

Report on the investigation of the death by asphyxiation of  
two crewmen on board

***Sava Lake***

approaching Dover Strait on

18 January 2008



Maritime Administration of Latvia,  
Division for Investigation of Marine Accidents  
5 Trijadibas Street  
Riga  
LV-1048

**MAIB**

Marine Accident Investigation Branch  
Carlton House  
Carlton Place  
Southampton  
United Kingdom  
SO15 2DZ

**Report No 15/2008  
September 2008**

Pursuant to the International Maritime Organization's 'Code for the Investigation of Marine Casualties', the UK Marine Accident Investigation Branch (MAIB) has taken the role of lead investigating body in this joint investigation with the Maritime Administration of Latvia.

Throughout the investigation, MAIB has enjoyed the full cooperation of the Maritime Administration of Latvia.

**Extract from**  
**The United Kingdom Merchant Shipping**  
**(Accident Reporting and Investigation)**  
**Regulations 2005 – Regulation 5:**

*"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."*

**NOTE**

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

Further printed copies can be obtained via our postal address, or alternatively by:

Email: [maib@dft.gsi.gov.uk](mailto:maib@dft.gsi.gov.uk)

Tel: 023 8039 5500

Fax: 023 8023 2459

All reports can also be found at our website:

[www.maib.gov.uk](http://www.maib.gov.uk)

# CONTENTS

	Page
<b>GLOSSARY OF ABBREVIATIONS AND ACRONYMS</b>	
<b>SYNOPSIS</b>	<b>1</b>
<b>SECTION 1 - FACTUAL INFORMATION</b>	<b>2</b>
1.1 Particulars of <i>Sava Lake</i> and accident	2
1.2 Background	3
1.2.1 Sava Lake	3
1.2.2 Trading pattern	3
1.2.3 Steel turnings	3
1.2.4 Manning	3
1.3 Narrative	3
1.3.1 Pre-loading	3
1.3.2 Cargo loading at Copenhagen	6
1.3.3 Cargo loading at Horsens	6
1.3.4 The voyage	9
1.4 The search for the missing men	13
1.4.1 The search	13
1.4.2 Actions on finding the men	14
1.5 Post-accident	15
1.5.1 Diversion	15
1.6 The owner / manager	16
1.7 Parties involved in cargo fixing	16
1.7.1 Time charterer	16
1.7.2 Time charterer's broker	18
1.7.3 The shipper	18
1.7.4 The ship broker	18
1.7.5 The cargo intermediary	18
1.7.6 Cargo agents	18
1.7.7 Terminal operators	18
1.8 Crew	18
1.8.1 Employment of the crew	18
1.8.2 Crew working routine	18
1.9 The forward store	19
1.9.1 Configuration and contents	19
1.9.2 Ventilation	21
1.10 Cargo hold ventilation	23
1.10.1 Cargo hold ventilation system	23
1.10.2 Cutting of the ventilation bellows	23
1.10.3 Planned maintenance	28
1.11 Regulation	28
1.11.1 IMO	28
1.11.2 Documentation requirements	28
1.12 Cargo documentation	29
1.12.1 Mate's Receipt	29
1.12.2 Bill of Lading	29
1.12.3 Classification Society - Document of Compliance – Special Requirements for Ships Carrying Dangerous Goods	29
1.13 Findings related to cause of death	30
1.13.1 Oxygen within the hold	30
1.13.2 Postmortem	30
1.13.3 The physiological effects of reduced oxygen	30
1.13.4 Other noxious gasses	31
1.14 Enclosed space entry	31
1.14.1 Procedures	31
1.14.2 Atmosphere test equipment	31

<b>SECTION 2 - ANALYSIS</b>	<b>32</b>
2.1 Aim	32
2.2 The accident	32
2.3 The ventilation system	32
2.3.1 Design	32
2.3.2 Ventilation system maintenance	33
2.3.3 Class approval and certification	33
2.4 The cargo	33
2.4.1 Ferrous metal turnings	33
2.4.2 European “steel turnings” exports	33
2.5 Terminal operations	35
2.6 Cargo documentation	35
2.7 Communication of cargo details to the master	35
2.8 Enclosed space entry	37
2.8.1 Onboard procedures	37
2.8.2 Ship familiarisation	37
2.8.3 Emergency response	38
2.9 Coastal and short sea trades	38
2.10 Fatigue	38
2.11 Similar accidents	38
<b>SECTION 3 - CONCLUSIONS</b>	<b>40</b>
3.1 Safety issues directly contributing to the accident which have resulted in recommendations	40
3.2 Other safety issues identified during the investigation also leading to recommendations	40
3.3 Safety issues identified during the investigation which have not resulted in recommendations but have been addressed	40
<b>SECTION 4 - ACTION TAKEN</b>	<b>41</b>
<b>SECTION 5 - RECOMMENDATIONS</b>	<b>42</b>
<b>Annex 1</b> - BIMCO steel turnings clause	
<b>Annex 2</b> - SOLAS Chapter VII, Part A-1, Regulation 7-3	
<b>Annex 3</b> - Extract from IMDG Code	
<b>Annex 4</b> - Extract from the BC Code	
<b>Annex 5</b> - Appendix 7 from the BC Code	
<b>Annex 6</b> - MAIB Safety Bulletin	
<b>Annex 7</b> - Adolph Andersens Succr new procedures	
<b>Annex 8</b> - Stena Jern & Metal A/S new procedures	
<b>Annex 9</b> - MAIB Safety Flyer	

## **GLOSSARY OF ABBREVIATIONS AND ACRONYMS**

AB	-	Able Bodied Seaman
BC Code	-	Code of Safe Practice for Solid Bulk Cargoes, 2004
BCSN	-	Bulk Cargo Shipping Name
BIMCO	-	Baltic and International Maritime Council
CHB	-	Cargoes Hazardous only in Bulk
COHb	-	Carboxyhemoglobin
CO	-	Carbon Monoxide
CO <sub>2</sub>	-	Carbon Dioxide
DNV	-	Classification Society Det Norske Veritas
DoC	-	Document of Compliance – Special Requirement for Ships Carrying Dangerous Goods
Gearless	-	Without cranes or gantries for self load or discharge
ICHCA	-	International Cargo Handling and Coordination Association
IMDG Code	-	International Maritime Dangerous Goods Code, 2004
IMO	-	International Maritime Organization
Kopervik	-	Kopervik Ship Invest A/S
kW	-	Kilowatt
Liepajas	-	Liepajas Juras Birojs Ltd, the ship manager. Where the ship owner, Liepaja Shipping Company, is mentioned their name is used in full.
m	-	Metres
MAIIF	-	Marine Accident Investigators' International Forum
MHB	-	Materials Hazardous only in Bulk
SCBA	-	Self Contained Breathing Apparatus
SMS	-	Safety Management System
Stena	-	Stena Jern & Metal A/S
Swarf	-	Ferrous metal turnings in a finely divided form
t	-	Tonnes
UHF	-	Ultra High Frequency
UN	-	The United Nations

**All times used in this report are UTC +2 hours unless otherwise stated**



Sava Lake

## SYNOPSIS



On 18 January 2008, the Latvian registered cargo vessel *Sava Lake* was proceeding towards the Dover Strait when it was discovered that two of the vessel's able seamen were missing. During a search of the vessel, the bodies of the two missing crew were found at the bottom of the access ladder inside the forward store. The deaths were reported to the UK authorities, and *Sava Lake* diverted to Dover, where an investigation into the causes and circumstances of the accident was commenced by the MAIB in cooperation with the Maritime Administration of Latvia.

*Sava Lake* had loaded parcels of "steel turnings" in Copenhagen and Horsens, Denmark, before sailing for Leixoes, Portugal on 15 January. Prior to loading, the master of *Sava Lake* had received conflicting information about the properties of the intended cargo. Notwithstanding this uncertainty, the master accepted the cargo, which was in fact an IMDG Code Class 4.2 material, *ferrous metal turnings*. This type of cargo is liable to self-heat, and can therefore reduce the levels of oxygen within the cargo hold. Documentation held on board the vessel specifically prohibited *Sava Lake* from carrying this type of cargo.

The investigation found that:

- To clear the cargo hold ventilation trunking of any build up of cargo residues from the hold, or sea water from the deck ventilator, an earlier crew had cut the flexible bellow pieces that were fitted adjacent to the ventilation fan. This created a direct air path from the cargo hold into the forward store.
- Air in the hold, with oxygen levels of around 6% by volume, almost certainly migrated into the forward store, leading to the asphyxiation of the two ABs when they entered the unventilated space. The reason why the two men entered the forward store, without the knowledge of the vessel's senior officers, could not be established.
- Notwithstanding the nature of the cargo stowed in the adjacent hold, the ship's staff did not consider the forward store to be an enclosed space, therefore no precautions were taken before the store was entered.

Following the accident, brokers and shippers involved in the fixture of *Sava Lake*'s cargo introduced measures to ensure that information and cargo handling procedures required by the BC Code are closely adhered to in the future.

The MAIB has promulgated a flyer to industry in order to highlight the safety lessons that have been identified during the investigation. Additionally, recommendations have been made to the managers of *Sava Lake* which are designed to: produce improvements to the design of the vessel's cargo ventilation system; improve awareness of the cargo carriage restrictions imposed by the Dangerous Cargo certification issued to its fleet; and improve company procedures covering the identification and entry into enclosed spaces.

Recommendations have also been made to specific maritime and trade associations designed to ensure that hazardous or potentially hazardous cargoes are properly identified and described in cargo documentation.

## **SECTION 1 - FACTUAL INFORMATION**

### **1.1 PARTICULARS OF SAVA LAKE AND ACCIDENT**

#### **Vessel details**

Registered owner	:	Liepaja Shipping Company
Manager(s)	:	Liepajas Juras Birojs Ltd
Time charterer	:	Kopervik Shipping A/S
Port of registry	:	Liepaja
Flag	:	Latvia
Type	:	Gearless, dry cargo
Built	:	July 1990
Classification society	:	Det Norske Veritas
Construction	:	Steel
Length overall	:	74.65m
Gross tonnage	:	2030
Engine power and/or type	:	1475kW
Service speed	:	10.4 knots loaded / 11.5 knots ballast
Other relevant info	:	Bow thrusters

#### **Accident details**

Time and date	:	Between 1000 and 1900 ship's time, 18 January 2008
Location of incident	:	In, or approaching, the SW Traffic lane of the English Channel
Persons on board	:	Seven
Injuries/fatalities	:	Two fatalities
Damage	:	No damage



## 1.2 BACKGROUND

### 1.2.1 *Sava Lake*

Built in 1990, *Sava Lake* was a 3146t deadweight, gearless, single hold general cargo vessel. At the time of the accident, the hold was not subdivided by the two full, or four half height bulkheads, stowed at the forward and aft ends of the hold. *Sava Lake*'s hold contained a cargo of "steel turnings" which had been loaded in Copenhagen and Horsens, Denmark on 14 January and 15 January respectively.

### 1.2.2 Trading pattern

The charter party limited the vessel's trading area to "trading full European trade, including Iceland, Azores, Canary Islands, North Africa not south of Dakar, Black Sea, Baltic, White Sea in Season".

*Sava Lake* mainly traded on the tramp market<sup>1</sup> throughout Europe and North Africa. Previous cargoes had included, for example, stone, sunflower seed and mechanical cranes.

### 1.2.3 Steel turnings

Steel turnings are produced by the machining, turning, milling and drilling of steel. Steel turnings are liable to self-heat and ignite spontaneously, particularly when in a finely divided form, wet, or contaminated with such materials as unsaturated cutting oil, oily rags and other combustible material.

The Bulk Cargo Shipping Name (BCSN) for steel turnings is *Ferrous Metal, Borings, Shavings, Turnings or Cuttings UN2793 in a form liable to self heating*.

### 1.2.4 Manning

*Sava Lake* was issued with a minimum safe manning certificate for seven crew, and was manned to that level. The crew consisted of: master, chief officer, chief engineer, watch engineer, two ABs and an ordinary seaman / cook.

## 1.3 NARRATIVE

### 1.3.1 Pre-loading

The cargo of steel turnings was sold by Stena Jern & Metal A/S (Stena) via an intermediary for recycling at a smelting plant in Leixoes, Portugal. On 10 January 2007, Stena's ship broker, Adolph Andersens Succr., fixed the charter of *Sava Lake* from the time charterer's broker, Hoyergruppen AS. Adolph Andersens Succr.'s broker forwarded the terms of the charter to Hoyergruppen AS and, recognising that the cargo of steel turnings was an IMDG Code Class 4.2 cargo, also sent them the BIMCO steel turnings clause (**Annex 1**). Adolph Andersen Succr. advised the Stena terminals at Copenhagen and Horsens of the fixture and appointed a cargo agent at each port, sending them both the draft Bill of Lading for the cargo (**Figure 1**).

On 10 January 2008, *Sava Lake*'s master received a telex from Hoyergruppen AS which provided details of the next voyage. The telex (**Figure 2**) advised that he should load a single grade of *Turnings, IMO 4.2* cargo in Horsens (2250t) and Copenhagen (600t). The order of loading was to be, preferably, Copenhagen on Saturday 14 January and Horsens the following day. The master did not consult the ship's copy

---

<sup>1</sup> Where ship owners scan the market for suitable cargo on a voyage by voyage basis.

Figure 1

Stena Jern + Metal A/S, Nordhavnsvej 16, DK – 4600 Koege Denmark		
To Order of S N Maia, Siderurgia Nacional, S.A. 4425-514 S. Pedro Fins, Maia		
		COPY
Navex – Empresa Portuguesa de Navegacao S.A. Rua de Vareiro, 19 – Leca de Palmira, 4450-799 Matosinhos Portugal		
M/V = SAVA LAKE =    Horsens / Copenhagen Leixoes		R4: Recycling / Reclamation of metals and metal compounds
Steel Turnings		kilos
Sucata de Limalha		
GA 430 Iron and Steel Scrap (100%)		
C/P dated 10-01-08		
As per C/P		Copenhagen
3 / Three		Master

Draft Bill of Lading

Figure 2

From: George Hammond p. l. c. To: 0037167062157

---

Receive Message

Message No. : R0080110.001  
 Message Ref. No. : 00785230  
 LES : Telenor S.S.Inc  
 Priority : Normal  
 Message Size : 1137 characters  
 Receive Date & Time : 08-01-10 16:55(UTC)

Elk LES 10-JAN-2008 16:53:02 785230

Subject: voyageorder for Savo Lake voy 2/08; 2DK/ Leixoes  
 From: Sabine Paschedag <sabine.paschedag@hoyergruppen.com>

Dear capt. Leonov,

as per telcon have now fixed next voyage as follows:

c/p dated 10.1.2008

- f/c cargo of turnings imo 4.2.- one grade
- Horsens 2250 mt +Copenhagen 600 mt (reverting with rotation) / Leixoes
- l/c 14.1., but chrts now try to load sat in Copenhagen and sunday in Horsens
- 24+24/ 1000 mt disch

agent Horsens:

---

EP Spedition  
 Ove Jensens Alle 54  
 DK 8700 Horsens

tel: +45 75616766  
 fax: +45 75616768  
 mail: ep@spedition.dk

agent Copenhagen

---

Adolph Andersen; Branch office Copenhagen  
 Nordsj.vej 21  
 DK 2100 Copenhagen

tel: +45 39274343  
 fax: +45 86428882  
 mail: info@adolph-andersen.dk

agent Leixoes

---

TBN

Further, will arrange bunker abt 70-75 mt for you either  
 Copenhagen/Skagen/  
 Kiel-canal dep. price.  
 Reverting 2morrow.

best regards/Viele Gruesse/Mvh

Sabine Paschedag

Telex from Broker to Master

of the appendix to *Sava Lake*'s Document of Compliance (DoC) (**Figure 3**) to verify if carriage of the nominated cargo was permitted as it was his custom to discuss the properties of cargoes which the ship loaded with the relevant loading terminal personnel. He was also aware that details of the cargo to be loaded were often subject to change.

The Liepajas Juras Birojs (Liepajas) fleet manager was made aware of the next cargo planned for *Sava Lake* when he was talking to the Hoyergruppen AS broker on routine ship's business. The fleet manager's concern was sufficient for him to send a fax of the vessel's DoC to the broker. As *Sava Lake* had carried steel turnings on a previous voyage from Rotterdam to Barreiro, Portugal, in April 2007, when the vessel had been owned and commercially operated by the Liepajas group, the broker believed that the vessel was capable of carrying the cargo and did not cross reference the cargo with the DoC.

The fleet manager was aware that, although this was an IMDG Code Class 4.2 cargo, the term "steel turnings" did not appear in the IMDG Code. However, he knew that "steel swarf" and "ferrous metal turnings" did appear in the code. He was also aware that the Bill of Lading contained no advice that this cargo was dangerous, and asked the master to confirm the status of the cargo on arrival in Copenhagen, prior to accepting the cargo.

### 1.3.2 Cargo loading at Copenhagen

*Sava Lake* arrived alongside in Copenhagen on Saturday 12 January, ready to load. Neither the local cargo agent nor the terminal manager believed the cargo required additional care either prior to, or during, loading, or that the cargo should be considered to be an IMDG material. Both the terminal manager and the cargo agent had exported steel turnings from this jetty several times before, without problem.

Loading started at 0715 on Monday 14 January. The vessel was loaded with 718t of steel turnings by grab from the quayside where the cargo had been exposed to earlier rain. The weather during loading was overcast with rain. Loading completed at 1330 the same day.

The local agent in Copenhagen issued a Mate's Receipt on completion of loading cargo. The Mate's Receipt (**Figure 4**) described the cargo as "steel turnings", in English and Portuguese. The master accepted the cargo, having been reassured by both the terminal manager and the agent, noting that the Mate's Receipt did not state that the cargo was dangerous, and no other documentation indicated that the cargo was hazardous. *Sava Lake* departed an hour after completion of cargo loading.

### 1.3.3 Cargo loading at Horsens

*Sava Lake* arrived in Horsens on the morning of 15 January at 0550. When the hatch covers were opened, the master saw that the cargo was emitting a visible vapour (**Figure 5**). The master asked for advice from the terminal personnel as to the nature of the cargo, and was advised that the cargo was not dangerous and that the cargo vapour was a normal phenomenon; the master, again, accepted the cargo. The second parcel of 2165t of cargo was loaded by grab between 0800 and 1950. The weather during this period was overcast with rain.

Figure 3

**APPENDIX TO  
DOCUMENT OF COMPLIANCE  
SPECIAL REQUIREMENTS FOR SHIPS CARRYING  
DANGEROUS GOODS**

Document No.:  
4150  
DNV Id. No.:  
15734  
Date of Issue:  
2006-09-06

DANGEROUS SOLID BULK CARGOES (including MHB)		Cargo holds										Footnotes:
Technical name	Class	1	2	3	4	5	6	7	8	9	10	
Aluminium ferrallicon powder	4.3	X										
Aluminium nitrate	5.1	B										
Aluminium silicon powder, uncoated	4.3	X										
Aluminium smelting or remelting by-product	4.3	X										
Ammonium nitrate	5.1	B										1) 4)
Ammonium nitrate fertiliser, Type A	5.1	B										1) 4)
Ammonium nitrate fertiliser, Type B	9	B										3) 4)
Barium nitrate	5.1	B										
Brown coal briquettes	MHB	X										
Calcined pyrites	MHB	B										
Calcium nitrate	5.1	B										
Castor beans	9	B										
Charcoal	MHB	B										
Coal	MHB	X										
Copra	4.2	B										2)
Direct reduced iron, DRI	MHB	X										
Direct reduced iron, briquettes, hot moulded	MHB	B										4) 5)
Ferrophosphorus	MHB	X										
Ferrosilicon, 30% - 80%	4.3	X										
Ferrous metal, borings, shavings, etc.	4.2	X										
Fishmeal, fish scrap, anti-oxidant treated	9	X										
Fluorspar (calcium fluoride)	MHB	B										
Iron oxide, iron sponges, spent	4.2	X										
Lead nitrate	5.1	B										
Lime (unslaked)	MHB	9										
Magnesia (unslaked)	MHB	B										
Magnesium nitrate	5.1	B										
Metal sulphide concentrates	MHB	B										6)
Peat moss	MHB	B										
Petroleum coke (tempered or untempered)	MHB	B										
Pitch prill, prilled coal tar, pencil pitch	MHB	B										
Potassium nitrate (saltpetre)	5.1	B										
Radioactive material, LSA-1	7	B										
Radioactive material, SCO-1	7	B										
Sawdust	MHB	B										
Seed cake, cont. vegetable oils (a)	4.2	X										
Seed cake, cont. vegetable oils (b)	4.2	X										
Seed cake, cont. vegetable oils (c)	4.2	X										
Silicon manganese	MHB	X										
Sodium nitrate (chile saltpetre)	5.1	B										
Sodium nitrate:Potassium nitrate, mixture	5.1	B										
Sulphur (lump or coarse grained)	4.1	X										
Tankage	MHB	X										
Vanadium ore	MHB	B										
Woodchips	MHB	B										
Wood pulp pellets	MHB	B										
Zinc ashes	4.3	X										
Zinc dross, residue, skimmings	4.3	X										

B indicates BULK CARGO PERMITTED  
X NOT ALLOWED  
See notes and footnotes on last page.

Appendix to Document of Compliance -  
Special Requirements for Ships Carrying Dangerous Goods

Figure 4

2000 13.07 77000100112 CODE NAME "CONGENBILL" EDITION 1984 Shipper Stena Jern + Metal A/S Nordhavnen 16 DK - 4600 Koege Denmark Consignee To Order of S N Maia, Siderurgia Nacional, S.A. 4425-514 S. Pedro Fina, Main		<b>BILL OF LADING</b> TO BE USED WITH CHARTER-PARTIES B/L No. Reference no.	
Notify address Navex - Empresa Portuguesa de Navegacao S.A. Rua de Vareiro, 19 - Leca de Palmira 4450-799 Matosinhos Portugal		<b>MATES RECEIPT</b>	
Port of discharge Leixoes		R4: Recycling / Reclamation of metals and metal compounds	
Shipper's description of goods		Gross weight	
Steel Turnings		718750 kilos	
Sucata de Limalha			
GA 430 Iron and Steel Scrap (100%)			
(at which) C/P dated 10-01-08 on Deck at Shipper's risk, the Carrier not being responsible for loss or damage howsoever arising			
Freight payable as per CHARTER-PARTY dated _____  FREIGHT ADVANCE Received on account of freight: _____  Time used for loading _____ days _____ hours		<b>SHIPPED</b> at the Port of Loading in apparent good order and condition on board the Vessel for carriage to the Port of Discharge or so near thereto as she may safely get the goods specified above Weight, measure, quality, quantity, condition, contents and value unknown. IN WITNESS whereof the Master or Agent of the said Vessel has signed the number of Bills of Lading indicated below all of this tenor and date, any one of which being accomplished the others shall be void FOR CONDITIONS OF CARRIAGE SEE OVERLEAF	
Freight payable at As per C/P Number of original B/L 3/Three		Place and date of issue Copenhagen Signature 140-6719073 Master M.V. "SAVA LAKE" Kopperly/K Ship Invest A/S	

Printed and sold by  
 P. O. Knudsen Bogtrykkeri A/S, 61 Vesterbrogade,  
 DK-2625 Valensbæk, Telefon +45 4366 0904  
 by authority of The Baltic and International Maritime Council  
 (BIMCO), Copenhagen

Mate's receipt issued at Copenhagen





Steel turnings on board *Sava Lake*  
(as photographed in Dover on 19 January 2008)

On completion, a Bill of Lading for the total 2875t, from both ports, of single grade steel turnings was issued (**Figure 6**). No certification was issued to declare whether or not the cargo was liable to self-heat. *Sava Lake* departed Horsens at 2115 on 15 January for Leixoes, Portugal.

#### 1.3.4 The voyage

On departure Horsens the forward deck (**Figure 7**) was secured for sea. *Sava Lake* crossed the southern Baltic Sea in moderate weather conditions, initially destined for the Kiel Canal. The master routinely advised the crew not to go forward during the voyage, particularly when heavy weather was forecast, without seeking permission from either the chief officer or himself.

As *Sava Lake* approached the Kiel Canal, both able bodied seamen (ABs) Lozynsky and Babienko entered the forward store to pass up the mooring lines on to deck. *Sava Lake* transited the Kiel Canal and River Elbe during the afternoon of 16 January. The weather forecast received during this time for the English Channel was for a south-west wind of Force 8-9.

The master directed that the vessel be secured for the predicted heavy weather, as he did routinely for passages in winter, by securing all the deck vents on the forward deck including the paint locker, forward store and CO<sub>2</sub> bottle room. The cargo vents were routinely kept closed, as were the fire dampers within the mushroom vent (**Figure 8**).

During 17 January, as *Sava Lake* headed south-west, the wind and swell increased; *Sava Lake* pitched heavily and slammed into head seas. When the wind increased to south west Force 9 during the evening, taking water over her deck, her speed was reduced to around 5 knots through the water.

Figure 6

080116-00035414 Received 16.01.2008 11:09:12 - Subject: 5 pages	Page 2 of 5  User: MH
---	-----------------------------

16/01 2008 11:01 FAX 002

Page 2

CODE NAME: "CONGENBILL", EDITION 1994 Shipper <b>STENA JERN &amp; METAL A/S</b> <b>NORDHAVNSVEJ 16</b> <b>DK-4600 HORSSENS</b> Consignee <b>TO ORDER OF S.N. MAIA SIDERURGIA NACIONAL S.A.</b> <b>4425-514 S. PEDRO FINS, MAIA</b> Notify address <b>NAVEX - EMPRESA PORTUGUESA DE NAVEGACAO S.A.</b> <b>RUA DE VAREIRO - LICA DE PALMIRA</b> <b>4450 - 799 MATOSINHOS</b> <b>PORTUGAL</b> Vessel V "SAVA LAKE" Port of loading <b>HORSSENS</b> Port of discharge <b>LEIXOES</b> Shipper's description of goods	<b>BILL OF LADING</b> TO BE USED WITH CHARTER-PARTIES Reference No.  <b>R4 RECYCLING/RECLAMATION OF</b> <b>METALS AND METAL COMPOUNDS</b> Gross weight
--	--

1 CARGO STEEL TURNINGS	2875.220 KGS
SUCATA DE LIMALHA	
GA 430 IRON AND STEEL SCRAP (100%)	
COPY	

(of which on Deck at Shipper's risk, the Carrier not being responsible for loss or damage howsoever arising)

Freight payable as per CHARTER-PARTY dated <b>10.01.08</b>  FREIGHT ADVANCE. Received on account of freight:  Time used for loading _____ days _____ hours.	<b>SHIPPED</b> at the Port of Loading in apparent good order and condition on board the Vessel for carriage to the Port of Discharge or so near thereto as she may safely get the goods specified above. Weight, measure, quality, quantity, condition, contents and value unknown. IN WITNESS whereof the Master or Agent of the said Vessel has signed the number of Bills of Lading indicated below all of this tenor and date, any one of which being accomplished the others shall be void. FOR CONDITIONS OF CARRIAGE SEE OVERLEAF
--	---

Freight payable at <b>As per C/P</b> Number of original B/Ls <b>3/ THREE</b>	Place and date of issue <b>HORSSENS, 15.01.2008</b> Signature <b>Master M/S SAVA LAKE</b>
---	--

Printed and sold by  
 F. G. Knudtzon, Opglysnings A/S, 61 Valdemarsvej,  
 DK-1825 Valdemarsk, Telefon +45 43 60 07 08  
 by authority of The Baltic and International Maritime Council,  
 (BIMCO), Copenhagen

Bill of Lading, issued at Horsens



Figure 7



Forward deck of *Sava Lake*

Figure 8



Starboard forward cargo mushroom ventilator and fire damper

At around 0900 the following morning, the master asked AB Lozynsky to check that the main deck and the forward part of the vessel were secure. The chief engineer also asked the AB to check if the recently replaced door seals of the CO<sub>2</sub> room were weather tight.

Wearing heavy weather clothing, ABs Lozynsky and Babiienko went forward, watched by the master from the bridge.

The two men returned from their inspection, reporting all was secure. They changed out of their wet weather gear and AB Lozynsky reported back to the bridge. The chief officer told the two ABs that, due to the heavy weather, once their tasks were complete they could take the afternoon off. The two men were not seen after 1100 that morning.

The two ABs did not eat lunch in the mess room, although this was not unusual, and their food was left out for them to eat later. When the chief officer took over the watch from the master at 1400, he believed that the two ABs were resting in their cabins.

It is not clear when the two ABs went forward, nor is it known why. No evidence has been found to indicate that they were doing anything unusual; the most likely explanation is that they both went to the forward store to collect tools, or materials, to fit replacement laminate flooring in AB Babiienko's cabin (**Figure 9**).

Figure 9



AB Babiienko's cabin

The master was the first to realise the two ABs were missing when he arrived in the mess room for dinner at 1930 and noticed that the two ABs had eaten neither lunch nor dinner.

## 1.4 THE SEARCH FOR THE MISSING MEN

### 1.4.1 The search

The master instructed the chief officer and watch engineer to find the two ABs. They checked the men's cabins, the accommodation, and then searched out on deck, heading forward along the main deck.

The chief officer noticed that the weather tight door to the forward store was closed, but that the locking securing arrangement was not closed as he would have expected (**Figure 10**). The chief officer opened the door to the forward store and saw the two missing men lying motionless at the bottom of the ladder.

The smell of cargo vapour was immediately apparent to both the chief officer and the watch engineer.

Figure 10



Weather tight door to forward store



#### 1.4.2 Actions on finding the men

The chief officer entered the store, leaving the watch engineer on deck, and tried to move the two men. After a short while he found difficulty breathing and his vision began to tunnel; he returned to deck and recovered his breath. The chief officer advised the master of the situation by VHF radio and returned to the bridge to brief the master more fully. The chief officer then returned to the forward store where, with self contained breathing apparatus (SCBA), he re-entered the store and confirmed that the two men had no pulse, were not breathing and were difficult to move.

The master decided it was impractical to recover the men to deck as it was clear they were both dead. The master advised the director of Liepajas of the situation, contacted Dover Coastguard, and requested permission to divert *Sava Lake* to Dover for assistance (**Figure 11**).

Reproduced from Admiralty Chart 1610 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 11

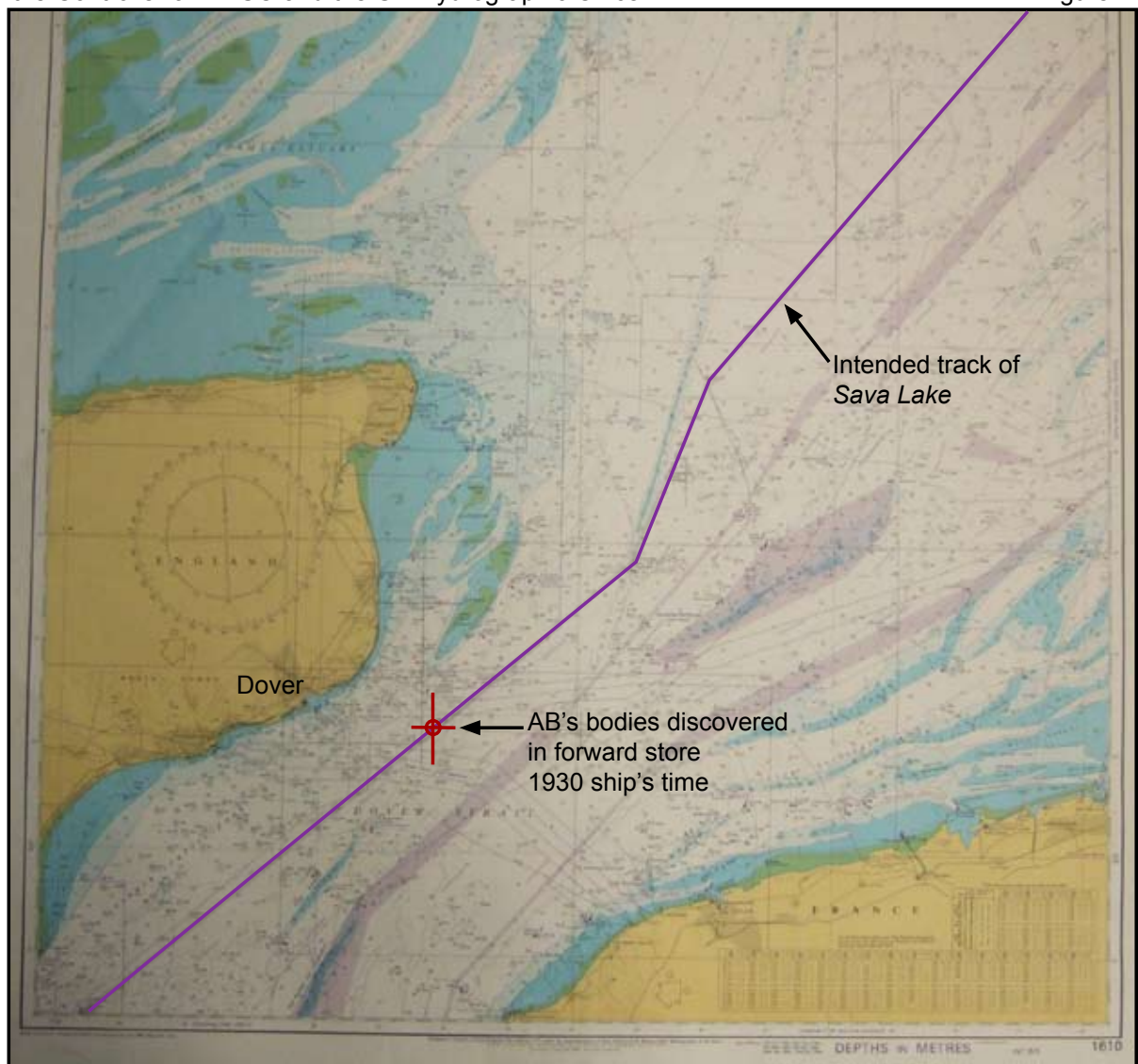


Chart of the track of Sava Lake

## 1.5 POST-ACCIDENT

### 1.5.1 Diversion

*Sava Lake* diverted to the Port of Dover, where she arrived alongside at 2150 UTC on 18 January, to be met by the emergency services.

The bodies of the two men were removed by the local Fire and Rescue Service and transferred for postmortem examination.

The vessel remained alongside for several days while investigations were carried out. During that time the cargo continued to self heat and Kent Fire and Rescue Service monitored the cargo temperature. *Sava Lake* was permitted to sail by her Classification Society DNV on a restricted voyage to Newhaven once the vessel complied with the Class requirements to carry ferrous turnings. This included the provision of additional SCBA and the fitting of remote temperature and oxygen gauges.

The cargo was unloaded in Newhaven on 6 February (**Figure 12**) when it was noted to be heavily oxidised.

Figure 12



Cargo unloaded in Newhaven

## 1.6 THE OWNER / MANAGER

In August 2006, *Sava Lake* had been sold by Kopervik to the Liepaja Shipping Company. She was subsequently chartered back, on time charter, by Kopervik in October 2007.

The Liepaja Shipping Company and *Sava Lake*'s managers, Liepajas, were headed by the same director.

Liepaja Shipping Company owned, and Liepajas managed, a fleet of four vessels, all similar to *Sava Lake*. Two vessels were chartered through their in-house chartering department, while *Sava Lake* and her sister vessel *Sava Ocean* were time chartered to Kopervik.

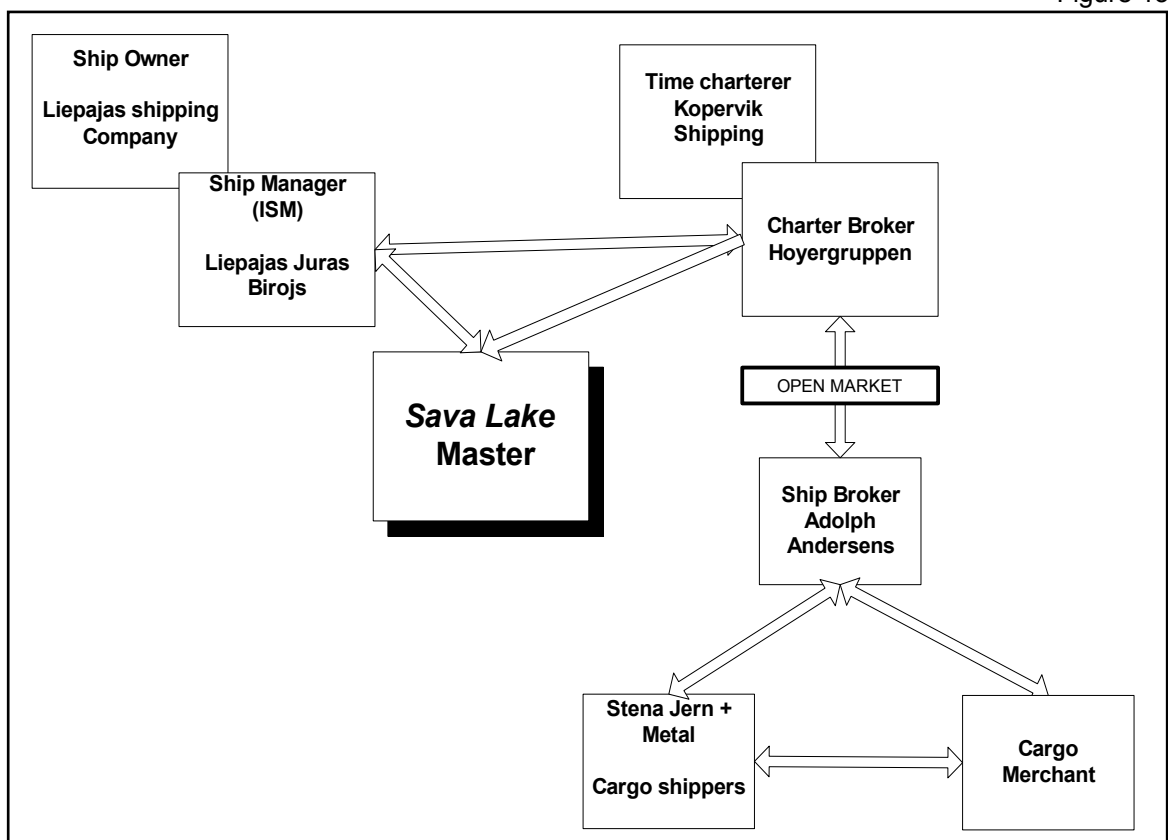
## 1.7 PARTIES INVOLVED IN CARGO FIXING (Figure 13)

### 1.7.1 Time charterer

The BIMCO uniform Time-Charter, as revised 2001 (Baltimex 1939), was signed on 12 October 2007 between Liepaja Shipping Company and Kopervik Ship Invest AS. As the ship's previous owner, Kopervik Ship Invest A/S (Kopervik) staff were familiar with the capabilities of the vessel.

Rider clause 55 of the charter party stated "*The vessel shall at all times be in a condition enabling her to carry IMO cargoes as per the vessels "Dangerous Goods Carriage Certificate"* (Figure 14).

Figure 13



Information flow between parties involved in cargo fixing

52 : The time-charter rate to be kept private and confidential.

53 : In the event the vessel being denied or restricted in the use of port and/or loading and/or discharging facilities or shore labour and/or tug and/or pilotage assistance because of the vessels flag or Ownership or Management or the wages or conditions of employment of the Officers and/or Crew or of the Officers and/or Crew of any other vessel under the same Ownership or Management or because of the previous trading of the Vessel or any other vessel as aforesaid, hire shall cease for the time thereby lost and Owners shall be responsible for and shall promptly reimburse Charterers all extra expenses which Charterers may incur in trying to solve the situation (including proceeding to an alternative port or ports).

54 : After suspension of hire from any cause including off hire for repair and drydocking the vessel to be placed again at Charterers disposal, in the same port or place or position where hire was suspended, always within ordinary office hours only. For the purpose of annual repair works the Owners to give the Charterers not less than 60 days notice for taking the vessel out of service, the Owners respecting the Charterers scheduled employment. Whenever the vessel is out of service due to the above or any other cause for a continued period of five days or more the Owners to give the Charterers not less than five days definite notice for re-entering the Time-Charter. This does not exempt the Owners from the obligations to keep the Charterers closely informed about the exact nature and up-dated position of repairwork as well as expected time of completion of repairs and re-entry into the Time-Charter. If the vessel has been offhire for a total period of 30 days or more during this Time-Charter, the Charterers have the option to cancel the balance of the Time-Charter.

55 : The vessel shall at all times be in condition enabling her to carry imo cargoes as per vessels "Dangerous Goods Carriage Certificate". In case vessel being rejected by Shippers/Charterers for loading such or other cargoes, she is to be considered off-hire from such time until she again is accepted and ready for loading. Extra expenses if any to be held by the Owners. The vessel to be in every way fitted for grabdischarge.

56 : Deleted

57 : Charterers to supply vessel with MGO with sulphur-oxide not more than 0,2

58 : Owners are free to sell the vessel at any time during the Time-Charter, bearing in mind that new Owners to keep their obligation under present Time-Charter.

### **1.7.2 Time charterer's broker**

Hoyergruppen AS exclusively brokered the vessels owned and chartered by Kopervik. The broker who secured *Sava Lake*'s cargo of "steel turnings" had regularly fixed her when the vessel had been previously owned by Kopervik.

### **1.7.3 The shipper**

The shipment of steel turnings was owned by the Danish company Stena Jern & Metal A/S (Stena), part of the Stena Metal Group of Companies; the leading recycling company in the Nordic region<sup>2</sup>.

### **1.7.4 The ship broker**

Adolph Andersens Succr. worked closely with Stena, providing the majority of their brokerage services, and sourced *Sava Lake* for their shipment of turnings.

### **1.7.5 The cargo intermediary**

The intermediary coordinated the sale of the cargo for recycling by Siderurgia Nacional in Leixoes, acting as an agent for Stena. He created the draft Bill of Lading for use in cargo documentation, and sent this draft to the ship broker, Adolph Andersens Succr.

### **1.7.6 Cargo agents**

The cargo agents in both Copenhagen and Horsens were appointed by the shipper's broker Adolph Andersen Succr. The agents were forwarded the cargo details of steel turnings as stated in the draft Bill of Lading. They were not advised, nor were they aware, that the cargo was an IMDG Code Class 4.2 material.

### **1.7.7 Terminal operators**

The terminals at both Copenhagen and Horsens were part of Stena Jern & Metal A/S. Although the terminals mainly exported scrap steel, steel turnings accounted for about 10% of their loadings.

The procedures for grab loading metal scrap and steel turnings were the same. No specific instructions were provided to Stena terminal managers for the handling of steel turnings. Turnings were washed and mainly stored undercover, although prior to and during loading, the cargo was exposed to snow and rain.

## **1.8 CREW**

### **1.8.1 Employment of the crew**

Senior officers and crew were employed directly by Liepajas. However, personnel joining the company for the first time, including the two deceased, were sourced via crewing agencies in the Ukraine.

### **1.8.2 Crew working routine**

Officers and crew usually worked 4 months on board followed by 2 months leave, unless otherwise mutually agreed. The master and chief officer split the bridge watchkeeping, working 6 hours on / 6 hours off, with the majority of the cargo work being supervised by the chief officer. The two ABs were employed on day work carrying

---

<sup>2</sup> [www.stenametal.com](http://www.stenametal.com)



out maintenance and hatch cleaning; they worked on the bridge as required. The AB / cook worked mainly as cook and mess man, occasionally assisting the other two ABs in port.

The ship had a zero tolerance on alcohol consumption on board, and none was evident. Hours of work records for all crew were recorded and held onboard.

- Master

The Russian master had been working on similar vessels, carrying similar cargoes to *Sava Lake*, for 7 years. He held appropriate qualifications for his rank and had received specific training in the carriage of dangerous goods in bulk and packaged form.

He had worked for Liepajas for about a year, and was at the end of his first 4 month contract on board *Sava Lake*.

- Chief officer

The Latvian chief officer was nearing the end of his first trip with the company. He held an STCW II/2 Certificate of Competence for vessels greater than 3000t and had worked as chief officer on similar vessels for several years.

- AB Sergiy Lozynsky (deceased)

This was Sergiy Lozynsky's first contract on board *Sava Lake*. He had been on board for 3 months prior to the accident, and was regarded as the senior of the two ABs. He was a Ukrainian national.

- AB Oleg Babiienko (deceased)

AB Oleg Babiienko, joined *Sava Lake* for the first time on 14 December, 1 month before the accident. He had completed the required safety familiarisation process and was known as a hardworking member of the crew. He was also a Ukrainian national.

- Chief engineer

On board *Sava Lake* since 2005, this was the Latvian chief engineer's fourth contract on *Sava Lake*, and he was the longest serving officer on board. He held a less than 3000kW Certificate of Competence, and was responsible for maintenance of the machinery and technical spaces on board.

## 1.9 THE FORWARD STORE

### 1.9.1 Configuration and contents

The forward store was directly forward of the cargo hold and aft of the paint store and chain lockers (**Figures 15 a & b**). The store was under the carbon dioxide (CO<sub>2</sub>) bottle room, located on the open forward deck, and was above the bow thrust space and forward water ballast tanks.

The forward store was accessed through a weather tight door on the starboard side of the deck house and down a single steep ladder. The store contained the vertical access ladder down to the bow thrust room. The two compartments were separated by a hatch (**Figure 16**). The hatch was routinely left open on passage and the two spaces were effectively common.

Figure 15a

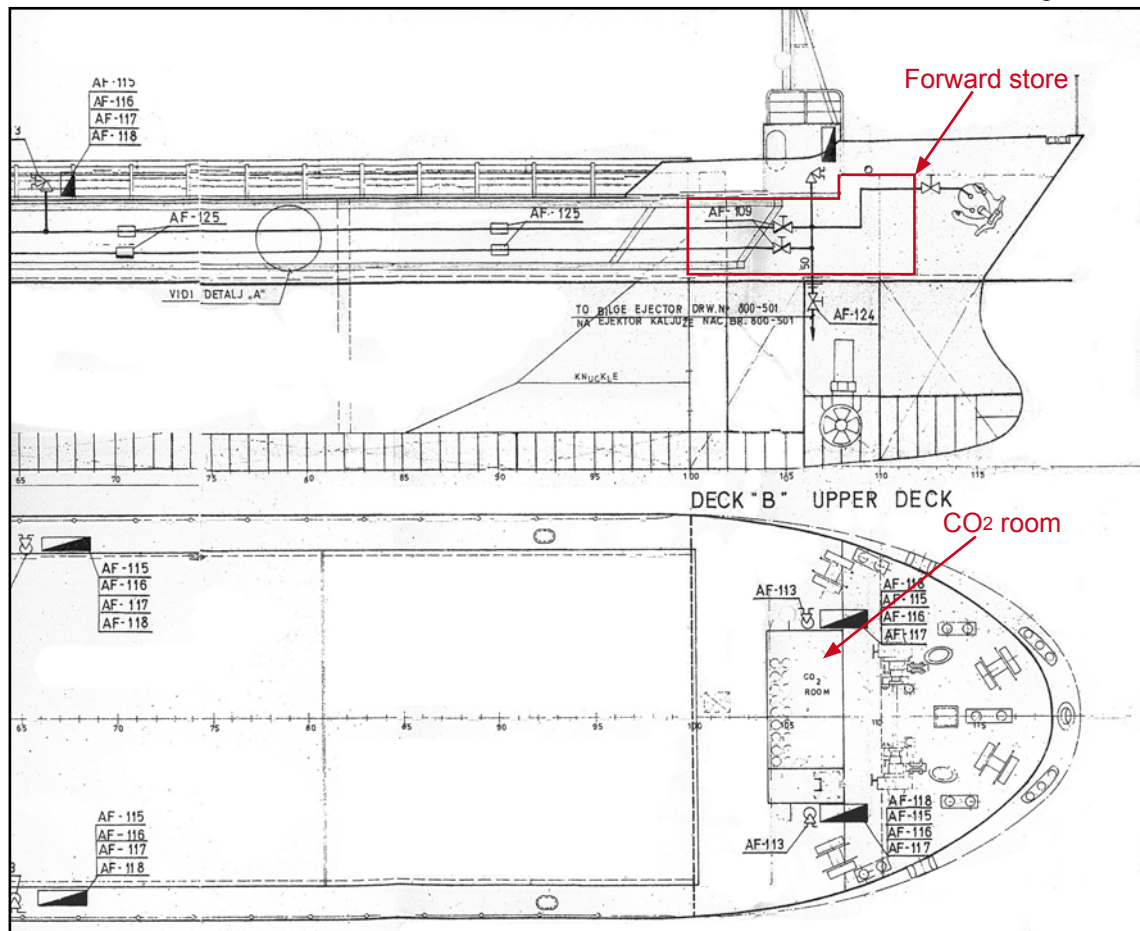
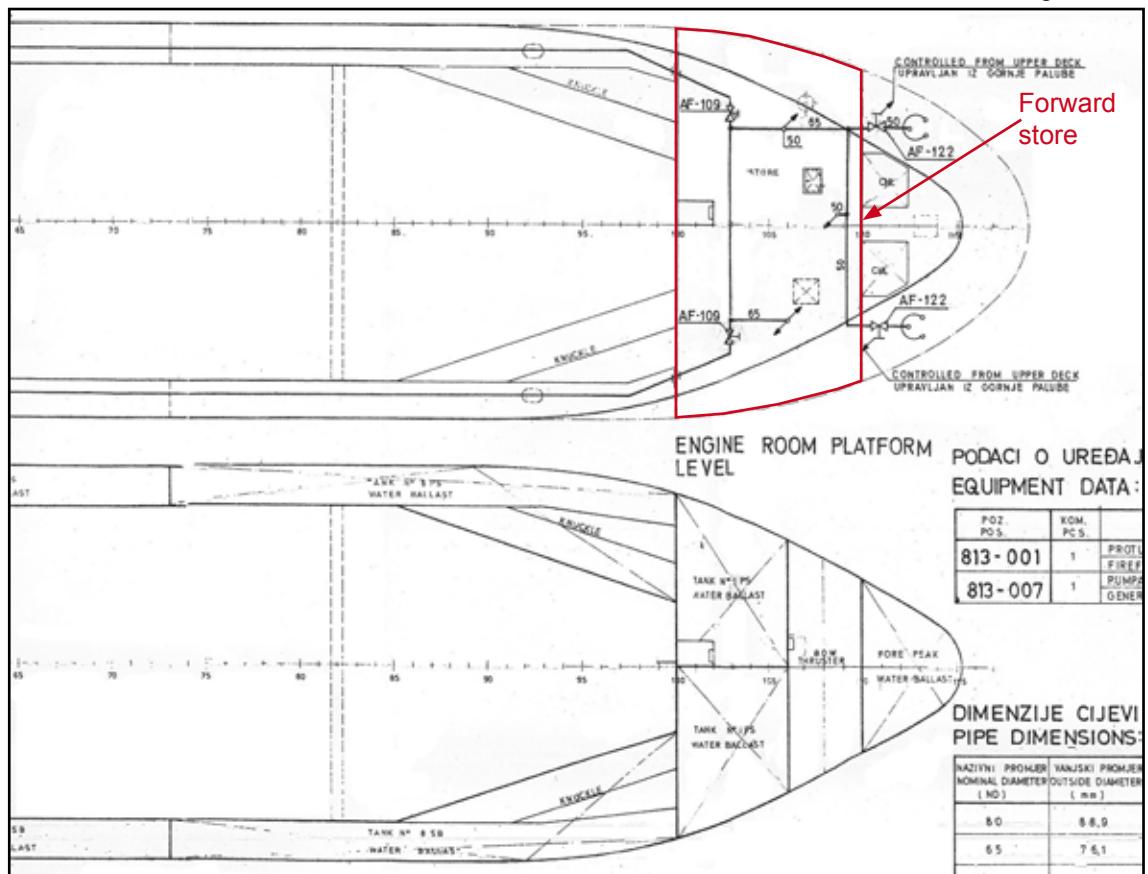


Figure 15b





Hatch from forward store to bow thrust room

The forward store was used as an AB's workshop and store, and contained the usual deck workshop tools and small quantities of paint and chemicals (**Figures 17**). The space also contained electrical switchboards for deck machinery, hydraulic oil tanks and provided storage for *Sava Lake*'s forward mooring ropes when these were not required on the fore deck.

The cargo hold ventilation trunking passed along both outboard sides of the forward store (**Figure 18**).

### 1.9.2 Ventilation

The bow thrust room and forward store were supplied by independent forced ventilation fans located within the forward store (**Figure 19**). Because the two spaces were common when the connecting hatch was left open, only the bow thrust space ventilation fan was routinely used, as this could be operated from the bridge as well as from within the forward store. The forward store fan was only operable from within the store.

Natural and forced ventilation required the vent flaps on the forward deck to be opened to be effective. The vent flaps were routinely closed at sea, particularly for passages in winter.



Figure 17



Forward store

Figure 18



Forward store - port cargo ventilation trunking



Forward store ventilation fan

## 1.10 CARGO HOLD VENTILATION

### 1.10.1 Cargo hold ventilation system

Cargo ventilation was provided at the forward and aft ends of the cargo hold.

The aft system consisted of natural ventilation only with several securable flaps aft of the cargo hold (**Figure 20**). Within the cargo hold, shutters were fitted over the ducts; the flaps were sealed with various types of expanding foam and sealant (**Figure 21**).

The forward ventilation ducts within the hold were fitted with wooden shutters (**Figure 22**), and attempts had been made to seal these using a sealant of unknown origin.

The system (**Figure 23 a & b**) led immediately into the forward store and consisted of two, symmetrical, independent tubular steel ducts located at the outer extremities of the space.

The two cargo ventilation ducts led forward through the store, through an extraction fan in each duct, and continued to the forward end, where they turned up to mushroom vents on the main deck above.

The extraction fans were fitted on either side with flexible bellows pieces to allow for the vibration of the fan unit (**Figure 24**) and provide access to it. The control switches for the extraction fans were located in the forward store, adjacent to the ventilation ducts.

### 1.10.2 Cutting of the ventilation bellows

Three of the four bellows pieces were found to have been cut to create openings of up to 30 cm at the bottom of the ducts. The cuts had allegedly been made by an earlier crew of *Sava Lake* to allow for the drainage of sea water during heavy weather and to facilitate the removal of cargo residue that had been drawn in from the adjacent hold (**Figure 25**).



Figure 20



Aft cargo ventilation flaps on deck

Figure 21



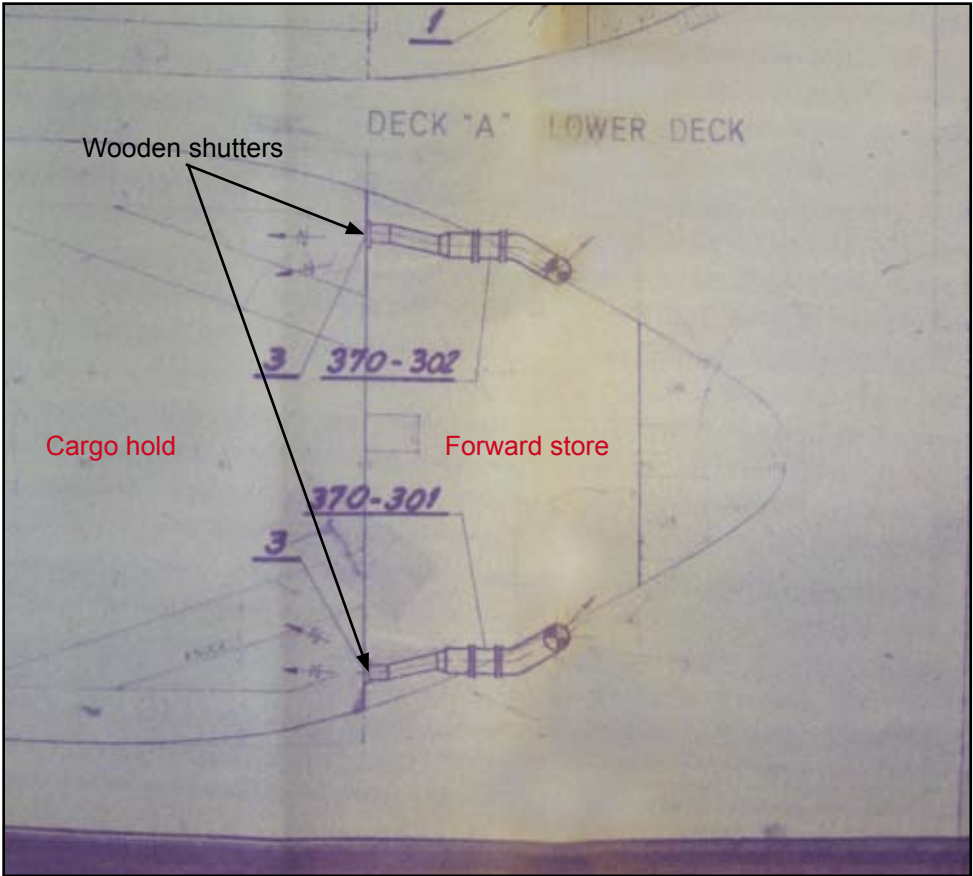
Aft cargo ventilation flaps within hold

Figure 22



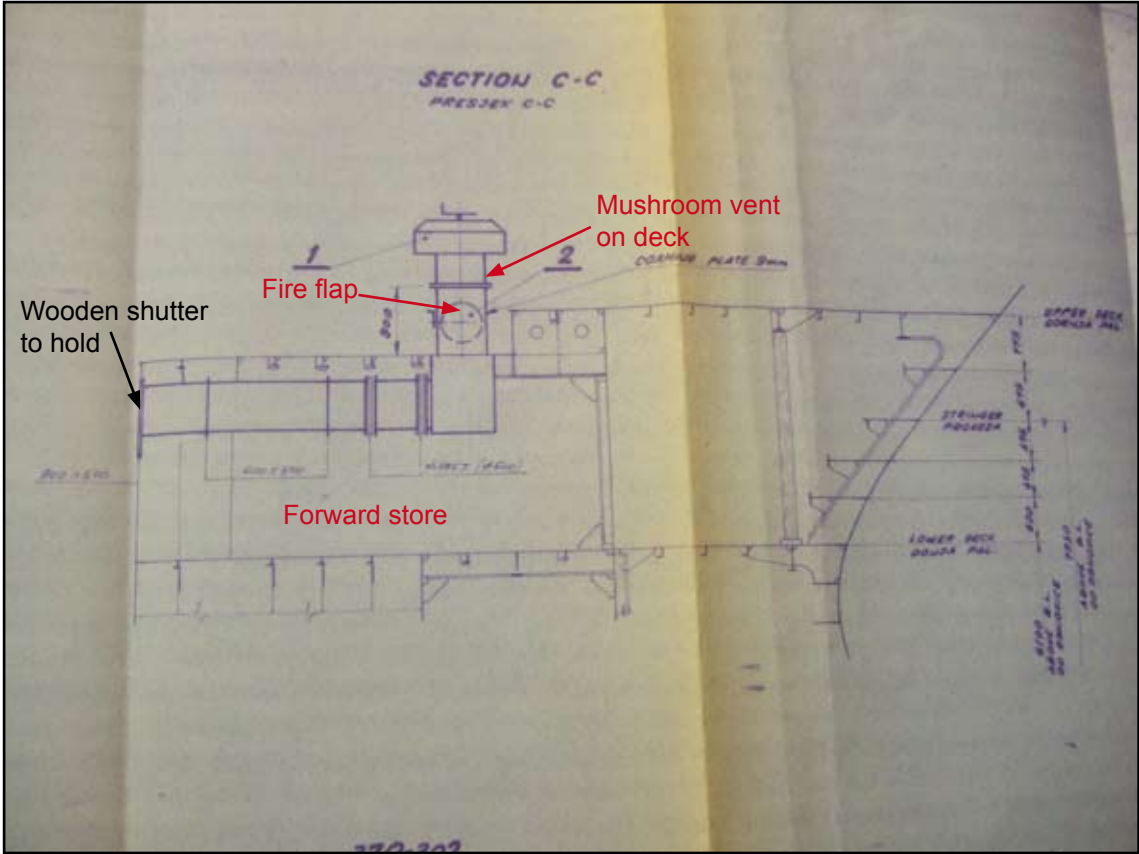
Wooden shutter to cargo ventilation system - port forward cargo hold

Figure 23a



Plan of forward ventilation system

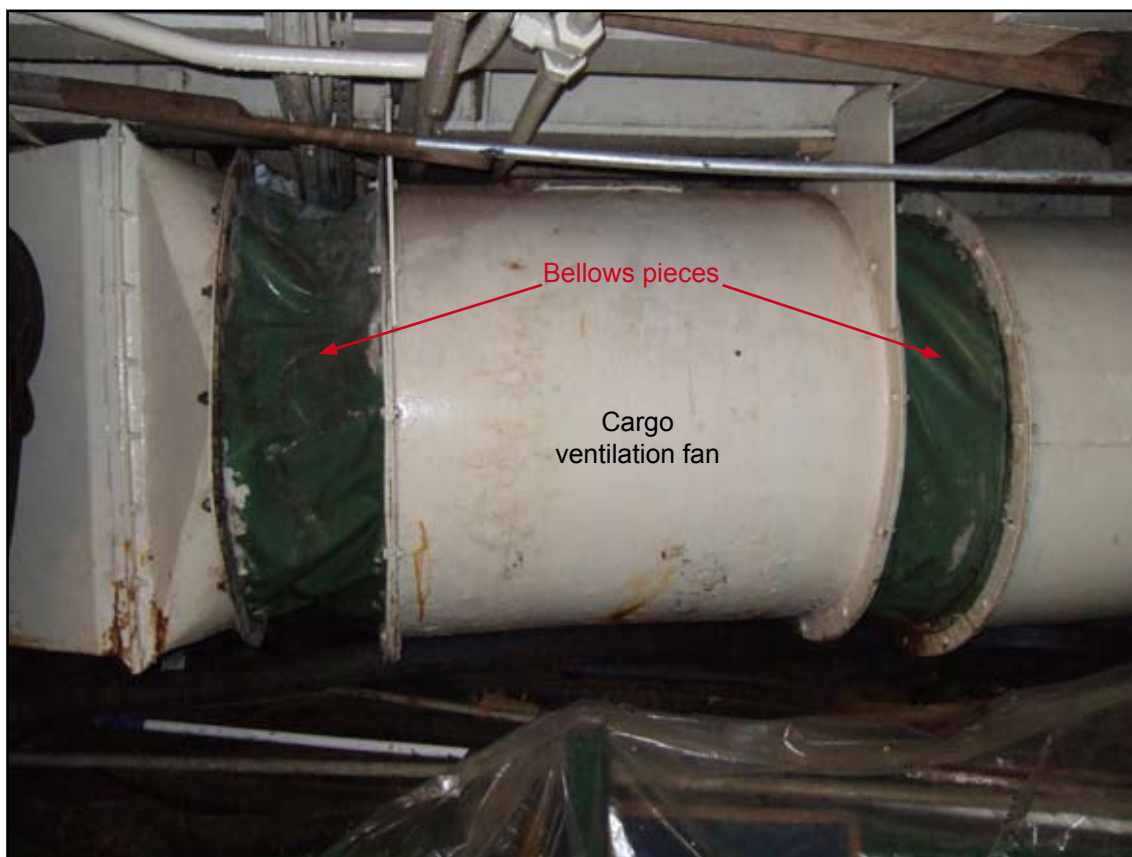
Figure 23b



Plan of forward ventilation system

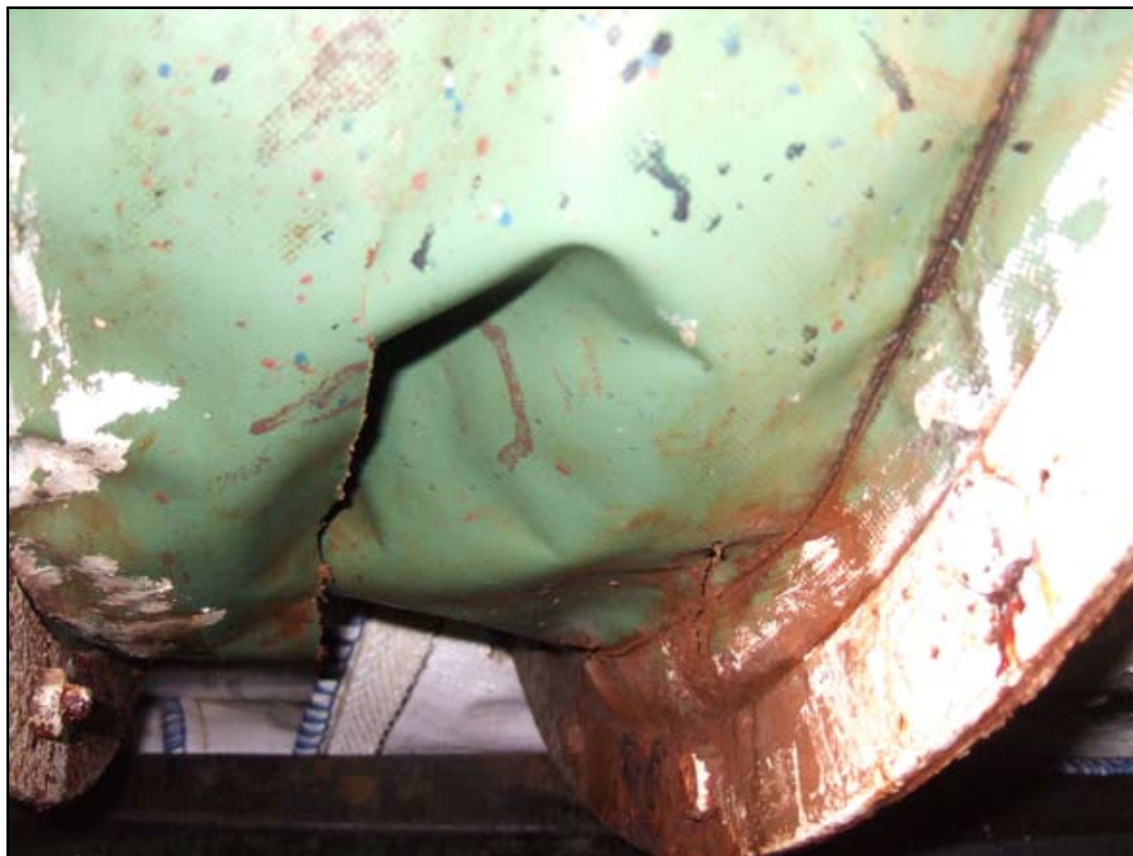


Figure 24



Cargo ventilation fan and bellows pieces

Figure 25



Cut bellows piece

### 1.10.3 Planned maintenance

The cargo ventilation fans were tested every month by the chief engineer in accordance with the vessel's planned maintenance system. A check on the overall condition of the associated pipework and couplings did not form part of these tests.

## 1.11 REGULATION

### 1.11.1 IMO

SOLAS Chapter VII, Part A-1, Regulation 7-3 (**Annex 2**) states that Ferrous Metal Turnings, in bulk, which are prone to self heating should not be carried unless precautions have been taken to minimize the likelihood of the outbreak of fire.

Ferrous Metal Turnings are an IMDG Code Class 4.2 material: *Substances liable to spontaneous combustion*.

Both the IMDG Code (**Annex 3**) and the BC Code (**Annex 4**) entries for *FERROUS METAL BORINGS, SHAVINGS, TURNINGS, or CUTTINGS in a form liable to self heating (UN No. 2793)* note the self heating properties of these cargoes, particularly when carried in a finely divided form, wet or contaminated with cutting oil or combustible material.

The codes state that:

*Self heating or inadequate ventilation may cause a dangerous depletion of oxygen in the stowage spaces and that the swarf should be protected from moisture prior to and after loading. If during loading the weather is inclement, the hatches should be closed or otherwise protected to keep material dry.*

The BC Code further directs that:

*During loading, the material should be compacted in the cargo spaces as frequently as practicable with a bulldozer or other means. Keep the bilge of each cargo space in which the cargo is stowed as dry as practicable. After loading, the cargo should be trimmed to eliminate peaks and compacted. The cargo should not be ventilated.*

The BC Code, in appendix 7 (**Annex 5**), Recommendations for entering enclosed spaces aboard ships, states:

*Recommendations for entering enclosed spaces aboard ships:*

*Unsafe atmosphere may also be present in spaces adjacent to those spaces where a hazard is known to exist.*

Current versions of both the IMDG and BC Codes were held on *Sava Lake*.

### 1.11.2 Documentation requirements

In accordance with the BC Code, the cargo of "steel turnings" should have been assigned a Bulk Cargo Shipping Name (BCSN) and a United Nations (UN) number prior to shipping, which should have been confirmed in writing and supported by appropriate shipping documents prior to loading.

The information provided by the shipper should have been accompanied by a declaration stating whether the cargo was, or was not, liable to self heat.

## 1.12 CARGO DOCUMENTATION

### 1.12.1 Mate's Receipt

A Mate's Receipt was issued at the first load port of Copenhagen (**Figure 4**). This is a document signed for by the mate, or master, when goods for carriage are received into the ship's charge. This avoided separate Bills of Lading being issued for the combined single grade cargo and contained the same cargo description as the Bill of Lading.

### 1.12.2 Bill of Lading

A Bill of Lading is defined as the *Ship master's detailed receipt for cargo received on board, evidence of the contract between the shipper and the ship owner*<sup>3</sup>.

The Bill of Lading (**Figure 6**) shows the cargo as steel turnings in English and Portuguese along with an EU identifying code for the recycling process "GA 430 Iron and Steel Scrap". The total mass of cargo loaded in both ports is also stated.

### 1.12.3 Classification Society - Document of Compliance – Special Requirements for Ships Carrying Dangerous Goods

The vessel had been issued with a Document of Compliance (DoC) – Special Requirements for Ships Carrying Dangerous Goods by the Classification Society Det Norske Veritas (DNV).

Attached to the DoC is an appendix (**Figure 3**) which lists the dangerous cargoes, including Materials only Hazardous in Bulk (MHB)<sup>4</sup> that *Sava Lake* could, and could not carry. The certificate stated *Ferrous Metal, borings, shavings etc were not allowed*.

The certificate did permit *Sava Lake* to carry several materials that were capable of oxygen depletion, such as Copra (IMDG Code Class 4.2) and woodchips and charcoal (MHB).

Before issuing *Sava Lake* with the requisite certification that was necessary to permit the vessel to carry "Ferrous Metal, borings, shavings etc" DNV would have required the following:

1. Installation of fixed (CO<sub>2</sub>) fire-fighting system for the hold.
2. Provision of an additional SCBA.
3. Fitting of insulation of bulkheads between hold and machinery spaces of A60 standard or provide a 3m horizontal separation.
4. Provision of remote oxygen measuring within the hold.
5. Provision of remote temperature measuring within the hold.

---

<sup>3</sup> Glossary of Maritime Technology - Edited by NS Swindells

<sup>4</sup> MHB cargoes consist of materials which may possess chemicals hazards when transported in bulk other than materials classified as dangerous goods in the IMDG Code.

## 1.13 FINDINGS RELATED TO CAUSE OF DEATH

### 1.13.1 Oxygen within the hold

With the O<sub>2</sub> level in the hold measured at 6% when the hatch covers were initially opened, had the O<sub>2</sub> level been similar in the forward store then the men would have died shortly after entering the space. It was not possible to determine with any accuracy the actual O<sub>2</sub> content of the forward store at the time of the accident.

### 1.13.2 Postmortem

It was the pathologist's opinion that the death of both ABs was caused by asphyxiation. The postmortem report states *the findings are consistent with asphyxiation from lack of oxygen but awaits final toxicology results*.

Toxicology results showed no evidence of alcohol or common drugs. There were no physical injuries to either man.

### 1.13.3 The physiological effects of reduced oxygen

In a normal ambient atmosphere the expected O<sub>2</sub> level would be around 20.9%, by volume.

In general, O<sub>2</sub> deficiency leads to a loss of mental alertness and a distortion of judgment and performance. This happens within a relatively short time, without the person's knowledge and without prior warning.

The following table<sup>5</sup> indicates the effects of O<sub>2</sub> deficient atmospheres on humans. These values are approximate and can vary. Note that exposure to an atmosphere containing less than 18% by volume of O<sub>2</sub> poses a significant risk.

<b>Asphyxia – Effect of O<sub>2</sub> Concentration</b>	
<b>O<sub>2</sub> (volume %)</b>	<b>Effects and Symptoms</b>
18-21	No discernible symptoms can be detected by the individual.
11-18	Reduction of physical and intellectual performance without the sufferer being aware.
8-11	Possibility of fainting within a few minutes without prior warning. <b>Risk of death below 11% vol</b>
6-8	Fainting occurs after a short time. Resuscitation possible if carried out immediately.
0-6	Fainting almost immediate. Brain damage may occur, even if rescued.

---

<sup>5</sup> Reference source - University of Oxford <http://www.admin.ox.ac.uk/safety/s403.shtml>

#### **1.13.4 Other noxious gasses**

A carbon monoxide (CO) level of 550 PPM was recorded in the main hold. This level is around 5 times that which may be encountered in temperature inversions or in heavy urban traffic<sup>6</sup>.

Exposure to a constant air concentration of CO results in a constant carboxyhemoglobin (COHb) level after an equilibrium period of some hours. The level of COHb detected in the ABs blood was minimal, precluding CO as the cause of their death, and indicating that they died quickly.

The CO<sub>2</sub> bottle room was located directly above the forward store, the system was inspected and found intact, and the bottles full.

Working stocks of open paint pots and closed chemical containers were found within the store, but the volumes were not in sufficient quantity to be harmful.

### **1.14 ENCLOSED SPACE ENTRY**

#### **1.14.1 Procedures**

Enclosed space procedures were in place within the company safety management system (SMS) and the procedures, including the use of a Permit to Work system, had been previously used for entry into known enclosed spaces, such as water ballast tanks.

The forward store was not considered, either by the vessel's managers ashore or by the crew on board, to be an enclosed space.

#### **1.14.2 Atmosphere test equipment**

The crew had available an *OX PEM* personal oxygen meter and *Pac Ex* rechargeable gas detection instrument for the measurement and monitoring of combustible gases.

Both meters were functioning, but were overdue for calibration.

---

<sup>6</sup> Disposition of Toxic Drugs and Chemicals in Man - Seventh Edition 2004. Randall C. Baselt, Ph.d

## **SECTION 2 - ANALYSIS**

### **2.1 AIM**

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

### **2.2 THE ACCIDENT**

The cuts in the flexible bellows pieces fitted to the ventilation ducts that ran through the forward store created an air path between the store and the adjacent cargo hold. This created an “unsafe condition” that, with the right combination of cargo and circumstances allowed a noxious atmosphere to develop within the forward store.

The cargo of ferrous metal turnings, IMDG Code Class 4.2, was loaded wet and untrimmed, providing optimum conditions for self heating of the cargo to occur with attendant depletion of the oxygen level within the cargo. The air path to the forward store allowed the air within the store to become similarly depleted, a process that was probably accelerated by the vessel panting as she pounded into heavy seas.

The reason the two ABs entered the forward store that day, closing the door behind them, cannot be stated with certainty. However, neither they nor the ship’s officers considered the forward store to be an enclosed or hazardous space, and they took no steps to ventilate the space or check the atmosphere before entry. All the indicators are that they were quickly overcome by the oxygen depleted atmosphere and died before they could exit the space or raise the alarm.

### **2.3 THE VENTILATION SYSTEM**

#### **2.3.1 Design**

The design of the forward cargo ventilation ducts did not allow for the practical removal of sea water or cargo residue that would, inevitably, build up in the system.

The mushroom vents on deck did not provide a seal sufficient to completely stop water ingress into the ventilation ducts; similarly the wooden shutters in the hold did not fully prevent the passage of cargo residues. Over time, therefore, water and cargo residue built up in the ventilation duct and needed to be removed.

A previous crew had elected to drain and clear the system by the easiest method available, cutting the bellows pieces either side of the fan. Oblivious to the danger, and perhaps believing the hold shutter to be an effective barrier between the forward store and the hold, they unintentionally created a path for the oxygen depleted air.

The practice of cutting the bellows was known by some of the current crew and also by the ISM managers. As the risk of oxygen depletion within the forward store was not understood, and therefore not considered, the ventilation system was not considered to be safety critical and the vessel’s managers or crew had not considered redesigning the system.

It is possible, but unlikely, that the weaknesses in the ventilation duct maintenance arrangement could have been identified by the classification society at the design approval stage. However, ship’s officers or shore management could subsequently

have recognised the risks associated with cutting the bellows pieces, and then instigated a review and redesign of the ventilation system to facilitate their maintenance and cleaning.

### **2.3.2 Ventilation system maintenance**

The cargo ventilation system had not been used for a considerable time, and the implication of the cut bellows had not, therefore, been recognised. Although the chief engineer tested the ventilation fans monthly, there was no routine for visually inspecting the system as a whole and the defective trunking bellows pieces went unnoticed. A thorough routine visual inspection of the ducting could have shown the cuts in the ducting, and raised awareness of the inadequacies of the system design.

### **2.3.3 Class approval and certification**

The Appendix to *Sava Lake*'s DoC did not permit the carriage of *ferrous metal turnings, borings, etc.* The vessel was already fitted with a suitable CO<sub>2</sub> fixed fire-fighting system for the hold, and in order for her to depart Dover for her discharge port, the classification society required that she was equipped with additional SCBA, and that oxygen and temperature gauges were fitted.

However, no changes were required to the cargo hold ventilation system so, in themselves, the additions required for *Sava Lake* to carry IMO 4.2 *ferrous metal turnings, borings etc.*, would not have prevented this accident. Importantly, neither would they have prevented similar accidents occurring in the forward store as, in the Appendix to the DoC, the classification society had already authorised *Sava Lake* to transport several other cargoes, including IMDG and MHB cargoes, that were prone to self-heating and which could cause oxygen depletion within the hold.

## **2.4 THE CARGO**

### **2.4.1 Ferrous metal turnings**

The correct BCSN was not used to describe *Sava Lake*'s cargo. The cargo was variously described as "steel turnings", "turnings", and "turnings IMO 4.2".

*Sava Lake*'s cargo was liable to self-heating and therefore the cargo should have been properly defined and the requirements of the BC Code adopted, including the use of the BCSN. The BCSN for the cargo was *ferrous metal, borings, shavings, turnings or cuttings UN 1793 in a form liable to self-heating*.

### **2.4.2 European "steel turnings" exports**

*Sava Lake* had shipped "steel turnings" earlier in the year from Rotterdam to Barreiro, Portugal (**Figure 26**). There is, therefore, evidence that shipments of ferrous metal turnings are shipped from at least two European ports using the term "turnings" or "steel turnings" without applying the requirements of the BC Code.

The inherent risks of ferrous metal turnings and the BC Code requirements are either unknown, or bypassed, by some shippers and terminal operators, therefore allowing for the possibility that this tragedy may happen again. Shippers, brokers, managers and terminal operators should be aware of the requirement to load this cargo in compliance with the BC Code and supply masters with the factual information and guidance the Code requires.



Figure 26

CODE NAME: "CONGENBILL" - EDITION 1994 Page 2

Shipper  
**BRT ROHSTOFF TRADING GMBH & CO KG**  
**RHEINHAFEN ST. JOHANN 2**  
**CH-4056 BASEL**  
**SWITZERLAND**

Consignee  
**SN SEIXAL, SIDERURGIA NACIONAL SA**  
**FABRICA DE SEIXAL**  
**2840-996 ALDEIA DE PAIO PIRES**  
**SEIXAL - (PORTUGAL)**  
**VAT.N.PT.507.105.147**

Notify address  
**NAVEX-EMPRESA PORTUGUESA DE NAVEGACAO SA**  
**TRAVESSIA DO ALECRIM, 1-3º. ANDAR**  
**1200-019-LISBOA (PORTUGAL)**  
**PHONE : 351-21-322 63 36**  
**FAX : 351-21-322 63 19**

**BILL OF LADING** B/L Nº **1**  
 TO BE USED WITH CHARTER-PARTIES Reference Nº

**ORIGINAL**

Vessel **M/V "SAVA LAKE"** Port of loading **ROTTERDAM (THE NETHERLANDS)**  
 Port of discharge **BARREIRO (PORTUGAL)**

Shipper's description of goods **STEEL TURNINGS** Gross weight **2339,261 METRIC TONNES**

(of which **NIL** on deck at Shipper's risk, the Carrier not being responsible for loss or damage howsoever arising)


Freight payable as per **CHARTER-PARTY 10-04-2007**  
 FREIGHT ADVANCE  
 Received on account of freight:

Time used for loading \_\_\_\_\_ days \_\_\_\_\_ hours

**SHIPPED** at the Port of Loading in apparent good order and condition on board the Vessel for carriage to the Port of Discharge or so near thereto as she may safely get the goods specified above.  
 Weight, measure, quality, quantity, condition, contents and value unknown.  
 IN WITNESS whereof the Master or Agent of the said Vessel has signed the number of Bills of Lading indicated below all of this tenor and date any one of which being accomplished the others shall be void  
 FOR CONDITIONS OF CARRIAGE SEE OVERLEAF

Freight payable **AS PER C/P** Place and date of issue **ROTTERDAM, 13.04.2007**  
 Number of original B/L **3/THREE** Signature **MASTER OF M/V "SAVA LAKE"**

By Authority of the Baltic and International Maritime Council (BIMCO), Copenhagen.



Previous Bill of Lading for 'steel turnings' loaded on board *Sava Lake* (April 2007)



## 2.5 TERMINAL OPERATIONS

The BC Code guidelines for “ferrous metal borings, shavings, turnings or cuttings” were not acknowledged nor followed by the terminal operators in either of the load ports. The cargo was loaded in rain, not trimmed, not compacted, and the cargo temperature was not taken at any time. The terminals in both load ports did not consider the cargo to be hazardous.

The lack of correct loading procedures increased the possibility of the cargo self-heating. Had the cargo not been wet, not loaded in rain, and been trimmed effectively, the potential for self-heating and consequent oxygen depletion would have been reduced.

## 2.6 CARGO DOCUMENTATION

The text for the Bill of Lading was provided by the cargo intermediary. The intermediary was fully aware of the hazardous nature of the cargo, but he was not required to state the correct BCSN, or clarify the hazards of the cargo, in the draft documentation he provided.

The text used for the draft Bill of Lading ultimately appeared on the Mate’s Receipt and the final Bill of Lading for the complete cargo. The broker, Adolph Andersens Succr., did not consider amending the description of the cargo on the Bill of Lading to the BCSN or adding the IMDG Code Class or UN number. Had this information been added to the Bill of Lading, or supplied as part of the supporting cargo documentation provided to the master, the hazardous nature of the cargo would have been clearly identified.

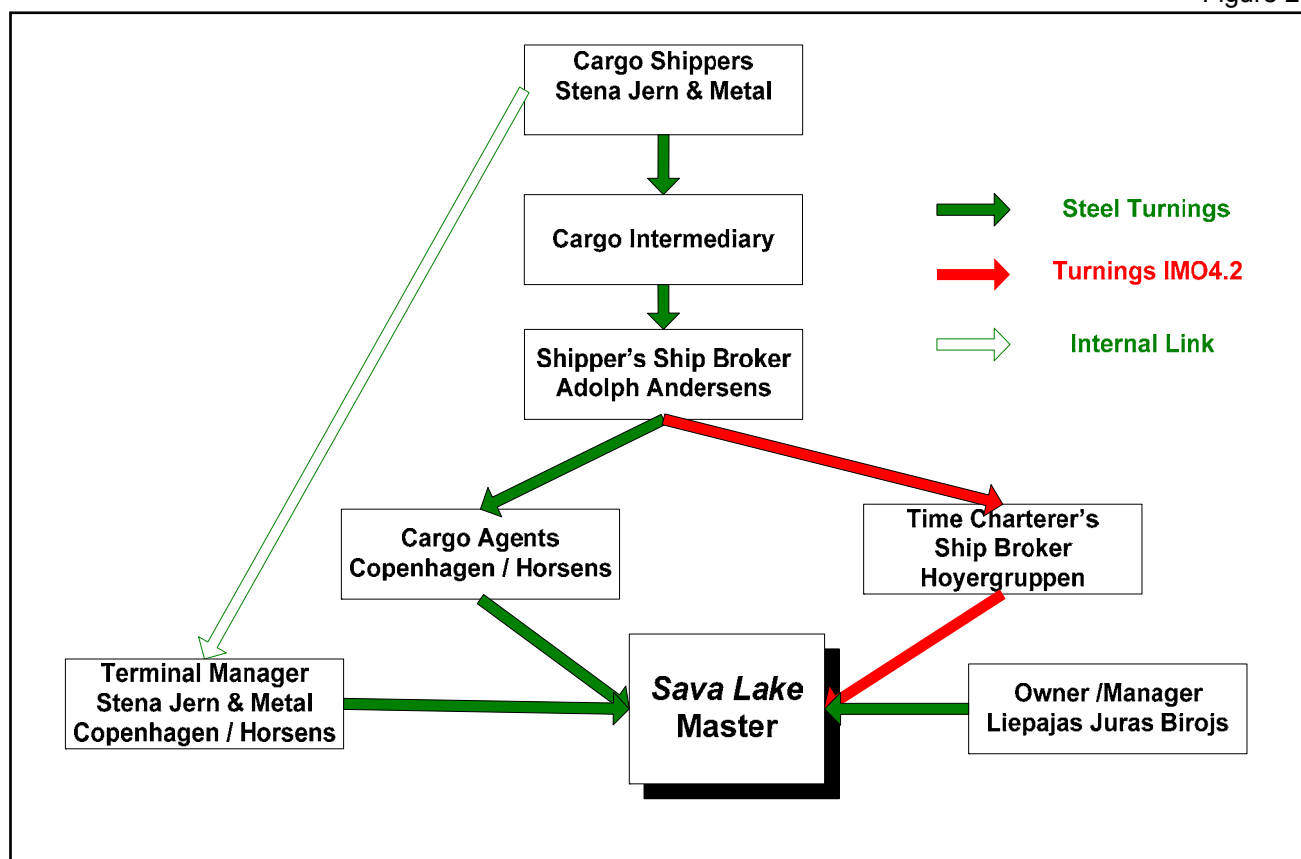
Although Adolph Andersens Succr. correctly identified the hazards of the cargo, and supplied the BIMCO turnings clause to the ship broker Hoyergruppen AS, the BIMCO documentation could not be passed to the master as only telex and telephone were available on board *Sava Lake*. Had the vessel been fitted with Email or fax, the additional documentation could have been sent to *Sava Lake* by the Hoyergruppen AS broker.

## 2.7 COMMUNICATION OF CARGO DETAILS TO THE MASTER

**Figure 27** shows the flow of information to the master concerning whether the cargo was an IMDG Code Class 4.2 (IMO 4.2), or not.

The master was advised by the ship broker, Hoyergruppen AS, by telex that the cargo was *turnings IMO 4.2*. As this was not supported by the additional BIMCO clause information supplied by Adolph Andersens Succr., this was the only advice the master had that stated this was a dangerous cargo, albeit the correct BCSN was not included in the information.

The Adolph Andersens Succr. broker, aware that the additional BIMCO turnings clause had been forwarded to Hoyergruppen AS, assumed that *Sava Lake* was suitable to carry the intended cargo and that the master would be aware of the additional carriage requirements. The broker, therefore, did not consider it necessary to make the local agents in Horsens and Copenhagen aware of the additional requirements of the cargo, especially as it was routinely exported from their ports.



Information flow to the Master

The Hoyergruppen AS broker, on receipt of the initial cargo information, and again when sent a fax copy of *Sava Lake*'s DoC by the ship managers, assumed that *Sava Lake* was certified to carry the intended cargo, and did not check the contents of the Appendix to the DoC. Relying on the historic information that the ship had carried the cargo before did not set a precedent for carrying the cargo in future, and the opportunity to refuse the cargo was missed due to this oversight.

The ship managers were also aware of the possible hazards of this cargo, and advised the master to be cautious, and to confirm the nature of the cargo prior to loading. The managers should have taken a firmer stance and confirmed the nature of the cargo, or asked DNV for clarification, rather than relying on the ambiguous fax of the DoC sent to the Hoyergruppen AS broker. They could have then provided the master, alongside for almost 2 days in Copenhagen prior to loading, with greater support in clarifying the status of the cargo and *Sava Lake*'s ability to carry that cargo.

The master did not refer to his copy of the DoC, but relied on the advice he received from other parties. Aware that this cargo had been described as *turnings IMO 4.2*, he should have noted that this would be included within the term *ferrous metal, borings, shavings etc. - Class 4.2.* stated on the DoC. This knowledge would have supported his suspicions as to the hazardous nature of the cargo.

There was no specific communication between the Stena senior managers and the terminal managers in Copenhagen and Horsens with regard to *Sava Lake*'s intended cargo, as the shipment was not considered extraordinary. There were no additional procedures in place for the loading of ferrous metal turnings than for the other grades of scrap loaded at the Stena terminals.

The master was left to discuss the properties of the cargo with the local cargo agents, appointed by Adolph Andersens Succr. and terminal managers in each of the load ports. On each occasion he was told that the cargo was not hazardous. The master, although in doubt, accepted the cargo without asking for the assistance of the time charterer or ship manager. As the master did not ask for further assistance, none was provided, and he made his decision to load the cargo on the balance of information received. Had the master called for additional support from his managers, or refused to accept the cargo at either of the load ports, rather than accepting the flawed information, he could have prevented this hazardous cargo from being loaded.

However, the more robust procedure would be for the brokers involved in the fixing of the cargo to ensure that a complete description of the cargo is incorporated with all documentation used during the fixture.

## **2.8 ENCLOSED SPACE ENTRY**

### **2.8.1 Onboard procedures**

*Sava Lake's* SMS contained adequate procedures for enclosed space entry, including a functioning permit to work system. However, the forward store was not considered to be an enclosed space, despite the BC Code advice that spaces adjacent to those where a hazard is known to be present may contain an unsafe atmosphere. Had the forward store been established as an enclosed space, for the duration of the voyage, the accident could have been avoided.

If the master had fully considered the potentially hazardous nature of the cargo, he could have briefed the crew of the risks involved in entering the forward store. In this event, the two ABs would then have been fully aware of the dangers, and it is very unlikely they would have attempted to enter the store, at least without informing someone of their intentions.

By carrying a potentially hazardous cargo, *Sava Lake's* forward store effectively changed status from being a working space to that of an enclosed space. No enclosed spaces were identified on board *Sava Lake*, yet if these spaces had been identified, assessed and controlled, the crew would have been aware of their current status.

Where compartments can be deemed either routine working spaces, or hazardous spaces, it is important that the status of the compartment is made clear by briefing and appropriate labelling. It is also important that crew members are familiarised on joining with the procedures to be adopted for entering such hazardous spaces.

### **2.8.2 Ship familiarisation**

The officers and crew were not fully aware of the arrangements for providing ventilation within the forward store. The bow thrust and forward store were supplied with independent ventilation systems, but only the lower, smaller, bow thrust store ventilation could be activated remotely. The hatch between the forward store and the bow thrust compartment was normally left open, so the bow thrust fan could ventilate the combined bow thrust and forward store, prior to entry. With the hatch closed, the forward store relied on natural ventilation, which required the mushroom vents and fire flaps to be opened, until such time as someone entered the store to start the fans.

The relocation or provision of a remote forward store fan switch, combined with an established procedure for entry, would allow the space to be fully ventilated prior to entry.

### 2.8.3 Emergency response

The chief officer was confronted with the two collapsed men within the forward store and, despite the strong cargo odour, he immediately entered the space, where he was quickly affected by the lack of oxygen. He was exceptionally fortunate to get out of the store before he, too, was asphyxiated. The chief officer's collapse could then have encouraged the watch engineer to assist, creating an even greater tragedy. The chief officer felt compelled to assist; his underpinning knowledge and training were not sufficient to overcome this natural impulse. Despite numerous industry attempts to inform and train crews in the correct response to such accidents, the incorrect response is repeatedly made. Further training is required to ensure that ship's staff react appropriately to enclosed space accidents. The MAIB has issued a Safety Bulletin to the industry emphasising this requirement (**Annex 6**).

The O<sub>2</sub> meter and gas multi-meter calibration were both out of date for calibration. However, had they been routinely calibrated and used to analyse the forward store atmosphere prior to entry they would, in conjunction with the heavy odour of cargo, have immediately alerted the crew to the hazardous environment in the store.

## 2.9 COASTAL AND SHORT SEA TRADES

It is widely recognised that the short sea trade is a highly competitive business, often with small financial margins between profit and loss. It is also apparent that steel turnings are routinely transported without the required safety procedures and documentation in place. The pressures on masters, owners and charterers to accept cargo that might not be considered dangerous by some shippers is ever present. The master, ultimately responsible for the decision to load the cargo, must have the authority to refuse cargo until he is fully satisfied that the cargo is correctly declared, is in a safe condition to carry, and that he has been supplied with the correct documentation and safety advice.

### 2.10 FATIGUE

Fatigue is not considered to have contributed to this accident. The ABs were well rested prior to the accident, however, the heavy pitching of the vessel might have restricted the amount of effective sleep the crew had received in the 36 hours prior to the accident.

### 2.11 SIMILAR ACCIDENTS

#### MAIB statistics

Death by asphyxiation in enclosed spaces continues to be a frequent cause of fatal accidents. Within the last 12 months MAIB has investigated two other accidents where failure to adopt enclosed space procedures has killed another four crewmen, and is currently investigating a further accident in which a man died in similar circumstances.

IMO Assembly Resolution A.864(20): *Recommendations for Entering Enclosed Spaces Aboard Ships* was adopted in 1997 following widespread industry concern over the number of fatalities that had occurred resulting from ship's personnel entering spaces in which the atmosphere was oxygen depleted, toxic or flammable. MAIB records show that 15 deaths and 31 reportable injuries, as a result of accidents in circumstances similar to the *Sava Lake* accident, have occurred on UK registered vessels, or in UK waters, during the period since IMO Assembly Resolution A.864(20) was adopted.

**Marine Accident Investigators' International Forum (MAIIF)**

Concerned at the continued loss of life due to improper confined space entry procedures, MAIIF tasked the Department of Maritime Affairs, Vanuatu, with the collection and dissemination of material relating to confined space entry, in anticipation of a paper on the subject being submitted to the IMO.

At the time of drafting this investigation report, Vanuatu had collated data from six administrations which listed 63 separate confined space incidents, resulting in 44 deaths and 63 injuries on board vessels of 15 different flag states, during the period 1993 to the current date. The data also identified that deaths due to lack of oxygen or toxic atmosphere were occurring in spaces other than those routinely identified as dangerous compartments.

## **SECTION 3 - CONCLUSIONS**

### **3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT WHICH HAVE RESULTED IN RECOMMENDATIONS**

1. The design of the forward cargo hold ventilation ducts did not allow for the practical removal of cargo residue or sea water that would, inevitably, build up in the system. [2.3.1]
2. A previous crew had elected to drain and clear the ventilation system by cutting the bellows pieces either side of the fan, unintentionally creating a path for air from the hold to enter the forward store. [2.3.1]
3. The annex to *Sava Lake*'s Document of Compliance – Special Requirement for Ships Carrying Dangerous Goods did not permit the carriage of “turnings”, however, the ship was permitted to carry several oxygen depleting cargoes. [2.3.3]
4. The correct BCSN, as defined in the BC Code, was not used on either the Bill of Lading, or associated cargo documentation, to describe the cargo that *Sava Lake* carried. The information that was provided did not clearly lead the master, managers, cargo agents or terminal operators to recognise the hazards of the cargo. [2.4.1] [2.6]
5. The master ultimately decided to load the cargo, unsure as to whether it was appropriate to do so, when he could have refused the cargo and sought further advice from the brokers or ship managers. [2.7]
6. Enclosed spaces, including the forward store that alternated between a working space and an enclosed space, should have been identified and the crew familiarised with the procedures for enclosed entry. [2.8.1] [2.8.2]
7. The initial response to the discovery of the two men could have resulted in further death by asphyxiation. [2.8.3]

### **3.2 OTHER SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION ALSO LEADING TO RECOMMENDATIONS**

1. It is evident that *ferrous metal borings, shavings, turnings or cuttings UN1793 in a form liable to self heating* are shipped between European ports using various names other than the correct BCSN, and without shippers applying the requirements of the BC Code. [2.9]

### **3.3 SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION WHICH HAVE NOT RESULTED IN RECOMMENDATIONS BUT HAVE BEEN ADDRESSED**

1. The terminal managers in each of the load ports did not recognise the cargo as hazardous and had no procedures to handle the cargo as required by the BC Code. [2.5]



## SECTION 4 - ACTION TAKEN

**Liepajns Juras Birojs Ltd.** has:

- Replaced the ventilation system bellows pieces within the forward store to the satisfaction of DNV.
- Established the forward store, and other spaces adjacent to the hold, as enclosed spaces, placing warning signs on their access.
- Improved cargo communication procedures with time charterers.
- Implemented additional crew briefings by the master prior to loading cargo.
- Increased and improved enclosed space entry training on board company ships.

**Adolph Andersens Succr.** has:

Established procedures (**Annex 7**) to ensure that:

- Written confirmation is received from the ship owner stating that the ship is suitable to carry *ferrous metal borings, shavings, turnings or cuttings UN2793 in a form liable to self heating*.
- The cargo agent returns a receipt, signed by the master, to Adolph Andersens Succr., to acknowledge the master's receipt of an extract of the BC Code relating to the cargo.
- Should the master refuse to load the cargo, or acknowledge receipt of the BC Code extract, loading should be delayed until the dispute is resolved between the shippers and the ship's managers.

**Stena Jern & Metal A/S** has:

Established procedures (**Annex 8**) to ensure:

- The shipper confirms that the chartering broker has written confirmation that the vessel is suitable to carry the cargo and has provided the master with an extract of the BC Code.
- Branch managers:
  - Keep cargo as dry as is practicable.
  - Monitor and record cargo temperatures prior to, and during, loading, adhering to the maximum permitted temperatures.
  - Stop cargo operations in rain or snow, if so requested by the master.
  - Compact and trim cargo to eliminate peaks.

**MAIB** has:

Produced a Safety Flyer (**Annex 9**) which summarizes the safety issues identified in this investigation. This has been sent to the following maritime organisations:

- International Chamber of Shipping
- Institute of Chartered Shipbrokers

- International Association of Classification Societies
- BIMCO
- Bureau of International Recycling
- Nautical Institute
- International Association of Maritime Institutions
- International Federation of Shipmasters' Associations
- ICHCA International Limited

The organisations have been requested to promulgate to their members the issues identified, actions taken and the recommendations made in this report.

**MAIB** has also:

Produced a Safety Bulletin (**Annex 6**) making recommendations to:

- Ship owners, managers, industry bodies and organisations to individually and collectively raise awareness of the high incidence of fatalities in enclosed spaces, and to identify and implement measures aimed at improving the safety of personnel in such spaces.
- The Maritime and Coastguard Agency, to co-sponsor with the Maritime Administration of Vanuatu, a submission to the IMO aimed at raising awareness of the issues and highlighting the need for further measures which reduce the unnecessary loss of life.

## SECTION 5 - RECOMMENDATIONS

**Leipaja Juros Birojs Ltd.** is recommended to:

- 2008/154      Review the design of the forward cargo ventilation system on board *Sava Lake*, and her sister vessel, to remove the potential hazard of the common air path between the forward store and cargo hold.
- 2008/155      Review its Safety Management System to:
- Identify all dangerous and potentially hazardous spaces on board its vessels.
  - Include procedures and equipment for safe entry into closed, and therefore potentially hazardous, spaces.
  - Define maintenance roles and responsibilities for cargo ventilation equipment.
  - Ensure that masters and relevant shore staff are fully aware of the vessel's *Document of Compliance – Special Requirements for ships Carrying Dangerous Goods*.

**The Bureau of International Recycling and ICHCA International Limited, International Chamber of Shipping and Institute of Chartered Shipbrokers** are recommended to:

- 2008/156      Promulgate to members the importance of industry best practice for the correct identification of cargoes and the provision of the appropriate cargo documentation in accordance with international rules.

**September 2008**  
**Marine Accident Investigation Branch**