Accident Investigation Board Norway

Issued May 2012

REPORT Sjø 2012/07

REPORT ON INVESTIGATION OF AN OCCUPATIONAL ACCIDENT ON BOARD THE SOLSTRAUM, LDEB3, EN ROUTE TO ROTTERDAM 4 FEBRUARY 2011

Accident Investigation Board Norway • P.O. Box 213, N-2001 Lillestrøm, Norway • Phone: + 47 63 89 63 00 • Fax: + 47 63 89 63 01
www.aibn.no • post@aibn.no

This report has been translated into English and published by the Accident Investigation Board Norway (AIBN) to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

AIBN has compiled this report for the sole purpose of improving safety at sea. The object of a safety investigation is to clarify the sequence of events and root cause factors, study matters of significance for the prevention of maritime accidents and improvement of safety at sea, and to publish a report with eventually safety recommendations. The Board shall not apportion any blame or liability. Use of this report for any other purpose than for improvements of the safety at sea should be avoided.

Photo of ferry on the Norwegian west coast: Bente Amandussen

CONTENTS

NOTIFICATION OF THE ACCIDENT

The Accident Investigation Board (AIBN) was notified of an occupational accident on board the Solstraum by the Norwegian Maritime Directorate on Friday, 4 February 2011. According to the notification, a crew member had died during tank cleaning work, while the vessel was en route from Wilhelmshaven to Rotterdam

Later the same day, the AIBN decided to carry out an investigation. The shipping company and the Norwegian Maritime Directorate were informed of this. According to the shipping company, the vessel was scheduled to call on Rotterdam in the afternoon on 5 February 2011.

Two accident investigators from the AIBN arrived in Rotterdam in the evening 5 February. However, the Solstraum was delayed due to strong winds and rough sea, and did not arrive in Rotterdam until around midday on Sunday, 6 February 2011. The accident investigators boarded the vessel the same day and spoke with the crew and carried out technical investigations of the vessel.

Figure 1: The occupational accident on board the Solstraum took place at 14:45[1] on 4 February 2011, while the vessel was en route from Wilhelmshaven to Rotterdam. The vessel's position when the accident occurred is marked with a red cross.

[1] All times stated in this report are local times = Norwegian times.

SUMMARY

After loading ethylene dichloride (1.2-Dichloroethane) in Eastham on 31 January 2011, the crew on board the Solstraum were to take samples of the cargo so that they would subsequently be able to document that the cargo had not deteriorated during transport, should this become relevant. However, the tube used to collect such samples became stuck in the heating coils at the bottom of cargo tank 7P (7 port side). As it was impossible dislodge, the measuring tape it was attached to was fastened above deck. The sampling device was thus suspended inside cargo tank 7P until it probably came loose and fell into the tank, either before the Solstraum arrived at Wilhelmshaven, in connection with the discharging there, or during the following cleaning process.

After discharging its cargo in Wilhelmshaven, the Solstraum set the course for Rotterdam to take on board new cargo. At the same time, the process of cleaning the cargo tanks was started. When cargo tank 7P had been cleaned for an hour with cold seawater, the cleaning process was stopped and the pumpman instructed the deckhand on watch to mount and start the fan in order to ventilate the tank. The fan had been running for approximately 5 minutes when the pumpman asked the deckhand to keep watch at the hatch. Although the pumpman did not communicate his intentions to anyone, the AIBN assumes that he intended to retrieve the cargo sampling device.

Without using a breathing apparatus, the pumpman climbed down the inside ladder on the forward side of the tank and moved aft. However, when he reached the middle of the tank, he quickly turned back and climbed up the ladder. Half way up the ladder he fell backwards, back into the tank. He fell 4 – 5 metres and lay lifeless at the bottom of the tank. The crew rescued the pumpman out of the tank, but, despite efforts to save his life, he was later declared dead.

The AIBN assumes that the pumpman died as a result of a oxygen deprivation. At the time of the accident, the oxygen content of the atmosphere at the bottom of the tank was probably less than 7.2%. The nitrogen content was probably over 90%. In addition, the atmosphere may have contained some ethylene dichloride vapour at the time of the accident, but probably not enough to cause the pumpman's death. The report from the team of doctors that examined the deceased after the accident supports the AIBN's conclusion that the pumpman probably died as a result of oxygen deprivation.

In the AIBN's opinion, the pumpman, who had extensive experience, was familiar with the risks involved in entering the tank. He probably thought he would be able to climb down the ladder, retrieve the equipment and climb back up again without an oxygen supply.

The AIBN believes that the accident was not due to a lack of knowledge, but a lack of motivation in relation to complying with the procedures in the management system. During the investigation, it was found that such non-compliance with procedures did not only concern the deceased pumpman who entered the cargo tank without following the procedures for entering enclosed spaces. On the voyage in question, the procedures for holding a pre-arrival conference, the procedures for holding a tank cleaning meeting and the procedures for logging nitrogen inerting were not complied with.

After the accident, the shipping company has conducted an internal investigation. Among other things, the investigation concludes that the accident took place because there were no procedures for marking inerted cargo tanks, and that the procedures for entering enclosed spaces and the procedures for conducting a so-called pre-arrival conference were ignored.

On this basis, the shipping company has decided to arrange a S & QMS (Safety & Quality Management System) refresher course for all the shipping company's employees, to establish a programme to improve the HSE culture (Health, Safety & Environment culture), to put leadership and cultural differences on the agenda, to introduce labelling/sealing of inerted cargo tanks, and to prohibit filter masks and physically remove the masks from all the company's vessels.

The AIBN's investigation of this marine accident has not identified circumstances over and above those the shipping company focused on in its own internal report and which will be followed up by corrective actions initiated by the shipping company itself. The AIBN therefore finds no need to propose safety recommendations in this report.

1. FACTS

1.1 Details of the vessel and the accident

Vessel details

Name of vessel	:	Solstraum
Call sign	:	LDEB3
IMO number	:	8913708
Shipping company	:	Utkilen Shipping AS, P.O. Box 1163, NO-5811 Bergen
Responsible for ISM	:	Utkilen AS, P.O. Box 1163, NO-5811 Bergen
Home port	:	Bergen
Country of registration /register	:	Norway / NIS
Class society	:	DNV
Vessel type	:	Chemical / oil tanker
Year of build	:	1990
Construction material	:	Steel
Length overall	:	101.70 metres
Width	:	18.25 metres
Moulded depth	:	8.90 metres
Gross tonnage	:	3,998
Engine power	:	3 238 KW / 4 400 BHK

Figure 2: Solstraum. Source: Utkilen Shipping AS

Details of the accident

Date and time	:	14:45 on 4 February 2011
Accident location	:	N54 11,8 E006 52,2
Persons on board	:	12
Injuries/fatalities	:	One crew member died
Damage to the vessel	:	None

1.2 Course of events

The Solstraum arrived at Eastham in England on 29 January 2011 to load 4526,821 tonnes of ethylene dichloride (1.2 dichloroethane). As part of the preparations, cargo tanks 2P, 2S, 3S, 4P, 5P, 7P and 7S were to be inerted with nitrogen (N_2) (cf. section 1.8.4).

The operation of adding nitrogen started at 21:05 on 29 January. The operation was monitored by measuring the tanks' oxygen content. The measurements were started at 05:20 on 30 January. At that time, all the cargo tanks contained less than 5% oxygen. Adding nitrogen was stopped at 06:20. So-called balanced loading/ventilation was then carried out, i.e. nitrogen was released as the cargo was taken on board.

Nitrogen was introduced again, from 01:15 to 01:25 on 31 January 2011. Loading was completed at 01:35 on 31 January 2011. When loading had been completed, the N_2 level was topped up and maintained during the voyage to Wilhelmshaven, Germany, where the Solstraum's cargo was to be discharged.

In accordance with the shipping company's procedures, cargo samples were to be collected in connection with both loading and discharging, so as to be able to document that the quality of the cargo had not deteriorated on board. This was to be done by using a device consisting of a sampling tube attached to a steel measuring tape, cf. figure 3.

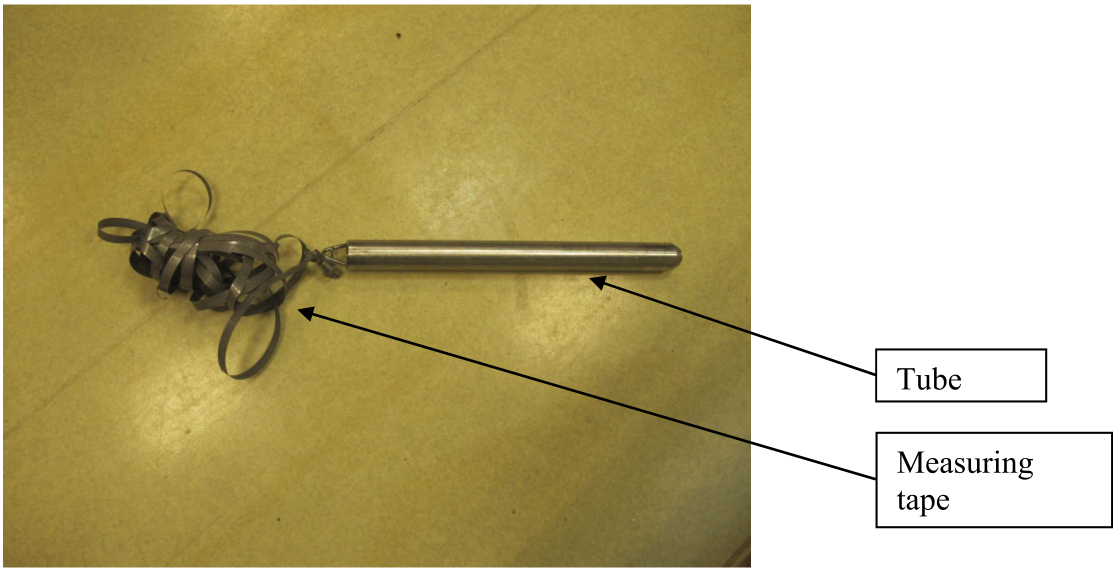


Figure 3: The sampling device used to collect cargo samples.

The sampling would take place by standing on deck and lowering the device into each cargo tank through a valve in the butterworth hatch at the aft end of each cargo tank. Figure 4 shows the butterworth hatch of cargo tank 7P.

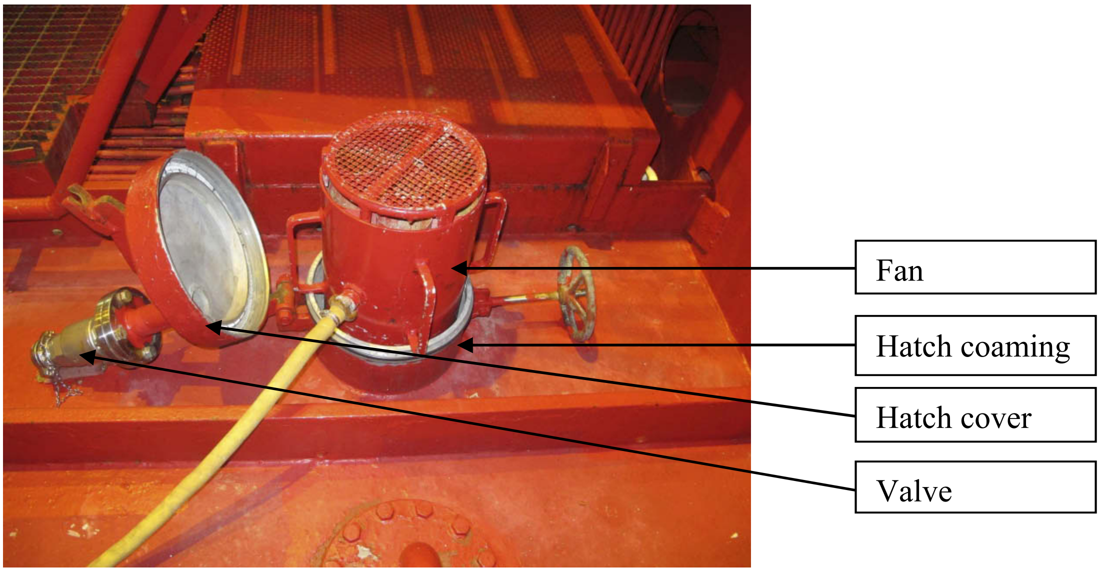


Figure 4: The butterworth hatch of cargo tank 7P. In the photo, the cover has been removed and a fan mounted in its place, in order to ventilate the tank.

When a cargo sample was to be collected from cargo tank 7P after loading in Eastham, the tube became stuck in the heating coils at the bottom of the tank, cf. figure 5. After unsuccessful attempts to dislodge the tube and retrieve the sampling device from the tank, the measuring tape was temporarily fastened above deck to prevent the whole sampling device from disappearing into the cargo tank.

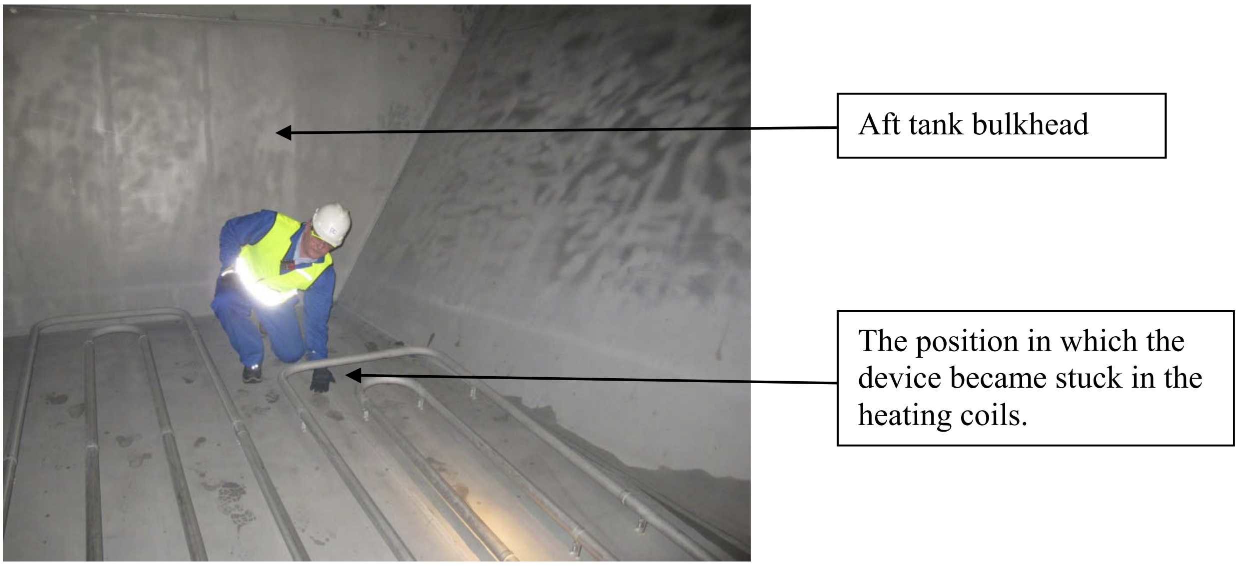


Figure 5: The heating coil where the cargo sampling device became stuck.

Before discharging in Wilhelmshaven in Germany, a so-called pre-arrival conference was held at 14:00 on 3 February 2011. The chief officer, the officer on watch and the pumpman were present at this meeting. The discharge operation was planned in this meeting.

Discharging commenced at 16:50. Nitrogen was added during discharging, so that the atmosphere in the cargo tanks contained 99.9% nitrogen. Discharging was completed at 05:25 on 4 February 2011.

When discharging was completed, the Solstraum set the course for Rotterdam in the Netherlands where the vessel was to take on board caustic soda. The sampling device was still stuck in the heating coils at the bottom of cargo tank 7P, with the measuring tape fastened above deck.

Before the Solstraum_could take on board new cargo, the cargo tanks had to be cleaned. In that connection, a tank cleaning meeting was held from 05:30 to 06:00 on 4 February 2011. The chief officer, the master and the pumpman were present at the meeting. The meeting reviewed the procedure for the cleaning work and prepared a plan/checklist.

In accordance with the tank cleaning plan, the bottom of each of the cargo tanks 2P, 2S, 3S, 4P, 5P, 7P and 7S was to be flushed for five minutes with seawater, then cleaned for one hour with cold seawater with the hatches closed, and finally cleaned for one and a half to two hours with warm seawater (60–70 degrees Celsius) with the hatches closed. After cleaning with warm seawater, the chief officer was to be called to conduct smell tests. After that, the cargo tanks were to be cleaned for ten minutes with freshwater, and then ventilated, mopped and dried.

In accordance with the tank cleaning plan, the cargo tanks 2P, 2S, 3S, 4P, 5P, 7P and 7S were bottom-flushed and the tanks were cleaned with cold seawater. The work of cleaning cargo tanks 2P and 4P with warm water had begun, cf. figure 6, when the pumpman instructed the deckhand on watch that he was to mount and start the fan for ventilating cargo tank 7P.

CLEANING Ethylene di Cloritane FOR CAUSTIC SODA

Tank no.	5 min Bottom flush with . SW	1Hr. BW SW/ cloased tanks	BW Hot SW 60-70* 1,5-2 HR/ check smell	Bw FW 10 MIN	Vent cont/Ejecting	Mopping	Drying
2P	X	X	/				
2S	X	X					
3S	X	X					
4P	X	X	/				
5P	X	X					
7P	X	X					
7S	X	X					

Stripping line.

Cofferdam purge with water

All Valve Close & Open

PV Valves

For list use 5P/S WBT

Use filter mask during work on manifold

Entry in to the tank only after c/o permition.

During hot water ventilate./ call c/o when no smel for check the tank

7p. – SAMPLING DEVICE

Figure 6: The checklist shows the status of the cleaning process at the time of the accident. The bottom of cargo tanks 2P, 2S, 3S, 4P, 5P, 7P and 7S had been flushed, and the tanks had been cleaned with cold seawater. The work of cleaning cargo tanks 2P and 4P with warm water had commenced when the pumpman entered cargo tank 7P.

The fan had been running for approximately five minutes when the pumpman called the deck crew member and asked him to stand watch by the hatch. The pumpman did not explain why, but the deck crew member understood that he was about to enter the tank. Both the deckhand and the pumpman were wearing filter masks.

The pumpman took two deep breaths before climbing down the inside ladder on the forward side of the cargo tank. From the deck, the deck crew member keeping watch at the hatch saw the pumpman reach the bottom of the tank and walk aft. About halfway across the tank bottom, the pumpman turned back and moved quickly to reach the ladder. He started climbing, but halfway up the ladder he fell backwards, back into the tank. He fell 4 – 5 metres, cf. figure 7, and lay lifeless at the bottom of the cargo tank. The time was then 14:45.

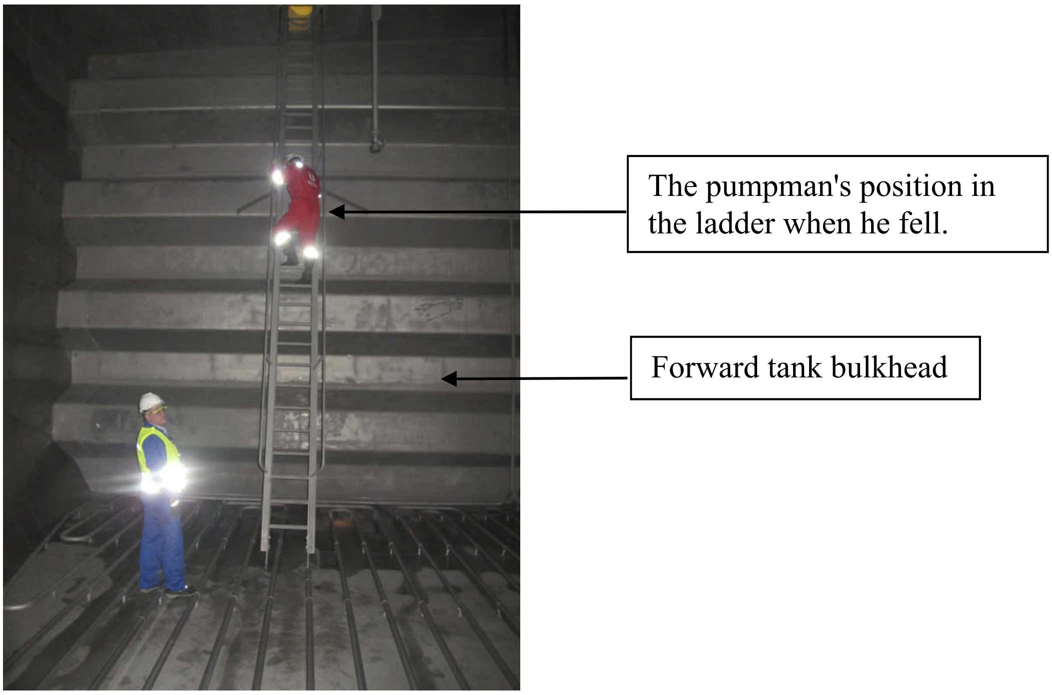


Figure 7: Reconstruction of the accident The pumpman fell 4-5 metres (from the position of the person wearing the red overalls) and lay lifeless at the bottom of cargo tank 7P.

The deck crew member who stood watch at the hatch ran aft to the control room forward of the accommodation area on the main deck to get help. He also contacted the officer on watch by VHF radio and informed him that the pumpman was lying unconscious at the bottom of cargo tank 7P. The officer on watch alarmed the master who waked up the chief officer. The chief officer ran up to the bridge. From his position, neither the deck crew member nor the access hatch for cargo tank 7P was within his line of sight. The chief officer then ran down to the control room to fetch a gas detector and a breathing apparatus. He then ran out and across the deck to the access hatch for cargo tank 7P. The deckhand who had been watch at the hatch had fetched a harness and lifting equipment, and a stretcher.

After having informed the crew about the accident, the master called Radio Medico. After discussing whether the pumpman could have sustained physical injuries in the fall, and whether moving him would be inadvisable, it was decided to lift the pumpman out of the cargo tank.

Before the crew entered the tank, the chief officer checked the atmosphere in the tank using the gas detector[2]. Readings were taken at several vertical levels in the tank. The oxygen content varied from 14.3 to 14.5%. The LEL (Lower Explosive Limit) readings were zero. The time was then approximately 14:50.

Due to the low oxygen level, the crew donned a breathing apparatus before entering the tank. By means of the harness and lifting equipment, the pumpman was lifted out of the tank at approximately 15:00. No pulse or heartbeat was registered. A helicopter with a doctor on board was requisitioned.

The pumpman was laid on the stretcher and brought to the hospital on board, while cardiopulmonary resuscitation was administered continuously. The pumpman was also

[2] Detector type: Dräger X-am 5000

hooked up to a defibrillator, but before shocks were administered, the defibrillator returned a message to continue cardiopulmonary resuscitation. The doctor who arrived by helicopter declared the pumpman to be dead at approximately 16:00. The pumpman was then brought to his cabin.

When the pumpman had been lifted out of cargo tank 7P, the tank was closed. New readings of the atmosphere were taken at 22:20. Use of a gas detector [3] and a hose that went approximately half way into the tank, returned a methyl bromide reading of 0.1 ppm.

After arrival in Rotterdam, the pumpman was examined by a Dutch medical team before he was sent home to Latvia. According to the report from the Dutch medical team, the cause of death was probably oxygen deprivation.

1.3 Shipping company and fleet

The Solstraum is owned by Utkilen Shipping AS. The shipping company was formed in 1967 and currently employs around 50 staff at its head office in Bergen in Norway. Utkilen Shipping AS operates a fleet of 22 chemical and oil tankers with a deadweight tonnage[4] of between 2,500 and 19,500, which makes it one of the biggest companies shipping chemicals and other liquid cargoes in Northern Europe. The shipping company employs approximately 370 Norwegian and foreign crew members on board its vessels. Most of the shipping company's vessels are registered in the Norwegian International Ship Register (NIS).

Utkilen Shipping AS was issued a 'Document of Compliance' (DOC) by Det Norske Veritas (DNV) on 5 July 2007. The document was stated to be valid until 10 June 2012, on the condition that verifications were carried out annually. The most recent annual audit prior to the accident was carried out on 2 September 2010.

The shipping company has been forthcoming and has contributed to facilitating the AIBN's safety investigation after the accident on board.

1.4 The vessel

The chemical/oil tanker Solstraum was built in 1990 by Aker Aukra AS in Norway, and has an overall length of 101.70 metres and a moulded depth of 8.90 metres. The vessel has 14 cargo tanks (seven tanks on the starboard side and 7 tanks on the port side) with a total volume of 6,800 cubic metres. The vessel is registered in NIS and classed by DNV with class notation 1A1 ICE-1A Tanker for Chemicals and Oil Products ESP E0.

All the vessel’s certificates were valid at the time of the accident. Most of the certificates were issued in 2010 and are valid until 2015. For example, the Safety Management Certificate (SMC) was issued on 20 December 2007 and is valid until14 November 2012.

1.5 The crew

At the time of the accident, the Solstraum had a crew of 12. The master, the chief officer, the second officer, the deceased pumpman and the second engineer were all from Latvia.

[3] Tube type: Dräger-Tube Methyl Bromide 0,2/a
[4] Load capacity

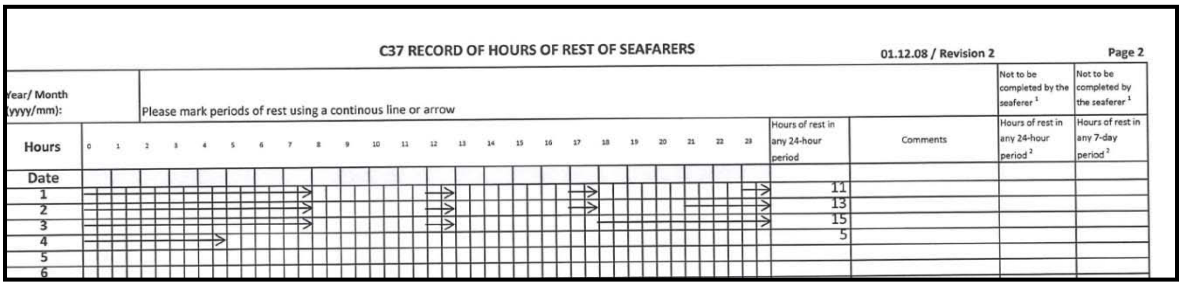
The chief engineer was from Lithuania, and the remaining crew were from the Philippines.

The deceased was born in 1957, and had many years of seafaring experience. In addition to being a certified pumpman, he had a tankerman certificate for both chemical and oil tankers. He had been with Utkilen Shipping AS since April 2000, and had worked for several years on board the Solstraum, first for a period from January 2004 to August 2005, and then from October 2006 until the accident occurred. During the latter period he was pumpman on board.

1.6 Watch arrangements on board

Normally the crew works sea watches, four hours on and eight ours off. The chief officer works as a 'dayman' during periods when his workload is heavy. In such cases, the two other officers work six-hour watches with six hours on and six hours off.

The AIBN has collected information about the crew's rest periods prior to the accident. Based on the logs presented, the AIBN believes that the crew involved had had sufficient sleep and rest prior to the accident. Figure 8 shows a log of the pumpman's hours of rest.


C37 RECORD OF HOURS OF REST OF SEAFARERS 01.12.08 / Revision 2 Page 2

Year/ Month (yyyy/mm):

Please mark periods of rest using a continous line or arrow

Date	Hours of rest in any 24-hour period	Comments	Not to be completed by the seafarer[1] Hours of rest in any 24-hour period[2]	Not to be completed by the seafarer[1] Hours of rest in any 7-day period[2]
1	11			
2	13			
3	15			
4	5			
5				
6				

Figure 8: Log showing the pumpman's hours of rest prior to the accident on 4 February 2011.

1.7 Safety representative system on board

A safety representative system has been established on board and the work environment committee holds monthly meetings, so-called WEC meetings. In these meetings between the safety representatives and the vessel's management, the focus is on safety on board. Monthly crew meeting are also held in which safety issues can be raised by everybody on board.

1.8 The safety management system – applicable procedures

1.8.1 Procedures for conducting a pre-arrival conference

According to the management system, a conference shall be held before the vessel arrives at the port of loading or port of discharge. Everyone involved in the upcoming loading/discharge operation shall participate in this pre-arrival conference, which is led by the chief officer. The purpose of the conference is to review the individual operations/activities, including a review of:

- the characteristics of the cargo, focusing on necessary precautions. In this connection, the Material Safety Data Sheet (MSDS) shall be consulted.

- the procedures for commencing and concluding the loading/discharge operation;

- communication between the cargo control room and the deck;
- conditions specific to the loading/unloading terminal in question;
- the procedures for emergency situations and communication;

Prior to the accident on 4 February 2011, a pre-arrival conference was held in connection with the Solstraum's arrival in Wilhelmshaven. The chief officer, the officer on watch and the pumpman were present at this meeting. It has not been confirmed that the crew, including the deckhand who stood watch at the hatch when the accident occurred, participated in the meeting, and the shipping company has therefore concluded that he probably did not.

1.8.2 Procedures for taking samples of the cargo

According to the vessel's manual for loading operations[5], samples shall be taken of the cargo to protect and/or defend the shipping company against claims as a result of a deviations in the quality of the cargo. Manifold samples shall be taken in connection with both loading and discharging. Samples can also be taken from the cargo tanks after loading and before discharging.

1.8.3 Procedures for handling and monitoring special cargoes

The vessel's manual for loading operations[6] contains general procedures for handling and monitoring special cargoes. By way of introduction, it is emphasised that some cargo types require special handling during loading, carriage and discharging. In this connection, the MSDS shall always be consulted for information about the cargo in question.

When carrying toxic cargoes, the procedure specifies that a Dräger tube shall be available for measuring gas concentrations. In order to decide whether a Dräger tube is required for a specific cargo type, the Dräger tubes & CMS Handbook[7] shall be consulted. If the cargo type in question is listed in the handbook, the relevant tube shall be available on board.

At the time of the accident, the Solstraum had discharged ethylene dichloride from tanks 2P, 2S, 3S, 4P, 5P, 7P and 7S. According to the Dräger tubes & CMS Handbook, there is no specific tube for measuring the concentration of ethylene dichloride. However, as ethylene dichloride is cross-sensitive to methyl bromide, a methyl bromide 0.2/a tube can be used to measure the concentration of ethylene dichloride.

Regarding the concentration of nitrogen, the shipping company states that the concentration of nitrogen is determined on the basis of the measured concentration of oxygen.

1.8.4 Procedure for use of inert gas

Many chemicals have properties that require the oxygen in the cargo tanks to be replaced by a neutral gas, a so-called inert gas. The purpose of removing the oxygen is to prevent a

[5] Cargo Operation Manual 12.1.1
[6] Cargo Operation Manual 6.1.1
[7] Confirmed by Dräger Safety Norge AS

fire or explosion, prevent chemical reactions and maintain the quality of the cargo. Nitrogen (N_2), which is used as an inert gas, is pumped into the tanks both before and during loading, during the voyage and in connection with discharging.

The vessel's manual for loading operations[8] contains procedures for the use of inert gases. Nitrogen is normally supplied at high pressure and at a high flow rate. The procedure therefore reminds the reader that chemical tankers are not designed to withstand high internal pressures, and that structural deformations can arise at overpressures of less than 0.5 bar. Furthermore, the procedure points out the importance of agreement on the procedures for handling nitrogen, and that a plan for adding nitrogen should be part of the pre-loading checklist between ship and shore. The procedure describes other factors that must be taken into considerations with a view to taking necessary precautions when inerting with nitrogen.

The procedure does not contain information about what cargo types require inert gas. However, such information is usually provided in the cargo manifest.

The decision to add nitrogen to the cargo tanks in connection with the shipment of ethylene dichloride prior to the accident on 4 February 2011, was made by the cargo owner. The execution of this process was controlled by an onshore surveyor in Eastham. In addition to the cargo owner and surveyor, the shipper, agent, charterer, shipping company and the crew on board the Solstraum were all aware of the cargo owner's requirement that the cargo be inerted. While the Solstraum was in port at Eastham, the surveyor, together with the vessel's crew, checked the nitrogen content of the tanks by measuring the oxygen content.

When a decision is made to introduce inert gas to the cargo tanks, the shipping company's management system requires certain checks to be carried out and logged for the voyage in question. Fixed forms have been prepared for this purpose, including a log for nitrogen inerting[9], a log for atmospheric pressure checks[10] and a log for leakage checks[11].

Of the logs mentioned, the form for logging atmospheric pressure and the form for logging leakage checks were used, while the form for logging nitrogen inerting was not used on the voyage in question.

1.8.5 Procedures for tank cleaning after discharging the cargo

The vessel's manual for loading operations[12] contains procedures for cleaning and freeing the cargo tanks of gas. The procedure points out that the work of cleaning the tanks and freeing them of gas shall be carried out in a safe manner and according to the physical and chemical characteristics of the different types of cargo, including flammability, corrosiveness, toxicity and reactivity. Mandatory rules and regulations, as well as the relevant industrial standards, shall always be complied with.

[8] Cargo Operation Manual 11.1.1
[9] Form CO24 'Nitrogen / Air operations'
[10] Form CO26 'Managing tank atmosphere'
[11] Form CO20 'Monitoring build up Flammable / Toxic Vapours'
[12] Cargo Operation Manual 13.1.1

1.8.5.1 *Procedure for planning the cleaning process*

The procedure emphasises the importance of planning the cleaning on the basis of the type of cargo that has been discharged from the tanks and the type of cargo that is to be loaded into the tanks. The plan shall take account of the following:

- Any instruction received from the shipping company and shipper
- The availability and condition of necessary equipment
- The cleaning procedures to be applied
- Expected time of cleaning
- The readiness of boilers, pumps and heating elements
- The detailed plan of the tank cleaning operations
- Crew requirements
- Safety precautions

Prior to all tank cleaning processes, a meeting shall be held under the leadership of the chief officer. All crew members taking part in the cleaning operation shall participate in the meeting. The agenda for the meeting shall cover all items in the tank cleaning plan.

Prior to the accident on 4 February 2011, a tank cleaning meeting was held in which the chief officer, the master and the pumpman participated. It has not been confirmed that the crew, including the deckhand who stood watch at the hatch when the accident occurred, participated in the meeting, and the shipping company has therefore concluded that he probably did not.

1.8.5.2 *Documentation relating to the cleaning process*

The following documentation shall be prepared as applicable for any tank cleaning and gas freeing operation:

- Enclosed space entry permit
- Tank cleaning plan
- Tank atmosphere check before use of chemical additives

1.8.5.3 *Opening the tank hatches*

During tank cleaning operations, the tank hatches shall only be opened if the tanks in question are being cleaned and the hatches must be closed as soon as the operation is completed. The discharge of flammable or toxic gasses at deck level should be reduced and/or avoided where possible.

1.8.5.4 *Cleaning after carriage of flammable cargoes*

The shipping company's management system defines all types of cargo with a flashpoint of less than 60 degrees Celsius as flammable[13]. In accordance with the procedures for tank cleaning after carriage of flammable cargoes, tanks that have not been inerted shall be bottom-flushed[14] to remove cargo residues.

Cargo residues shall be washed out with ambient-temperature water, with a minimum of activities and equipment involved. When cargo residues have been removed, the tank shall be ventilated until the gas concentration in the atmosphere reaches 10% or less of the lowest explosion limit (LEL). When the tank has been ventilated and the atmosphere has been measured and verified to be below 10% of LEL, further cleaning using a detergent and warm water may commence. The wash-down may be substituted by a mandatory pre-wash in accordance with the requirements of MARPOL.

In addition to the above, the procedure lists several general safety precautions for cleaning tanks with atmospheres below 10% of LEL. Among other things, the tanks shall be kept closed until cleaning commences. Only those hatches that will be used during the cleaning process should be opened. Furthermore, regular gas tests shall be carried out at various stages of the cleaning process. Air condition systems shall be stopped during gas freeing. If it is suspected that gas is being drawn into the air condition system, the system shall be shut off immediately and the ventilation openings shall be closed.

1.8.5.5 *Gas freeing*

Among other things, the procedure for gas freeing emphasises the following:

- All tanks that are to be ventilated shall be kept closed until gas freeing commences.

- Transportable fans shall be mounted in such a way that they blow fresh air down into the tank. This is especially important when extracting explosive gases. The reason for this is that these gases must not pass through the fans, in the event that sparks are created by breakdown of equipment.

- During gas freeing, people must keep away from the deck area immediately above the tank in question, especially during the initial phase.

- When toxic gases are freed, the vessel must keep a steady course to ensure that the gases do not enter the accommodation area. The vessel's position in relation to where the gas freeing is carried out must also be taken into account.

- When the gas freeing process has been completed, all fans must be turned off for at least ten minutes before final gas readings are taken using an explosive meter or Dräger test tube. The readings shall be taken at several levels in the tank as well as in the cargo lines.

[13] EDC has a flashpoint of 13 °C
[14] According to the shipping company, this is done to fill up the tank with seawater using first the pump and subsequently the dropline, to avoid static electricity.

- A tank shall only be deemed to be gas-free when flammable and/or toxic gases can no longer be detected. Upon completion of all gas freeing operations, all equipment that may contain cargo residue shall be checked.

- All tanks that are gas free or do not require ventilation, shall be battened down.

1.8.6 Procedures for entering enclosed spaces and procedures for entering the cargo tanks

According to the vessel's manual for loading operations[15], no cargo surveyor or other personnel shall enter a cargo tank before the enclosed space entry permit checklist has been filled in and a responsible officer is present at the tank hatch.

During loading, ballasting and tank cleaning, a breathing apparatus shall be available in the immediate vicinity of the cargo deck.

Pursuant to the vessel's main manual[16], entry into enclosed spaces is considered a critical operation and shall be monitored by a responsible person. A risk assessment shall be carried out (cf. MSM 7.1.1).

Enclosed spaces include, but are not limited to, cargo tanks, double bottoms, fuel oil tanks, ballast tanks, pump room, cofferdams, void spaces, duct keels, inter-barrier spaces, engine crankcases and waste oil tanks.

When entering enclosed spaces, attention must be paid to the following:

- Possible lack of oxygen content in air (less than 21%)

- Possible presence of explosive and/or toxic gases

- Safe access/escape to/from the area

- Adequate illumination

- Adequate communication

- Adequate means to carry out a rescue operation in an emergency

A watchman must be posted at the entrance to the enclosed space at all times when personnel are inside enclosed space(s).

1.8.6.1 *Responsibility*

The vessel's master has overall responsibility for enclosed space and tank operations. The chief officer shall carry out necessary gas measurements. However, the safety officer/ duty officer can be authorised by the chief officer to carry out such measurements and prepare the enclosed space entry permit, provided that this person's knowledge of the use/operation of gas measuring equipment has been documented.

---

[15] Cargo Operation Manual 2.1.1
[16] Main Shipboard Manual 7.1.3

1.8.6.2 *Emergency situations*

If an emergency situation arises during work in enclosed spaces / cargo tanks, the procedure 'Rescue from cargo tanks and other enclosed spaces' shall be complied with.

1.8.6.3 *Entry permits*

Before any personnel enter an enclosed space, an enclosed space entry permit must be obtained. Together with the risk assessment, the permit shall be posted in a prominent place during the entire operation.

The permit shall only be granted for a period sufficient to carry out the assignment. Under no circumstances must the period exceed eight hours.

The permit shall be deemed to be invalid if ventilation of the space ceases or should any of the preconditions on the checklist change.

The enclosed space entry permit shall be signed by the master or the chief officer (only applies to cargo tanks).

1.8.6.4 *Entry permit for cargo tanks*

To simplify the administrative process, a permit can apply to all cargo tanks that have been checked and found to be safe to enter, but the permit must include readings for each compartment and the same entry procedures must apply to all compartments entered.

A complete tank plan showing which tanks are safe to enter shall be posted in a prominent place.

1.8.6.5 *Atmosphere checks*

When a gas freeing process has been completed, all fans must be turned off for at least ten minutes before final gas readings are taken using the following equipment:

Always:

- Oxygen meter – oxygen content shall be 21% by volume.
- Explosive meter – hydrogen vapour concentration. Measured level to be less than 1% LEL.

When applicable:

- Dräger test tube – for toxic products (consult the Material Safety Data Sheet). The measured level must not exceed 0 ppm

Remember to carry out metering at several levels in the enclosed space and in lines, ventilation systems and valves connected to the enclosed space.

Low points of bilge wells shall be opened to ensure that all lines are free of liquid.

If the material that was previously held in the enclosed space was toxic or if the surrounding areas contain / have contained toxic material, the enclosed space shall be measured for toxic gas.

Make sure that the measured values do not change while entering the tank/enclosed space.

A change in the measured values can be caused by cargo residue in the tanks or adjoining pipes. Account must also be taken of possible leakages in heating coils and adjacent tanks. Regular checks in accordance with the entry permit must be carried out during the entire operation.

Personnel entering enclosed spaces shall be equipped with personal analysers.

1.8.6.6 *Tagging*

When an enclosed space has been checked and found safe for entry, the entrance shall be marked with a board reading 'SAFE FOR ENTRY'.

A sign reading 'WORK IN PROGRESS' shall be posted at the enclosed space opening and the sign shall be removed when the work has been completed and all personnel have left the space.

If an enclosed space entry permit is cancelled, the board 'SAFE FOR ENTRY' shall be removed from the enclosed space entrance and the hatch closed.

1.8.6.7 *Safety equipment*

Appropriate safety equipment shall be used when entering enclosed spaces.

Safety equipment ready for immediate use in the event of a rescue operation shall be prepared and placed in an easily accessible place.

As a minimum, such equipment shall comprise:

- One set of breathing equipment
- One rescue line
- One rescue harness
- One flashlight

1.8.6.8 *Communication*

When entering enclosed spaces, a dedicated watch able to communicate with the persons entering the enclosed space shall be placed by or near the entrance.

1.8.7 <u>Procedures for entering contaminated spaces</u>

In accordance with the vessel's Cargo Operation Manual, enclosed spaces shall generally not be entered before the oxygen content is confirmed to be sufficient and the atmosphere is clean and free of explosive and toxic gases. Should it become necessary to enter contaminated spaces in an emergency situation or in connection with cleaning of cargo tanks, the procedures for entry into enclosed spaces shall be complied with and the following additional precautions shall be taken:

- Lack of oxygen: breathing apparatus to be worn
- Flammable or toxic liquids/gases: gas-tight suits to be worn
- Tanks to be cleaned

Some cargoes may leave behind residues or sediments that can only be removed mechanically by personnel entering the cargo tanks.

Such operations must only be carried out when the following criteria are met:

- It is IMPOSSIBLE to remove previous cargo without personnel entering the cargo tanks
- A risk assessment has been conducted
- An enclosed space entry permit has been verified and signed by the master
- The precautions mentioned in the Material Safety Data Sheet have been complied with
- All hazards and safety issues relating to the operation in question have been documented and necessary precautions agreed upon.

Before any personnel enter an enclosed space / cargo tank, checklist S3 shall be used.

An enclosed space entry permit shall be issued and available. The tank entry permit shall be posted in the control room during the operation.

To simplify the administrative process, a permit can apply to all cargo tanks that have been checked and found to be safe to enter, but the permit must include readings for each compartment and the same entry procedures must apply to all compartments entered. Under such circumstances, the cargo tanks shall be tagged to indicate which are safe to enter and which are not, and rigorous control must be in place to ensure that permits are cancelled and the tags changed when entry has been completed.

The permit shall only be granted for a period sufficient to carry out the task. Under no circumstances shall the period exceed eight hours.

The permit shall be deemed to be invalid if ventilation of the space ceases or should any of the preconditions on the checklist change.

If an emergency situation arises during work in enclosed spaces / cargo tanks, the procedure 'Rescue from cargo tanks and other enclosed spaces' shall be complied with.

The enclosed space entry permit shall be signed by the master or the chief officer (applies to cargo tanks only).

The chief officer shall carry out necessary gas measurements. However, the safety officer/ duty officer can be authorised by the chief officer to carry out such measurements and prepare the enclosed space entry permit, provided that this person's knowledge of the use/operation of gas measuring equipment has been documented.

When the gas freeing process has been completed, all fans must be turned off for at least ten minutes before final gas readings are taken using an explosive meter and Dräger test tube.

The readings shall be taken at several levels in the tank as well as in the cargo lines.

The person in charge of preparing the tanks/spaces cannot be responsible for checking the tanks/spaces for gas, as that would lead to a lack of control integrity.

1.9 The properties of the cargo

The Solstraum had carried 4526,821 tonnes of ethylene dichloride (now also known as 1.2-Dichloroethane) distributed in cargo tanks 2P, 2S, 3S, 4P, 5P, 7P and 7S, from Eastham in England to Wilhelmshaven in Germany. Discharging in Wilhelmshaven was completed at 05:25 on 4 February 2011, nine hours and twenty minutes before the accident occurred.

Ethylene dichloride is a chemical product with UN number 1184. According to the IMDG Code, ethylene dichloride is a colourless liquid with a chloroform-like smell. The liquid has an ignition temperature of 13 degrees Celsius and an explosion limit of 6.2 – 15.9%, which means that an atmosphere containing more than 6.2% and less than 15.9% ethylene dichloride vapour is explosive.

Ethylene dichloride vapour is toxic if inhaled. Acute exposure can affect the nervous system, with effects such as nausea and vomiting. Cardiac arrhythmia, pulmonary oedema, bronchitis, haemorrhagic gastritis and colitis, depression and changes in brain tissue have been reported in people who have inhaled large quantities of ethylene dichloride[17]. The threshold value for permitted concentrations of ethylene dichloride (IDLH[18]) is 50 ppm, with a permitted peak intake of 200 ppm for a maximum of five minutes during any three-hour period[19].

In connection with the shipment, the Solstraum was given an MSDS (Material Safety Data Sheet) by the shipper, cf. Annex B.

1.10 The properties of the inert gas

According to the European Industrial Gases Association (EIGA[20]), nitrogen is the gas that annually kills the most people in connection accidents in Europe. The gas is odourless. It is not toxic, but it displaces air, and hence oxygen, causing suffocation.

Dry, clean air contains 78.08% by volume of free nitrogen, cf. Table 1.

[17] Source: Environmental Protection Agency (EPA)
[18] Immidiately Dangerous To Life or Health
[19] US Department of Labor, Occupational Safety & Health Administration
[20] European Industrial Gases Association

Table 1: The composition of gases in a dry atmosphere, per volume [21] . Humid atmospheres also contain water vapour

Type of gas	Content in % by volume
Nitrogen (N_2)	78.084
Oxygen (O_2)	20.946
Argon (Ar)	0.934
Carbon dioxide (CO2)	0.039
Neon (Ne)	0.001818
Helium (He)	0.000524
Methane (CH_4)	0.000179
Krypton (Kr)	0.000114
Hydrogen (H_2)	0.000055
Nitrous oxide (N_2O)	0.00003
Xenon (Xe)	9×10^{-6}
Ozone (O_3)	$0 – 7 \times 10^{-6}$
Nitrogen dioxide (NO_2)	2×10^{-6}
Carbon monoxide (CO)	0.00001

At normal temperatures, nitrogen is hardly reactive. This is because the atoms in the nitrogen molecules are strongly bonded. The reactivity increases as the temperature rises.

Because nitrogen is incapable of supporting combustion, it is used as a protective atmosphere when transporting flammable substances.

1.11 The properties of methyl bromide[22]

In connection with an atmosphere check the crew carried out at 22.20 on the day of the accident, 7.5 hours after the accident, a Dräger-Tube Methyl Bromide 0.2/a was used. By means of this tube, which is designed to cover the range 0.2 - 8 ppm, the gas concentration in cargo tank 7P was found to be 0.1 ppm.

Methyl bromide, CH_3BR, is a colourless gas at room temperature and a liquid at temperatures below 38.5 °F (3.5 °C). It is odourless in low concentrations, but emits a mouldy or fruity smell when present in high concentrations (over 1,000 ppm). Methyl bromide is three times heavier than air and can pile up in low-lying areas and poorly ventilated areas.

The gas is toxic and can cause cramps, coma and long-term neuromuscular and cognitive impairment. Short exposure to high concentrations or prolonged inhalation of lower concentrations can be deadly. Exposure levels that lead to death vary from 1,600 to 60,000 ppm, depending on the duration of the exposure.

According to Dräger Safety Norge AS, methyl bromide gas is cross-sensitive to ethylene dichloride gas.

[21] Source: Wikipedia
[22] Source: ATSDR (Agency for Toxic Substances & Disease Registry)

1.12 Survival aspects

1.12.1 Investigation of the deceased's mask

During the work of cleaning the tank, both the pumpman and the deck crew member wore filter masks[23] manufactured by Dräger. After the accident, the mask that the pumpman had worn was sent to the manufacturer for analysis. The results of the analysis can be summarised as follows:

- Because of its age (year of manufacture: 1990), the mask showed clear signs of wear and early signs of porosity and rupturing. Among other things, a double button on the strap was defective. The requirement for leakage tightness was not satisfied during testing, even after the double button had been replaced. However, the tightness requirement was satisfied when the mask's valve was replaced. The analysis concluded that whether the mask was leakage-tight or not at the time of the accident cannot be determined with any certainty.

- The filter, which was received by the mask manufacturer in a plastic bag containing a yellow, oily liquid, showed signs of corrosion as a result of being affected by the liquid. Among the many substances the filter was checked for, only traces of ethylene dichloride were found. The analysis concluded that the filter had been exposed to an atmosphere containing ethylene dichloride, but that it was impossible to say with any certainty whether this had occurred inside the tank when the accident occurred or at an earlier time.

1.12.2 Physiological effects of reduced oxygen levels in the atmosphere

In a normal ambient atmosphere the expected oxygen level would be around 20.9% by volume. In general, oxygen deprivation leads to loss of mental alertness, distorted judgement and reduced performance. This occurs in the course of a relatively short period of time, and without the person being aware of it.

Table 2 shows the effect of oxygen deficient atmospheres on the individual. The values in the table are approximate and may vary from person to person. Note that exposure to atmospheres containing less than 18% of oxygen by volume poses a significant risk, and that there is a risk of death at oxygen concentrations of less than 11%.

[23] Filter type: Combined Filter 900 A2B2E2K1 P2 R D

Table 2: Asphyxia – effect of O_2 concentrations[24]

% by volume Concentration of O_2	Effects and symptoms
18 - 21	No discernible symptoms can be detected by the individual.
11 - 18	Reduced physical and intellectual performance without the individual being aware of it.
8 - 11	The individual may lose consciousness in the course of very few minutes without prior warning. **Risk of death at concentrations below 11% by volume**.
6 - 8	Loses consciousness after a short time. Cardiopulmonary resuscitation is possible if carried out immediately.
0 - 6	Loses consciousness almost immediately. Brain damage may occur, even if rescued.

1.13 Previous accidents

Pursuant to the Norwegian Maritime Directorate's data base of accidents, no similar accidents have been registered on board the Solstraum or any other of the shipping company's vessels.

1.14 Current rules and regulations

Pursuant to Section 9a of the Ship Safety and Security Act[25], a ship shall be so designed, constructed and equipped that it, according to its purpose and trade area, provides for the satisfactory protection of life, health, property and the environment. The Ministry issues regulations relating to how vessels shall be designed, built and fitted out in order to meet the above requirements.

Section 6 of the Act states that the shipping company has an overall duty to ensure that the construction and operation of the ship is in accordance with the rules laid down in or pursuant to the Act, including that the master and other persons working on board comply with the legislation.

Requirements for safety management systems are regulated by the ISM Regulations[26]. Among other things, these regulations apply to Norwegian cargo vessels with a gross tonnage of 500 or more. Pursuant to Section 2 of the regulations, all shipping companies shall have a safety management system in place covering both the onshore organisation and each individual ship in accordance with the ISM Code.

Matters relating to personal safety are regulated by the Working Environment Regulations[27]. For ships required to have safety management systems, the shipping company shall ensure, by means of the safety management system, that the requirements that follow from the Working Environment Regulations are complied with. The Working

[24] Source: University of Oxford http://www.admin.ox.ac.uk/safety/s403.shtml.
[25] Act of 16 February 2007 No 9 relating to ship safety and security
[26] Regulations of 14 March 2008 No 306 concerning a safety management system for Norwegian ships and mobile offshore units
[27] Regulations of 1 January 2005 No 8 concerning the working environment, health and safety of workers on board ships

Environment Regulations are designed to ensure that work and off-duty activities on board are prepared and organised so as to safeguard the physical and mental well-being of employees.

1.14.1 Requirements relating to the carriage of goods in bulk

Norwegian provisions relating to the carriage of cargo include the Cargo Carriage Regulations[28] and the Dangerous Cargo Carriage Regulations[29]. The first set of regulations is a general one concerning the carriage of cargoes that, owing to the special danger the goods represent to the ship or those on board, may require special precautions. The latter set of regulations concerns the carriage of dangerous cargoes in bulk or as packaged goods, the carriage of liquid chemicals or gases in bulk, and the carriage of irradiated nuclear fuel, plutonium and high-level radioactive waste. Pursuant to Chapter 4 of the regulations, ships carrying dangerous, liquid chemicals in bulk shall comply with:

- SOLAS chapter VII Part B
- the IBC Code
- IMO Resolution A.673(16)

The SOLAS Convention's chapter VII Part B generally refers to the requirements of the IBC Code.

Among other things, the IBC Code, which has been made mandatory through references in SOLAS, contains requirements relating to ventilation and gas freeing of cargo tanks (chapter 8), atmosphere checks (chapter 9), personal safety equipment (chapter 14) and operational requirements (chapter 16).

Among other things, IMO Resolution A.673(16) contains conditions relating to the ventilation of cargo tanks and the detection of vapours.

1.14.2 Requirements relating to ventilation and gas freeing of cargo tanks

The IBC Code distinguishes between so-called open ventilation systems and controlled ventilation systems. The difference is that in so-called controlled ventilation systems, the cargo tanks are fitted with pressure and vacuum relief valves to reduce the pressure/vacuum in the tank, while tanks in an open ventilation system have no such valves. Pursuant to chapter 17 of the code, cargo tanks shall be arranged with a controlled ventilation system when carrying ethylene dichloride.

1.14.3 Requirements relating to control of the atmosphere

Areas with vapours in or near the cargo tanks may require special control of the atmosphere. According to the IBC Code, the atmosphere can be controlled in one of the following four ways:

- inerting: filling the cargo tank and adjacent pipe systems with a gas or vapour that does not support or maintain combustion, and does not react with the cargo;

[28] Regulations of 29 June 2006 No 785 concerning carriage of cargoes on ships and barges
[29] Regulations of 8 August 2009 No 1481 concerning the carriage of dangerous goods on board Norwegian ships

- padding: filling the cargo tank and adjacent pipe systems with a liquid, gas or vapour that separates the cargo from the air and maintains this condition;
- drying: filling the cargo tank and adjacent pipe systems with dry (moisture-free) gas or vapour with a dewpoint of -40°C or lower at atmospheric pressure, and maintaining this condition;
- ventilation: forced or natural ventilation.

According to the code there are no special requirements for controlling the atmosphere in connection with the carriage of ethylene dichloride.

1.14.4 Requirements for personal equipment

Chapter 14 of the IBC Code contains rules on personal protective equipment, personal safety equipment and personal equipment for use in emergency situations. Among other things, at least three sets of safety equipment are required to be in place on board, one of which shall include a breathing apparatus. In addition to this, breathing protection and eye protection shall be available to everybody on board in the case of an emergency. In this context, filter masks are not sufficient.

However, the above minimum requirements are not applicable during transport of ethylene dichloride.

1.14.5 Rules relating to operational factors

Chapter16 of the IBC Code, which deals with operational factors, contains rules on maximum permitted cargo per tank, the type of information that must accompany the cargo, crew training, opening and entering cargo tanks, and storage of cargo samples, in addition to rules on what cargo types must not be exposed to high temperatures.

In connection with the rules on opening and entering cargo tanks, it is stated that the hatches of the cargo tanks shall be kept closed during treatment and transport of cargoes that produce flammable and/or toxic vapour. Crew shall not enter a cargo tank unless:

- the tank is free of toxic vapour and without a shortage of oxygen , or
- the person entering the tank uses a breathing apparatus and other protective equipment as required, and the whole operation is overseen by a responsible officer.

Furthermore, it is stressed that crew must not enter tanks where the only danger is one of fire, except when the operation is overseen by a responsible officer.

Requirements for control of gas hazards etc. are also described in the Safety Regulations[30]. Before persons without approved breathing equipment enter tanks, confined, enclosed spaces, tunnels or similar where gas may be present or where there may be a shortage of oxygen, these regulations require that control measurements are carried out of the air inside such spaces to ensure that it is not hazardous. Measurements shall be taken at various vertical levels, repeatedly if required.

[30] Regulations of 15 June 1987 No 507 concerning safety measures etc. on cargo ships, passenger ships and lighters

The regulations also require the presence on board of at least one measuring instrument for measuring hydrocarbons and at least one measuring instrument for measuring the oxygen content of the air or whether the air in the enclosed space contains toxic or hazardous gases. If any cargo is carried that requires the use of special measuring equipment to measure toxic, hazardous or explosive gas concentrations, such equipment shall be kept on board. The regulations also require that those who carry out the measurements receive necessary training in how to use the equipment. Furthermore, the regulations require that all doors, hatches, manhole covers etc. for spaces with a gas hazard or in which there may be a shortage of oxygen, shall be clearly marked with a sign or adhesive plate that warns of the danger of poisoning and/or oxygen deprivation that a person may suffer on entering the space.

On 27 November 1997, after many accidents in connection with entry of enclosed spaces, IMO adopted resolution Res. A.864(20) Recommendations for entering enclosed spaces aboard ships.

The AIBN is aware that international initiatives are now being taken under the auspices of both MAIIF and IMO to reduce the number of accidents in connection with entry of enclosed spaces, and that the above-mentioned resolution is being revised. In that connection the AIBN would like to refer to safety recommendation MARINE No 2011/04T[31], in which the AIBN recommends that the Norwegian Maritime Directorate consider harmonising national regulations with international recommendations /rules relating to entry of enclosed spaces.

1.15 The authorities and classification society's supervisory activities/inspections

The Solstraum is registered in the Norwegian International Ship Register (NIS). The Norwegian authorities have delegated the inspection of vessels registered in NIS, including verification and approval of the shipping companies' and the vessels' safety management systems, to seven recognized classification societies[32].

As the Solstraum is classified by Det Norske Veritas (DNV), supervisory activities and classification inspections are carried out by DNV. DNV has also issued a Document of Compliance (DOC) to Utkilen Shipping AS, and all relevant certificates, including a Safety Management Certificate (SMC), to the Solstraum.

DOC and SMC are issued to confirm that DNV has audited the management system in the shipping company's onshore organisation and on board the Solstraum.

1.16 Implemented actions

Following the accident on board the Solstraum on 4 February 2011, the shipping company carried out an internal investigation. In that connection, the shipping company concluded that the accident had the following underlying causes:

- The importance of complying with procedures for entry of enclosed spaces was ignored

[31] Cf. the AIBN report on the Investigation of an occupational accident on board Bow Cecil on 8 March 2010.
[32] Det Norske Veritas (DNV), American Bureau of Shipping (ABS), Lloyds Register (LR), Germanischer Lloyd (GL), Bureau Veritas (BV), RINA S. p. A. (Registro Italiano Navale) og Class NK (Nippon Kaiji Kyokai). The last two recognized from the autumn 2011.

- Procedures for marking inerted cargo tanks were not in place
- The importance of complying with procedures for holding a post-departure meeting was ignored
- The pumpman was perceived as an authoritarian person

The shipping company has summarised the results of the internal investigation in a diagram to illustrate the relationship between causes and effects, see Figure 9:

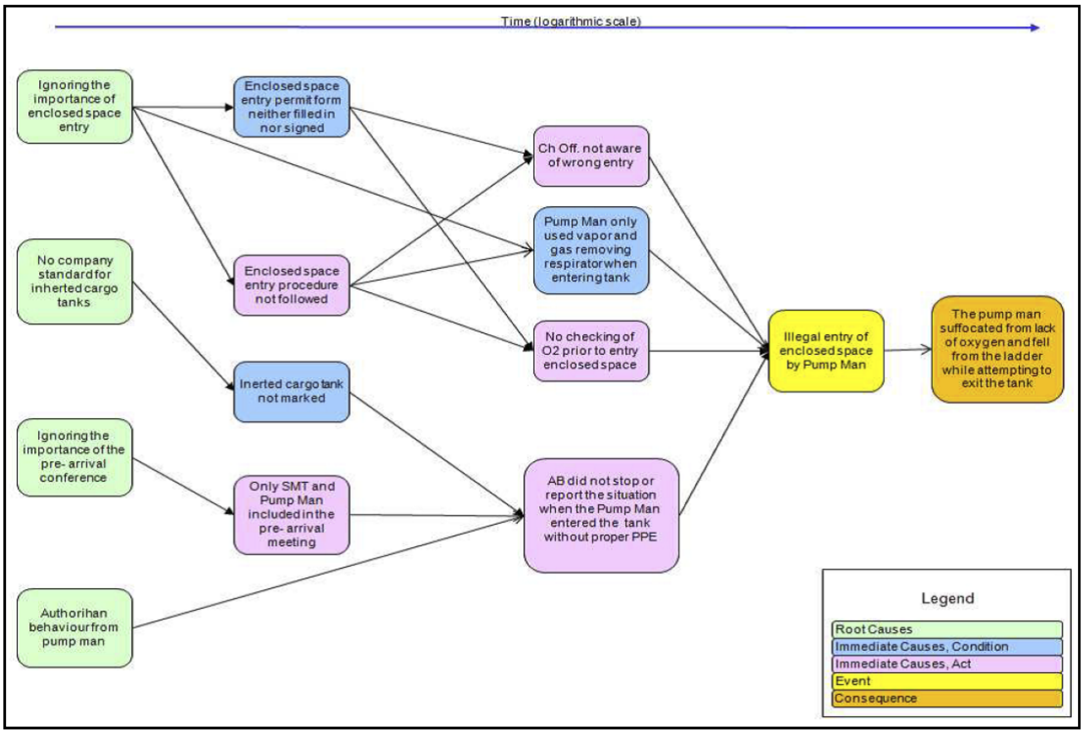


Figure 9: Cause and effect model. Source: The shipping company's internal report following the accident.

On the basis of the cause and effect model, the shipping company has decided to implement several corrective and preventive actions, cf. Table 3. The shipping company has also decided to establish barriers on the basis of contributory causes, cf. Table 4.

Table 3: Schedule of corrective and preventive actions
Source: The shipping company's internal report following the accident

Root causes	Require change in	Category	Description	Responsible	Status
(1) Ignoring the importance of enclosed space entry (2) No company standard for marking of inerted cargo tanks (3) Ignoring the importance of the pre arrival conference (4) Authoritarian leadership by pump man	Procedures	Corrective action	Strengthen procedures for Inerted Cargo Tanks	HSSEQ Manager	Deadline 15.03.2011
	Procedures	Corrective action	Vapour and Gas Removing Filter Respirators are prohibited	Safety Manager	Closed 21.02.2011
	Tools/ equipment	Corrective action	Implement marking/ sealing of inerted cargo tanks	Safety Manager	Deadline 15.03.2011
	Tools/ equipment	Corrective action	Removing all vapour and gas removing filter respirators on all vessels	HSSEQ Manager	Closed 21.02.2011
	Training/ Competence	Preventive action	* All employees are given S&QMS refresher training. Additional day during officer conferences in 2011	HSSEQ Manager	Deadlines: Manila 02.04.2011 Riga 13.04.2011 Bergen 26.05.2011 Bergen 29.09.2011 Manila 01.12.2011 Riga 08.12.2011
	Training/ Competence	Preventive action	Establish "Prudent HSE culture" programme *(Sharing, Caring, Complying, Searching and Learning)*	HSSEQ Manager	Deadline: 31.12.2011
	Training/ Competence	Preventive action	* Management type, leadership and cultural differences are included in all officer conferences in 2011	Director Ship Management	Deadline: Manila 02.04.2011 Riga 13.04.2011 Bergen 26.05.2011 Bergen 29.09.2011 Manila 01.12.2011 Riga 08.12.2011

Table 4: Strengthening of barriers on the basis of contributory causes
Source: The shipping company's internal report following the accident

Contributing factor	Procedures	Tools/Equipment	Training/ Competence
Inerted tank operations rarely practiced by crew	Strengthen procedures for Inerted Cargo Tanks	Implemented Marking/ Sealing of Inerted Cargo Tanks	*All employees are given S&QMS refresher training. Additional day during all 6 officer conferences in 2011
Respirator used by pump man as PPE before entering the tank	Vapour and Gas Removing Filter Respirators are prohibited	Vapour and Gas Removing Filter Respirators have been removed from all vessels	*All employees are given S&QMS refresher training. Additional day during all 6 officer conferences in 2011
Crew member watched pump man entering the tank but did not protest and/or report	Establish "Prudent HSE culture" programme *(Sharing, Caring, Complying, Searching and Learning)*	N/A	Implement "Prudent HSE culture" programme *(Sharing, Caring, Complying, Searching and Learning)* * Management type, leadership and cultural differences are included in all officer conferences in 2011

2. ANALYSIS

2.1 Introduction

The analysis is designed to clarify the details surrounding the chain of events, including to understand the background to why the pumpman climbed down into the tank and why entering the tank had such a tragic outcome. According to the report from the medical team that carried out an examination of the deceased after arrival in Rotterdam, the probable cause of death was oxygen deprivation. This analysis will discuss the atmosphere in the tank at the time of the accident.

The analysis also aims to demonstrate what barriers should be in place in order to prevent the recurrence of such an incident. In that connection, the AIBN has considered rules and regulations relating to transport of chemicals in bulk and entry of cargo tanks, in addition to rules and regulations relating to risk analyses and safety management. The AIBN has also considered the authorities' supervisory activities related to the applicable rules and regulations. However, the AIBN has not found any need to amend the regulations or change the authorities' supervisory activities.

On that basis, the analysis is limited to a review of the shipping company's safety management system in relation to the regulations and of whether the system has been implemented in a satisfactory manner on board the vessel.

In addition to this, the AIBN has also considered whether the crew members involved had had sufficient sleep and rest prior to the accident, but, on the basis of logs that have been presented of the working hours of those involved, it has concluded that tiredness or sleepiness was probably not a contributory factor.

2.2 Assessment of the course of events

After loading ethylene dichloride in Eastham, the device that was being used for sampling of the cargo became stuck in the heating coils at the bottom of cargo tank 7P. After unsuccessful attempts to dislodge the device and retrieve it from the tank, the measuring tape was temporarily fastened above deck to prevent the whole sampling device from disappearing into the cargo tank.

The device was left hanging in cargo tank 7P until is probably came loose and fell into the tank, either before the Solstraum arrived at Wilhelmshaven, in connection with the discharging there, or during the following cleaning process. This could cause a problem, as the device could have been pulled into the pipes and pump systems. In such case, the cargo sampling device could have caused material damage, and the pumpman probably tried to prevent this from happening.

Although the pumpman did not communicate his intentions to anyone, the AIBN assumes that he wanted to enter cargo tank 7P as soon as possible in order to retrieve the cargo sampling device. The longer he waited during the cleaning process, the greater the probability that the cargo sampling device would cause damage. After flushing the bottom of the tank for five minutes and then cleaning it with cold seawater for an hour, he instructed the deckhand on watch to assemble and start the fan to ventilate the tank. However, the fan had only been in operation for five minutes when the pumpman again called the deckhand and asked him to stand watch at the hatch. Both the pumpman and the deck crew member wore filter masks as prescribed by the shipping company's procedures for tank cleaning.

According to the statements of the other crew members, the atmosphere in the tank was not measured before the tank was entered by the pumpman. Nor did the pumpman use a breathing apparatus. The AIBN assumes that the pumpman, based on his long experience as crew and pumpman on chemical tankers, must have known that the atmosphere in the tank made it unsafe to spend any time there. The AIBN believes that the pumpman took a calculated risk when he entered the tank. He only wanted to retrieve the cargo-sampling device and he did not think that this would take much time. He could hold his breath. On this basis, he took two deep breaths and proceeded to climb down the ladder. When he had climbed down into the tank, he probably realised that he would not be able to retrieve the cargo-sampling device. He turned when he was half way between the ladder and the device and climbed back up the ladder. Half way up the ladder he probably lost consciousness and fell backwards, back into the tank.

The AIBN also believes that the deck crew member standing watch at the hatch when the accident occurred understood that it was potentially dangerous to enter the tank, but that he could not have prevented the pumpman from entering the tank.

2.3 The atmosphere in the cargo tank

Measurements carried out by the crew approximately five minutes after the accident showed an oxygen content in the tank of between 14.3 and 14.5%. The LEL reading was zero. A measurement of tank 7P carried out by the crew after a further 7.5 hours using a Dräger methyl bromide tube 0.2/a, returned a value of 0.1 ppm. The amount of nitrogen was not measured.

Because nitrogen had been added to cargo tank 7P while it was being loaded in Eastham, during the voyage and while the cargo was being discharged in Wilhelmshaven, there was a greater concentration of nitrogen in the tank than in normal, clean air. The AIBN sees no need to calculate the exact composition of the atmosphere in the tank at the time, but assumes that, immediately after discharging the cargo, the atmosphere in the tank probably consisted mainly of nitrogen and ethylene dichloride vapour. It is assumed that the oxygen content was virtually zero.

Once the cargo had been discharged, work on cleaning the tank was started. The bottom of cargo tank 7P was flushed with cold seawater for five minutes, and then cleaned with cold seawater for one hour. These are closed processes that do not effect the atmosphere in the tank.

When the pumpman entered the tank, the fan had been running for approximately five minutes, while it had been running for approximately ten minutes when the atmosphere was measured by the crew. If the oxygen content of the atmosphere had increased linearly, the tank would have contained approximately 7.2% oxygen when it was entered by the pumpman. However, the fan for ventilating the tank was mounted in the deck, and the air at the top of the tank will have been replaced first, gradually followed by the air further down. The AIBN therefore assumes that the oxygen content at the bottom of the tank was less than 7.2% at the time of the accident, and concludes that the low oxygen content could have caused the pumpman's death.

Since the oxygen content was low, the nitrogen content was probably correspondingly high. Nitrogen in itself is not toxic and, even though it was present in a high concentration, the nitrogen per se cannot have caused the death of the pumpman.

In addition to oxygen and nitrogen, the atmosphere at the bottom of the cargo tank probably contained some ethylene dichloride vapour at the time of the accident. The measurement carried out by the crew a further 7.5 hours after the accident, using a Dräger methyl bromide tube 0.2/a, returned a value of 0.1 ppm. Because ethylene dichloride is cross-sensitive to methyl bromide, the tube will have registered both substances. However, the AIBN assumes that the tube measured the content of ethylene dichloride and not methyl bromide. Unlike nitrogen, ethylene dichloride vapour is toxic when inhaled. Given the relatively low concentration of ethylene dichloride vapour (0.1 ppm) in relation to the threshold value for permitted concentration (50 ppm), the AIBN deems it highly improbable that the pumpman's death can have been caused by the presence of ethylene dichloride vapour. The argument would be the same had the tube measured the content of methyl bromide.

Based on the above considerations, the AIBN believes that the low oxygen content of cargo tank 7P was most probably the reason for the fatal outcome of the accident. The report from the medical team that examined the deceased person after arrival in Rotterdam also concluded that oxygen deprivation was the probable cause of the pumpman's death.

2.4 The safety management system – content and compliance

The shipping company's safety management system includes procedures for sampling of the cargo, use of inert gas and cleaning of cargo tanks, as well as procedures for entry of enclosed spaces, including entry of cargo tanks and entry of polluted spaces. Many of the procedures are supported by checklists for use on board.

The AIBN has considered the content of and compliance with the procedures most relevant to this specific accident.

2.4.1 Planning the work

According to the management system, a conference shall be held before the vessel arrives at the port of loading or port of discharge. Everyone involved in the upcoming loading/discharge operation shall participate in this so-called pre-arrival conference, which is led by the chief officer. Furthermore, meetings shall be held prior to each tank cleaning process in order to plan the work. The tank cleaning meeting shall also be led by the chief officer, and all crew members who are to participate in the work shall also participate in the meeting.

Prior to the accident on 4 February 2011, a pre-arrival conference and a tank cleaning meeting were held at 14:00 on 3 February and at 05:30 on 4 February, respectively. In addition to the chief officer, both the master and the pumpman were present at both these meetings. The deck crew, including the deckhand who stood watch when the accident occurred, did not participate in any of these meetings.

The AIBN consider these meetings to be very important to safety. It is important that everyone who is to take part in a work process on board knows what the work consists of and what precautions need to be taken. The pre-arrival conference and the meeting to plan the tank cleaning operation are therefore important barriers in relation to avoiding hazardous situations during execution of the work.

In the present case, both these meetings were held without everyone who was to take part in the work being present. Hence, the procedures in the safety management system were not complied with on this point.

2.4.2 Sampling of the cargo

The procedure for sampling the cargo alone is not deemed to constitute a barrier in relation to avoiding accidents. However, the procedure is of interest to the consideration of compliance with the management system. The procedure describes how sampling shall be carried out and how cargo samples shall be stored. By reference to the IBC code, it also states the types of cargo of which samples shall be taken. Sampling equipment is available on board, consisting of a steel tube attached to a steel measuring tape, see Figure 3. According to the procedure, sampling shall be logged on a prescribed form.

In connection with the loading of ethylene dichloride in Eastham, four samples were taken of manifold no 1. This was logged in accordance with the procedure. However, when cargo samples were to be taken from cargo tank 7P, the steel tube became stuck in the heating coils at the bottom of the tank and sampling was not completed for the voyage in question.

In the AIBN's view, the procedure for sampling the cargo was, in principle, followed during the voyage under consideration and that the management system was complied with on this point.

2.4.3 Use of inert gas

By way of introduction, the procedure for use of inert gas points out that many chemicals have properties requiring the oxygen in the tank to be replaced by nitrogen. The procedure explains why inert gas must be used, how it must be used and the precautions that must be taken. However, the procedure does not contain any information about what types of cargo require a nitrogen blanket. The AIBN believes that, on this point, the procedure should have referred to the IBC Code and the shipper's recommendations in the form of the MSDS.

According to the IBC Code and the MSDS, there are no special requirements for controlling the atmosphere in connection with the transport of ethylene dichloride. Even so, the cargo tanks holding ethylene dichloride were nevertheless inerted both during loading in Eastham, en route and in connection with discharging the cargo in Wilhelmshaven. Seen in isolation, this was not a problem. Nor can it be concluded that the safety management system was not complied with on this point, given that the procedure for use of inert gas does not contain any information about what types of cargo require a nitrogen blanket. However, in the AIBN's view, even if inerting was not a requirement, it is important to observe the procedures that apply to inerting of cargo tanks, whenever inert gas is used. For example, the form for logging nitrogen inerting was not used in connection with this carriage as prescribed by the management system. The form has the double function of controlling the operation and providing documentation of the operation. It is also important that a pre-arrival conference and tank cleaning meeting are held, so as to ensure that everyone participating in the work are aware of the fact that the tanks are inerted.

2.4.4 Cleaning and gas-freeing of cargo tanks

The procedure for cleaning and freeing the cargo tanks of gas state that the work shall be carried out safely and in accordance with the physical and chemical characteristics of the products carried. Laws and regulations, as well as applicable industrial standards, shall always be complied with.

The procedure stresses the importance of planning the cleaning operation on the basis of the type of cargo that has been discharged from the tanks and the type of cargo that will be loaded into the tanks, and the plan shall take account of any instructions from the shipping company and the shipper, the availability and condition of necessary equipment and the cleaning procedures to be followed. In the AIBN's opinion, the procedure for cleaning and gas-freeing of cargo tanks is satisfactory.

The AIBN's investigation also indicates that the procedure was complied with prior to the accident, and the cleaning operation that was in progress when the accident occurred was planned as prescribed by the safety management system. However, as mentioned in section 2.4.1 concerning the pre-arrival conference and the tank cleaning meeting, not everyone who was to participate in the tank cleaning process had participated in the planning.

2.4.5 Entering enclosed spaces

Entering encloses spaces in general, including entering cargo tanks and entering contaminated spaces, receives much attention in the safety management system. In principle, nobody must enter a cargo tank before the enclosed space entry permit checklist has been filled in. The entry permit for cargo tanks shall be signed by the vessel's master or chief officer, and the responsible officer / dedicated wach shall be present by the tank hatch. It is also made clear that entry of enclosed spaces shall be treated as a critical operation that requires a risk assessment to be carried out.

The AIBN considers that the procedures for entering enclosed spaces are satisfactory, but that the procedures were not complied with in connection with the accident. The checklist for entering enclosed spaces was not used, and a permit to enter the cargo tank was not obtained from the vessel's master or chief officer. No risk assessment was carried out and no control measurements were taken of the atmosphere in the tank.

2.5 Personal safety equipment – availability, maintenance and use

According to the procedure for entering enclosed spaces, the atmosphere in the tank should have been checked prior to entry. Equipment for checking the atmosphere was available on board, and the equipment could have been used to check the oxygen level and LEL. A Dräger methyl bromide tube was also available on board, which could have been used to check the content of ethylene dichloride. However, there was no tube for checking the concentration of nitrogen. According to the shipping company, the concentration of nitrogen is determined on the basis of the measured concentration of oxygen.

In addition to the fact that control measurements should have been carried out of the atmosphere in the tank, the pumpman should have been equipped with personal measuring equipment. Such equipment was available on board, but was not used in connection with the accident. If measurements are not carried out to verify that the atmosphere is safe, the management system requires the person entering the enclosed space to use a breathing apparatus and, if applicable, protective coveralls. Such equipment was available on board, but was not used in connection with the accident.

Both the pumpman and the deck crew member standing watch at the hatch when the accident occurred wore filter masks as prescribed by the safety management system for tank cleaning operations.

In the AIBN's opinion, the equipment required to carry out enclosed space operations in a safe and secure manner was available on board. In this case too, the problem lay in the practical operation, i.e. in the failure to use the equipment. In that connection, the AIBN also has doubts about the use of filter masks for this work. In practice, such masks protect against particles in the air, and also some toxic gases, but not against a low oxygen content. Filter masks can therefore give a feeling of false safety.

2.6 Training and transfer of experience

In principle, the vessel's crew have many opportunities to transfer knowledge and experience to each other. In addition to the shipping company's training and familiarisation programme for new employees, there is also a safety representative system on board. The working environment committee has monthly meetings that focus on safety on board. Monthly crew meeting are also held in which safety issues can be raised by everybody on board. In addition to the above, there is a requirement for holding pre-arrival conferences in which all those involved in the upcoming loading/discharge operation must participate. Before each tank cleaning process, all crew members who are to participate in the operation are also required to participate in a meeting.

In the AIBN's opinion, the shipping company has satisfactory arrangements for training and transfer of experience. The AIBN believes that the accident was not due to a lack of knowledge, but to lack of motivation and correct attitudes in relation to complying with the procedures in the management system.

2.7 The shipping company's follow-up after the accident

In the AIBN's opinion, the shipping company has followed up the accident in a good manner in accordance with the intentions of the ISM Code and the Norwegian Working Environment Regulations, in that it conducted an internal investigation to determine the underlying causes and in that it has implemented and plans to implement corrective actions.

3. CONCLUSION

The Accident Investigation Board Norway can sum up the investigation of the accident on board the Solstraum on 4 February 2011 by drawing the following conclusions:

- The pumpman probably intended to retrieve the equipment for sampling the cargo when the accident occurred.
- The AIBN finds that, at the time of the accident, the oxygen content at the bottom of the tank was probably below 7.2%. The nitrogen content was probably over

90%. In addition, the atmosphere at the bottom of the cargo tank contained some ethylene dichloride vapour at the time of the accident.

- Prior to the accident, the pumpman had not obtained permission to enter the tank, and a risk assessment had not been conducted. The atmosphere in the tank had not been checked and he did not use a breathing apparatus.
- The pumpman entered the tank wearing a filter mask. In the AIBN's opinion, filter masks can give a feeling of false safety in situations of this kind.
- Given that the atmosphere in the tank probably contained less than 7.2% oxygen and that a breathing apparatus was not used, the AIBN believes that the pumpman probably died as a result of oxygen deprivation. This is also supported by the report from the medical team that examined the deceased after the accident.
- In the AIBN's opinion, the pumpman, who had extensive experience, was familiar with the risks involved in entering the tank. He probably thought he would be able to climb down the ladder, retrieve the equipment and climb back up again without an oxygen supply.
- The deck crew member standing watch at the hatch when the accident occurred has told the AIBN that he understood that it was potentially dangerous to enter the tank, but that he could not have prevented the pumpman from entering the tank.
- In its investigation, the AIBN has not revealed any faults or deficiencies in those parts of the shipping company's safety management system that deal with matters of relevance to the accident.
- The AIBN believes that the accident was not due to a lack of knowledge, but to lack of motivation and correct attitudes in relation to complying with the procedures in the management system.
- The AIBN's investigation found that, on the voyage in question, procedures in the shipping company's management system were not complied with, neither in relation to the pre-arrival conference, the tank cleaning meeting, logging of nitrogen inerting, nor entering enclosed spaces. It therefore seems that non-compliance with the management system dis not only concern the deceased pumpman who entered the cargo tank without following the procedures for entering enclosed spaces.
- In the AIBN's opinion, the shipping company has followed up the accident in a good manner in accordance with the intentions of ISM Code and the Norwegian Working Environment HSE Regulations, in that it conducted an internal investigation to determine the underlying causes and in that it has implemented and plan to implement corrective actions.

4. SAFETY RECOMMENDATIONS

The investigation of this marine accident has not identified topics in addition to those the shipping company focused on in its own internal report and which will be followed up by corrective actions initiated by the shipping company itself. The AIBN therefore finds no need to propose safety recommendations in this report[33].

Accident Investigation Board Norway
Lillestrøm, 2 May 2012

[33] The investigation report is submitted to the Norwegian Ministry of Trade and Industry, which will take necessary action to ensure that due account is taken of the safety recommendations.

APPENDICES

APPENDIX A: RELEVANT ABBREVIATIONS

ASH	:	Working environment and health
DNV	:	Det norske Veritas
DOC	:	Document of Compliance
EIGA	:	European Industrial Gases Association
ETA	:	Estimated Time of Arrival
HSE	:	Health, safety and the environment
IMDG	:	International Maritime Dangerous Goods
IMO	:	International Maritime Organisation
ISM	:	International Safety Management
LEL	:	Lower Explosive Limit
NHD	:	Ministry of Trade and Industry
NIS	:	Norwegian International Ship Register
MSC	:	Maritime Safety Committee
DSDS	:	Mechanical Safety Data Sheet
PEC	:	Protection and Environment Committee
SAFIR	:	Safety Improvement Report
AIBN	:	Accident Investigation Board Norway
SMC	:	Safety Management Certificate
SMS	:	Document Management System
SSQM System	:	Safety, Security and Quality Management System
VHF	:	Very High Frequency

PRODUCT NAME: ETHYLENE DICHLORIDE

SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY/UNDERTAKING

Address/Phone No.:

INEOS Chlor Limited
Runcorn Site HQ
South Parade, PO Box 9
Runcorn, Cheshire, WA7 4JE
Tel : (01928) 561111, Fax : (01928) 516632

Emergency Phone No.:

IN AN EMERGENCY DIAL 999 (UK only)
For specialist advice in an emergency telephone Runcorn (01928) 572000

Use of Substance / Preparation:

Chemical intermediate
Specialised solvent.

2. COMPOSITION/INFORMATION ON INGREDIENTS

Alternative names : 1,2-Dichloroethane

EC INDEX No. 602-012-00-7

2.1 HAZARDOUS INGREDIENT(S)

Hazardous ingredient(s)	%(w/w)	CAS No.	EC No.	Symbol	R Phrases
1,2-Dichloroethane (Ethylene Dichloride)	>99	000107-06-2	203-458-1	F, T	R45 R11 R22 R36/37/38

3. HAZARDS IDENTIFICATION

EC Classification: HIGHLY FLAMMABLE AND TOXIC , EU Category 2 Carcinogen

HIGHLY FLAMMABLE

TOXIC

Hazards

Highly flammable.
May cause cancer.
High exposures by inhalation may produce anaesthetic effects. Very high exposures may cause an abnormal heart rhythm and prove suddenly fatal.
Harmful if swallowed. Irritating to eyes, respiratory system and skin. Can be absorbed through skin.
Repeated exposure to high levels may produce liver and kidney damage.

4. FIRST-AID MEASURES

Inhalation
Remove patient from exposure, keep warm and at rest. Administer oxygen if necessary. Apply artificial respiration if breathing has ceased or shows signs of failing.
Obtain immediate medical attention.

Skin Contact
Remove contaminated clothing. After contact with skin, wash immediately with plenty of water.
Obtain immediate medical attention.

Eye Contact
Immediately irrigate with eyewash solution or clean water, holding the eyelids apart, for at least 10 minutes.
Obtain immediate medical attention.

Ingestion
Do not induce vomiting. Provided the patient is conscious, wash out mouth with water and give 200-300 ml (half a pint) of water to drink.
Obtain immediate medical attention.

Further Medical Treatment
Symptomatic treatment and supportive therapy as indicated.
Adrenaline and similar sympathomimetic drugs should be avoided following exposure as cardiac arrhythmia may result with possible subsequent cardiac arrest.

5. FIRE-FIGHTING MEASURES

Highly flammable.
The gas is heavier than air and may travel a considerable distance to a source of ignition and flash back.
Take precautionary measures against static discharges.

Extinguishing Media	Water spray should be used to cool containers. For small fire, use foam, carbon dioxide or dry powder.
Fire Fighting Protective Equipment	A self contained breathing apparatus must be worn in fire conditions.

6. ACCIDENTAL RELEASE MEASURES

Eliminate sources of ignition. Ensure suitable personal protection during removal of spillages in a confined area. Contain spillages with sand, earth or any suitable adsorbent material. Do not adsorb onto sawdust or other combustible materials. Do not empty into drains. Transfer to a container for disposal or recovery. Allow small spillages to evaporate provided there is adequate ventilation. Spillages or uncontrolled discharges into watercourses must be alerted to the Environment Agency or other appropriate regulatory body.

7. HANDLING AND STORAGE

7.1 HANDLING
Avoid exposure. Obtain special instructions before use.
Wherever possible should be handled in high containment systems.
Do not breathe vapour. Avoid contact with skin and eyes.
Keep away from oxidising agents. Keep away from sources of ignition - No Smoking.
Take precautionary measures against static discharges.

7.2 STORAGE
Keep container tightly closed. Keep in a cool, well ventilated place. Keep away from heat and sources of ignition.
Protect from light.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Wear suitable protective clothing and eye/face protection.
Butyl rubber is better than PVC.
Gloves and protective clothing should be changed when permeation is likely.
Gloves and protective clothing should be changed if excessive exposure has occurred.
In case of insufficient ventilation, wear suitable respiratory equipment.
Atmospheric concentrations should be minimised and kept as low as reasonably practicable below the occupational exposure limit.

8.1 Occupational Exposure Limits

Hazardous ingredient(s)	CAS No.	LTEL 8 hr TWA ppm	LTEL 8 hr TWA mg/m3	STEL ppm	STEL mg/m3	Note:
1,2-Dichloroethane (Ethylene Dichloride)	000107-06-2	5	21	-	-	MEL Sk

9. PHYSICAL AND CHEMICAL PROPERTIES

These properties are the most relevant and no other properties are available.

Form	volatile oily liquid
Colour	clear colourless
Odour	slightly sweet
Odour Threshold (ppm)	40 approx
Boiling Point (Deg C)	83.5
Melting Point (Deg C)	-35.5
Flash Point (Deg C) [Closed cup].	13
Flammable Limits (Lower) (%v/v)	6.2
Flammable Limits (Upper) (%v/v)	16.2
Auto Ignition Temperature (Deg C)	413
Vapour Pressure (mm Hg)	64 at 20 Deg C
Density (g/ml)	1.26 at 20 Deg C
Solubility (Water)	slightly soluble
Solubility (Other)	miscible with chlorinated solvents , soluble in: organic solvents
Vapour Density (Air= 1)	3.35

10. STABILITY AND REACTIVITY

Hazardous Reactions	Keep away from strong oxidising agents and active metals. May react with strong alkalis to form chloracetylene which is very toxic and explosive.
Hazardous Decomposition Product(s)	toxic vapours of hydrogen chloride

11. TOXICOLOGICAL INFORMATION

Inhalation
High concentrations of vapour are irritant to the respiratory tract. High atmospheric concentrations may lead to nausea, headache, lightheadedness and drowsiness. May cause damage to liver and kidneys. Very high exposures may cause an abnormal heart rhythm and prove suddenly fatal.

Skin Contact
Irritating to skin. Will remove the natural greases resulting in dryness, cracking and dermatitis. Can be absorbed through skin. Repeated and/or prolonged skin contact with impregnated clothing may cause reddening, burning and blisters.

Eye Contact
Irritating to eyes. The vapour and liquid may be irritant. May cause severe eye irritation if not immediately irrigated.

Ingestion
Harmful if swallowed.
Will cause irritation of the gastrointestinal tract. May cause adverse effects similar to inhalation, resulting in circulatory failure which could prove fatal. Large doses may produce adverse effects on the liver and kidneys.

Long Term Exposure
Repeated exposure to low concentrations above the occupational exposure limit may produce adverse effects on the central nervous system, resulting in nausea, vomiting and damage to liver, kidney and adrenals.
May cause cancer.
Lifetime ingestion studies in animals have shown that repeated doses produce cancer in both rats and mice. However inhalation studies in animals exposed to comparable doses have shown no increased tumour incidence. None of these effects are likely to occur in humans, provided exposure is maintained at or below the occupational exposure limit.

12. ECOLOGICAL INFORMATION

Environmental Fate and Distribution
High tonnage material used in wholly contained systems.
Liquid with moderate volatility.
The product is sparingly soluble in water.
The product has no potential for bioaccumulation.

Persistence and Degradation
Generally non-persistent, but may persist in ground water.
The product evaporates rapidly from water into the atmosphere where it degrades rapidly to harmless breakdown products.
The product has no potential for global warming or the creation of photochemical oxidants.
Does not deplete ozone.

Toxicity
Low toxicity to aquatic organisms.

Effect on Effluent Treatment
Unlikely to have an effect on effluent treatment systems.

13. DISPOSAL CONSIDERATIONS

Disposal should be in accordance with local, state or national legislation.

14. TRANSPORT INFORMATION

UN No.	1184
UN Pack. Group	II
AIR	
ICAO/IATA	
: primary	3
: subsidiary 1	6.1
UN Packing group Air	II
SEA	
IMDG	
: primary	3
: subsidiary 1	6.1
U.N. Packing group Sea	II
Proper Shipping Name	ETHYLENE DICHLORIDE
Road/Rail	
ADR/RID Class	3
ADR Sin	1184

15. REGULATORY INFORMATION

Name & Address of Supplier:	INEOS Chlor Limited Runcorn Site HQ South Parade, PO Box 9 Runcorn, Cheshire, WA7 4JE Tel : (01928) 561111, Fax : (01928) 516632
Name of Substance or Preparation:	ETHYLENE DICHLORIDE
Hazard(s) and Symbol(s):	HIGHLY FLAMMABLE : F TOXIC : T
Risk Phrases	R45 May cause cancer. R11 Highly flammable. R22 Harmful if swallowed. R36/37/38 Irritating to eyes, respiratory system and skin.
Safety Phrases	For use in industrial installations only. S53 Avoid exposure. Obtain special instructions before use. S16 Keep away from sources of ignition - No Smoking. S29 Do not empty into drains. S45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
EC No.	203-458-1 EC Label
Special Restrictions:	Marketing and Use Directive (76/769/EEC) Carcinogens Directive (90/394/EEC as amended by 97/42/EC and 1999/38/EC) European Pollutant Emission Register (EPER). EU Decision 2000/479/EC. EU. Black List. Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment.
UK Control Regulations	Control of Substances Hazardous to Health Regulations (COSHH) 1999 SI 1999/437 and COSHH essentials: Easy steps to control chemicals - Control of Substances Hazardous to Health Regulations HSG193.

16. OTHER INFORMATION

This data sheet was prepared in accordance with Directive 2001/58/EC

The following sections contain revisions or new statements: 1,2,3,9,14,15,16

In the EU; this product cannot be placed on the market for sale to the general public and/or in diffusive applications such as in surface cleaning and cleaning of fabrics with the exception of medical,veterinary and cosmetic products (as defined by EU) and for purposes of research and development or for purpose of analysis.

Information in this publication is believed to be accurate and is given in good faith, but it is for the Customer to satisfy itself of the suitability for its own particular purpose. Accordingly, Ineos Chlor Limited gives no warranty as to the fitness of the Product for any particular purpose and any implied warranty or condition (statutory or otherwise) is excluded except to the extent that such exclusion is prevented by law. Freedom under Patent, Copyright and Designs cannot be assumed.

Glossary

OES : Occupational Exposure Standard (UK HSE EH40)
MEL : Maximum Exposure Limit (UK HSE EH40)
COM : The company aims to control exposure in its workplace to this limit
TLV : The company aims to control exposure in its workplace to the ACGIH limit
TLV-C: The company aims to control exposure in its workplace to the ACGIH Ceiling limit
MAK : The company aims to control exposure in its workplace to the German limit
Sk : Can be absorbed through skin
Sen : Capable of causing respiratory sensitisation
Bmgv : Biological monitoring guidance value (UK HSE EH40)
ILV : Indicative Limit Value (UK HSE EH40)
IOELV : Indicative Occupational Exposure Limit Value

INTERNATIONAL MARITIME ORGANIZATION

IMO

E

A 20/Res.864
5 December 1997
Original: ENGLISH

ASSEMBLY
20th session
Agenda item 9

RESOLUTION A.864(20)
adopted on 27 November 1997

RECOMMENDATIONS FOR ENTERING ENCLOSED SPACES ABOARD SHIPS

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

BEING CONCERNED at the continued loss of life resulting from personnel entering shipboard spaces in which the atmosphere is oxygen-depleted, toxic or flammable,

BEING AWARE of the work undertaken in this regard by the International Labour Organization, Governments and segments of the private sector,

NOTING that the Maritime Safety Committee, at its fifty-ninth session, approved appendix F to the Code of Safe Practice for Solid Bulk Cargoes concerning recommendations for entering cargo spaces, tanks, pump-rooms, fuel tanks, cofferdams, duct keels, ballast tanks and similar enclosed spaces,

NOTING FURTHER the decision of the Maritime Safety Committee at its sixty-sixth session to replace appendix F referred to above with the recommendations annexed to this resolution,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its sixty-sixth session,

1. ADOPTS the Recommendations for Entering Enclosed Spaces Aboard Ships set out in the Annex to the present resolution;

2. INVITES Governments to bring the annexed Recommendations to the attention of shipowners, ship operators and seafarers, urging them to apply the Recommendations, as appropriate, to all ships;

3. REQUESTS the Maritime Safety Committee to keep the Recommendations under review and amend them, as necessary.

ANNEX

RECOMMENDATIONS FOR ENTERING ENCLOSED SPACES ABOARD SHIPS

PREAMBLE

The object of these recommendations is to encourage the adoption of safety procedures aimed at preventing casualties to ships personnel entering enclosed spaces where there may be an oxygen deficient, flammable and/or toxic atmosphere.

Investigations into the circumstances of casualties that have occurred have shown that accidents on board ships are in most cases caused by an insufficient knowledge of, or disregard for, the need to take precautions rather than a lack of guidance.

The following practical recommendations apply to all types of ships and provide guidance to seafarers. It should be noted that on ships where entry into enclosed spaces may be infrequent, for example, on certain passenger ships or small general cargo ships, the dangers may be less apparent, and accordingly there may be a need for increased vigilance.

The recommendations are intended to complement national laws or regulations, accepted standards or particular procedures which may exist for specific trades, ships or types of shipping operations.

It may be impracticable to apply some recommendations to particular situations. In such cases, every endeavour should be made to observe the intent of the recommendations, and attention should be paid to the risks that may be involved.

1 INTRODUCTION

The atmosphere in any enclosed space may be deficient in oxygen and/or contain flammable and/or toxic gases or vapours. Such an unsafe atmosphere could also subsequently occur in a space previously found to be safe. Unsafe atmosphere may also be present in spaces adjacent to those spaces where a hazard is known to be present.

2 DEFINITIONS

2.1 *Enclosed space* means a space which has any of the following characteristics:

.1 limited openings for entry and exit;

.2 unfavourable natural ventilation; and

.3 is not designed for continuous worker occupancy,

and includes, but is not limited to, cargo spaces, double bottoms, fuel tanks, ballast tanks, pump-rooms, compressor rooms, cofferdams, void spaces, duct keels, inter-barrier spaces, engine crankcases and sewage tanks.

2.2 *Competent person* means a person with sufficient theoretical knowledge and practical experience to make an informed assessment of the likelihood of a dangerous atmosphere being present or subsequently arising in the space.

2.3 *Responsible person* means a person authorised to permit entry into an enclosed space and having sufficient knowledge of the procedures to be followed.

3 ASSESSMENT OF RISK

3.1 In order to ensure safety, a competent person should always make a preliminary assessment of any potential hazards in the space to be entered, taking into account previous cargo carried, ventilation of the space, coating of the space and other relevant factors. The competent person's preliminary assessment should determine the potential for the presence of an oxygen-deficient, flammable or toxic atmosphere.

3.2 The procedures to be followed for testing the atmosphere in the space and for entry should be decided on the basis of the preliminary assessment. These will depend on whether the preliminary assessment shows that:

.1 there is minimal risk to the health or life of personnel entering the space;

.2 there is no immediate risk to health or life but a risk could arise during the course of work in the space; and

.3 a risk to health or life is identified.

3.3 Where the preliminary assessment indicates minimal risk to health or life or potential for a risk to arise during the course of work in the space, the precautions described in 4, 5, 6 and 7 should be followed as appropriate.

3.4 Where the preliminary assessment identifies risk to life or health, if entry is to be made, the additional precautions specified in section 8 should also be followed.

4 AUTHORIZATION OF ENTRY

4.1 No person should open or enter an enclosed space unless authorised by the master or nominated responsible person and unless the appropriate safety procedures laid down for the particular ship have been followed.

4.2 Entry into enclosed spaces should be planned and the use of an entry permit system, which may include the use of a checklist, is recommended. An Enclosed Space Entry Permit should be issued by the master or nominated responsible person, and completed by a person who enters the space prior to entry. An example of the Enclosed Space Entry Permit is provided in the appendix.

5 GENERAL PRECAUTIONS

5.1 The master or responsible person should determine that it is safe to enter an enclosed space by ensuring:

.1 that potential hazards have been identified in the assessment and as far as possible isolated or made safe;

.2 that the space has been thoroughly ventilated by natural or mechanical means to remove any toxic or flammable gases, and to ensure an adequate level of oxygen throughout the space;

.3 that the atmosphere of the space has been tested as appropriate with properly calibrated instruments to ascertain acceptable levels of oxygen and acceptable levels of flammable or toxic vapours;

.4 that the space has been secured for entry and properly illuminated;

.5 that a suitable system of communication between all parties for use during entry has been agreed and tested;

.6 that an attendant has been instructed to remain at the entrance to the space whilst it is occupied;

.7 that rescue and resuscitation equipment has been positioned ready for use at the entrance to the space, and that rescue arrangements have been agreed;

.8 that personnel are properly clothed and equipped for the entry and subsequent tasks; and

.9 that a permit has been issued authorizing entry.

The precautions in .6 and .7 may not apply to every situation described in this section. The person authorizing entry should determine whether an attendant and the positioning of rescue equipment at the entrance to the space is necessary.

5.2 Only trained personnel should be assigned the duties of entering, functioning as attendants, or functioning as members of rescue teams. Ships' crews should be drilled periodically in rescue and first aid.

5.3 All equipment used in connection with entry should be in good working condition and inspected prior to use.

6 TESTING THE ATMOSPHERE

6.1 Appropriate testing of the atmosphere of a space should be carried out with properly calibrated equipment by persons trained in the use of the equipment. The manufacturers' instructions should be strictly followed. Testing should be carried out before any person enters the space, and at regular intervals thereafter until all work is completed. Where appropriate, the testing of the space should be carried out at as many different levels as is necessary to obtain a representative sample of the atmosphere in the space.

6.2 For entry purposes, steady readings of the following should be obtained:

.1 21% oxygen by volume by oxygen content meter; and

.2 not more than 1% of lower flammable limit (LFL) on a suitably sensitive combustible gas indicator, where the preliminary assessment has determined that there is potential for flammable gases or vapours.

If these conditions cannot be met, additional ventilation should be applied to the space and re-testing should be conducted after a suitable interval. Any gas testing should be carried out with ventilation to the enclosed space stopped, in order to obtain accurate readings.

6.3 Where the preliminary assessment has determined that there is potential for the presence of toxic gases and vapours, appropriate testing should be carried out using fixed or portable gas or vapour detection equipment. The readings obtained by this equipment should be below the occupational exposure limits for the toxic gases or vapours given in accepted national or international standards. It should be noted that testing for flammability does not provide a suitable means of measuring for toxicity, nor vice versa.

6.4 It should be emphasized that pockets of gas or oxygen-deficient areas can exist, and should always be suspected, even when an enclosed space has been satisfactorily tested as being suitable for entry.

7 PRECAUTIONS DURING ENTRY

7.1 The atmosphere should be tested frequently whilst the space is occupied, and persons should be instructed to leave the space should there be a deterioration in the conditions.

7.2 Ventilation should continue during the period that the space is occupied and during temporary breaks. Before re-entry after a break, the atmosphere should be re-tested. In the event of failure of the ventilation system, any persons in the space should leave immediately.

7.3 In the event of an emergency, under no circumstances should the attending crew member enter the space before help has arrived and the situation has been evaluated to ensure the safety of those entering the space to undertake rescue operations.

8 ADDITIONAL PRECAUTIONS FOR ENTRY INTO A SPACE WHERE THE ATMOSPHERE IS KNOWN OR SUSPECTED TO BE UNSAFE

8.1 If the atmosphere in an enclosed space is suspected or known to be unsafe, the space should only be entered when no practical alternative exists. Entry should only be made for further testing, essential operation, safety of life or safety of a ship. The number of persons entering the space should be the minimum compatible with the work to be performed.

8.2 Suitable breathing apparatus, e.g. of the air-line or self-contained type, should always be worn, and only personnel trained in its use should be allowed to enter the space. Air-purifying respirators should not be used as they do not provide a supply of clean air from a source independent of the atmosphere within the space.

8.3 The precautions specified in 5 should also be followed, as appropriate.

8.4 Rescue harnesses should be worn and, unless impractical, lifelines should be used.

8.5 Appropriate protective clothing should be worn particularly where there is any risk of toxic substances or chemicals coming into contact with the skin or eyes of those entering the space.

8.6 The advice in 7.3 concerning emergency rescue operations is particularly relevant in this context.

9 HAZARDS RELATED TO SPECIFIC TYPES OF CARGO

9.1 Dangerous goods in packaged form

9.1.1 The atmosphere of any space containing dangerous goods may put at risk the health or life of any person entering it. Dangers may include flammable, toxic or corrosive gases or vapours that displace oxygen, residues on packages and spilled material. The same hazards may be present in spaces adjacent to the cargo spaces. Information on the hazards of specific substances is contained in the IMDG Code, the Emergency Procedures for Ships Carrying Dangerous Goods (EMS) and Materials Safety Data Sheets (MSDS). If there is evidence or suspicion that leakage of dangerous substances has occurred, the precautions specified in 8 should be followed.

9.1.2 Personnel required to deal with spillages or to remove defective or damaged packages should be appropriately trained and wear suitable breathing apparatus and appropriate protective clothing.

9.2 Bulk liquid

The tanker industry has produced extensive advice to operators and crews of ships engaged in the bulk carriage of oil, chemicals and liquefied gases, in the form of specialist international safety guides. Information in the guides on enclosed space entry amplifies these recommendations and should be used as the basis for preparing entry plans.

9.3 Solid bulk

On ships carrying solid bulk cargoes, dangerous atmospheres may develop in cargo spaces and adjacent spaces. The dangers may include flammability, toxicity, oxygen depletion or self-heating, which should be identified in shipping documentation. For additional information, reference should be made to the Code of Safe Practice for Solid Bulk Cargoes.

9.4 Oxygen-depleting cargoes and materials

A prominent risk with such cargoes is oxygen depletion due to the inherent form of the cargo, for example, self-heating, oxidation of metals and ores or decomposition of vegetable oils, animal fats, grain and other organic materials or their residues. The materials listed below are known to be capable of causing oxygen depletion. However, the list is not exhaustive. Oxygen depletion may also be caused by other materials of vegetable or animal origin, by flammable or spontaneously combustible materials, and by materials with a high metal content:

.1 grain, grain products and residues from grain processing (such as bran, crushed grain, crushed malt or meal), hops, malt husks and spent malt;

.2 oilseeds as well as products and residues from oilseeds (such as seed expellers, seed cake, oil cake and meal);

.3 copra;

.4 wood in such forms as packaged timber, roundwood, logs, pulpwood, props (pit props and other propwood), woodchips, woodshavings, woodpulp pellets and sawdust;

.5 jute, hemp, flax, sisal, kapok, cotton and other vegetable fibres (such as esparto grass/Spanish grass, hay, straw, bhusa), empty bags, cotton waste, animal fibres, animal and vegetable fabric, wool waste and rags;

.6 fishmeal and fishscrap;

.7 guano;

.8 sulphidic ores and ore concentrates;

.9 charcoal, coal and coal products;

.10 direct reduced iron (DRI)

.11 dry ice;

.12 metal wastes and chips, iron swarf, steel and other turnings, borings, drillings, shavings, filings and cuttings; and

.13 scrap metal.

9.5 Fumigation

When a ship is fumigated, the detailed recommendations contained in the Recommendations on the Safe Use of Pesticides in Ships* should be followed. Spaces adjacent to fumigated spaces should be treated as if fumigated.

10 CONCLUSION

Failure to observe simple procedures can lead to people being unexpectedly overcome when entering enclosed spaces. Observance of the principles outlined above will form a reliable basis for assessing risks in such spaces and for taking necessary precautions.

*Refer to the Recommendations on Safe Use of Pesticides in Ships, approved by the Maritime Safety Committee of the Organization by circular MSC/Circ.612, as amended by MSC/Circ.689 and MSC/Circ.746.

APPENDIX

EXAMPLE OF AN ENCLOSED SPACE ENTRY PERMIT

This permit relates to entry into any enclosed space and should be completed by the master or responsible officer and by the person entering the space or authorized team leader.

General

Location/name of enclosed space...

Reason for entry...

This permit is valid from:................hrs Date..................

to :................hrs Date...................

(See note 1)

Section 1 - Pre-entry preparation

(To be checked by the master or nominated responsible person)

	Yes	No
● Has the space been thoroughly ventilated ?	❒	❒
● Has the space been segregated by blanking off or isolating all connecting pipelines or valves and electrical power/equipment ?	❒	❒
● Has the space been cleaned where necessary ?	❒	❒
● Has the space been tested and found safe for entry ? (See note 2)	❒	❒

● Pre-entry atmosphere test readings:

- oxygen.......................% vol (21%) By:....................
- hydrocarbon.............% LFL (less than 1%)
- toxic gases.................ppm (specific gas and PEL) Time:................

(See note 3)

	Yes	No
● 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 ?	❒	❒

	Yes	No
● Is rescue and resuscitation equipment available for immediate use by the entrance to the space ?	❒	❒
● Has a responsible person been designated to be in constant attendance at the entrance to the space?	❒	❒
● Has the officer of the watch (bridge, engine room, cargo control room) been advised of the planned entry ?	❒	❒
● 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 all equipment used in good working condition and inspected prior to entry ?	❒	❒
● Are personnel properly clothed and equipped ?	❒	❒

Section 2 - Pre-entry checks

(To be checked by the person entering the space or authorized team leader)

	Yes	No
● I have received instructions or permission from the master or nominated responsible person to enter the enclosed space	❒	❒
● Section 1 of this permit has been satisfactorily completed by the master or nominated responsible person	❒	❒
● I have agreed and understand the communication procedures	❒	❒
● I have agreed upon a reporting interval of.......................minutes	❒	❒
● Emergency and evacuation procedures have been agreed and are understood	❒	❒
● **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**	❒	❒

Section 3 - Breathing apparatus and other equipment
(To be checked jointly by the master or nominated responsible person and the person who is to enter the space)

	Yes	No
● Those entering the space are familiar with the breathing apparatus to be used	❒	❒
● The breathing apparatus has been tested as follows:		
- gauge and capacity of air supply	....	
- low pressure audible alarm	....	
- face mask - under positive pressure and not leaking	....	
● The means of communication has been tested and emergency signals agreed	❒	❒
● All personnel entering the space have been provided with rescue harnesses and, where practicable, lifelines	❒	❒

Signed upon completion of sections 1,2 and 3 by:

Master or nominated responsible person..................... Date................. Time...............

Responsible person supervising entry .... Date.................. Time...............

Person entering the space or
authorized team leader .... Date.................. Time...............

Section 4 - Personnel entry
(To be completed by the responsible person supervising entry)

Names	Time in	Time out
....	....	....
....	....	....
....	....	....
....	....	....

Section 5 - Completion of job
(To be completed by the responsible person supervising entry)

● Job completed Date.......................... Time......................

● Space secured against entry Date............................ Time.......................

● The officer of the watch has been duly informed Date.............................
Time.........................

Signed upon completion of sections 4 and 5 by:

Responsible person supervising entry .... Date................... Time................

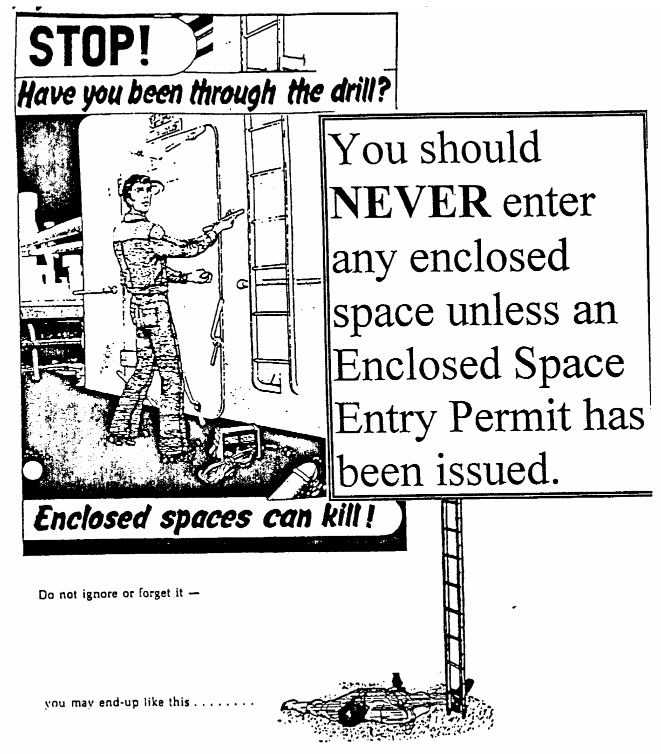
THIS PERMIT IS RENDERED INVALID SHOULD VENTILATION OF THE SPACE STOP OR IF ANY OF THE CONDITIONS NOTED IN THE CHECKLIST CHANGE

Notes:

1 The permit should contain a clear indication as to its maximum period of validity.

2 In order to obtain a representative cross-section of the space's atmosphere, samples should be taken from several levels and through as many openings as possible. Ventilation should be stopped for about 10 minutes before the pre-entry atmosphere tests are taken.

3 Tests for specific toxic contaminants, such as benzene or hydrogen sulphide, should be undertaken depending on the nature of the previous contents of the space.


STOP!
Have you been through the drill?
You should **NEVER** enter any enclosed space unless an Enclosed Space Entry Permit has been issued.
Enclosed spaces can kill!
Do not ignore or forget it —
you may end-up like this ....

____