage tank. However, no fuel oil outlet valve was directly fitted on the tank. Under such circumstance, if the fuel oil pipe between the fuel oil storage tank and the suction of the circulating pump were damaged, it would allow oil to escape from the storage tank into the engine room.

5.26 The manhole covers for the fuel oil storage tanks inside the store room were left opened during the fuel oil transfer operation. Flammable vapour inside the fuel oil storage tanks could be emitted through the manhole openings into the store room. Although the odour of flammable vapour was apparent in the vicinity of the manhole covers, the Engineer Officer still disconnected the power plug of the portable pump without first cut off the electrical power from the source outside the compartment. The latter action was vulnerable to produce electric spark. It is considered that the safety awareness of Chief Engineer and the Engineer Officer was poor.

5.27 The Chief Engineer and the Engineer Officer opened the adjacent manhole covers of the two tanks inside the store room and used the portable electrical submersible pump to carry out the fuel oils transfer. However, there was existing fuel oil piping system on board the vessel capable for internal transfer of fuel oil between the starboard and port fuel oil storage tanks. It is considered that the Chief Engineer and the Engineer Officer were not familiar with the fuel oil piping system of vessel.
Refer to paragraph 5.12, heavy oil could be used directly by the main engine if it was heated to about 110°C. It is considered that the Chief Engineer of Kum Song 8 was not familiar with the fuel oil specification requirements for the main engine.
6 Conclusions

6.1 At about 08:50 hrs on 20 November 2012, a fire explosion happened on board the Democratic People’s Republic of Korea registered general cargo/container vessel *Kum Song 8* while she was mooring in the Western Anchorage No.1 at the position 22° 18.131’N 114° 04.329’E.

6.2 At the time of the accident, the Chief Engineer and the Engineer Officer were transferring diesel oil from the starboard diesel oil storage tank to the port heavy oil storage tank using a portable electrical submersible pump with the manhole covers of the two fuel oil storage tanks left opened during the transfer.

6.3 It is deduced from the available evidence that the cause of the fire and explosion accident was due to ignition of the flammable vapour by electric sparks generated at the socket of the portable power extension cable, when the power supply to the portable submersible pump was interrupted by disconnecting the power plug from the socket. Fire was started at once as flammable vapour was ignited by electric sparks and it started at the position near the diesel oil storage tank. The fire flashed back inside the tank and generated a great pressure which forced a flame of burning vapour out into the store room. The fire flame died down after flammable gas was depleted. Apart from some tools in the store room were burned, the store room sustained no fire damage.

6.4 The Chief Engineer and the Engineer Officer, who were staying in vicinity of the fire were engulfed by flame. Their working clothes were burned and the Chief Engineer and the Engineer Officer sustained serious skin burns of about 50% and 90% respectively. At about 09:40 hrs, Marine Police and Fire Services Department launches arrived at the vessel. The two injured persons were sent to the hospital for treatment by the Government Flying Services.

6.5 The Chief Engineer was repatriated back home for treatment on 6 December 2012. The Engineer Officer was later certified dead in the hospital in Hong Kong on 21 December 2012.

6.6 Investigation into the accident revealed the following main contributing factors:-

a) Safety awareness of engineer officers was poor when handling fuel oil transfer within the space where oil vapour could be trapped and electric sparks from the interrupted power supply to the portable pump could be generated during operation.

b) Chief Engineer of *Kum Song 8* was not familiar with the fuel oil specification requirements for the main engine and the ship management company did not investigate and solve the root cause of the problem which could be resolved.
by heating up the heavy oil to a temperature that could be burnt by the main engine;

c) the Chief Engineer and Engineer officers on board were not familiar with fuel oil piping system which could be used for internal transfer of fuel oils between the port and starboard fuel oil storage tanks; and

d) without assessing the risk, the ship management company did not object the Chief Engineer to use the inappropriate arrangement of using a portable electrical submersible pump for transferring diesel oil to mix with the heavy oil for use by the main engine.

6.7 One safety factor revealed by the investigation was the piping system for the newly installed screw pump did not comply with the SOLAS requirements or approved by the Classification Society of the vessel.
7. **Recommendations**

7.1 The ship management company of the vessel is required:

a) to enhance the safety awareness of crewmembers, in particular, the engineer officers with respect to the use of portable electrical appliances in hazardous environment.

b) to ensure the Chief Engineer is familiarized with the fuel oil specification requirements of main engine on board and provide all necessary shipboard supports including solving the root causes when similar problems arise;

c) to ensure the Chief Engineer and Engineer officers are familiarized with shipboard fuel oil piping systems, particularly to the piping systems designed for internal transfer of fuel oils; and

d) to ensure the piping arrangement for the newly installed screw pump for circulating heavy oil in the port storage tank comply with the relevant SOLAS requirements and approved by the Classification Society of the vessel.
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 the draft report in part or in entirety to that person or organization for their comments.

8.2 The draft report has been sent to the flag Administration and the management company of *Kum Song 8* for comments. There was no comment received from the ship management company. The feedback from the flag Administration has been considered and incorporated in the final report as appropriate.