



# REPUBLIC OF THE MARSHALL ISLANDS

## Maritime Administrator

### TRF MANDAL MARINE SAFETY INVESTIGATION REPORT

Enclosed Space Fatality

Arabian Sea | 23 July 2022

Official Number: 6542

IMO Number: 9732773





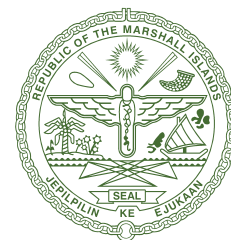
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## **AUTHORITY**

An investigation, under the authority of the Republic of the Marshall Islands laws and regulations, including all international instruments to which the Republic of the Marshall Islands is a Party, was conducted to determine the cause of the casualty.



*Maritime Administrator*



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## LIST OF ABBREVIATIONS AND ACRONYMS

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C/O	Chief Officer
2/O	Second Officer
ASD	Able Seafarer Deck
COT	Cargo Only Tank
CPR	Cardiopulmonary Resuscitation
EEBD	Emergency Escape Breathing Device
IMO	International Maritime Organization
ISM	International Safety Management
m	Meter
MLC, 2006	Maritime Labour Convention, 2006
OOW	Officer on Watch
OS	Ordinary Seafarer
P	Port
PPE	Personal Protective Equipment
PA	Public Address
S	Starboard
SCBA	Self-contained Breathing Apparatus
SMS	Safety Management System
STCW Code	Seafarers' Training, Certification and Watchkeeping Code





## PART 1: EXECUTIVE SUMMARY

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On 23 July 2022, the Republic of the Marshall Islands-registered oil / chemical tanker TRF MANDAL, managed by Anglo-Eastern Shipmanagement (Singapore) PTE. Ltd. (the “Company”), was underway in the Arabian Sea. The ship was on a ballast voyage from Mumbai, Republic of India (hereinafter “India”) to Al Jubail, Kingdom of Saudi Arabia (hereinafter “Saudi Arabia”). Cleaning of all COTs was to be completed during the voyage.

While tank cleaning was ongoing, the C/O entered COT No. 1P to check the cleanliness of the tank. COT No. 1P had last contained a cargo which was required by the Charterer to be loaded, transported, and discharged under nitrogen padding (less than 0.1% oxygen). COT No. 1P had not been ventilated or gas freed prior to the C/O’s entry.

While entering the tank, the C/O called over the Deck Cadet and asked him to hold his portable radio. The Deck Cadet, recognizing that the COT No. 1P was an enclosed space, asked the C/O to wait so that he could retrieve a portable gas detector. The C/O refused and continued to climb down into the tank, where he was quickly rendered unconscious on the upper platform of the COT No. 1P.

The Deck Cadet witnessed the incident and immediately notified other crewmembers. An enclosed space rescue was carried out to remove the C/O from COT No. 1P without further incident. Despite the efforts of the crewmembers, the C/O was determined to be deceased.



The marine safety investigation conducted by the Republic of the Marshall Islands Maritime Administrator (the “Administrator”) identified the following:

1. Causal factors that contributed to this very serious marine casualty include:
  - (a) entering the inerted COT No. 1P without taking any precautions and without complying with the enclosed space entry procedures contained in the Company’s SMS;
  - (b) the C/O disregarding the Deck Cadet when he intervened and requested to check the atmosphere of COT No. 1P with a portable gas detector prior to entry;
  - (c) the risk assessment and Toolbox Talk completed prior to starting tank cleaning did not include the hazards posed by working in or around inerted COTs; and
  - (d) failure to adhere to the Company’s stop work policy.
2. Additional causal factors that may have contributed to this very serious marine casualty include:
  - (a) potential complacency regarding the dangers of entering enclosed spaces and/or working around inerted COTs.
3. Actions or events that reduced the adverse consequences of this very serious marine casualty include:
  - (a) crewmembers immediately recognizing the need to carry out an enclosed space rescue when the C/O fell unconscious in COT No. 1P and conducting the rescue in accordance with the established shipboard procedures.

## PART 2: FINDINGS OF FACT

The following Findings of Fact are based on the information obtained during the Administrator’s marine safety investigation.

1. Ship particulars: *see* chart to right.
2. TRF MANDAL is an oil / chemical tanker with 14 cargo tanks and two slop tanks (*see Figure 1*).

### SHIP PARTICULARS

**Vessel Name**  
TRF MANDAL

**Registered Owner**  
WLR/TRF HMN8 Holdings I LLC

**ISM Ship Management**  
Anglo-Eastern Shipmanagement  
(Singapore) PTE. Ltd.

**Flag State**  
Republic of the Marshall Islands

IMO No.	Official No.	Call Sign
9732773	6542	V7IM9

Year of Build	Gross Tonnage
2015	23,861

Net Tonnage	Deadweight Tonnage
9,905	37,595

**Length x Breadth x Depth**  
177.4 x 27.4 x 17.2 m

**Ship Type**  
Oil / Chemical Tanker

**Document of Compliance  
Recognized Organization**  
DNV

**Safety Management Certificate  
Recognized Organization**  
DNV

**Classification Society**  
DNV

**Persons on Board**  
25

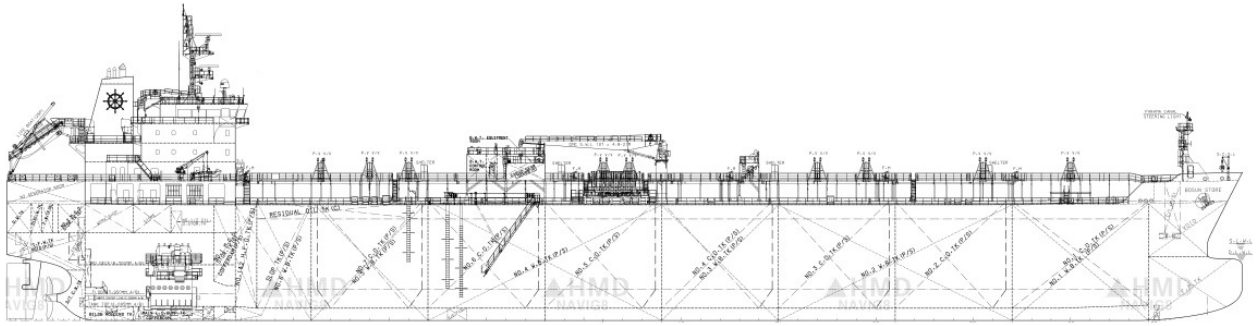


Figure 1: General arrangement of TRF MANDAL, profile view.

- TRF MANDAL completed loading and departed Freeport, Texas, United States of America on 7 June 2022. The cargo on board is shown in the following table:

TANK	CARGO	TANK	CARGO
COT No. 1P	Neodene 14	COT No. 1S	Ethylene dichloride
COT No. 2P	Mono-ethylene glycol	COT No. 2S	Mono-ethylene glycol
COT No. 3P	Ethylene dichloride	COT No. 3S	Ethylene dichloride
COT No. 4P	Ethylene dichloride	COT No. 4S	Ethylene dichloride
COT No. 5P	Empty	COT No. 5S	Mono-ethylene glycol
COT No. 6P	Ethylene dichloride	COT No. 6S	Ethylene dichloride
COT No. 7P	Mono-ethylene glycol	COT No. 7S	Mono-ethylene glycol
Slop P	Empty	Slop S	Diisobutylene

- In accordance with the cargo handling information supplied to the ship by the Charterer, Neodene 14 was required to be inerted with a blanket of 99.1% pure nitrogen.<sup>1</sup> The Charterer also required that oxygen levels be maintained below 0.1% during loading, transit, and discharge. COT No. 1P was inerted during loading using 99.1% nitrogen provided by the loading terminal.
- Neodene 14 is a colorless liquid that has a mild hydrocarbon odor. It is not reported to be toxic nor contain any substance with an occupational exposure limit. The vapor density of Neodene 14 is greater than 1.<sup>2</sup>
- On 14 July 2022, TRF MANDAL arrived at Hazira, India for discharging cargo. Ethylene dichloride was discharged from COT Nos. 1S, 3P, 3S, 4P, 4S, 6P, and 6S. Mono-ethylene glycol was discharged from COT Nos.

1 Nitrogen is a colorless, odorless gas which displaces oxygen. It has a vapor density of 0.967 and is lighter than air.  
 2 Shell Chemical LP safety data sheet “NEODENE 14 Alpha Olefin.”

2P (partial) and 5S. Diisobutylene was discharged from Slop S. The ship departed for the next discharge port on 15 July 2022.

7. On 16 July 2022, TRF MANDAL arrived at Pipavav, India. Neodene 14 was discharged from COT No. 1P.
8. All of the Neodene 14 was discharged from COT No. 1P at Pipavav. During discharge, 99.5% nitrogen was supplied to the tank from the ship's nitrogen generator.
9. TRF MANDAL departed Pipavav on 18 July 2022 and anchored at Mumbai, India outer anchorage on 19 July 2022.
10. On 21 July 2022, TRF MANDAL shifted to berth at Mumbai to discharge mono-ethylene glycol from COT Nos. 2P, 2S, 5S, and 7S.
11. TRF MANDAL departed Mumbai at 0630<sup>3</sup> on 23 July 2022. The ship was in ballast and proceeding to Al Jubail, Saudi Arabia for loading. Tank cleaning was planned during the voyage. A tank cleaning plan for cleaning COT Nos. 1P, 2P, 2S, 5S, and 7S was prepared by the C/O, in consultation with the Company, and approved by the Master. COT No. 1P was to undergo a nine-step cleaning program:

<b>COT NO. 1P TANK CLEANING PROGRAM</b>	
<b>CLEANING STEP</b>	<b>TIME</b>
Ambient Sea Water Wash	1.5 hours
Chemical Circulation	3 hours
Warm Sea Water Wash	1 hour
Hot Sea Water Wash	2 hours
Fresh Water Wash	0.5 hours
Steaming	2 hours
Purging / Gas Freeing	5 hours
Ventilate	4 hours
Mop / Dry	0.5 hours

12. The tank cleaning plan included the restriction from using tank access hatches for introducing tank cleaning chemicals to the COTs, which was dictated by the Company.
13. The entire tank cleaning program was estimated to take about three and a half days. The voyage to the loading port was about five days.

<sup>3</sup> Unless otherwise stated, all times are ship's local time (UTC +5.5).

14. A risk assessment for the tank cleaning operation was also completed. The specific risks associated with nitrogen inerted tanks was not identified since the planned task did not require entry into COT No. 1P. However, it was reported that all involved crewmembers were aware that COT No. 1P was inerted.
15. Prior to starting tank cleaning, the C/O conducted a Toolbox Talk with all involved crewmembers to review the tank cleaning plan. It was reported that the hazards of working around nitrogen inerted tanks were not discussed during the Toolbox Talk because entry into COT No. 1P was not planned.
16. Tank cleaning commenced at about 1030 on 23 July 2022. The ambient sea water wash of COT Nos. 1P, 1S, 2P, 2S, 3P, and 3S were completed first. Ambient sea water washing of COT Nos. 4S, 6P, and 6S were then started.
17. After ambient sea water washing was completed, the C/O directed the Bosun and an ASD to open the access hatch to COT No. 1P (see Figure 2). Once open, the C/O inspected the underside of the access hatch. Based on what he observed, he determined that the planned chemical recirculation was needed.



Figure 2: COT No. 1P access hatch and trunk.

18. The C/O directed the Bosun to prepare for chemical recirculation in COT No. 1P. The Bosun then assigned the OS1 and the Deck Cadet to remove a blank from a flange for supplying the cleaning chemical to the COT No. 1P deep well pump. The OS1 and Deck Cadet were facing away from the COT No. 1P access hatch while completing this task. Meanwhile, the Bosun proceeded aft, using the elevated walkway, to retrieve the cleaning chemical.
19. Shortly before 1300 on 23 July 2022, the C/O was partly inside the access trunk to COT No. 1P when he called the Deck Cadet to come to him. The Deck Cadet reported that the C/O had one leg inside the access trunk on the

ladder at the time and handed the Deck Cadet his radio and told him to hold it until he exited the COT. The Deck Cadet stated that the C/O said he was worried he would drop it while climbing the access ladder. The C/O was reported to have not been wearing a personal gas detector or an SCBA.

20. The Deck Cadet asked the C/O to wait until he could go get a portable gas detector to check the atmosphere of the COT. The C/O declined, stating that it was not a problem as he was only going to the upper platform inside COT No. 1P. The C/O continued into the tank without atmospheric monitoring being conducted. Aside from the Deck Cadet, no other crewmember was aware of the C/O's intention to enter COT No. 1P. The OS1 remained facing away from the access hatch and was occupied with the task he was completing while the Deck Cadet was with the C/O.
21. At the time, the Deck Cadet reported that he had to step back from the open access hatch due to the vapors being emitted from COT No. 1P.<sup>4</sup> After about 30 seconds, the Deck Cadet approached the access hatch and looked into the COT. He observed the C/O kneeling on the upper platform inside the COT with his hands on the ladder rails. Within seconds, the C/O fell backwards onto the platform. The Deck Cadet yelled to the C/O, but he did not respond.
22. The Deck Cadet immediately notified the Bosun by portable radio that the C/O was unresponsive in COT No. 1P. The Bosun rushed to COT No. 1P and saw the C/O lying on the platform. He then directed the Deck Cadet to notify the OOW.
23. The Deck Cadet used his radio to notify the 2/O, who was the OOW, on the Bridge. The 2/O then used the PA system to raise the alarm and initiate the enclosed space rescue procedures.
24. The Master was resting in his cabin at the time of the announcement. He immediately went to the Bridge and relieved the 2/O so that he could assist with the enclosed space rescue.
25. At approximately 1305, all available crewmembers were mustered near COT No. 1P with the equipment needed to carry out the enclosed space rescue. The Pumpman and OS1 donned SCBAs and climbed down to the upper platform inside COT No. 1P. An EEBD and harness were fitted around the C/O. Crewmembers on deck used a tripod over the access hatch to hoist the C/O up to deck, with the assistance of the Pumpman and OS1.
26. At approximately 1314, the C/O was removed from COT No. 1P. He was exhibiting shallow breathing and had a barely detectable pulse. Crewmembers immediately began CPR and provided medical oxygen.
27. At approximately 1322, the C/O was transferred to the ship's Hospital and CPR was continued.
28. At 1336, the Master turned the ship back towards Mumbai. At the same time, shoreside medical advice was sought.
29. At 1358, the C/O was no longer breathing and his pulse was 115 beats per minute. A pulse oximeter indicated that the C/O's oxygen saturation was 65%.<sup>5</sup> Crewmembers continued to provide resuscitative efforts in accordance with the direction provided by the shoreside medical authority, including artificial respirations with supplemental oxygen.

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<sup>4</sup> As previously noted, nitrogen is lighter than air.

<sup>5</sup> The normal oxygen saturation is 95-100%. See Cleveland Clinic, Health Library / Diagnostics & Testing (Blood Oxygen Level), <https://my.clevelandclinic.org/health/diagnostics/22447-blood-oxygen-level>.

30. At 1720, the C/O no longer had a pulse. Crewmembers continued CPR and artificial respirations with supplemental oxygen. The shoreside medical authority was informed of the C/O's condition and, at 1801, the shoreside medical authority determined that the C/O was deceased.

**COT No. 1P Atmosphere**

31. A warning statement reading “ENCLOSED SPACE DO NOT ENTER WITHOUT PERMIT” was on the outside of the access trunk leading into COT No. 1P (see Figure 3). There was not a similar warning on the inside of the trunk.



Figure 3: COT No. 1P access hatch showing warning label.

32. The warning label was on the same side of the access trunk as the hinge for the hatch cover and the access ladder for COT No. 1P.

33. Atmospheric testing of COT No. 1P was conducted daily while the tank contained Neodene 14. Oxygen levels remained below the required 0.1% at all times (see Figure 4). During the voyage, 99.9% nitrogen was added to COT No. 1P on 10 occasions to maintain the low oxygen level.



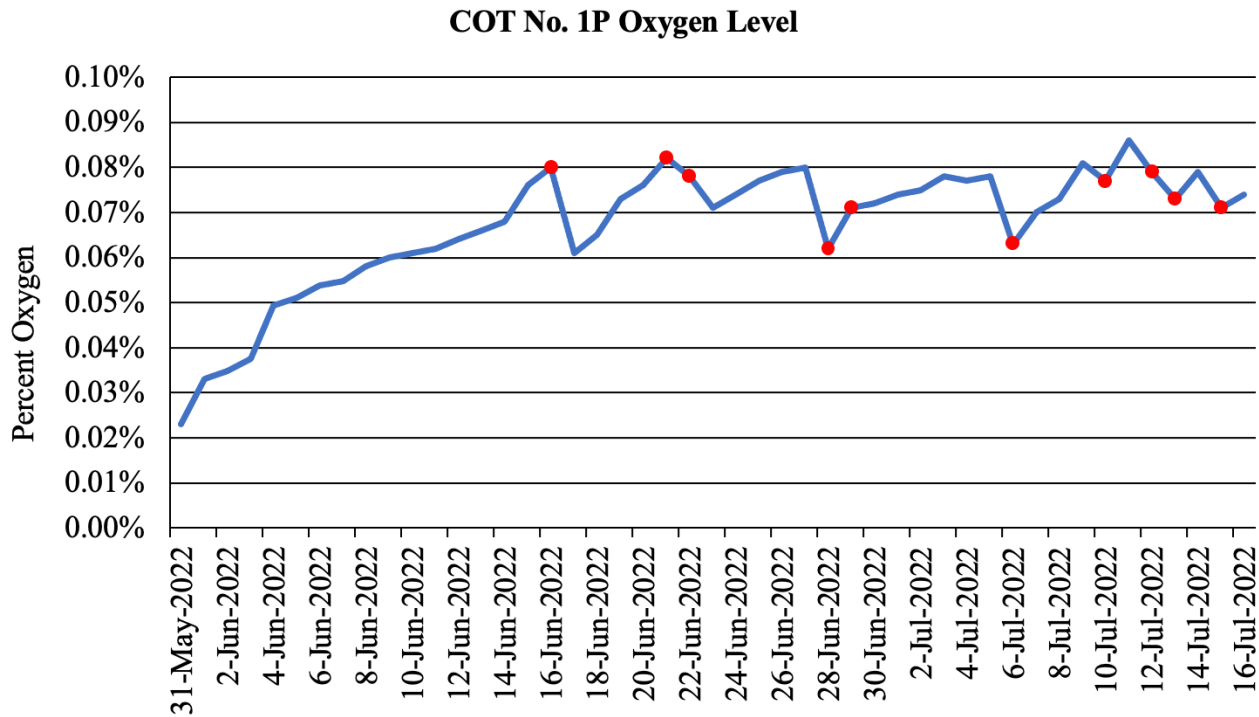


Figure 4: Oxygen levels in COT No. 1P. Dates which nitrogen was added to the COT are indicated in red.

34. “Revised Recommendations for Entering Enclosed Spaces Aboard Ships” (IMO Resolution A.1050(27)) recommends that the oxygen concentration acceptable for entry into enclosed spaces is 21%.
35. During the Administrator’s onboard investigation on 25 July 2022, the oxygen level in COT No. 1P was found to be 7%. It is reported that no nitrogen, or other inert gas, had been introduced into the tank since completion of the discharge of Neodene 14 on 16 July 2022. The nitrogen supply valve to COT No. 1P was secured in the closed position with a chain and padlock.

#### SMS

36. As required by the ISM Code, the Company maintained a comprehensive SMS which was implemented aboard TRF MANDAL.
37. All crewmembers are required to complete initial onboard familiarization upon joining TRF MANDAL. Among other items, this includes familiarization with their duties and responsibilities, emergency duties, use of safety and firefighting equipment, the Company’s permit to work system, and the Company’s safe work practices. The designated enclosed spaces aboard the ship are also required to be discussed. Records available on board indicate that all crewmembers completed this required familiarization.
38. The Company’s SMS also included detailed enclosed space entry procedures. Familiarization with these procedures is included in the initial onboard familiarization training. They require that a permit to work be issued by the Master prior to entering an enclosed space. Additionally, they designate all cargo tanks as enclosed spaces, regardless of gas free status. The Company’s enclosed space entry procedures provide a detailed list of actions

that must be taken prior to entry being authorized, including atmospheric monitoring of the space. All interviewed crewmembers were familiar with the Company's enclosed space entry procedures and that the COTs were designated as enclosed spaces.

39. The enclosed space entry procedures include the following warning: "Nitrogen is a colorless and odorless gas – when used as an inert gas, causes oxygen deficiency in enclosed spaces and near exhaust openings on deck during purging of tanks, void spaces and in cargo holds. A single breath of 100% nitrogen gas will be fatal."
40. TRF MANDAL is provided with 10 portable gas detectors. Records indicate that on 22 June 2022 all portable gas detectors were calibrated and determined to be functional.
41. The Company's SMS details the PPE required for various work activities. Safety helmets, safety boots, overalls, and eye protection are required while working on deck during normal weather conditions. In addition to what is required for working on deck, the SMS requires that a personal gas detector be used during enclosed space entry.<sup>6</sup>
42. The Company's SMS requires that crewmembers participate in enclosed space rescue drills at least every two months. The SMS requires that the following topics be discussed during the enclosed space rescue drills: required PPE, communication procedures, expected hazards, conducting atmospheric monitoring, first aid and resuscitation techniques, lifting procedures, use of EEBDs, and use of relevant rescue equipment. Records indicate that the crew last completed an enclosed space rescue drill on 27 May 2022. The C/O participated in this drill.
43. The Company has established and implemented a behavior-based safety program aimed at encouraging a positive safety culture with shipboard and shoreside staff. This program provides all crewmembers, regardless of rank, the authority to intervene when an unsafe act or condition is observed. All crewmembers interviewed as part of the Administrator's investigation were aware of this program and the authority to intervene to stop unsafe acts or conditions. Training on the Company's safety program is provided during pre-joining training and at regular intervals on board. However, several crewmembers stated that they were not confident in exercising the authority to intervene if needed.
44. The Company's SMS also includes a section discussing the hazards of nitrogen. Specifically, they state that nitrogen is a colorless and odorless gas, which may result in oxygen deficiency in enclosed spaces and near their openings.

***TRF MANDAL Crew***

45. TRF MANDAL had a complement of 25 crewmembers, nine more than required by the Minimum Safe Manning Certificate issued by the Administrator.

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<sup>6</sup> The portion of the Company's SMS addressing PPE includes a requirement that consideration be given to the use of fall prevention systems when conducting pre-task planning for enclosed space entry. The decision whether the use of fall protection systems would be based on the specifics of the planned work.

## 46. Crew Experience

RANK	TIME ON BOARD TRF MANDAL	TIME IN RANK	TIME WITH COMPANY	TOTAL TIME AT SEA
Master	3 months, 5 days	7 years	7 years	12 years
C/O	2 months, 23 days	2 years, 8 months	2 months, 23 days	5 years
2/O	1 month, 19 days	6 months	7 years	3 years
Bosun	7 months, 7 days	4 years	10 years	24 years
Pumpman	1 month, 17 days	1 month, 17 days	11 years, 3 months	6 years, 8 months
OS1	4 months, 9 days	1 year	1 year	2 years
Deck Cadet	10 days	1 year	1 year	8 months

47. All involved crewmembers held the appropriate Republic of the Marshall Islands-issued seafarer documentation for their positions.
48. The Administrator did not find any indication that crewmembers involved with this incident failed to receive the amount of rest mandated by the STCW Code, Section A-VIII/1, paragraphs 2 and 3 and the MLC, 2006, regulation 2.3.
49. Alcohol testing was conducted on all the crewmembers following the incident, with the exception of the C/O, with no alcohol being detected.
50. Since joining TRF MANDAL, the C/O had previously overseen tank cleaning operations twice prior to the incident. On both occasions, entry into the cargo tanks was required and the C/O properly implemented the enclosed space entry requirements contained in the Company's SMS.
51. Although the C/O had been newly hired by the Company, he had five years of experience on board oil / chemical tankers, including more than two and a half years in his current rank. Prior to joining TRF MANDAL, the C/O had successfully completed the Company's new joiner induction process. This included a review of the Company's SMS, which the C/O acknowledged understanding.
52. The C/O's most recent preemployment medical examination was conducted on 19 April 2022. He was found fit for duty without restrictions.

## PART 3: ANALYSIS

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The following Analysis is based on the above Findings of Fact.

### *COT No. 1P*

The last cargo carried in COT No. 1P was Neodene 14. The instructions received by the ship from the Charterer required that the oxygen in the tank be maintained below 0.1% during loading, transport, and discharge. The ship's nitrogen generator, shore supplied nitrogen, and nitrogen bottles were used to maintain the atmosphere below this required level (see Figure 4). The atmosphere of COT No. 1P was checked during the Administrator's investigation. It was found that COT No. 1P contained only 7% oxygen two days after the incident. Atmospheric testing was not conducted at the time of the C/O's entry; however, the oxygen concentration would have been between 0.07% (last recorded testing on 16 July 2022) and 7% (testing conducted on 25 July 2022). This is significantly below the 21% recommended by IMO Resolution A.1050(27).

### *C/O Entry into COT No. 1P*

The C/O entered COT No. 1P while tank cleaning operations were in progress without any precautions being taken and without complying with the enclosed space entry procedures contained within the SMS. This included not testing the atmosphere inside the tank and not wearing a personal gas detector. The C/O was quickly incapacitated and fell unconscious shortly after entering COT No. 1P and climbing down to the upper platform.

When interviewed, several of the ship's crewmembers reported that the C/O had previously not followed established onboard safe work practices to expedite work. However, it is also noted that since joining TRF MANDEL, the C/O had twice overseen tank cleaning operations that required entry into COTs and had on both times properly implemented the Company's enclosed space entry requirements. Why, on this occasion, the C/O decided to enter COT No. 1P while the tank cleaning operations were in progress since the tank was known to not be gas free could not be determined based on the information available to the Administrator.

### *Enclosed Space Awareness*

The access hatches for all COTs on board TRF MANDAL were marked with a warning which indicated that the tank was an enclosed space, and that entry was not allowed without a permit. The warning labels are on the side of the access hatch and brightly colored. The warning label on COT No. 1P would have been clearly visible even with the access hatch open.

The Company's SMS contains requirements for crewmembers to participate in enclosed space entry and rescue training at least once every two months. The last training was completed on 27 May 2022. Records indicate that the C/O was in attendance. During the Administrator's investigation, it was found that crewmembers, in general, were familiar with the Company's enclosed space entry procedures. Additionally, it is reported that the C/O had overseen tank entry on two previous occasions while aboard TRF MANDAL. Both times, records indicate that the enclosed space entry procedures were fully implemented.

Additionally, crewmembers were found to be aware of the enclosed spaces aboard the ship. Even the most junior crewmember, the Deck Cadet, recognized that the COT was an enclosed space. Although it cannot be confirmed, it is presumed that the C/O was aware that COT No. 1P was an enclosed space since he had previously implemented enclosed space entry procedures for entering other COTs. Further, the Deck Cadet had asked the C/O to not enter until he could get a portable gas detector so that the atmosphere could be checked.

#### ***Actions to Stop Unsafe Acts***

As the C/O was climbing down into COT No. 1P, he called the Deck Cadet over to hold his radio so that he did not drop it. The Deck Cadet recognized the hazard posed by entering the enclosed space without taking precautions and asked the C/O to wait until he could retrieve a portable gas detector. The C/O rejected the Deck Cadet's suggestion and continued to climb down into the tank.

There is no indication that there was a need or urgency for the C/O to enter COT No. 1P as he was monitoring the tank cleaning. Allowing the Deck Cadet to retrieve a portable gas detector and checking the atmosphere of COT No. 1P would not likely have resulted in a significant delay. Further, the portable gas detector likely would have alerted the C/O of the hazardous atmosphere which may have caused him to not enter COT No. 1P.

All the crewmembers who were interviewed as part of the Administrator's investigation said they were aware the Company's SMS gave them the authority to intervene to stop unsafe acts or conditions. However, several crewmembers also stated that they were not confident exercising this authority. The Deck Cadet did not hesitate in questioning the C/O's actions when he identified an unsafe act; however, the C/O did not heed his warning.

#### ***Pre-task Risk Assessment and Toolbox Talk***

It was reported that the C/O had completed a risk assessment prior to starting tank cleaning. The risk assessment identified hazards commonly associated with tank cleaning but did not address any posed by the nitrogen inerted atmosphere of the cargo tanks.

A Toolbox Talk was also conducted by the C/O with the involved crewmembers. It is reported that the hazards identified on the risk assessment and the tank cleaning plan were discussed. However, the inerted atmosphere of the tanks, and the associated risks, were not discussed.

#### ***Enclosed Space Rescue***

Once the Deck Cadet saw the C/O become unconscious on the upper platform inside COT No. 1P, he immediately notified the Bosun but did not rush down into COT No. 1P to try to assist. Additionally, crewmembers recognized the same and properly implemented the enclosed space rescue procedures.

The C/O was quickly removed from COT No. 1P without any further incident or injury to any other crewmember. As observed by the Administrator in other marine safety investigations, potential rescuers have rushed into an enclosed space to try to rescue their fellow crewmembers, which often results in additional persons needing rescue. However, in this instance, the awareness of the responding crewmembers to the hazards posed within enclosed spaces prevented this from occurring, demonstrating a level of understanding of the enclosed space rescue procedures on board.

## **PART 4: CONCLUSIONS**

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The following Conclusions are based on the above Findings of Fact and Analysis and shall in no way create a presumption of blame or apportion liability.

1. Causal factors that contributed to this very serious marine casualty include:
  - (a) entering the inerted COT No. 1P without taking any precautions and without complying with the enclosed space entry procedures contained in the SMS;
  - (b) the C/O disregarding the Deck Cadet when he intervened and requested to check the atmosphere of COT No. 1P with a portable gas detector prior to entry;
  - (c) the risk assessment and Toolbox Talk completed prior to starting tank cleaning did not include the hazards posed by working in or around inerted COTs; and
  - (d) failure to adhere to the Company's stop work policy.
2. Additional causal factors that may have contributed to this very serious marine casualty include:
  - (a) potential complacency regarding the dangers of entering enclosed spaces and/or working around inerted COTs.
3. Actions or events that reduced the adverse consequences of this very serious marine casualty include:
  - (a) crewmembers immediately recognizing the need to carry out an enclosed space rescue when the C/O fell unconscious in COT No. 1P and conducting the rescue in accordance with established shipboard procedures.

## **PART 5: PREVENTIVE ACTIONS**

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In response to this very serious marine casualty, the Company has taken the following Preventive Actions:

1. An onboard safety meeting was conducted with all TRF MANDAL's crewmembers to discuss the:
  - (a) Company's safe work practices;
  - (b) authority provided to all crewmembers, regardless of rank, to stop unsafe actions;
  - (c) procedures for planning and conducting enclosed space entry; and
  - (d) hazards associated with nitrogen and nitrogen inerted cargo tanks.
2. A shoreside representative of the Company conducted an onboard audit of the tank cleaning and enclosed space entry operations. Training on both topics was subsequently conducted to ensure that crewmembers were fully aware of the requirements.
3. A safety alert was sent to all ships in the Company's managed fleet to highlight the incident and the lessons learned.
4. A safety stand down was conducted on all ships in the Company's managed fleet to require review of the enclosed space entry procedures prior to any further entry into enclosed spaces.



5. A survey of crewmembers on ships in the Company's managed fleet was conducted to determine the level of familiarity with the Company's enclosed space entry procedures. The results of this survey are being used to assess the effectiveness of the enclosed space training program.
6. A fleet-wide safety campaign was initiated to:
  - (a) improve onboard communication between crewmembers of all ranks;
  - (b) reaffirm the authority for all crewmembers to take action to stop unsafe acts and the requirement for everyone, regardless of rank, to comply until the situation can be properly reviewed; and
  - (c) raise awareness of the hazards posed by nitrogen gas.
7. The Company conducted a thorough review of the tank cleaning and cargo tank entry procedures, taking into account the causal factors of this incident. The procedures were subsequently amended to restrict opening of all cargo tank access hatches until the respective tank was gas freed.
8. A training workshop was held with all crewmembers serving aboard oil / chemical tankers in the Company's managed fleet to discuss enclosed space entry, workplace injuries, and promotion of a positive safety culture on board.
9. An incident review video was produced and shared with all ships in the Company's managed fleet to reinforce the lessons learned from this incident.

## **PART 6: RECOMMENDATIONS**

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Based on the above Conclusions and in consideration of the Preventive Actions taken, the Administrator has no recommendations.

The Administrator's marine safety investigation is closed. It will be reopened if additional information is received that would warrant further review.