

# **FINAL REPORT**

## **LOSS OF LIFE ON BOARD SOUTHERNPEC 12 IN SINGAPORE ANCHORAGE ON 11 DECEMBER 2018**

**MIB/MAI/CAS.055**

**Transport Safety Investigation Bureau  
Ministry of Transport  
Singapore**

**17 March 2020**

## The Transport Safety Investigation Bureau

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## **SYNOPSIS**

On 11 December 2018 at about 1500hrs, an Able Seafarer Deck (ASD), who was part of a five-men team (deck crew) tasked to carry out tank cleaning, collapsed inside a cargo oil tank on a product tanker Southernpec 12, while the vessel was anchored in Singapore. The ASD was subsequently evacuated from the tank and was conveyed ashore, but lost vital signs enroute.

The TSIB classified the occurrence as a very serious marine casualty and launched an investigation.

The investigation revealed that the ASD had entered the cargo tank, which had been earlier declared as gas-free, after a prolonged break without carrying out any checks on the tank atmosphere. The crew had not been provided with personal gas detectors and there was no safety equipment kept on standby at the entrance of the enclosed space being entered. The permits to work issued for the space were, according to the Chief Officer, closed and no entry was permitted but the space had not been safeguarded from unauthorised entry.

The investigation also revealed that inappropriate method was used to gas free the cargo oil tank by connecting the ventilation blowers via chutes to the manifolds, without flushing the pipelines to remove remnants of the previous cargo. In addition, the investigation discovered that proper procedures were not followed for enclosed space entry and there were gaps identified in the implementation of the Safety Management System (SMS) on board.

## DETAILS OF VESSEL

<b>Name</b>	Southernpec 12
<b>IMO Number</b>	9620279
<b>International Call Sign</b>	9V9270
<b>Flag Registry</b>	Singapore
<b>Classification Society &amp; ISM<sup>1</sup> Recognised Organisation (RO)</b>	Bureau Veritas
<b>Ship type</b>	Product Oil Tanker
<b>Year Built</b>	2011
<b>Owner</b>	Eray Marine Pte.Ltd.
<b>ISM Company</b>	Southernpec (Singapore) Shipping Pte. Ltd. <sup>2</sup>
<b>Crew List<sup>3</sup></b>	8 Officers/ 9 Ratings/ 2 Cadets
<b>Gross tonnage</b>	5036
<b>Length overall</b>	118.00m
<b>Breadth</b>	17.60m
<b>Draught</b>	3.0m (Fwd) / 5.0m (Aft)
<b>Total capacity of cargo oil tanks (COTs)</b>	8200m <sup>3</sup> (Largest <sup>4</sup> COT was 3-Starboard with a capacity of 988m <sup>3</sup> with the length of the tank at approx. 16m)
<b>Cargo tank groups</b>	No. 1 (No. 1-Wing COT / No. 3-Wing COT); No. 2 (No. 2- Wing COT / No. 4-Wing COT); No. 3 (No. 5-Wing COT and SLOP Wing tanks)

<sup>1</sup> International Management Code for the Safe Operation of Ships and for Pollution Prevention – Under which ISM Company is the legal entity managing the vessel in compliance with the ISM and ISPS Codes, as required by the Flag Registry. The Company was issued with a Document of Compliance (DOC) by the ISM RO to demonstrate compliance with the ISM Code.

<sup>2</sup> Taken over on 3 May 2012 and ceased management of the vessel with effect from 29 November 2019. Management of the vessel was transferred to the Owner. The Owner also managed a Singapore registered tanker Southernpec 9 (SP9).

<sup>3</sup> All officers and ratings held valid statutory certificates for their position under The International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW) Convention.

<sup>4</sup> 1-Port and 1-Starboard: Approximately 605 cubic metre (m<sup>3</sup>) each, 2-Port and 2-Starboard: Approximately 909m<sup>3</sup> each, 3-Port Approximately 984m<sup>3</sup>

## VIEW OF VESSEL



MT Southernpec 12

Source: MarineTraffic

## 1 FACTUAL INFORMATION

All times used in this report are Singapore Local Time. (UTC +8.0)

### 1.1 Sequence of events

1.1.1 MT Southernpec 12 (SP12) departed Tanjung Uban, Indonesia, at about 2120H on 9 December 2018, after discharging a cargo of Gasoline 98 RON<sup>5</sup>. Soon after, the Chief Officer (CO) began preparations for cargo oil tank (COT) cleaning<sup>6</sup> operations with the Bosun<sup>7</sup>, three ASDs and a Deck Cadet. The CO stated that before the departure from Tanjung Uban, the vessel received indicative voyage orders from the Company's operations department to load a cargo of diesel (a higher grade of cargo) from Tanjung Langsat, Malaysia. After consulting the Master, the CO initiated washing of the COTs. COTs cleaning was expected to continue enroute to Singapore, which is a short passage.

1.1.2 The tank cleaning plan<sup>8</sup> prepared by the CO required the use of portable tank washing machines which utilised seawater for washing the COTs, for about 10 to 20 minutes (per COT), and then stripping<sup>9</sup> them to holding tanks (Slop<sup>10</sup>). The plan also required the tank domes (hatches for the COTs) and other

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<sup>5</sup> From Safety Data Sheet of this compound, harmful effects due to inhalation includes birth defects and could cause serious damage to health by prolonged exposure. If high concentrations of mist or vapours are inhaled, may cause nausea, dizziness, headache and drowsiness.

<sup>6</sup> For the purpose of grade changeover.

<sup>7</sup> This Bosun had been on board for about nine months and signed off the vessel one day prior to the occurrence.

<sup>8</sup> This documented tank cleaning plan as per Company's Safety Management System (SMS) was dated 10 December 2018. The Company was not sent a copy of the plan.

<sup>9</sup> Means to empty the remnants inside a cargo tank typically using cargo pumps.

<sup>10</sup> Slop Tanks – a tank specifically designated for the collection of tank draining, tank washings and other oily mixtures

openings like sampling points, to be kept open for ventilation<sup>11</sup>. These openings were reportedly kept open since the washing had commenced. The plan did not specifically state which pipelines<sup>12</sup> would be flushed to remove remnants of the previous cargo.

1.1.3 By about 2230H, COTs washing had been completed and the CO arranged for the COTs to be ventilated so that entry into the COTs could be done subsequently. The vessel had three electrically operated intrinsically safe ventilation blowers which would be connected to ducts (normally referred as chutes) to ventilate the COTs.

1.1.4 The CO instructed the same deck team to connect the chutes to the two manifolds<sup>13</sup> on the starboard side and one manifold on the port side (see example in **Figure 1a & 1b**). All deck crossover valves were opened, as were the droplines, and the ventilation commenced at about 2300H, circulating fresh air from blowers, via the chutes, through crossover lines<sup>14</sup> into the COTs and out of the tank dome.



**Figure 1a:** One remaining chute connected to starboard manifold when investigation team was on board

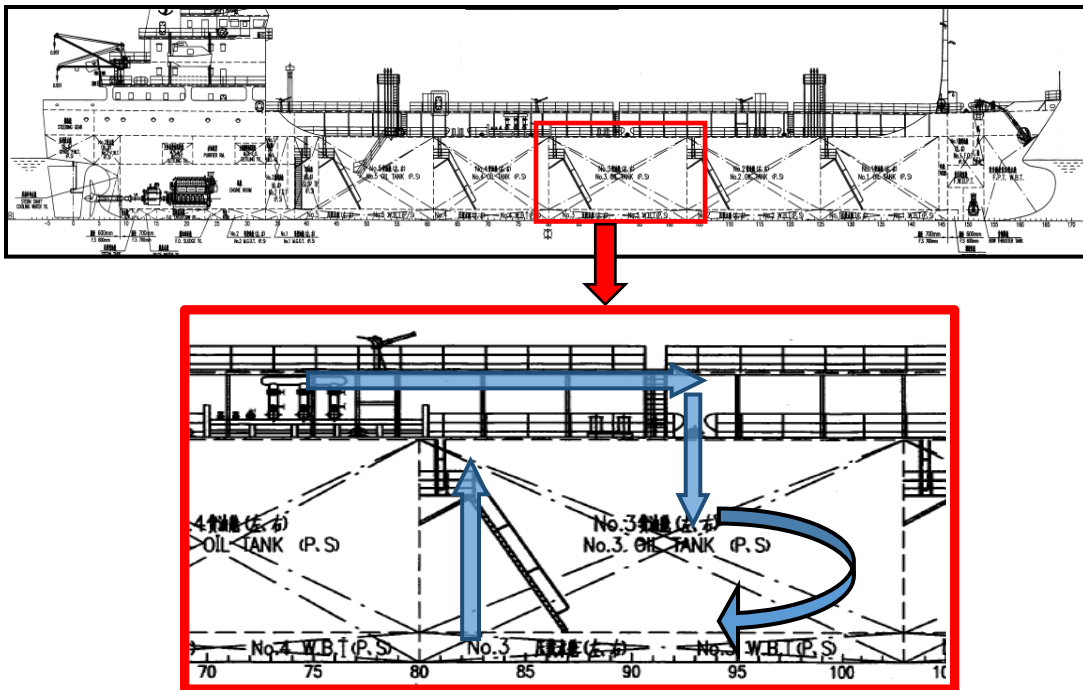
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<sup>11</sup> The ship was not required to be fitted with an inert gas system as per SOLAS regulations for a vessel of this size (SOLAS Reg. II-2/4.5.5 – inert gas system to be fitted on all new oil and chemical system tankers of 8000 deadweight and above).

<sup>12</sup> E.g. cargo pipelines at the manifold, crossover lines and main cargo lines.

<sup>13</sup> Typically, ventilation blowers are connected via chutes to the openings (tank domes or manholes) directly so that fresh air can get circulated into the COT and exit from the farthest openings. On SP 12, there was one tank dome per COT and two other openings spread across the dimensions of the COT. Distance between tank dome (located at the aft most section of 3S COT) and the forward most opening was about 13m.

<sup>14</sup> The layout of SP12's pipelines is of a typical vessel of this size and type, where the pipes rise upwards from the manifold towards the crossovers before entering vertically down into the COTs as droplines.



**Figure 1b:** For Illustration only and not to scale. The blue arrows show the direction of the air circulation from the blower (chute) via the manifold to COT (via cargo line and dropline) and out from the tank dome. Annotated by TSIB.

1.1.5 By about 0330H on 10 December 2018, SP12 arrived Singapore anchorage<sup>15</sup> (Western Petroleum Anchorage 'Alpha' - AWPA) and was awaiting her loading Laycan<sup>16</sup>. Ventilation blowers were kept running throughout the duration of her arrival and subsequent stay at anchor<sup>17</sup>. There were no records of the vessel, the Company or the agent seeking a permission<sup>18</sup> from the Port Master for tank cleaning or gas-freeing.

1.1.6 In the interview by the investigation team, the CO added that the deck crew<sup>19</sup> had been instructed to keep the ventilation blowers for COTs running continuously regardless of rain. At daybreak, SP12 received some ship's stores and supplies (fresh water by barge) as arranged by the Company. Some crew change was also expected during the day.

<sup>15</sup> According to Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives - DGPE) Regulations, written permission must be obtained from the Port Master for cleaning or gas-freeing of vessel's tanks.

<sup>16</sup> Period during which a vessel has to present itself ready in all respects to load the cargo.

<sup>17</sup> During SP12 stay at the anchorage, intermittent rain was experienced.

<sup>18</sup> The agent confirmed that they were not aware of SP12 carrying out cleaning / gas-freeing in port and that typically operators' vessels, which call Singapore regularly (including SP12) are aware of the requirements to inform the agents if such an operation is to be performed. The agent also confirmed that any new vessel for which they were appointed would be informed of regulatory matters beforehand.

<sup>19</sup> Comprising the Bosun, the three ASDs and Cadet. ASD1, ASD3 and Cadet were from Myanmar, while ASD2 was from China.



- 1.1.7 At about 1200H, a new joiner Bosun (BSN) boarded SP12 with some other crew. The handing-over Bosun was planned for disembarking from the vessel at about 1300H, as arranged by the Company in the same launch. The newly joined BSN was asked by the CO to freshen up and assist the deck crew with the stores and supplies.
- 1.1.8 During the CO's bridge watch at anchor from 1600H to 2000H, the CO prepared further details for tank cleaning, which included initiating entry of deck crew into the COTs on the next day for removing water and drying up of the COTs (mopping). This work (Refer to 1.3.1) required conducting a risk assessment<sup>20</sup> and obtaining approval from the Master, in accordance with the Company's SMS. None of the deck crew were aware<sup>21</sup> of this risk assessment or its contents.
- 1.1.9 After handing over the bridge watch at about 2000H to the next watchkeeper, the CO informed the deck crew (comprising the BSN, three ASDs and a Deck Cadet) about the plan for entering COT on the next day for mopping and cleaning. The BSN was instructed by the CO to follow the guidance and advice of the senior ASD (ASD1), considering that the BSN was new to the vessel and might need to get familiar with the vessel and its operations. The familiarisation records<sup>22</sup> for BSN were signed off by the CO, with the CO taking into account that the previous Bosun would have adequately briefed the BSN before disembarking. The records also contained the BSN's acknowledgement<sup>23</sup> dated 10 December 2018.
- 1.1.10 The next day (11 December 2018), being aware of the day's plan, the deck crew gathered in the crew's mess room at about 0600H to discuss the grouping in which they would enter the COTs. Amongst them, they decided that at about 0830H, ASD1 and ASD3 (Group 1) would enter the first COT to pump out the remaining water in the bilge well, using the portable air driven diaphragm pump (commonly known as a wilden pump). On completion of this task they would proceed to the next COT. The second group (Group 2) comprising the BSN and ASD2 would then enter the first COT for wiping the remaining traces of water and drying up the tank by mopping it.

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<sup>20</sup> The risk assessment form was dated 11 December 2018 (the day of the incident, i.e. the next day after this RA was prepared and approved)

<sup>21</sup> The CO stated that the contents had been discussed with the deck crew.

<sup>22</sup> New joiners were required to be familiarised with Enclosed Space entry precautions, actions to be taken in shipboard emergencies and location of Breathing Apparatus, Emergency Escape Breathing Device (EEBD) amongst others as per Shipboard Operational Procedures Manual (SOPM) 3110.

<sup>23</sup> On being queried further by the investigation team, the BSN confirmed that the handing-over Bosun had disembarked the vessel around 1300H. The BSN could not provide any details of the scope of the familiarisation.

1.1.11 At about 0630H, as per daily duty, the ASD1 went to the bridge to perform routine cleaning of the bridge. The CO, who was keeping the 0400H to 0800H bridge watch then left the bridge to take gas measuring equipment from the cargo control room (CCR) and went on deck to measure the atmosphere in the COTs. The readings<sup>24</sup> recorded by the CO for six of the 10 COTs were as follows:

COTs	Oxygen (O <sub>2</sub> ) - %	Hydrocarbon (LEL) <sup>25</sup> - %
1-Port	20.9	0.0
1-Starboard	20.9	0.0
2-Port	20.9	0.0
2-Starboard	20.9	0.0
3-Port	20.9	0.0
3-Starboard	20.9	0.0

1.1.12 Thereafter the CO returned to the bridge to prepare the enclosed space entry permits for these six COTs. The Master subsequently approved the entry for these tanks noting that all the items had been checked and prepared. When enquired by the investigation team, none of the deck crew were aware of the contents prepared in these permits.

1.1.13 At about 0800H, the CO handed over the bridge watch to the Third Officer (3O) and informed the 3O of the plan for the day (i.e. tank entries by the deck crew). The CO then met the deck crew in the mess and informed them that the six COTs were ready for entry (i.e. 1-wing<sup>26</sup> to 3-wing). There was no further discussion amongst the CO and deck crew, neither was there any specific instructions to the crew to prepare additional equipment for the enclosed space entry.

1.1.14 The deck crew prepared the wilden pump and cleaning tools for the entry to COTs. Each group had a walkie-talkie but did not carry any personal gas detectors (PGDs). The crew also prepared face masks with spare canisters for the COT entry (see **Figure 4**). From about 0830H to 1015H, the two groups entered four COTs in the following sequence<sup>27</sup>:

<sup>24</sup> The CO stated to have switched the ventilation blowers off when taking the gas readings of the COTs. The ventilation blowers were switched on after taking the readings.

<sup>25</sup> Lower Explosive Limit.

<sup>26</sup> Each pair of tanks (e.g. 1-Port & 1-Starboard/ 2-Port & 2-Starboard) is known as wing.

<sup>27</sup> Timings collated based on interviews from the deck crew. No records on the time of entry by each group were kept by the bridge nor any other designated person to record them.

TIME IN (estimated)	GROUP (crew)	LOCATION	TIME OUT (estimated)
0830H	1 (ASD1 + ASD3)	COT 1-Starboard (pumping of water)	0845H
0850H	2 (BSN + ASD2)	COT 1-Starboard (Wiping/ Mopping)	0910H
0850H	1	COT 1-Port (pumping of water)	0910H
0915H	2	COT 1-Port (Wiping/ Mopping)	0940H
0915H	1	COT 2-Port (pumping of water)	0940H
0945H	2	COT 2-Port (Wiping/ Mopping)	1015H
0945H	1	COT 2-Starboard (pumping of water)	1015H
<b>1015H</b>	<b>Both groups went for tea break</b>		

- 1.1.15 Before going for the tea break at 1015H, the wilden pump was lowered by Group 1 into 3-Starboard COT. During the tea break, there was some continuous light rain and the BSN went on deck (own accord) to switch off the electric<sup>28</sup> (*sic*) blowers<sup>29</sup> and swung the tank dome (over the opening) to prevent rain from entering the COTs.
- 1.1.16 Since the rain continued beyond the typical 30-minute tea break, the deck crew took rest and separately had their lunch. At about 1230H, the ASD3 requested the CO's permission to go for shore leave with the launch boat which had been arranged by the Company for another set of off-signers. Recalling that the ASD1 informed the CO<sup>30</sup> that cleaning for all the six COTs (i.e. 1-wing to 3-wing) had been completed and with no other COT entry was planned for that day, the CO had no objection to ASD3's request, as long as the deck crew were agreeable for ASD3's absence.
- 1.1.17 The CO subsequently informed the Master about the status of the COTs and closed the enclosed space entry permits of the six COTs. The bridge watchkeeping officer, the 3O, at that time who was covering duties for the Second Officer<sup>31</sup> (1200H to 1600H schedule) was not aware of the status of

<sup>28</sup> The manufacturer's manual obtained by the investigation team confirmed that the blowers were explosion proof and waterproof. There were no certificates for the blowers available for verification.

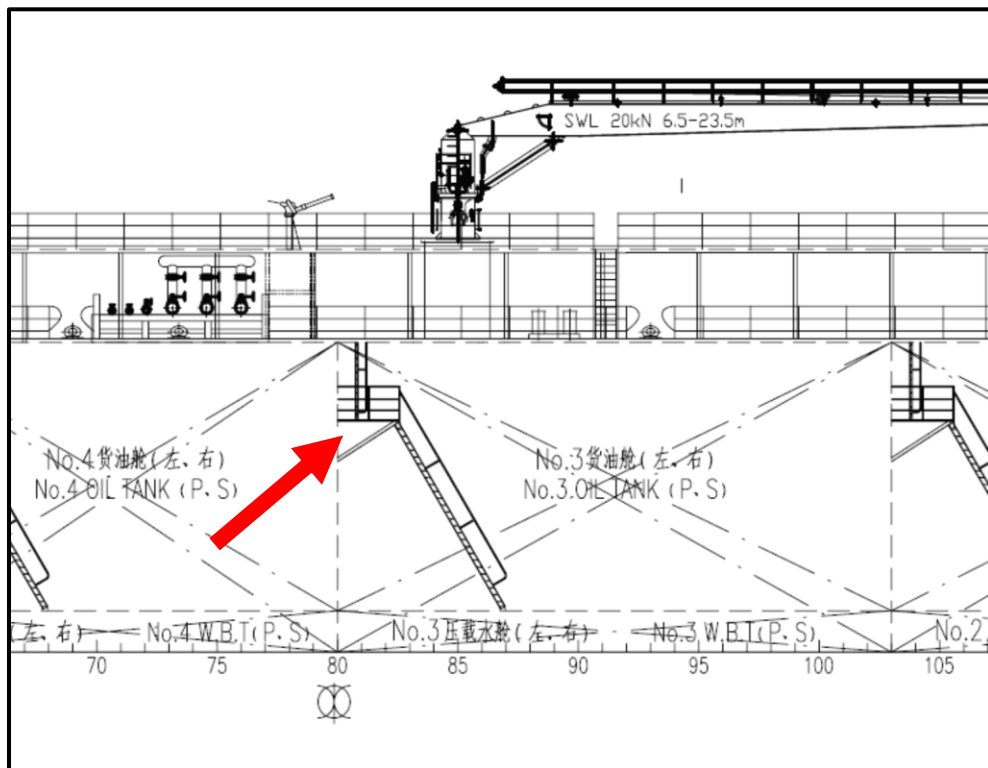
<sup>29</sup> The blowers were not turned on again thereafter.

<sup>30</sup> The CO was certain that the ASD1 had, at a time between 1200H and 1230H, informed him of the deck crew having completed cleaning of all the six COTs.

<sup>31</sup> Second Officer had gone ashore for shore leave with the ASD3.

the COTs, or the work on deck and the closure of the enclosed space entry permits by the CO. With the Master's permission, the CO went ashore too, with another launch boat at about 1345H<sup>32</sup>.

1.1.18 By about 1430H, the rain had stopped and the deck crew (now comprising the ASD1, ASD2, BSN and the Deck Cadet) went to 3-Starboard COT with the intention to continue pumping out the water using the wilden pump which had been lowered earlier. At about 1500H the ASD1 was seen by the others as wearing the face mask with a new canister cartridge and entering the first platform of the COT (see **Figure 2**). The ASD2 who was standing on deck could smell a strong odour of gas and told the ASD1 not to proceed down. The ASD1 was seen to continue descending the COT with a walkie-talkie. At about 1515H, on reaching the bottom of the tank, the ASD1 was seen by the deck crew walking erratically and appeared disoriented. The ASD1 was heard on the walkie-talkie by the deck crew to have said (twice) that ASD1 could not see anything and could not breathe.



**Figure 2:** 3-Starboard COT on Southernpec 12. The intermediate platform was the COTs ladder access as shown by the red arrow

<sup>32</sup> The CO clarified that before going ashore, no one was tasked to secure the six COTs from unauthorised entry nor was the bridge watchkeeper informed about the permits being closed.

- 1.1.19 The BSN immediately reported the situation to the bridge but could not recall whether it was acknowledged by the 3O. Both the BSN and ASD2 stated that they separately instructed the Deck Cadet to rush to the bridge to inform the 3O and call for assistance. Both the BSN and ASD2 removed the ventilation chute from the starboard manifold and lowered it down to the tank via the tank dome opening. The ASD2 donned another (canister) face mask and climbed down to the intermediate platform and tried to direct fresh air from the chute towards the ASD1. By about 1520H, the ASD1 was seen to collapse.
- 1.1.20 Shortly after this, the ASD2 felt dizzy and climbed out of the COT from the intermediate platform. At about 1530H, the Master arrived on deck with the 3O and the Fourth Engineer (4E). On Master's instructions, both the officers (3O and 4E) went to get the breathing apparatus (BA set), EEBD<sup>33</sup>, ropes and a stretcher from the life-saving appliances locker in the ship's accommodation.
- 1.1.21 Thereafter, rescue operations started with both the officers donning the BA set, entering the tank at about 1550H and recovering the ASD1 on a stretcher.
- 1.1.22 The ASD1's vital signs were observed to be weak. The Master instructed them to carry the ASD1 to a shaded area, where efforts to resuscitate the ASD1 by performing CPR and providing oxygen from the ship's medical equipment were done. The Master then went to the bridge to call the Company for emergency assistance at about 1600H.
- 1.1.23 By about 1630H, a launch boat arranged by the Company came alongside SP12, as did the Police Coast Guard (PCG). With the assistance of the PCG officers, the ASD1 was conveyed using the launch boat to Marina South Pier where an ambulance had been arranged. The ASD1 was declared to have lost vital signs on the way to the hospital. The CO received a phone call from the Master regarding the incident and came back on board between 1700H and 1715H.

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<sup>33</sup> Emergency Escape Breathing Devices – SOLAS Chapter II-2/ Regulation 13.3 – (Means of escape) –Emergency escape breathing devices. The ship was provided with 11 sets of EEBDs located in various parts of the vessel as per the Fire Control plan.

## 1.2 Crew experience and Rest Hours

1.2.1 SP12 was manned with a crew of 19 officers and ratings. The crew experience matrix of those involved is shown in the table.

Designation	Master	Chief Officer	Deck Cadet
<b>Qualification</b>	Deck Officer Class 1 STCW II/2, IV/2 <sup>34</sup> Issued 2009 Revalidated June 2018	Deck Officer Class 2 STCW II/2, IV/2 <sup>35</sup> Issued 2013 Revalidated 2016	Deck Officer Class 3 STCW II/1, IV/2 Issued Jan 2018
<b>Certification Authority</b>	MSA - China	MSA - China	Myanmar Ministry of Transport – Department of Marine Administration
<b>Nationality</b>	Chinese	Chinese	Myanmar
<b>Age</b>	51	40	29
<b>Experience in Rank</b>	8 years	3.5 years	1 year
<b>Period with Company</b>	(Master) 4 weeks	(Chief Officer) 3.5 years	(Cadet) 2 months
<b>Period on board</b>	3 weeks	2 months	2 months
<b>Harbour Duty Schedule</b>	N/A	0400 - 0800 2000 - 0000	Day Worker
Designation	Bosun (BSN)	Able Seafarer (Deck) – ASD2	Able Seafarer (Deck) – ASD3
<b>Qualification</b>	STCW II/5 <sup>36</sup> Issued 2014 Revalidated 2018	STCW II/4, II/5 Issued 2016	STCW II/4, II/5 Issued 2017
<b>Certification Authority</b>	India DG - Shipping	MSA - China	Myanmar Ministry of Transport – Department of Marine Administration
<b>Nationality</b>	India	Chinese	Myanmar
<b>Age</b>	33	26	28
<b>Experience in Rank</b>	11 months (Deck Cadet – 4 years)	1.5 years (Deck Cadet – 1 year)	2 years
<b>Period with Company</b>	1 week	1.5 years	1.5 years
<b>Period on board</b>	1 Day	2 months	2 months
<b>Harbour Duty Schedule</b>	Day Worker	Day Worker	Day Worker

<sup>34</sup> Including STCW Reg, V1-1.3 & V1-1.5 – Chemical and Oil tanker/s only.

<sup>35</sup> Including STCW Reg, V1-1.3 – Oil tanker/s only.

<sup>36</sup> Including STCW Reg, V/I – Oil tanker/s only.

<b>Designation</b>	<b>Able Seafarer (Deck) – ASD1 (DECEASED)</b>
<b>Qualification</b>	STCW II/4, II/5 Issued 2016
<b>Certification Authority</b>	Myanmar Ministry of Transport – Department of Marine Administration
<b>Nationality</b>	Myanmar
<b>Age</b>	35
<b>Experience in Rank</b>	2.5 years
<b>Period with Company</b>	2.5 years
<b>Period on board</b>	8 months
<b>Harbour Duty Schedule</b>	Day Worker

1.2.2 The ASD1's record of rest hours in the computer kept in the CCR indicated<sup>37</sup> that the working hours on the day of incident<sup>38</sup> were from 0730H to 1130H and 1400H to the time of incident. The records obtained for the BSN, ASD2, ASD3 and Deck Cadet were also recorded with the same timings. On the previous day, i.e. 10 December 2018, records of all the five crew showed their work to have stopped at 1730H.

1.2.3 The investigation team was also made aware that due to the loading of freshwater and stores that lasted till late on the previous night, the crew involved in these tasks (BSN, ASD1, ASD2, ASD3 and Deck Cadet) went to rest at about 2300H. There were no other indications of excessive work or fatigue.

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<sup>37</sup> It was made known to the investigation team, that the 3O was tasked to make entries for the deck crew in the computer and the crew were required to verify correctness of these entries on a monthly basis.

<sup>38</sup> The ASD1's hours of rest for any 7-day period for the month of December 2018 indicated the lowest hour of rest to be 108.0 hours of rest and in any 24-hour period being 11.5 hours. The records also indicated that the ASD1 had six hours of continuous rest. Maritime Labour Convention (MLC) 2006 provides guidelines on minimum number of hours of rest required for seafarers on merchant ships. Also established in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended (STCW Convention). A minimum of 10 hours of rest is required to be maintained in any 24-hour period, of which six hours must be continuous.

### 1.3 Records of tank cleaning and enclosed space entry

#### 1.3.1 Tank Cleaning Plan

1.3.1.1 The Company's tank cleaning plan which was originally prepared for a voyage between Tanjung Langsat (Malaysia) to Samarinda, East Kalimantan (Indonesia), was completed by the CO and approved by the Master on 10 December 2018. This plan was taking into account that the vessel might load a cargo of High Speed Diesel (HSD 0.25S<sup>39</sup>) at Tanjung Langsat.

1.3.1.2 In this approved tank cleaning plan, the personnel listed on "Operational Duty" were 2O<sup>40</sup>, 3O, BSN, ASD1, ASD2 and ASD3. The plan did not contain any signatures of the listed personnel.

1.3.1.3 The list of procedures stated in this tank cleaning plan included washing and ventilating (COTs), flushing (pipelines), mopping and drying (COTs). The CO clarified that only COTs had been washed with seawater and that pipelines had not been flushed.

1.3.2 Risk Assessment (RA) - The RA form was dated 11 December 2018 and prepared by the CO. According to the CO, the RA was approved by the Master together with the tank cleaning plan on 10 December 2018.

#### 1.3.3 Enclosed space entry permits

1.3.3.1 As per Company's SMS, the enclosed space entry permits for each tank required the officer responsible and the person(s) entering the enclosed space to complete the checklists of both 'pre-entry preparation' and 'pre-entry checks', respectively. For all the six COTs (1-wing to 3-wing), the pre-entry preparation sections were signed by the Master and the pre-entry check sections were signed by the 3O. Relevant sections of enclosed space entry permit for 3-Starboard COT is shown in **Figure 3**.

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<sup>39</sup> High Speed Diesel (HSD) 0.25S is considered as a higher grade cargo, compared to the cargo discharged in Tanjung Langsat, which is ULG 98R (Un-Leaded Gasoline 98 Ron)

<sup>40</sup> The investigation team noted that during the period of tank entry, the 2O would have been expected to be keeping the navigational watch from 1200H – 1600H.



IF ANY ANSWER IS 'NO', ENTRY IS NOT PERMITTED!!!		
Section 1		
Pre Entry Preparation (To be checked by nominated responsible officer)	Yes	No
• Has the space been thoroughly ventilated?	✓	
• Has the space been segregated by blanking off or isolating all connecting pipelines and electrical power equipment? If none, insert NA in YES column.	✓	
• Have valves on all pipelines serving the space been secured to prevent their accidental opening? If none, insert NA in YES column.	✓	
• Has the enclosed space been cleaned where applicable? If none, insert NA in YES column.	✓	
• Has the space been tested and found safe for entry? NOTE: Record values in below matrix.	✓	

ENCLOSED SPACE ENTRY PERMIT		
Section 1 (continued)		
Pre Entry Preparation (To be checked by nominated responsible officer)	Yes	No
• Has the Officer on Watch (bridge, engine room or cargo control room) been advised of the planned entry?	✓	
• Has an attendant been designated to be in constant attendance at the entrance to the space?	✓	
• Has a system of communication between all parties been tested and emergency signals agreed?	✓	
• Are emergency and evacuation procedures established and understood by all personnel involved with the enclosed space entry?	✓	
• Is rescue and resuscitation equipment available for immediate use by the entrance to the space?	✓	
• Is all equipment used of an approved type, calibrated, properly maintained & inspected prior to entry?	✓	
• Have arrangements been made for frequent atmosphere checks to be made while the space is occupied and after work breaks?	✓	
• Have arrangements been made for the space to be continuously ventilated throughout the period of occupation and during work breaks?	✓	
• Are access and illumination adequate?	✓	
• Are personnel properly equipped with appropriate PPE?	✓	

Signed upon completion of section 1:  
 Master or nominated responsible person: Signature:  Date... 11/11/18 Time ... 10:47...

Section 2		
Pre Entry Checks (to be checked by the person entering the space)	Yes	No
• I have received instructions or permission from the master or nominated responsible officer to enter the enclosed space.	✓	
• Section 1 of this permit has been satisfactory completed by the nominated responsible officer.	✓	
• I have agreed and understand the communication procedures.	✓	
• I have agreed upon a reporting interval of ... 15 ... minutes.	✓	
• Emergency and evacuation procedures have been agreed and are understood.	✓	
• The means of communication have been tested and emergency signals agreed.	✓	
• Person entering the enclosed space must carry the personal gas meter. (If more than one person is entering the enclosed space at the same time, at least one of them must have been provided with personal gas meter.)	✓	
• I am aware that the space must be vacated immediately in the event of ventilation failure or if atmosphere tests show a change from agreed safe criteria.	✓	

Figure 3: Sections 1 and 2 of enclosed space entry permit for 3-Starboard COT.

1.3.3.2 The details recorded for each COT in these permits obtained by the investigation team are summarised below. It is noted that the timings and grouping in these records were different from the actual done by the deck crew entering the COTs.

<b>1-Port COT</b>	<b>Designated person attending at entrance</b>	BSN
	<b>Person(s) entering the space</b>	ASD 1 and BSN
	<b>Time in / Time out</b>	0800 / 0821
	<b>Atmospheric checks</b>	0748, 0810, 0820
	<b>Completion of job</b>	0822
	<b>Signed by Master</b>	0822
<b>1-Starboard COT</b>	<b>Designated person attending at entrance</b>	BSN
	<b>Person(s) entering the space</b>	ASD3 and BSN
	<b>Time in / Time out</b>	0830 / 0850
	<b>Atmospheric checks</b>	0829, 0849
	<b>Completion of job</b>	0851
	<b>Signed by Master</b>	0851
<b>2-Port COT</b>	<b>Designated person attending at entrance</b>	ASD 2
	<b>Person(s) entering the space</b>	ASD 2 and ASD 3
	<b>Time in / Time out</b>	0920 / 0940
	<b>Atmospheric checks</b>	0912, 0920, 0935
	<b>Completion of job</b>	0942
	<b>Signed by Master</b>	0942
<b>2-Starboard COT</b>	<b>Designated person attending at entrance</b>	ASD 2
	<b>Person(s) entering the space</b>	ASD 2 and BSN
	<b>Time in / Time out</b>	0950 / 1015
	<b>Atmospheric checks</b>	0945, 1000, 1015
	<b>Completion of job</b>	1016
	<b>Signed by Master</b>	1016

<b>3-Port COT</b>	<b>Designated person attending at entrance</b>	BSN
	<b>Person(s) entering the space</b>	ASD 3 and BSN
	<b>Time in / Time out</b>	1025 / 1041
	<b>Atmospheric checks</b>	1020, 1030, 1040
	<b>Completion of job</b>	1046
	<b>Signed by Master</b>	1046
<b>3-Starboard COT</b>	<b>Designated person attending at entrance</b>	ASD 3
	<b>Person(s) entering the space</b>	ASD 1 and ASD 3
	<b>Time in / Time out</b>	1055 / 1115
	<b>Atmospheric checks</b>	1050, 1100, 1110
	<b>Completion of job</b>	1116
	<b>Signed by Master</b>	1116

## 1.4 SMS - Safety Procedures Manual

1.4.1 The pertinent points contained within the relevant section of the Safety Procedures Manual stated that:

- Rechecking of the atmosphere shall be done at specified intervals stated in the permit. It was also essential to check the atmosphere after break periods e.g. lunch and tea breaks.
- Each ship is to carefully plan and execute the tank entry operation with a senior officer taking charge of the operation and all the safety checks to be carried out by a responsible officer, detailing the crew at hand for correct and safe procedures.
- To ensure effective ventilation is carried out during man entry, plastic disposable ducts to be used in such a way that the person in the tank should have access to the end of the duct at all times.
- Proper record keeping to be kept for the tank cleaning operations. Ventilation timings and man entry records are to be made and kept for future records.
- Personnel working inside the tank should use PGDs and preferably keep sufficient EEBD sets with them.

## 1.5 SMS – Shipboard Operational Procedures Manual

1.5.1 Cargo Operation Procedures – this section within the Shipboard Operational Procedures Manual (SOPM) stated:

**“Use of Canister masks is strictly prohibited onboard on all company operated vessels.”**

The face masks with canister used by the deck crew, including the ASD1 prior to the occurrence is shown in **Figure 4**. Canister masks with cartridges had been used on prior occasions on board, and the vessel’s store had a supply of spare cartridges. A check with the Company’s purchasing department indicated that the Company had not supplied the masks or their cartridges on board<sup>41</sup>.



**Figure 4:** Canister (gas) masks reportedly worn by the deceased ASD1. The cartridge filter found with the mask bore the year of manufacture as 2004.

1.5.2 Tank Cleaning Procedures – this section in the SOPM stated that COTs were required to be cleaned as per charterer’s requirement and the COT cleaning plan must indicate the duration of cleaning. There was no requirement for this plan to be submitted to the Company for a review or verification.

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<sup>41</sup> The Company confirmed that a safety circular had been sent to its fleet of ships (after the occurrence) for disposal of the canister masks

- 1.5.2.1 The sub-section on 'Tank Cleaning Plan' further stated that the following has to be included in the plan:
- Tanks to be cleaned and the cleaning sequence.
  - Type of cargo to be cleaned and its characteristics. (MSDS<sup>42</sup> should be available to the crew<sup>43</sup>).
  - The safety equipment and personal protective equipment to be used and location.
  - The precautions necessary to confirm that the cargo deck is free from cargo vapours during tank washing and gas freeing operations.
- 1.5.2.2 A pre-cleaning meeting was required to be held so that all persons involved are made fully aware of the hazards involved.
- 1.5.2.3 The sub-section on 'Tank Cleaning Process' stated that pipelines and pumps should be drained completely and blown through (from both sides of the manifold to the tank) and should preferably (sic) be done prior to the tanks being mopped. The piping system, including cargo pumps, crossovers and discharge lines, should also be flushed with water.
- 1.5.2.4 There was no specific requirements stated in the SOPM on how the ventilation blowers were to be connected to the COTs for gas freeing.
- 1.5.3 Enclosed Space Entry Drills - In accordance with SOLAS (Chapter III – part B, Regulation 19 – Emergency training and drills) requirements, enclosed space entry drills<sup>44</sup> are required to be conducted every two months.
- 1.5.3.1 SP12's annual drill planner had documented that the enclosed space entry drills were to be conducted every 2-month starting from January 2018. Documentary evidence for drills conducted on board SP12 for the year obtained by the investigation team indicated that in 2018, six<sup>45</sup> such drills were documented.

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<sup>42</sup> Material Safety Data Sheet.

<sup>43</sup> The crew entering the COTs did not have a copy of the MSDS available to them.

<sup>44</sup> Each enclosed space entry and rescue drill shall include checking and use of PPEs required for entry, checking and use of communication equipment and procedures, checking and use of instruments for measuring the atmosphere in enclosed spaces, checking and use of rescue equipment and procedures; and instructions in first aid and resuscitation techniques. Enclosed space entry and rescue drills are intended to familiarise the crew with the basic knowledge on the safety precautions relating to enclosed space entry.

<sup>45</sup> January, March, May, July, September and November 2018. Six out of seven crew involved in the incident had participated in one enclosed space entry and rescue drill, i.e. November 2018.

## **1.6 Autopsy and Toxicology Reports<sup>46</sup>**

- 1.6.1 The autopsy performed on the ASD1 revealed external abrasions which were mainly on the left cheek, left arm and thigh. There were no skeletal fractures or indications of any foreign substances like pills in the alimentary system. The report noted a strong petrol-like odour after an internal examination of the body's cavities.
- 1.6.2 A further analysis on toxicology analysis carried out for the samples obtained from the deceased indicated the presence of Methyl Tert-Butyl Ether (MTBE<sup>47</sup>). From the toxicology report, the presence of MTBE in the blood level of deceased is 30 to 4,000 times the blood level of a study where no significant toxic effects were stated.
- 1.6.3 Air samples taken from COT 3-Starboard on 13 December 2018 were sent for a forensic laboratory analysis. The forensic scientist also took the oxygen level at a depth of 2.2m of COT 3-Starboard, where it contained about 17.1%<sup>48</sup> by volume and 640ppm of carbon monoxide. The laboratory result from the air sample revealed presence of MTBE.

## **1.7 Additional information**

- 1.7.1 The deck crew who had been involved in tank cleaning operations prior to this particular one, informed the investigation team that ventilation arrangement for the previous tank cleaning operation in October 2018 was done in a similar manner, i.e. the ventilation blowers via the same chutes were connected on to the manifolds with all the deck crossover valves opened. The CO's assessment was that this arrangement was done considering that the openings of the tank were too close to the tank dome and inserting the chute through the opening on deck would not be effective for ensuring gas freeing.
- 1.7.2 The deck crew did not recall using PGDs for any enclosed space entries in the past on board SP12.
- 1.7.3 The investigation team further gathered that the deck crew involved were not aware of the closure (as claimed by the CO) of the enclosed space entry permits

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<sup>46</sup> Extracted from the report of the Health Sciences Authority of Singapore (HSA)

<sup>47</sup> MTBE – a volatile, flammable and colourless organic compound, commonly used as an oxygenated blending component of gasoline (ie. instead of Lead). Exposure can cause difficulty concentrating, headache, nausea, dizziness, and physical weakness. Exposure limits – Time Weighted Average (TWA) of 50ppm.

<sup>48</sup> Ambient oxygen level on board SP12 was taken and found to be approximately 20.9% (by volume)

after lunch on 11 December 2018. Due to the rain, the tank dome for 3-Starboard COT was kept partially closed and the wilden pump was kept inside tied up with rope connected to the deck.

- 1.7.4 There were no reporting of tank entry and exit done by the deck crew and that the walkie-talkie was only used for routine communication amongst deck crew if they needed assistance as well as for use in emergencies. The deck crew were not aware of whether the bridge watchkeeping officer had been monitoring their conversations.
- 1.7.5 The deck crew also remarked that it was a practice to switch off the ventilation blowers when they were pumping out water and mopping, to avoid agitation of the petroleum vapours in the tank which could hinder their progress to clean the COTs, contrary to the CO's instructions (see paragraph 1.1.6). The CO also believed that the new BSN was informed by the former Bosun and the deceased of these instructions.
- 1.7.6 Since the time the COT entry commenced, the deck crew could not recall seeing any officer conducting atmospheric checks during their entries and exits. There was no emergency equipment (like stretcher, BA sets etc.) at the entrance of any of the COTs or on deck for the duration of the entry.
- 1.7.7 The vessel was provided with three sets of gas measuring equipment and four PGDs. Anecdotal evidence suggests that there was a perception on board that the crew had been mishandling the PGDs. As a result, the PGDs were not given to the crew for use during enclosed space entry and kept in the locker in the CO's cabin so that they could be available to be shown in working condition during a Port State Control or SIRE<sup>49</sup> inspection.
- 1.7.8 The CO could not recall if it was mandatory as per the Company's SMS to record the name of persons and timings for the entry and exit of the enclosed spaces. The CO could also not recall whether the deck crew had been instructed to report enclosed space entry and exit to the bridge. The CO confirmed that when the bridge watch was handed over to the 3O, the latter knew about the activities related to COT cleaning and would be expected to monitor what was happening on deck.

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<sup>49</sup> SIRE - Ship Inspection Report programme – a uniform inspection protocol focusing primarily on the quality and safety standard of individual tanker

1.7.9 **Figure 5** shows the atmosphere gas level of 3-Port COT and 3 Starboard COT (i.e. 3-Wing) by the Master after the incident. These readings indicated that 3-Wing COT were not<sup>50</sup> in gas free condition. 3-Starboard COT was subsequently cordoned off by the PCG officers.

COT		Top (1m)	MIDDLE (4m)	BOTTOM (7.5m)
3P	O <sub>2</sub>	20.9%	20.9%	20.9%
	H <sub>2</sub> S	0ppm	0ppm	0ppm
	CO	112ppm	134ppm	152ppm
	LEL	16%	17%	18%
COT		Top (1m)	MIDDLE (4m)	BOTTOM (7.5m)
3S	O <sub>2</sub>	20.9%	20.9%	20.9%
	H <sub>2</sub> S	0ppm	0ppm	0ppm
	CO	135ppm	172ppm	183ppm
	LEL	21%	23%	23%

**Figure 5:** Handwritten note provided to the investigation team by the Master on the atmosphere for 3-Wing COT after the incident

<sup>50</sup> See Para 1.6.3 on tank readings of 3-Starboard COT



## 2 ANALYSIS

Enclosed spaces are not meant for continuous occupancy. Associated risks are required to be appropriately assessed for ensuring the safety of the crew. Control measures and enclosed space entry permits, that is, permits to work (PTW), are intended to mitigate such risks. It was evident that the safety barriers, though indicated in the PTW as complied with, were missing for the intended duration of the COT entry (and re-entry). The investigation team looked into the following areas leading to this VSMC:

- Preparation of COTs for entry
- Checking of COTs atmospheric condition
- Communications pertaining to COT entry and closure of PTW
- Observations on proper procedures for enclosed space entry
- Gaps in the implementation of SMS on board SP12

### 2.1 Preparation of COTs for tank entry

2.1.1 In analysing how the previously ascertained safe for entry 3-wing COTs contained a higher concentration of hydrocarbon vapour at the time of occurrence, the investigation team evaluated the likelihood of vapours (containing hydrocarbon) from the remnants within the pipelines which were not flushed, to have been carried over when the ventilation blowers introduced fresh air into the COTs. This vapour then stayed within the tank and did not get displaced (with the tank domes covered) when the ventilation blowers were stopped by the BSN during the extended break.

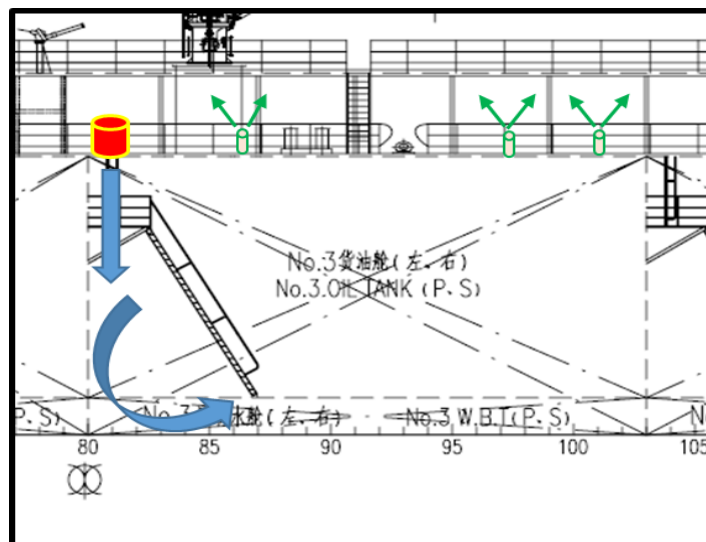
2.1.2 In addition, the investigation team held the view that the conduct of gas freeing by introducing fresh air through a pipeline containing remnants of previous cargo was not a good tanker practice, as it posed an explosion risk within the pipelines, considering that the hydrocarbon gas and air mixture could have become flammable<sup>51</sup>, which was not recognised by the CO.

2.1.3 Though not contributing to the occurrence, the investigation team assessed that it was also likely that the vessel's agent or the Company had not been made aware of the vessel performing cleaning / gas-freeing in port. Had it been done, written permission from the Port Master as required by MPA's DGPE regulations (see footnote 15 and 18) could have been obtained.

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<sup>51</sup> International Safety Guide for Oil Tankers and Terminals (ISGOTT) – Chapter 1 – Basic properties of petroleum – Flammability Composition Diagram.

- 2.1.4 The investigation team opined that the pipelines should have been thoroughly flushed and properly drained to remove any remnants before introducing fresh air (see 1.5.2.3). This would have eliminated the remnants of any previous cargo (generating hydrocarbon vapour) entering into the COTs.
- 2.1.5 The requirement to flush these pipelines as part of the tank cleaning procedures was stated in the SOPM, as part of the SMS. The tank cleaning plan for this operation also stated that flushing of pipelines by seawater was to be conducted. The investigation team was informed that as the Master ship crew did not submit the tank clean plan to the Company (see Footnote 8), the Company was not aware of the manner and extent of COT cleaning as well as related gas freeing for entering the COTs that was carried out on board SP12. It would have been desirable for such operations to be communicated to the Company, for appropriate intervention by the Company, in addition to providing safety related advice.
- 2.1.6 In addition, instead of introducing fresh air through the manifold via the deck crossover valves and the droplines into the COTs for ventilation, the investigation team held the view that portable blowers should have been placed at the openings of the COTs, as the distance between the tank domes and the forward most openings was sufficient to provide an effective exchange of air (see **Figure 6**). Such a method would prevent the introduction of remnants, residing in the pipelines (if any), into the COTs.



**Figure 6:** For Illustration only (not to scale). The red cylindrical shape shows the approximate location of the tank dome, while the green cylindrical shapes and arrows show the approximate location of the other openings (sampling points) on the tank. The forward most opening was

about 13m from the tank dome (entry of fresh air) if the chute were to be connected directly to the tank dome.

- 2.1.7 A possible shortcut, i.e. by connecting the chutes to the manifold and by opening the relevant crossover valves of the COTs and groups, was likely the reason why this method was adopted for gas freeing on board SP12. Efforts must be taken to ensure that such shortcuts are not adopted, for the safety of the vessel and its crew.

## **2.2 Checking of COTs atmospheric condition**

- 2.2.1 After the CO had conducted the atmospheric checks for 1-Wing to 3-Wing COTs, which were reportedly within the acceptable (safe) levels, PTWs were issued for tank entry. There were no records maintained on periodic COT atmosphere gas checks (as stated in the PTW to be 10-minute intervals). After the initial checks of the atmospheric conditions, there was no designated officer present on deck at the time of COT entry to ensure that the conditions had not been changed and the need to recheck at 10-minute intervals.
- 2.2.2 While the crew did not report of any unusual tank odour<sup>52</sup> during their entry and exit into 1-Wing and 2-Wing COTs, it must be noted that these tanks were relatively smaller than the 3-Wing COTs and were also likely to have been gas free in comparison<sup>53</sup>.
- 2.2.3 The BSN had mistakenly believed that the ventilation blowers being electric, needed to be switched off during the rain. The tank domes were then covered and these actions were not informed to anyone. From this time till the time when the deck crew made their re-entry, about 4-5 hours had elapsed. Without any ventilation being carried out, the tank's atmosphere had likely become unsafe for entry. This was contrary to the requirements issued in 'Section 1' of the Enclosed Space Entry permit, i.e. to ensure continuous ventilation throughout the period of entry and during work breaks. The condition was exacerbated by the fact that the remnants in the pipelines had not been flushed.
- 2.2.4 During the re-entry after the extended break of 4-5 hours, the atmospheric condition of the 3-Wing COTs would have changed significantly. A reassessment of the risk was absolutely necessary, as stated in the PTW.

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<sup>52</sup> The crew wore canister masks (see 2.3.3) throughout the entry into these tanks which may have had limitations on their ability to notice any unusual odours during their tank entry.

<sup>53</sup> The ventilation of these tanks was also conducted in a similar manner as No. 3 starboard, i.e. by connecting chutes to the manifold.

## **2.3 Communications pertaining to COT entry and closure of PTW**

- 2.3.1 There were no communications between the deck crew and with the bridge watchkeeper for continuous monitoring of activities and status of crew entering and exiting the COTs.
- 2.3.2 The CO claimed that the PTW had been closed based on the recollection of conversation with the deceased (ASD1) and that the latter entered the tank without any instruction. As the conversation took place between CO and the deceased, the investigation team could not corroborate CO's claim. The investigation team believed that if indeed the PTW had been closed, then proper procedures for closing the PTW should have been followed, such as informing the bridge watchkeeper(s), the Master and the deck crew involved and by securing the space for which the PTW was closed. The investigation team could not find any evidence to suggest that any of the above were carried out and had reasons to believe that the PTW had been closed after the occurrence.
- 2.3.3 The deck crew was unaware of the status of the PTWs, which had been reportedly closed by the CO and proper communications for re-entry would require the issuance of new PTWs. The space for which the PTW was closed should be guarded against unauthorised entry.
- 2.3.4 According to the deck crew, they had not been made aware that PTW's had been closed, i.e. previously issued PTW were still valid. Accordingly, proper checks as per the PTW should have been carried out by a responsible officer before the re-entry was made after the extended break by the deck crew. Had the COT's atmosphere been checked, its unsafe condition would have been recognised and entry could have been suspended and permits closed for a review. There was no toolbox meeting with the members of the crew involved in the COT entry, where details of the PTW could have been discussed, in particular establishing risk controls and checks as stated in the PTW.

## **2.4 Observations on proper procedures for enclosed space entry**

- 2.4.1 The following observations showed that there was a deviation from the established procedures for enclosed space entry:
- The crew entering the COTs had not signed the section of pre-entry checks (of the PTW) as required by the SMS. Instead, this section had been signed by the 3O, who was not aware of the tank entries which took place.

- The crew were not aware of the contents of the PTW relating to risk mitigating measures such as donning PGDs, emergency equipment such as BA sets, EEEDs, stretcher, at the entrance of the COT.
- Regular checks on COTs' atmospheric condition – There was no rechecking of the atmospheric condition of the COTs regularly for the safety of the crew entering the COTs.
- The crew did not challenge when not issued with PGDs, being the last line of defence to alert the crew entering the COTs of an unsafe condition.
- After recognising that the deceased had difficulty breathing, the ASD2 donned the canister mask and entered the COT to direct the air duct to the deceased with good intent. Though the ASD2 managed to exit the COT after having dizzy spells, ASD2's actions could have been fatal, and this action re-emphasised the need for ensuring proper precautions to be taken in relation to enclosed space entry procedures.
- It is possible that the BSN too, may not have been adequately familiar with the COT cleaning / gas freeing operations taking place on SP12, within one day of being on board. There was also no attempt by the BSN to stop the ASD2 from entering the tank when the latter adopted an unsafe act.

2.4.2 Except the BSN, who had been onboard for a day, six of the crew members involved had participated in an enclosed space entry and rescue drill in the month prior to the occurrence. Despite undergoing this drill, the lack of preparations for a rescue from an enclosed space and the inappropriate act adopted by ASD2, were indicative of the ineffectiveness of the drill carried out and deviation from established safety procedures.

## **2.5 Gaps in the implementation of SMS on board SP12**

2.5.1 Canister face masks consist of cartridge or canister attached to a face mask. They are designed to purify the air of specific contaminants and typically used for painting. They are not designed to provide fresh air and may not necessarily prevent inhalation of hydrocarbon vapour. Despite the Company's SMS stating that the use of canister masks was prohibited, the masks had been used on board.

- 2.5.2 The Company had not ensured that the masks and their cartridges were disposed, to ensure compliance with Company's SMS and these masks continued to be available for use, despite the prohibition.
- 2.5.3 The timings regarding tank entry recorded (refer to 1.1.14 and 1.3.3.2) in the PTW and information according to the crew interviews were different. It could not be established whether these documents were completed after the occurrence but the likelihood could not be ruled out.
- 2.5.4 While there was no evidence to suggest that fatigue had an effect on this occurrence, the ASD1's hours of rest were updated till 1530H by the 3O, i.e. a time when the ASD1 was inside the tank. Such a practice would not allow the individual crew member to be alerted and guided on the work / rest hours through the system as per the STCW and MLC requirements.
- 2.5.5 The last line of defence was the provision of PGDs. Had the crew been provided with this equipment, it would have immediately alerted them that the COT was unsafe for entry and an immediate exit was required. The misplaced priority for ensuring PGDs are available for a SIRE inspection underscored the importance of its actual usage.
- 2.5.6 It is evident that there were serious gaps in the implementation of the SMS on board SP12.

### 3 CONCLUSIONS

*From the information gathered, the following findings, should not be read as apportioning blame or determining liability to any particular organisation or individual.*

- 3.1 The fatal occurrence inside the COT was as a result of the ASD1 entering an enclosed space which, though had been previously declared as safe for entry, had not been checked after a prolonged period. During this period, the ventilation had been stopped mistakenly.
- 3.2 Prior to commencement of gas freeing of the COTs, the pipelines through which fresh air was being supplied by blowers had not been flushed to remove remnants of the previous cargo. As a result, it is likely that hydrocarbon vapors made way into the COT, making it unsafe for entry.
- 3.3 The enclosed space entry procedures were not followed properly despite the declaration that safety equipment and checks were in place as per the SMS. For instance, there was no provision of PGDs to the crew entering the COT, no safety equipment on standby at the entrance of the COTs, no continuous communication maintained between the crew entering the COTs and a responsible officer; and the absence of re-checking the COT atmosphere at each stated time intervals and prior to each entry.
- 3.4 While the CO claimed that the PTW had been closed, the alleged closure of the PTW was not communicated to the crew performing COT entry or made known to the bridge watchkeeper. In addition, the space where the PTW was allegedly closed had not been secured from unauthorised entry.
- 3.5 There was a deviation from the safety procedures for enclosed space entry on SP12, despite mandatory enclosed space entry and rescue drills being conducted in the month prior and attended by the crew (except the BSN).
- 3.6 There were gaps in the implementation of the SMS on board SP12.

## **4 SAFETY ACTIONS**

*During the course of the investigation and through discussions with the investigation team, the following preventive / corrective action(s) were taken by parties involved.*

### **4.1 Taken by the Company**

- 4.1.1 Conducted additional training for the crew on enclosed space entry, including a brief of the risk assessments.
- 4.1.2 Revised SMS (SOPM) to include seeking Company's approval for enclosed space entry for tank cleaning.

### **4.2 Taken by the Flag Administration**

- 4.2.1 Conducted a Flag State Control (FSC) inspection on SP12 after the incident and SP12 was imposed with additional DOC and shipboard SMC audit, to be carried out by the RO<sup>54</sup>.

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<sup>54</sup> The Company's DOC had been invalidated after the vessel was sold in November 2019. SP12 resumed operation after satisfying both the DOC and SMC audit carried out on the appropriate corrective actions that were taken, including additional familiarisation training and safeguards of ensuring SMS procedures are followed for critical shipboard operations.



## 5 SAFETY RECOMMENDATIONS

*A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.*

### 5.1 For the Owner

- 5.1.1 To improve the oversight of its procedures for the preparation of COT entry, in particular the requirement to flush the pipelines for ensuring remnants from previous cargo are removed. **[TSIB-RM-2020-003]**
- 5.1.2 To review the effectiveness of enclosed space entry and rescue drills, for personnel safety. **[TSIB-RM-2020-004]**
- 5.1.3 To ensure and monitor the established safety procedures for enclosed space entry are complied with. **[TSIB-RM-2020-005]**

**- End of Report -**