



Marine Safety Investigation Unit



MARINE SAFETY INVESTIGATION REPORT

**Safety investigation into a crew member fatality
inside the cargo hold on board the
Maltese registered general cargo**

KATI

**in the port of Wismar
on 16 July 2018**

201807/013

MARINE SAFETY INVESTIGATION REPORT NO. 11/2019

FINAL

Investigations into marine casualties are conducted under the provisions of the Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011 and therefore in accordance with Regulation XI-I/6 of the International Convention for the Safety of Life at Sea (SOLAS), and Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009, establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and amending Council Directive 1999/35/EC and Directive 2002/59/EC of the European Parliament and of the Council.

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The objective of this safety investigation report is precautionary and seeks to avoid a repeat occurrence through an understanding of the events of 16 July 2018. Its sole purpose is confined to the promulgation of safety lessons and therefore may be misleading if used for other purposes.

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LIST OF REFERENCES AND SOURCES OF INFORMATION

Fatal Accidents During Marine Transport of Wood Pellets Due to Off-Gassing:

Experiences from Denmark, <http://dx.doi.org/10.5772/66334>;

Hazardous Off-Gassing of Carbon Monoxide and Oxygen Depletion during Ocean

Transportation of Wood Pellets, doi:10.1093/annhyg/men013;

Master and crew members MV *Kati*;

Safety Management System Manuals MV *Kati*;

United States Department of Labor, Occupational Safety and Health Administration.

GLOSSARY OF TERMS AND ABBREVIATIONS

AB	Able bodied seafarer
BA	Breathing apparatus
MV	Motor vessel
DNV GL	Det Norske Veritas Germanischer Lloyd
DPA	Designated Person Ashore
Gt	Gross tonnage
kW	Kilowatt
LT	Local time
m	Metres
MSIU	Marine Safety Investigation Unit
Mt	Metric tonnes
RA	Formal risk assessment
RPM	Revolutions per minute
SMS	Safety management system
VHF	Very high frequency

SUMMARY

On 16 July, the Malta registered dry cargo ship *Kati* arrived in Wismar, Germany to discharge a cargo of fuel logs, stowed on deck and in the ship's two cargo holds.

During a customs' routine inspection, the able bodied seafarer (AB), who was stationed by the gangway, did not respond when he was called by the master to unlock his cabin for inspection. An initial search on board yielded no results. Subsequently, the missing AB was found on the cargo hold's tank top. He was later pronounced dead.

The safety investigation found that at the time of the accident, the percentage of oxygen in the air inside the cargo hold was about 2.1%.

Taking into consideration the Company's safety actions taken in the wake of the accident, the MSIU has issued no recommendations to the Company.

1 FACTUAL INFORMATION

1.1 Vessel, Voyage and Marine Casualty Particulars

Name	<i>Kati</i>
Flag	Malta
Classification Society	DNV GL
IMO Number	9173214
Type	General Cargo
Registered Owner	Hs Kati Ou
Managers	Hansa Ship Management
Construction	Steel (Double bottom)
Length overall	106.64 m
Registered Length	100.2 m
Gross Tonnage	3,454
Minimum Safe Manning	10
Authorised Cargo	Cargo in bulk
Port of Departure	Pärnu, Estonia
Port of Arrival	Wismar, Germany
Type of Voyage	Short International
Cargo Information	Pulp wood (2,667 mt)
Manning	10
Date and Time	16 July 2018 at 13:35 (LT)
Type of Marine Casualty	Very Serious Marine Casualty
Place on Board	Cargo hold
Injuries/Fatalities	One fatality
Damage/Environmental Impact	None
Ship Operation	Alongside moored / cargo discharge
Voyage Segment	Arrival
External & Internal Environment	Daylight. Good visibility with light air. Air temperature recorded at 23 °C
Persons on Board	15

1.2 Description of Vessel

Kati, a 3,454 gt general cargo, was built in 1998 and registered in Malta. She was owned by Hs Kati OU, managed by Hansa Ship Management OU, Estonia and classed by DNV GL.

The vessel had a length overall of 106.64 m, a moulded breadth of 13.30 m, and a moulded depth of 7.40 m. Her summer draught of 5.63 m corresponded to a summer deadweight of 4,911.4 tonnes.

Propulsive power was provided by a 6-cylinder MaK 6M32, medium speed diesel engine, producing 2,640 kW at 600 RPM. This drove a single, fixed pitch propeller through a reduction gearbox to reach a service speed of 11.5 knots.



Figure 1: MV *Kati*

Kati was operated on the spot market with no fixed routes or schedules and mainly across European ports, the Baltic, the North Sea region and occasionally, the Atlantic coast and the Mediterranean Sea. A variety of dry cargoes were carried, occasionally also including fuel logs. The latter was being carried at the time of the accident.

1.3 Crew

At the time of the accident, the vessel had a crew complement of 10, which satisfied the number stipulated in the Minimum Safe Manning Certificate issued by the flag State Administration. The crew members were Russian, Estonian and Ukrainian nationals.

The master, who was 69 years old at the time of the accident, had been at sea for 45 years, working for the Company for the last 9 years, with four years of service on board *Kati*.

The chief officer was 57 years old and had been working at sea for 20 years. He had worked 3.5 years for the Company, with two months of service on board *Kati*.

The AB in question was 49 years old and had been at sea for seven years. This was the only Company with whom he had worked as an AB. He had joined the vessel in Pärnu, Estonia on 11 July 2018 prior to the vessel departing for Wismar, Germany on 12 July. He had served on *Kati* on previous times, occasionally as a bosun.

According to the ship's hours of rest and work, the AB had rested between 0400 and 1200 before the accident happened at 1435.

1.4 Accident Site

Just forward of the cargo hold, a wave breaker (that protects deck cargo from seas breaking on the bow of the ship) was fitted between the forward part of the hatch coaming and the forecastle. As part of the wave breaker construction, the entrance to the stairway leading down to the bosun store (and further down to the bow thruster room) was arranged approximately amidships, at forecastle deck level.

The access door to the hatchway, leading down to cargo hold no. 1, was located further to starboard and within the wave breaker's structure. Vertical ladders led to the tank top (Figure 2), approximately nine metres below.

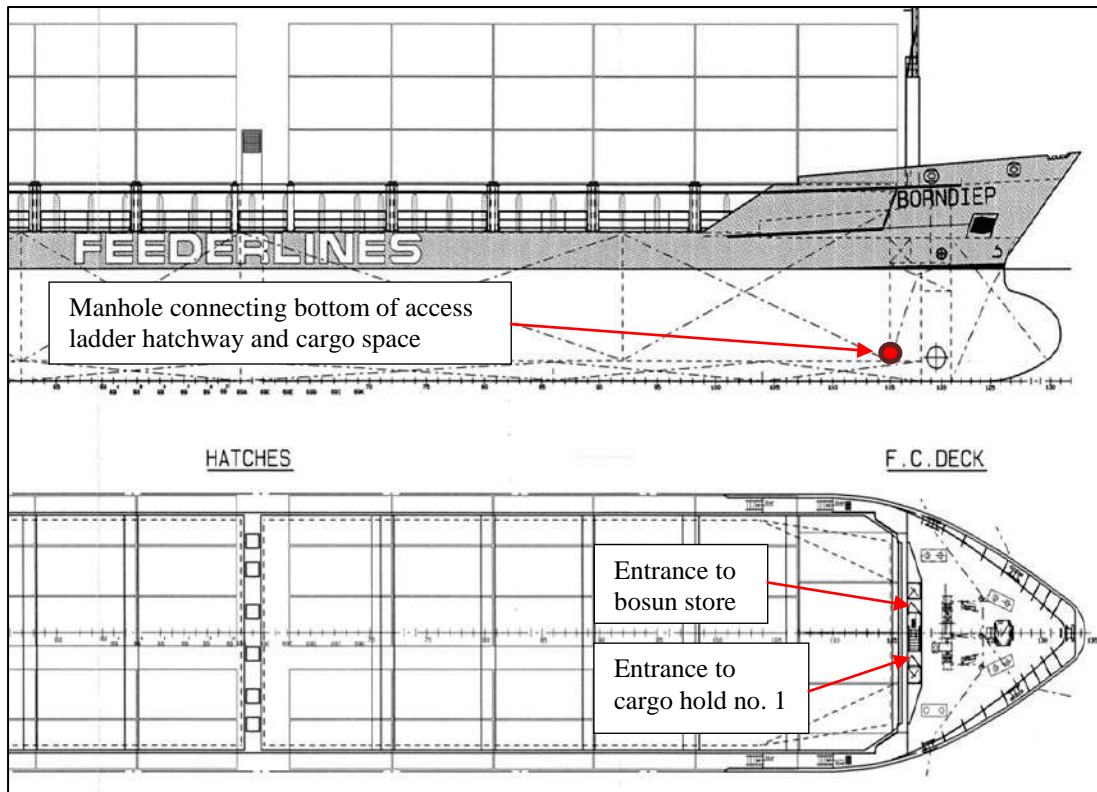


Figure 2: Access points iwo the wave breaker

These ladders were used when access to the cargo hold was necessary, for instance, in order to clean the cargo holds following discharge operations and in preparation for the new cargo. No stores and equipment were located inside the space. Normally, the access door was kept locked in a sealed and watertight condition. The manhole that served as a means of access between the bottom of the hatchway and the cargo hold could be blocked off by means of wooden boards (Figure 3).



Figure 3: Wooden boards in use to block access

However, with the current cargo of wooden logs, it was not found necessary to block the manhole since there was obviously no danger of cargo spilling inside the space¹.

1.5 Narrative

On 12 July 2018, at 1400, *Kati* departed from Pärnu in Estonia, loaded with 2,667 tonnes of fuel logs in bulk, stowed inside the two cargo holds and on the open deck (on top of the sealed hatches). The vessel was bound for Wismar, Germany. During the voyage in the Baltic Sea, on 13 July, a safety drill was carried out and a safety meeting was organised for all the crew members. The training and discussion was about escaping safely from enclosed spaces.

1.5.1 Cargo operations

Kati arrived safely alongside in Wismar on the morning of 16 July. The voyage was uneventful. After some hours of waiting, discharging of the timber cargo stowed on the forward part of the main deck commenced at 0745.

At 1220, a team of customs officers boarded *Kati*. The master was briefed in his cabin about the customs' intentions of a full search of the ship, as a routine check. The master was requested by a customs officer to muster the ship's crew in the mess room in order to give a briefing on the matter. The master made an announcement on the ship's PA system to instruct crew members to proceed to the messroom immediately. At the time, one crew member, an AB, was stationed at the gangway where he had taken over the watch at noon. The master informed the AB on the VHF radio about the matter since one element of the search was the inspection of the crew cabins. Afterwards, the master proceeded to the messroom to brief the remaining crew members together with the customs officers.

Immediately after the gathering in the messroom, the customs officers escorted each of the crew members to their respective cabins for the search. The cabin of the AB, who was on duty at the gangway, was found locked. The master went down on deck to ask the AB to open the door to his cabin. On deck, however, the master did not find the AB by the gangway. The master returned to the messroom and subsequently

¹ The wooden boards would not provide air / water tightness to keep the atmosphere in the space segregated from that inside the cargo hold.

to his own cabin, while he repeatedly tried to get in contact with the AB by means of the VHF radio, but to no avail.

Following the cabin inspections, the customs officers started searching technical spaces of the ship, with the assistance of the ship's crew members. The second mate and the bosun proceeded to the forecabin where the bosun store was located, assisting customs officers in their search through this part of the ship (Figure 4). After checking the bosun store, the second mate and the customs officer proceeded with the inspections in other spaces in the forecabin area. At this point, the bosun noticed that the entrance door to cargo hold no. 1, which was normally kept locked, was open.

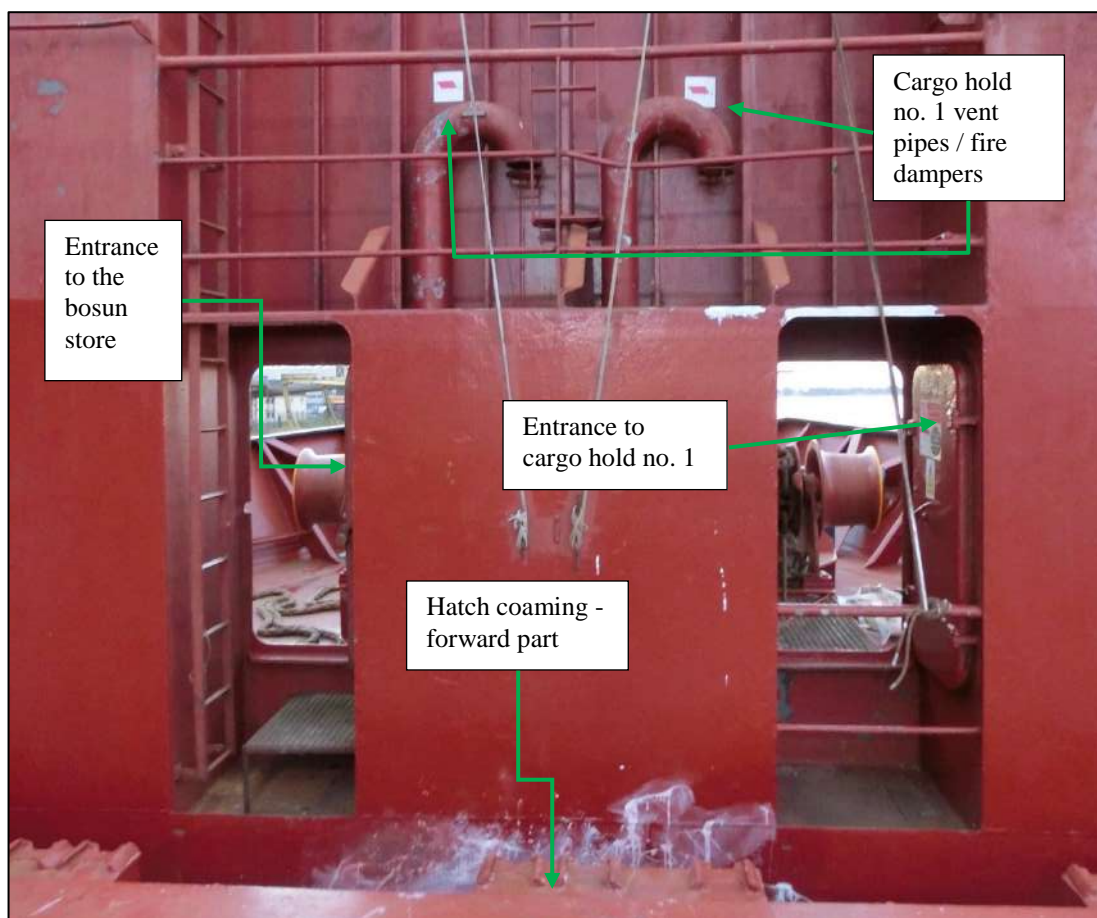


Figure 4: Wave breaker with entrance to bosun store and cargo hold no 1

At approximately 1335, the bosun went to have a look inside the cargo hold entrance (Figure 5) and noticed a person lying on the deck, approximately eight metres down at the bottom of the access duct. The bosun notified the master by VHF about his findings. Together with the chief officer, the master immediately proceeded to the forecabin.



Figure 5: Entrance to cargo hold no. 1

The chief officer brought a multi-gas detector and conducted an atmosphere test inside the duct leading down to the cargo hold. This test gave an oxygen level reading of 2.1 %. The master instructed the bosun and the chief officer to prepare the breathing apparatus (BA) sets from the bosun store. Cargo operations were suspended and the master requested the customs officer to immediately alarm the local emergency management services, while he contacted the Designated Person Ashore (DPA) to inform the Company about the situation on board. The master assessed that recovering the person from the cargo hold would require special equipment, which he figured that the fire brigade ashore would have.

In the meantime, the crew members tried to call the distressed person lying on the tank top (Figure 6) but no reaction was observed. The second officer donned his BA set and climbed down the ladders to check the condition of the person inside the cargo hold. Down inside the cargo hold, it was noticed that the person was the AB missing

from the gangway watch. Again, the second officer tried to call the AB but received no response.



Figure 6: Location where the crew member was found, in close proximity to the access duct

The shore emergency medical response team arrived on board *Kati* at about 1355, followed by the fire brigade. A fire brigade team member measured the atmosphere inside the cargo hold entrance duct. The results of the oxygen level were consistent with the measurements conducted earlier by the chief officer. A fire service officer entered the cargo hold and confirmed that the AB was unresponsive. The crew

member was eventually recovered from the cargo hold to the main deck and was pronounced dead at 1435.

Cargo operations in cargo hold no. 1 were authorised and resumed on the following day at 1115. The hatch covers were lifted at about 1230 to allow fresh air to enter the cargo hold. During the inspection of the area where the crew member was found, customs officers found packages of cigarette cartons. Cargo operations were completed on 19 July and the vessel departed Wismar early in the morning.

1.5.2 Cause of death

The cause of death, which was eventually entered in the ship's logbook, was notified to the vessel on 18 July. The notification indicated that the cause of death was asphyxia.

1.6 Properties of the Cargo

Kati had 2,767 mt of fuel logs in bulk (Figure 7).



Figure 7: Fuel logs loaded on board in Pärnu

The master, who had sailed once before with this type of cargo on *Kati*, was provided with a cargo manifest, a bill of lading, and a document with cargo information for solid bulk cargoes, which specified additional information on the properties of the cargo. This included procedures to handle the cargo and in particular, it referred to

associated risks that had to be mitigated. The document stated that the fuel logs loaded on board could deplete oxygen from the air (Figure 8).

Name of ship	KATI	Instructions or other matters	
Port of loading	Pärnu, Estonia	none	
Port of destination	Wismar, Germany		
General description of the cargo (type of material / particle size)	Fuel logs 4534,7 scbm	Gross mass (kg/tonnes)	2767,644 Mtms
Specifications of bulk cargo		Not applicable	
- stowage factor		Not applicable	
- angle of response, if applicable		by grab	
- trimming procedures			
- chemical properties if potential hazard		Capable of causing oxygen depletion	
Group of the cargo		Transportable moisture limit	Not applicable
<input type="checkbox"/> Group A and B		Moisture content at shipment	Not applicable
<input type="checkbox"/> Group A			
<input checked="" type="checkbox"/> Group B			
<input type="checkbox"/> Group C			
Relevant special properties of cargo (e.g. highly soluble in water)		Additional certificate(s) if required	
No requirements		<input type="checkbox"/> certificate of moisture content and transportable moisture limit	
		<input type="checkbox"/> weathering certificate	
		<input type="checkbox"/> exemption certificate	
		<input type="checkbox"/> other (specify)	

Figure 8: Cargo information for the solid bulk cargo received on board

1.6.1 Oxygen depletion

Wood products carried in bulk and in sealed cargo compartments are capable of depleting oxygen from the atmosphere, for instance, inside a cargo hold. There are various theories which explain the possible mechanisms leading to oxygen depletion including, microbiological activity and oxygen reactions with the constituent elements of wood. Moreover, the level of oxygen in the cargo hold is determined by the quality and level of sealing *i.e.*, the extent of atmospheric air exchange between the cargo spaces and the external environment.

1.7 Risk Mitigation

A Formal Risk Assessment (RA) concerning cargo handling had been carried out as part of the safety management system (SMS) procedures implemented on board. The RA record revealed that the risk of low oxygen during cargo handling had been identified and that it had to be mitigated through measurements of the atmosphere in the cargo space (Figure 9). To carry out the atmosphere measurements as laid out in

the risk assessment, the multi-gas detector carried on board had to be used (Figure 10).

Fleet Procedure Manual					
Risk Assessment - cargo handling					
Consequence	Slightly harmful	Harmful	Extremely harmful		
Risk factor	TRIVIAL(A)	TOLERABLE(B)	MODERATE(C)		
	TOLERABLE(B)	MODERATE(C)	MODERATE(D)		
	MODERATE(C)	MODERATE(D)	INTOLERABLE(E)		
n	Risk factor	Action to reduce risk/hazard	Existing/ New	Target date (if any)	Date completed
Age due	C	1. Crew safety instruction	B		13.07.18
		2. Work arrangement			
		3. PPE arrangement			
		4. Atmosphere measurement			
	Name	[Redacted]			
	Name				

Figure 9: Risk assessment for cargo handling on board

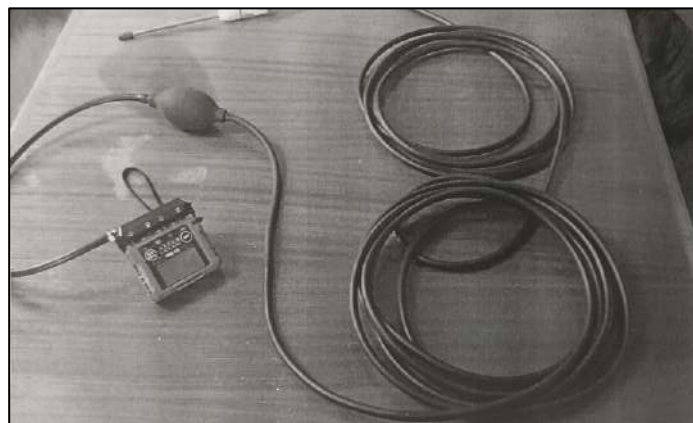



Figure 10: The multi-gas detector available on board

Kati also carried a Manual with procedure on the handling of wood cargo. The Manual contained information on the hazards of oxygen depletion (Figure 11).



Safety notice – wood chips and roundwood

- **It is important to note that wood chips and roundwood absorb oxygen.**
- **When the hatches are closed, no one should enter the empty space during the voyage to the discharging port or while moored in port.**
- **As soon as weather permits, and critically before discharge, the hatches should be opened to allow circulation and ventilation of fresh air into the hold space.**
- **Also, please be aware that all adjacent rooms to the hold for example the ‘fore peak’ should have their doors and manholes securely closed so that oxygen is not depleted in these areas also. Ventilation should also be considered before entry into these areas.**
- **During normal loading operations oxygen depletion should not pose any risk as hatch covers are always open, however, it should be considered that, if during the loading period the hatches are closed for long periods of time or overnight, oxygen depletion could occur. In these circumstances ventilation would be advised.**
- **Failure to take these precautions could lead to fatality through suffocation in a very short period of time.**

4

Figure 11: Extract from the on board procedure addressing the sea transportation of wood

1.8 Weather

At the time of the accident, the weather was clear with good visibility. Sea conditions were calm glassy with variable light airs. The air temperature was recorded at 23 °C.

2 ANALYSIS

2.1 Purpose

The purpose of a marine safety investigation is to determine the circumstances and safety factors of the accident as a basis for making recommendations, to prevent further marine casualties or incidents from occurring in the future.

2.2 Effects of Oxygen Depletion in the Cargo Hold

From measurements carried out by the chief officer as well as the fire service personnel, it was firmly established that the level of oxygen in the atmospheric air in cargo hold no. 1 was a mere 2.1 %. Furthermore, asphyxia was determined to be the cause of death. A significant drop in the oxygen level can have adverse effects on the body. Below 6 % oxygen, the body will experience convulsions and eventually cardiac arrest. Such effects occur with immediate effect.

The AB was found with injuries to his head. Although the MSIU could not verify the cause of these injuries, it was considered that probably, he had fallen off the ladder in the access duct for cargo hold no. 1 during his descent and before reaching the tank top, as a result of the above mentioned symptoms.

2.3 Entry into the Cargo Hold

As indicated in section 2.2, the accident happened when one of the ABs entered the access trunk leading down to cargo hold no. 1, where timber logs were stowed and with the deck cargo hatch covers still tightly closed and sealed.

None of the crew members had seen the AB entering the cargo hold and neither knew his intentions nor talked to him about the associated dangers immediately before his entry. To this extent, the safety investigation could neither establish what impelled him to access cargo hold no. 1 (despite the associated dangers), nor determine whether he was aware and had a thorough understanding of the risk of oxygen depletion within the cargo space.

In all probability, while the ship's officers do familiarise themselves with properties of the cargo as a natural part of their workflow (for instance, the handling of the cargo documents, manuals and other relevant literature), it cannot be assumed that an AB would naturally obtain the same degree of knowledge. The same applies for the potential danger of oxygen depletion. Furthermore, the entry to the cargo hold was accessible to the crew member (to the extent that he managed to open the access door and climb down the access ladder to the cargo hold), with no signs posted to remind of / mark the dangers that were inside, as a result of the nature of the stowed cargo.

2.4 Risk Associated with Access to the Cargo Hold

Literature suggests that behaviour may be considered as an indicator of a person's inner attitude – in this case, the attitude towards risk. Thus, rather than focussing on the crew member's actual behaviour, the safety investigation was more interested in the (underlying) attitude. In so doing, the safety investigation attempted to understand the factors, which influenced the crew member to access the cargo hold.

In the absence of witnesses, the analysis of the safety investigation led to two possibilities, *i.e.*, either:

- the situation inside the cargo hold was perceived not to be dangerous and / or life threatening; or
- a perceived negative situation on board forced a reactive stance *i.e.*, although aware of the danger, the benefits in accessing the cargo hold were considered by the crew member to overcome the perceived negative situation.

THE FOLLOWING CONCLUSIONS, SAFETY ACTIONS AND RECOMMENDATIONS SHALL IN NO CASE CREATE A PRESUMPTION OF BLAME OR LIABILITY. NEITHER ARE THEY BINDING NOR LISTED IN ANY ORDER OF PRIORITY.

3 CONCLUSIONS

Findings and safety factors are not listed in any order of priority.

3.1 Immediate Safety Factor

- .1 The immediate cause of the accident was exposure to an atmosphere which was deficient in oxygen.

3.2 Latent Conditions and other Safety Factors

- .1 It was probable that the crew member had fallen off the ladder in the access duct for cargo hold no. 1 during his descent and before reaching the tank top, as a result of symptoms related to breathing oxygen-deficient atmosphere;
- .2 It was not excluded that the degree of knowledge which the AB had on the particular characteristics of the cargo may have not been as thorough as that of the ship's officers;
- .3 The entry to the cargo hold was accessible to the crew member, with no signs posted to remind of / mark the dangers which were inside as a result of the nature of the stowed cargo;
- .4 Access to the cargo hold was due to two possible factors:
 - the situation inside the cargo hold was perceived not to be dangerous and / or life threatening; or
 - a perceived negative situation on board forced a reactive stance *i.e.*, although aware of the danger, the benefits in accessing the cargo hold were considered by the crew member to overcome a perceived negative situation.

3.3 Other Findings

- .1 None of the crew members had seen the AB entering the cargo hold and neither knew his intentions nor talked to him about the associated dangers immediately before his entry.

4 ACTIONS TAKEN

4.1 Safety Actions Taken During the Course of the Safety Investigation

Immediately following the accident, notices cautioning of the potentially hazardous situation on board were affixed on the access door to cargo hold no. 1 (Figure 12).



Figure 12: Warning sign affixed to the cargo hold access door

Moreover,

1. A safety meeting was held with the Company's Safety Manager with all the crew members and the preliminary findings of the internal investigation were discussed;
2. Crew members were briefed on 'Safety at Work' and 'Entrance in enclosed Spaces', SMS procedures. An evaluation was also made on board on these procedures;
3. Company has discussed 'Safety at Work' and 'Entrance in enclosed Spaces', SMS procedures in order to determine whether amendments were necessary (no changes affected);

4. Evaluation of Company procedure implementation will be carried out by the Technical Superintendent / Safety Manager during their routine visits on board;
5. An additional SMS audit was carried out in order to verify the implementation of corrective actions and action to prevent recurrence;
6. Company Information Letters were sent to all Company vessels, emphasising 'Safety at Work' and 'Entrance in enclosed Spaces', SMS procedures;
7. Additional ship's entry into enclosed space drills was also conducted on all ships;
8. The Company's Safety and Quality Managers, Superintendents, masters and safety/security officers were instructed to conduct relevant crew familiarisation/training on 'entry into enclosed spaces' procedures, during all their routine visits on board.