



**Bundesstelle für Seeunfalluntersuchung**  
**Federal Bureau of Maritime Casualty Investigation**  
Federal Higher Authority subordinated to the Ministry of Transport  
and Digital Infrastructure

Investigation Report 255/12

**Very Serious Marine Casualty**

**Fire and explosion on board the  
MSC FLAMINIA on 14 July 2012  
in the Atlantic and the ensuing  
events**

28 February 2014

The investigation was conducted in conformity with the law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law - SUG) of 16 June 2002, amended most recently by Article 1 of said Law dated 22 November 2011, BGBl. (Federal Law Gazette) I p. 2279.

According to said Law, the sole objective of this investigation is to prevent future accidents and malfunctions. This investigation does not serve to ascertain fault, liability or claims (Article 9(2) SUG).

This report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to Article 34(4) SUG.

The German text shall prevail in the interpretation of this investigation report.

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## A. SUMMARY

The German-flagged full container ship MSC FLAMINIA was en route back from the east coast of the United States to Europe. The ship sailed out of the port of Charleston on 8 July 2012. There were 23 crew members and two passengers on board. 2,876 containers of various sizes were stowed on the ship. 149 of these containers were carrying dangerous goods.

At 0542<sup>1</sup> on 14 July 2012, a sample extraction smoke detection system alarm sounded on the bridge. The alarm indicated smoke in cargo hold 4. The lookout sent from the bridge to the cargo hold confirmed there was fire in the hatch. Following that, the officer on watch sounded the general alarm. After everybody was accounted for, closed-down state was established around cargo hold 4. From 0642, CO<sub>2</sub> was discharged into the affected cargo hold to fight the fire. The area around cargo hold 4 was to be cooled down later. A team of seven crew members was working in this area to make the necessary preparations when a heavy explosion occurred at 0804. This was accompanied by the rapid development of the fire. One seaman was missing and four more were injured, some seriously, because of this explosion. All the members of the team were isolated on the fore section. The ship's command decided to abandon the ship due to the overall circumstances. After some difficulty in launching the lifeboat, the boat reached the fore section and took the team there on board. One member of the team was lowered down in an activated life raft due to his very severe injuries.

The crew of the MSC FLAMINIA was taken on board the tanker DS CROWN at about 1100 on the same day. The very seriously injured crew member died shortly afterwards on board the tanker. The other casualties were transferred from there to the MSC STELLA to take them to the area of a rescue helicopter from the Azores more quickly. One of the casualties later died in a specialised hospital in Portugal.

All the other crew members of the MSC FLAMINIA and the passengers disembarked from the tanker in Falmouth on 18 July 2012.

The vessel operator, NSB Niederelbe Schiffahrtsgesellschaft mbH & Co. KG, concluded a contract with the salvor, SMIT Salvage, on 14 July 2012. SMIT deployed three salvage tugs for the operation. These took over the task of fighting the fire on the MSC FLAMINIA and towing the ship towards Europe.

Supported by the three tugs, the stricken vessel was initially towed to a central position off the coast of western Europe in the following ten days. Her distance to the coasts of Ireland, southwest England, northwest France and the northwest of the Iberian Peninsula was between 200 and 300 nautical miles. During the towing operation, fire-fighting was carried out from the sea, later also by salvage team members on board the MSC FLAMINIA weather permitting. While these activities were ongoing, the salvor gradually contacted various European coastal States and

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<sup>1</sup> Unless stated otherwise all times shown in this report are UTC.



ports with the aim of having a place or port of refuge allocated. The flag State, Germany, took responsibility and the initiative for granting a place of refuge on 15 August 2012. This was the result of wide-ranging activities and dialogue, which appeared to be contradictory at times, involved different agencies to varying degrees, were accompanied by the stricken vessel's rapidly evolving situation and difficult weather conditions, and in the course of which the tow spent several weeks moving off the coast of western Europe. The first meeting between the representatives of the salvor and Germany took place on 17 August 2012.

As a result of the successful inspection of the stricken vessel off the south coast of England by British, French and German experts on 28 August 2012, the immediate movement of the MSC FLAMINIA to a port of refuge in Germany was considered the best solution for managing the remainder of the crisis. This was put into effect on 2 September 2012 with the start of the towing operation. On 9 September 2012, eight weeks after the fire broke out on board the ship, the MSC FLAMINIA made fast in Wilhelmshaven, where she was, as far as was technically possible, unloaded and cleared of debris and pollutants during a very complicated process that lasted several months before starting her voyage to Romania for repairs on 15 March 2013.

## B. FACTUAL INFORMATION

### 1. Ship Photo



Figure 1: Photo of the MSC FLAMINIA taken on 22/08/2012

### 2. Ship Particulars

Name of vessel:	MSC FLAMINIA
Type of vessel:	Container ship
Nationality:	German
Port of registry:	Hamburg
IMO number:	9225615
Call sign:	DHZR
Owner:	Conti 11. Container Schiffahrts-GmbH & Co. KG 'MSC FLAMINIA'
Operator:	NSB Niederelbe Schiffahrtsgesellschaft mbH & Co. KG
Year built:	2001
Shipyard/Yard number:	Daewoo Shipbuilding & Marine Engineering Co Ltd. – Geoje/4073
Classification society:	Germanischer Lloyd
Length overall:	299.9 m
Breadth overall:	40.00 m
Gross tonnage:	75,590
Deadweight:	85,823 t
Draught (max.):	14.5 m
Engine rating:	57,100 kW
Main engine:	B&W Hyundai Heavy Industries Co Ltd. 1 x 10K98MC-C
(Service) Speed:	25.5 kts
Hull material:	Steel
Hull design:	Double bottom, wing tanks
Minimum safe manning:	18

### 3. Voyage particulars

Port of departure:	8 July 2012, Charleston, United States
Port of call:	Scheduled: 16 July 2012 in Antwerp, Belgium
Type of voyage:	Merchant shipping/international
Cargo information:	2,876 containers of various sizes
Manning:	23
Draught at time of accident:	$D_f = 13.37$ m, $D_a = 13.62$ m
Number of passengers:	Two

### 4. Marine casualty or incident information

Type of marine casualty:	Very serious marine casualty; fire and explosion in cargo hold
Date, time:	14 July 2012, 0804 (explosion)
Location:	Atlantic
Latitude/Longitude:	$\phi 48^{\circ}13.8'N$ $\lambda 027^{\circ}57.9'W$
Ship operation and voyage segment:	Open sea
Place on board:	Cargo hold 4
Consequences:	Three fatally and two severely injured crew members, structural fire damage to ship, cargo damage



**5. Shore authority involvement and emergency response**

Agencies involved:	Agencies and port authorities from the United Kingdom, Ireland, France, Belgium, the Netherlands, Spain, Portugal, and Germany, MAR-ICE network
Resources used:	The French ARGONAUTE, various surveillance aircraft and helicopters, German multi-purpose ship NEUWERK, various expert teams
Action taken:	<p>Mutual information and coordination on required action between the salvor, the operator of the ship and involved States under the leadership of the British SOSREP.</p> <p>Air surveillance in respect of the course of the fire, condition of the ship, and leaking pollutants.</p> <p>Transportation of the international fact-finding team by the ARGONAUTE.</p> <p>Monitoring of the stricken vessel and transportation of the German fact-finding team by the NEUWERK.</p> <p>Assumption of overall control of the operation by the German Central Command for Maritime Emergencies (CCME) when the tug and tow entered German territory</p>
Results achieved:	Provision of a port of refuge by Germany

## C. FIRE ON THE MSC FLAMINIA

### 1 COURSE OF THE ACCIDENT AND INVESTIGATION

#### 1.1 Course of the accident

##### 1.1.1 Outbreak of fire and abandoning the ship

The German-flagged MSC FLAMINIA was engaged in a regular service connecting ports in west Europe with ports on the southeast coast of the United States, Mexico, and the Bahamas by the charterer Mediterranean Shipping Company (MSC). Charleston in the United States was the last port of loading/unloading before the crossing to Europe. The ship cast off from there at 2030 ship time (UTC -4) on 8 July 2012. There were 2,876 containers of various sizes on board. Converted into twenty-foot equivalent units<sup>2</sup> (TEU), 4,805 containers were on board. The pilot position of the port of destination (Antwerp) should have been reached at about 2100 on 16 July 2012.

23 crew members were employed on board. In addition, two passengers were travelling to Europe.

With the exception of two fire alarms in the area of the engine room, which proved to be false, and a black out on the night of 12 to 13 July 2012 due to an overload caused by a fault in the auxiliary engine's control system, the voyage was uneventful up until 14 July 2012.

The crew carried out a scheduled fire-fighting drill on 13 July 2012, which involved fighting a fire in a dangerous cargo container on deck.

During an inspection of the reefer container temperatures<sup>3</sup> on deck at about 1600 on 13 July 2012, a crew member also passed the passage on deck between cargo holds 3 and 4. It appears that no irregularities requiring appropriate action were noted.

Since there were no particular technical problems, the engine room was unmanned on the night of 13 to 14 July 2012, too.

Watches were not set that night. Ship time corresponded to UTC.

On Saturday 14 July 2012, the 00-04 watch was carried out by the second officer and an able bodied seaman tasked as lookout. A safety round of the superstructure by the able bodied seaman that started at 0200 was uneventful. At about 0400, the navigational watch was taken over by the chief officer and another able bodied seaman as planned. At this point, the course steered was 76° on a great circle; the ship sailed at about 20 kts speed over ground. The wind blew at 3 Bft from the west and thus from an aft direction. Swell was low. Air temperature was 16°C and water temperature was 15°C.

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<sup>2</sup> Corresponds to a 20-foot ISO container.

<sup>3</sup> Slot positions 220282 and 220284.

At 054218, an alarm sounded on the sample extraction smoke detection system's display for the cargo holds on the bridge. The alarm indicated smoke in cargo hold 4. Following that, the chief officer sent the able bodied seaman to cargo hold 4 to verify the situation at the scene and he confirmed that smoke was coming out of the cargo hold by means of his portable radio. As a result, the chief officer sounded the general alarm for the entire crew at about 0550. He also used the internal communication system to inform the crew that this was not a drill. At this point, with the exception of the navigational watch, as well as the cook and the steward, who were already working, all the crew members and passengers were in their quarters as work was not supposed to begin until 0800 on that day.

The master went to the bridge after the alarm was sounded, from where rising white smoke was clearly visible in the area of cargo hold 4, as it was now daylight. The chief technical officer and the electronics engineer manned the engine control room (ECR). The second nautical officer accounted for all the crew members and passengers on the muster station.

Shortly afterwards, the course of the ship was altered such that the wind blew from the starboard side. This was to protect the muster station located on the starboard side of A-deck from combustion gases. In addition, the master started to shut down the main engine at 055833.

Members of the support unit were given instructions to establish the closed-down state at cargo hold 4. After that, they returned to the assembly station at the storage room for the fire-fighting equipment (safety store). Meanwhile, the defense unit donned their equipment.

The main engine was stopped at 0621. The air conditioning system and all the ventilation fans inside the accommodation were turned off by about the same time.

The ship's command decided to discharge CO<sub>2</sub> into cargo hold 4. The crew started to discharge the CO<sub>2</sub> at 0642. At the same time as the discharge into the cargo hold was started, the CO<sub>2</sub> alarm for the engine room actuated. As a result of this, the auxiliary boiler and the auxiliary fan for the main engine turned off automatically. The actuation of the CO<sub>2</sub> alarm for the engine room was unintentional. The technical officers were unable to identify the cause. They were occupied with restarting the systems in order to start the main engine up until the ship was abandoned. For this reason the second and third technical officers, were tasked as support unit and additional unit leaders, they were no longer available for their actual task while fighting the fire.

After some time, CO<sub>2</sub> was discharged into cargo hold 4 again.

The area around cargo hold 4 was to be cooled down later. To achieve this, a team of seven crew members went forward and started to prepare the fire hoses under the leadership of the chief officer. As this task was being carried out, a very heavy explosion occurred in the area of cargo hold 4 at 0804. Due to the explosion, four members of the team were injured, some critically, and one member was missing. Several containers fell overboard or into the passages on both sides of the ship. The smoke increased rapidly. The team on the fore section was cut off due to the smoke and toppled containers.

Due to the situation, the ship's command decided to abandon the ship and a mayday message was transmitted on VHF channel 16 at 0827. This was picked up by the Bahamian tanker DS CROWN, which was about 30 nm away. Following that, the tanker altered course, sailed towards the distressed ship, and sent a mayday relay message, which was picked up by MRCC Falmouth.

The crew situated in the aft section of the MSC FLAMINIA occupied the lifeboat on the port side first of all. However, it was not possible to lower her into the water because containers were drifting in this area. Therefore, the crew moved to the boat on the starboard side, where she was lowered into the water with some difficulty. After casting off, they headed for the forward part of the ship to take up the team located there. The uninjured seamen had deployed a pilot ladder on the starboard side via which the two slightly injured casualties and the seriously injured casualty reached the lifeboat. The life raft located on the fore section was then cast into the water and activated. The critically injured crew member was lowered into that and then cared for by an uninjured team member from the fore section. After all the crew members had abandoned the ship, the life raft was taken in tow by the lifeboat and both moved away from the MSC FLAMINIA.

### **1.1.2 Assistance**

During his watch at 0828 on 14 July 2012, the chief officer of the DS CROWN became aware of the distress call transmitted on VHF channel 16 by the MSC FLAMINIA<sup>4</sup>. Therefore, it was known that an explosion had occurred and that the crew intended to abandon the ship. Immediately afterwards, he informed the master. The master of the DS CROWN sought contact on VHF unsuccessfully. Using the AIS information, he was able to see that the MSC FLAMINIA was approximately 30 nm away. The DS CROWN then altered course and increased her speed. At 0910, a mayday relay message was forwarded to MRCC Falmouth via FleetBroadband<sup>5</sup> and in the form of an email. The lifeboat from the MSC FLAMINIA was sighted at 1020 at a distance of about 6.5 nm. The crew of the DS CROWN had prepared for taking the casualties on board during the approach.

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<sup>4</sup> Statements made by the ship's command of the DS CROWN were kindly provided by her operator, V.Ships (Germany) GmbH.

<sup>5</sup> Satellite-based communication system of Inmarsat Ltd.



The loading and discharging crane amidships on the starboard side was ready and the gangway together with pilot ladder deployed. At 1048, the lifeboat and life raft were alongside the DS CROWN, where they were made fast using lines. The two slightly injured casualties, the seriously injured casualty, and the two passengers were lifted onto the deck of the DS CROWN using the crane and a personnel transfer basket.

In the case of the life raft, a sling was pulled through the roof, which was then attached to the crane. This made it possible to carry the critically injured casualty on board the DS CROWN without additional movement, even though the roof of the raft not actually designed for that. All other crew members of the MSC FLAMINIA reached the deck of the DS CROWN via the pilot ladder/gangway combination. All the crew members of the MSC FLAMINIA were picked up by 1208. The lifeboat was allowed to drift.

At this point, two different smoke clouds could be seen (Figure 3) above the MSC FLAMINIA. One was black/grey in colour and seemed to come from the open flames above cargo hold 4. The other was light grey. It was located below the other cloud and was more fog-like in structure. It appeared to come from a source further below in cargo hold 4.



Figure 3: MSC FLAMINIA seen from the DS CROWN

On board the DS CROWN, the slightly injured casualties and the seriously injured casualty were taken to the hospital immediately and cared for there. The critically injured chief officer was, inter alia, immediately treated with oxygen on deck and later also taken to the hospital. To ensure the medical treatment given to the chief officer was acceptable, the crew of the DS CROWN subsequently contacted the UK Radio Medical Advice Service by phone via MRCC Falmouth. In spite of all efforts made, the chief officer succumbed to his injuries on board the DS CROWN at about 1400.

Since the DS CROWN was only able to proceed at a low speed (12 kts), MRCC Falmouth assisted in organising the transfer of the casualties to the faster Panamanian container ship MSC STELLA so as to cover the route to the Azores and the rescue helicopter based there more quickly.

The MSC STELLA reached the DS CROWN at 1611. The casualties were transferred to the MSC STELLA's lifeboat using the personnel transfer basket. The transfer was completed at 1645.

Since the missing crew member was neither sighted on deck nor on the surface of the water and on the assumption that he did not survive the explosion, a decision was made to break off the SAR operation at 1706 on 14 July 2012 after consultation between MRCC Falmouth, the master of the MSC FLAMINIA, and the master of the DS CROWN. The ships involved were stood down and the DS CROWN continued her voyage to Falmouth. The MSC FLAMINIA was left drifting.

The casualty transfer between the MSC STELLA and the Portuguese rescue helicopter from the Azores was organised by MRCC Delgada in conjunction with RCC Lajes. The helicopter was assisted in its task by a C-295 reconnaissance aircraft. The casualties were taken on board the helicopter at about 0630 on 15 July 2012 and flown to Lajes Airbase, from where they were flown to a hospital in Ponta Delgada on the main island.

The seriously injured crew member was taken to a specialised hospital on the Portuguese mainland a few days later, where he died some time later.

The DS CROWN reached the roads of Falmouth, United Kingdom, on the night of 18 to 19 July 2012. When they were ashore, all the crew members and passengers were examined by a physician and looked after by the local seaman's mission. For the investigation into the cause of death of the chief officer and the missing able bodied seaman, local police officers interviewed all the crew members and passengers.

The vessel operator, NSB, concluded a salvage contract for the MSC FLAMINIA with the Dutch SMIT Salvage immediately on 14 July 2012. In turn, SMIT chartered the salvage tugs FAIRMOUNT EXPEDITION, ANGLIAN SOVEREIGN, and CARLO MAGNO.

The first salvage tug, the FAIRMOUNT EXPEDITION, arrived at the MSC FLAMINIA on 17 July 2012 and began to fight the fire. The third tug, the CARLO MAGNO, was at the scene on 21 July 2012.

The assist the salvor in its work on board the MSC FLAMINIA, the second technical officer of the HANJIN OTTAWA, a ship also operated by NSB, was ordered to board the salvage tug. The HANJIN OTTAWA reached the MSC FLAMINIA on the morning of 17 July 2012 and waited there for the arrival of the first salvage tug.

A salvage team entered the MSC FLAMINIA for the first time on 20 July 2012. On the same day, the salvage team established a towing connection with the FAIRMOUNT EXPEDITION.

The factual and legal issues connected with salvaging the ship are a subject of the separate part D of this investigation report.

### 1.1.3 Damages

Due to the explosions and fire, the ship and the cargo in the area of cargo holds 3 to 7 were damaged to varying degrees. The ship's structure was significantly weakened in this area and needs to be replaced. Extinguishing water entered the bridge and rendered part of the electronic systems installed there unserviceable.

The containers in bays 26 to 46, where the hatch covers lost their structural strength due to the temperatures generated and fell into the cargo holds together with the containers on them, sustained very heavy damage.

Also due to the high temperatures generated, the watertight transverse bulkhead between cargo holds 4 and 5 was destroyed. The supporting transverse bulkheads between bays 26/30, 34/38, and 42/46 were destroyed or very heavily damaged.



Figure 4: Starboard side of the MSC FLAMINIA

Due to the extinguishing work and cooling of the cargo and the ship, water was in all the cargo holds, except for cargo hold 2, at least temporarily. While entering Wilhelmshaven, there was water in cargo holds 1, 3, 4, 5, 6, and 7. This was several metres high and heavily contaminated in places. In addition, the salvor pumped extinguishing water into some of the ship's tanks. Inter alia, this was done to reduce the initial maximum draught from 19 m to 16 m for the entry into Wilhelmshaven and to counteract the initial 11° list.

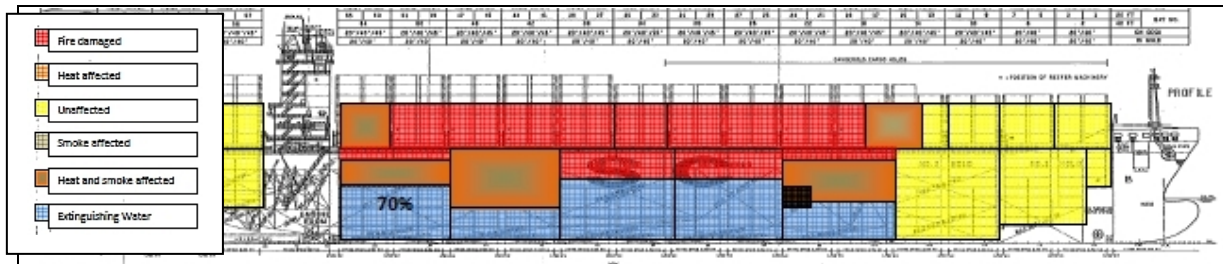


Figure 5: Areas affected by fire, smoke or water (SMIT, information as of 28/08/2012)

## 1.2 Investigation

### 1.2.1 Start of the investigation

The BSU's duty investigator on call was informed about the events on the MSC FLAMINIA by the DPA<sup>6</sup> of the vessel operator, NSB, at about 1200 on 14 July 2012. As events unfolded, the vessel operator gave prompt notification of the developments and action taken by it and the salvor. After the necessary contacts were established with other authorities, SOSREP<sup>7</sup> in particular, the investigators were also informed of progress from there.

The BSU notified the vessel operator of its intention to speak with all relevant members of the crew at an early stage. The vessel operator acknowledged this. Having regard to the mental strain on the crew members, interviews by the BSU immediately in Falmouth were dispensed with in consultation with the vessel operator and subject to certain conditions. The vessel operator did not adhere to the agreement subsequently as it did not provide the BSU with the opportunity to select crew members for interviewing. In the end, the investigators were able to speak with the following crew members at the offices of the vessel operator: master, chief technical officer, first and second technical officer, and second officer. In addition, the assistant officer and the ship mechanic were interviewed at the premises of the BSU.

The interview with the two casualties on the Azores was obstructed initially by the complicated healing process and later by their sudden transportation home in the Philippines. This meant that no crew member who was in the immediate vicinity of the explosion could be interviewed directly. The attempt to establish direct contact with the Philippine crew members by email as the investigation progressed was to no avail because of continuing poor health.

The transcripts of the police interview in Falmouth were placed at the disposal of the BSU by the authorities there. The police questioning focused mainly on the ascertainment of the circumstances of death, missing and the injuries of crew members.

<sup>6</sup> DPA = Designated person ashore; see also SOLAS Chapter IX and IMO Resolution A.741(18) – International Safety Management Code.

<sup>7</sup> SOSREP = Secretary of State's Representative for Maritime Salvage and Intervention, UK.

One of the passengers also gave a detailed statement.

To gain an impression of the conditions on board the MSC FLAMINIA beforehand, the vessel operator, NSB, organised a survey of the sister ship, MSC ALESSIA, on 27 August 2012 in Hamburg. She is fitted with an identical sample extraction smoke detection system and CO<sub>2</sub> extinguishing system.

After the MSC FLAMINIA arrived at her place of refuge in Wilhelmshaven at about 1800 on 9 September 2012, the ship was surveyed from the outside by a team from the BSU using a passenger-carrying basket under a container gantry crane for the first time on 11 September 2012. The investigators entered the ship on 12 September 2012. The survey was performed in consultation with the CCME, which still had overall control of the operation, as well as the competent public prosecutor's office in Hamburg, which at this point had custody of the ship because investigations were still ongoing in relation to the deceased, injured and missing crew members. A private security company guarded the ship at this point and access was controlled. While on board, the investigators found that important documents, such as nautical charts and logs, were no longer on the ship and that pages relevant to the time of the accident had been removed from documents. The master's quarters gave the impression of having been searched.

On being questioned, the vessel operator later confirmed that documents had been removed from the ship. Advice received from the vessel operator's English law firm was the justification given for this. The vessel operator submitted a list of the documents removed to the BSU and made them available to the investigators at a later date.

The BSU team entered and documented the important areas of the ship. These included the bridge, engine room, CO<sub>2</sub> room, and CO<sub>2</sub> release station in the superstructure, as well as the main deck. The voyage data recorder's final recording medium located on the observation deck was dismantled and taken into custody. A memory card from the voyage data recorder, various documents, memory sticks and cameras were also taken into custody.

Furthermore, during another survey of the vessel on 19 September 2012, the voyage data recorder's central processing unit was removed and taken into custody.

## **1.2.2 MSC FLAMINIA**

### **1.2.2.1 Manning**

The crew of the MSC FLAMINIA consisted of 23 people of different nationalities: three Poles, five Germans, and 15 Filipinos. In addition, one American and one Irish national were on board as passengers.

As with all the officers, the deck and engine crew had years of professional experience. That also applies to the vast majority of the remaining crew members.

The bridge crew had a four on/eight off watchkeeping schedule during the voyage. The engine room was unmanned at night.

During the interview, the atmosphere on board was described as friendly and without any conflict.

### 1.2.2.2 Ship

The MSC FLAMINIA is a Post-Panamax container ship with seven cargo holds forward of the superstructure and one cargo hold aft of the superstructure. The ship can carry 6,732 TEU of which 3,558 TEU can be carried on deck. There are 400 connections for reefer containers available on deck.

Cargo holds 1 to 7 are separated by watertight transverse bulkheads, which exhibit, due to their construction, no particular resistance to fire (fire classification A-0). Cargo holds 1 to 7 can each accommodate two 40' containers or four 20' containers in a longitudinal direction in the hatch and on deck. Here, each cargo hold has supporting transverse bulkheads (passable on foot) and lashing bridges on deck, both at 40' intervals. For cargo hold 4, this actually means that a passable, scaffold-like system covering several levels is installed at its aft edge (see Figure 7). This allows for the accessibility of the containers. The similarly designed passable supporting transverse bulkhead is located forward at a distance of 40'. The forward edge of the cargo hold is smooth. Consequently, the 40' containers stowed in the cargo hold are accessible from one side at least. That also applies to the carriage of 20' containers in the aft section of the cargo hold. However, the 20' containers at the forward edge of the cargo hold (bay 25) are not accessible.

Cargo holds 2 to 7 are each covered by six hatch covers; three covers always span the breadth of the ship (see also Figure 6). Cargo holds 1 to 4 are allowed for the carriage of particular categories of dangerous goods.

All the cargo holds are equipped with cell guides. These are vertical steel rails that facilitate loading and keep the containers in their position. This means that the containers need not be secured in the cargo holds.

The ship has a double bottom along her entire length. The tanks located there are designed specifically as ballast water tanks. Wing tanks are installed in the area of cargo holds 2 to 7. These are used for storing fuel in the area of cargo holds 6 and 7, as well as parts of 3 and 4. The tanks in the area of cargo hold 5 and parts of cargo hold 4 are used for ballast or to compensate for heeling when the ship is being loaded (heeling tank).

The ship has passageways on each side. These tunnel-like passages can be used for sheltered movement from the bow to the stern below the main deck. A closable entrance to the engine room from the passageway is present on both sides of the ship.

The superstructure spans nine decks.

The ship was equipped with two enclosed lifeboats, one on each side of the superstructure. These could be lowered into the water using conventional gravity davits. Two life rafts were also positioned on each side. An additional life raft was located at the forward edge of cargo hold 1<sup>8</sup>.

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<sup>8</sup> SOLAS Chapter III Regulation 31.1.4.

Ref.: 255/12

The MSC FLAMINIA was equipped with a simplified voyage data recorder<sup>9</sup> made by SAM Electronics GmbH. The analysis of the recording of the MSC FLAMINIA's voyage data recorder did not deliver any results. There were two reasons for this. Firstly, the crew did not activate an emergency backup before abandoning the ship. Secondly, auxiliary engine 1 was still running when the ship was abandoned. Consequently, the ship was supplied with power for 24 hours thereafter, resulting in the data for the accident period being overwritten in the voyage data recorder.

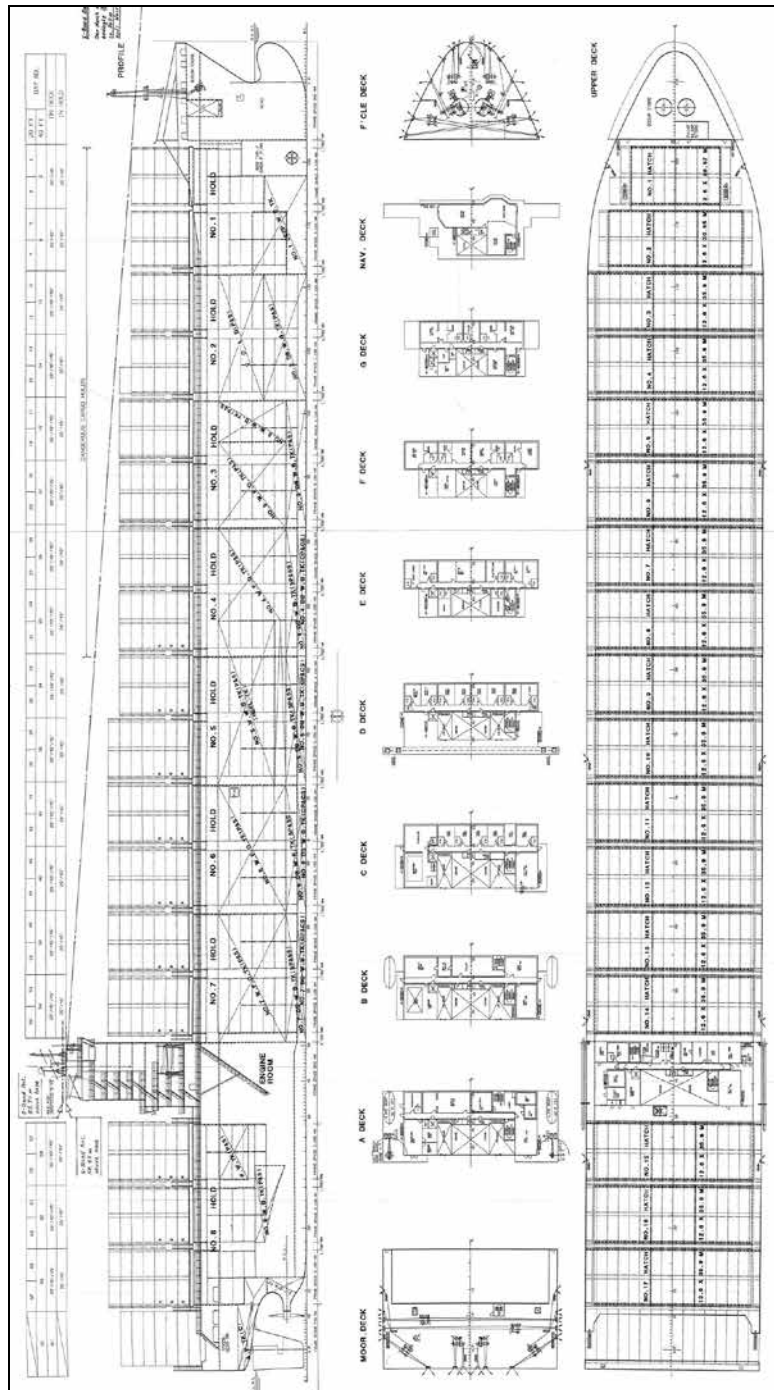


Figure 6: Ship plan for the MSC FLAMINIA

<sup>9</sup> Simplified voyage data recorder (S-VDR).

### **1.2.2.3 Sample extraction smoke detection system**

The permanently installed sample extraction smoke detection system – a visual smoke detection system – was used to detect fire in the cargo holds<sup>10</sup>. This was a type ST-960 system made by Scantec Engineering. To detect smoke, air from each cargo hold was extracted at two positions at the forward and aft edge and level with the supporting transverse bulkhead (Figure 7).

The six sampling points were then combined such that two fire alarm lines were present in each cargo hold. The pipes from all the cargo holds were directed to the CO<sub>2</sub> room in the stern of the ship. The equipment for suction the air and the gauging electronics (Figure 8) were located in a cabinet there. The gauging electronics in this system controls the presence of a continuous airflow for each alarm line, as well the presence of soot particles in the extracted air. Two independent measuring techniques are used in two measuring chambers to enhance detection reliability. A component belonging to the smoke detection system was installed on the bridge, which made it possible to display alarms and monitor the system.

The sample extraction smoke detection system installed for the cargo holds was equipped with a means of storage. However, the memory was not designed to retain data after a power failure. Since several power failures occurred after the ship was abandoned, the memory was empty at the time of the investigation. Inasmuch, it was no longer possible to state which alarm line actuated the fire alarm in cargo hold 4.

The alarm actuated by the sample extraction smoke detection system was recorded in the ship's alarm/event log as a general alarm with no further differentiation at 054218. The investigators have a printout of this on hand. However, this first alarm was registered as no longer present in the alarm/event log at 054253. At 060441, it sounded again. Ten seconds later, the alarm was no longer present and as things progressed no longer listed.

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<sup>10</sup> SOLAS Chapter II-2 Regulation 54.2.3 – Detection system





Figure 7: Sister ship (MSC ALESSIA). Aft edge of cargo hold 4, lashing bridge, middle hatch cover, improvement and intake vent for sample extraction smoke detection system



Figure 8: Identical sample extraction smoke detection system (MSC ALESSIA)

### 1.2.2.4 CO<sub>2</sub> fire-extinguishing system

In her statement concerning the draft report the shipping company declared: the maker submitted the CO<sub>2</sub> fire-extinguishing system for approval to the classification society, the classification society made an approval of drawings and, after construction, the system was tested at the yard. Reportedly, later on, the system was regularly tested by a service company respectively the classification society.

The maker of the CO<sub>2</sub> fire-extinguishing system was the Korean company Fain. Thereby that the used components of the German company Noske-Kaeser they operated under the name Fain-Noske-Kaeser at that time. Noske-Kaeser stated, that the cooperation was limited to the supply of components. The drawing up of building design and the assembling were carried out on the sole responsibility of Fain.

A CO<sub>2</sub> fire-extinguishing system consists generally of the hardware modules CO<sub>2</sub> bottles, release station and piping system.

On the MSC FLAMINIA the CO<sub>2</sub> fire-extinguishing system for the engine room had two release stations. One was located on the main deck. It was also possible to operate the emergency shut-offs for the fuel pumps and quick actuating closures for the fuel tanks from there. The other release station was located next to the steering gear compartment at the stern of the ship together with the CO<sub>2</sub> cylinders and the release station for the cargo holds. Emergency release for the engine room was also possible there.

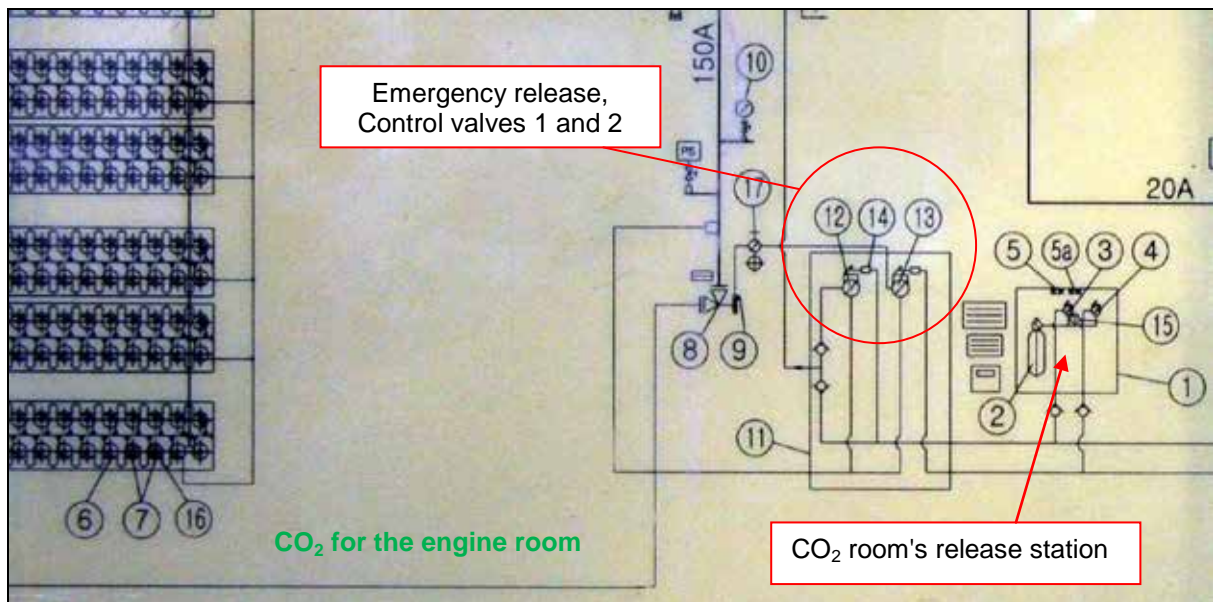


Figure 9: Excerpt from the schema – CO<sub>2</sub> for the engine room

In order to avert the uncontrollable and unnoticed release, respectively, of the odorless CO<sub>2</sub>, into the engine room or into the cargo holds, the respective release processes are technically secured protected and connected with the activation of an audible alarm. At the same time the ventilators of the respective rooms are switched off, in order to avoid the immediate ventilation of the gases.

Ref.: 255/12

Audible alarm and shutdown of the ventilators in the engine room are connected with opening of the door of one of both releasing stations.

Ventilation fans 1 to 4 for the engine room, the additional ventilation fans 1 to 3 for the main engine, the ventilation fan for the auxiliary boiler, and several other ventilation were shutdown in this way on MSC FLAMINIA.

An ordinary switch cabinet key was necessary to open the cabinet; however, this was stored in a separate box (Figure 10). A glass panel had to be destroyed with the hammer provided to obtain the key. The investigators determined that the glass panes at both releasing stations of MSC FLAMINIA were undamaged. Therefore it could be almost ruled out that an audible alarm and shutdown of the ventilators were triggered by opening a door.

In contrast with this the investigators determined during the survey of the MSC FLAMINIA that the position of the pilot valves 1 and 2 for the emergency release deviated from the normal position, in other words, they were open (figure 10). Part of the emergency release of the engine room is the manual actuation of the control valves 1 and 2.

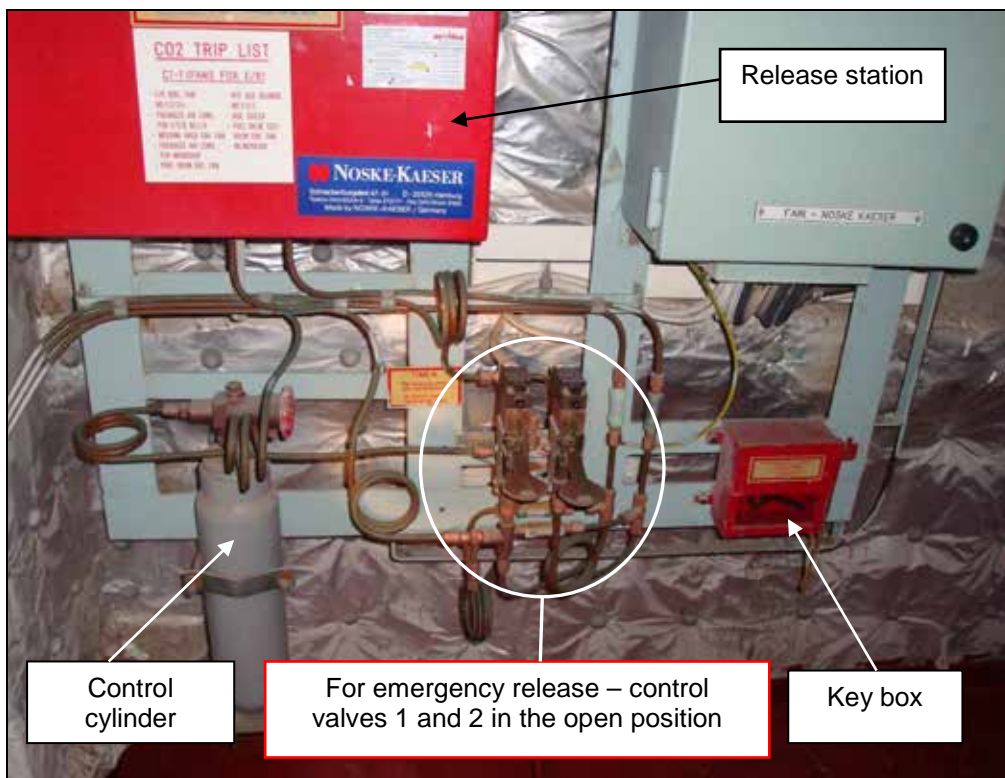


Figure 10: MSC FLAMINIA, release station in the CO<sub>2</sub> room, control valves, control cylinder, and key box



Figure 11: MSC ALESSIA – control valves 1 and 2 in the normal position (closed)

The fact that both valves seemed to have been activated manually, was initially interpreted by the investigators to that effect that it was an operating error of the crew. It was assumed, that the actuation of the pilot valves led to the activation of the electrical connections connected with them which in return triggered the alarm and shut down the ventilators. In contrast the vessel's operator advised the BSU in its statement supplied in December 2013 of the fact that an inspection of the releasing station in June 2013, carried out by the vessel's operator and Noske-Kaeser, revealed that an incorrect installation of pipes was the cause for the malfunction of the releasing station. Representatives of Noske-Kaeser confirmed this on inquiry of the BSU. Additionally it was made clear that in all likelihood the error already existed since the installation of the system. However, the error should have been detected with a proper acceptance of work. The error should also have been detected during regular inspections of the system.

In order to explain the erroneous release of the control valves 1 and 2, the normal CO<sub>2</sub> release process for the engine room is hereafter described. This is necessary in this respect since the incorrect assembly of the station, which is actually only indirectly affected when releasing the CO<sub>2</sub> for the cargo holds, was now directly involved.

Ref.: 255/12

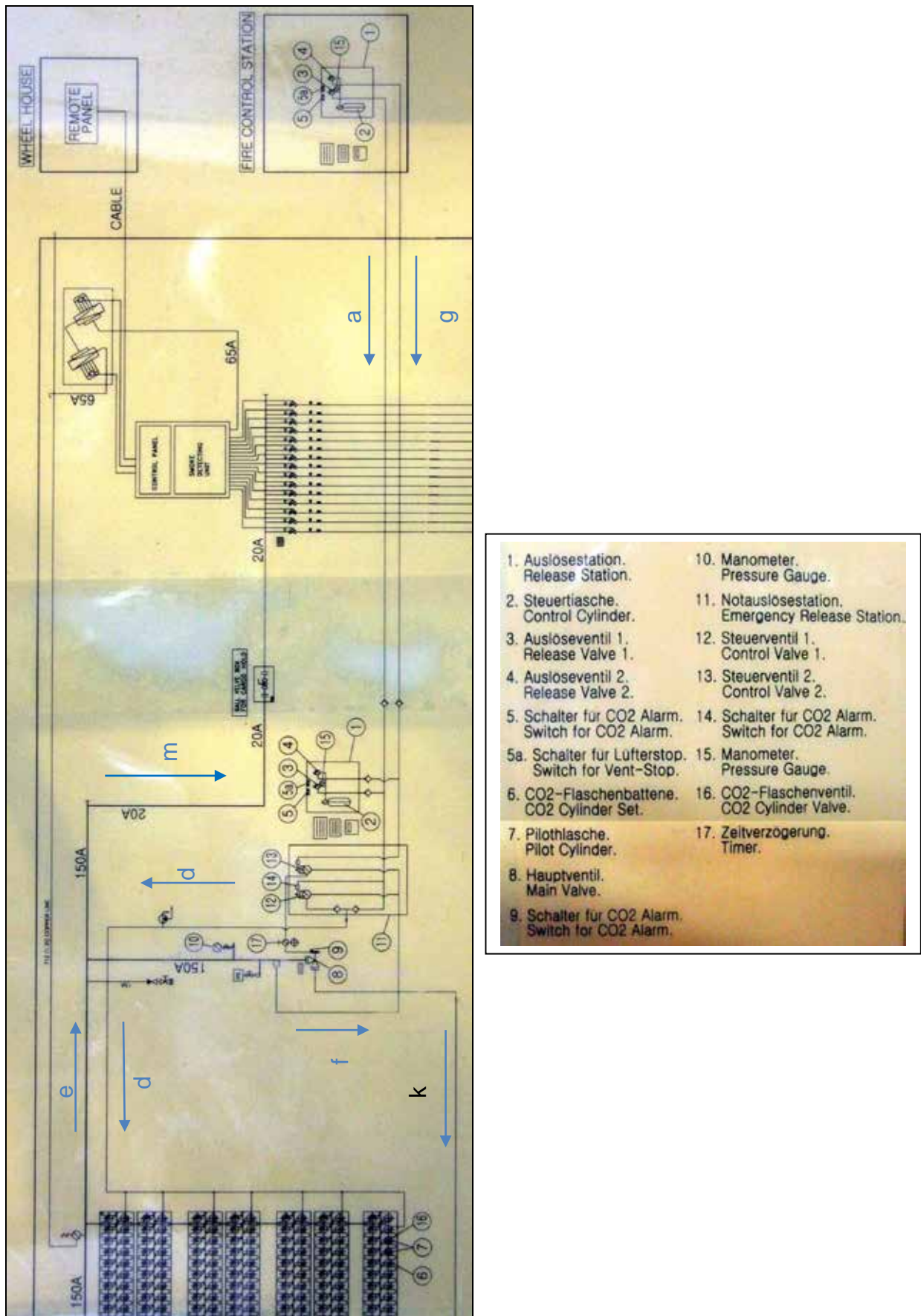


Figure 12: Detail of the CO<sub>2</sub> fire extinguishing system plan and the parts of the CO<sub>2</sub> system



After the filling of the timer cylinder, which requires at least 30 seconds, the pressure is transmitted through [i]. The main valve (8) then opens automatically. The CO<sub>2</sub> gas provided for extinguishing can then flood the engine room via [k].

The CO<sub>2</sub> fire extinguishing system for the cargo holds on board the MSC FLAMINIA could only be operated in the stern of the vessel. In a correct assembled system, the gas flows through the 150A-pipe [e] and the 20A-pipe [m] towards the distribution for the cargo holds, after the CO<sub>2</sub> has been released, in other words after the cylinders have been opened manual. At the same time the pressure is also applied to the main valve (8). However, the main valve remains closed in the further process. Via the lines [f] the full pressure also applies to the control valves 1 (14) and 2 (13). This is harmless since these are closed and remain closed. The pilot valves do not open when they are operated from this side.

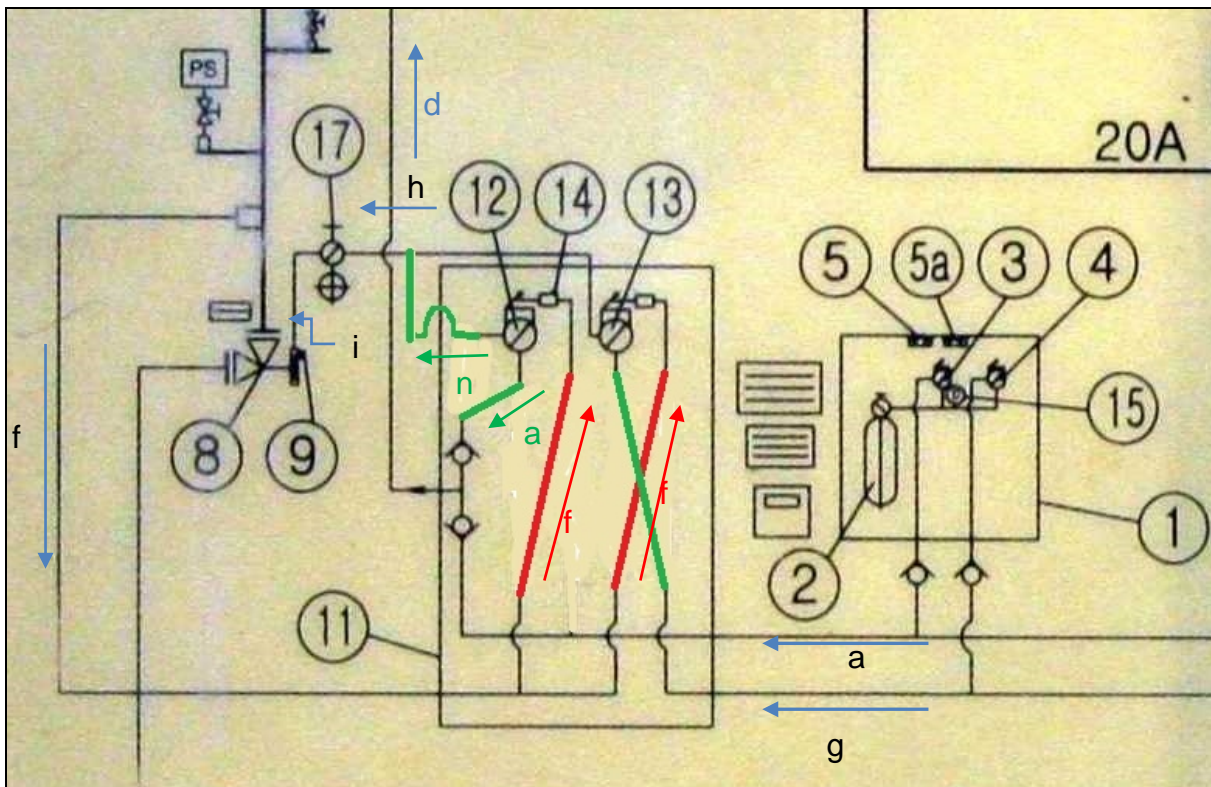


Figure 14: Piping schematic as assembled

Due to the incorrect assembly the pipes were connected like explained in figure 14. After opening the cylinders the CO<sub>2</sub> gas flew also into the 150A-pipe. The main valve was indeed closed but through the pipe (f) the full system pressure was also applied to the pneumatic pistons of the control valves 1 and 2. Thereby the control valves 1 and 2 were opened. Since there was no control pressure applied to the pipes [a] and [g], were neither further cylinders released nor the main valve to the engine room opened. Opening of the control valves only led to the triggering of the CO<sub>2</sub> alarm and the shutdown of the ventilators.

The plates with description of releasing CO<sub>2</sub> system, which were found at MSC FLAMINIA, were shown hereinafter (figures 15 and 16).

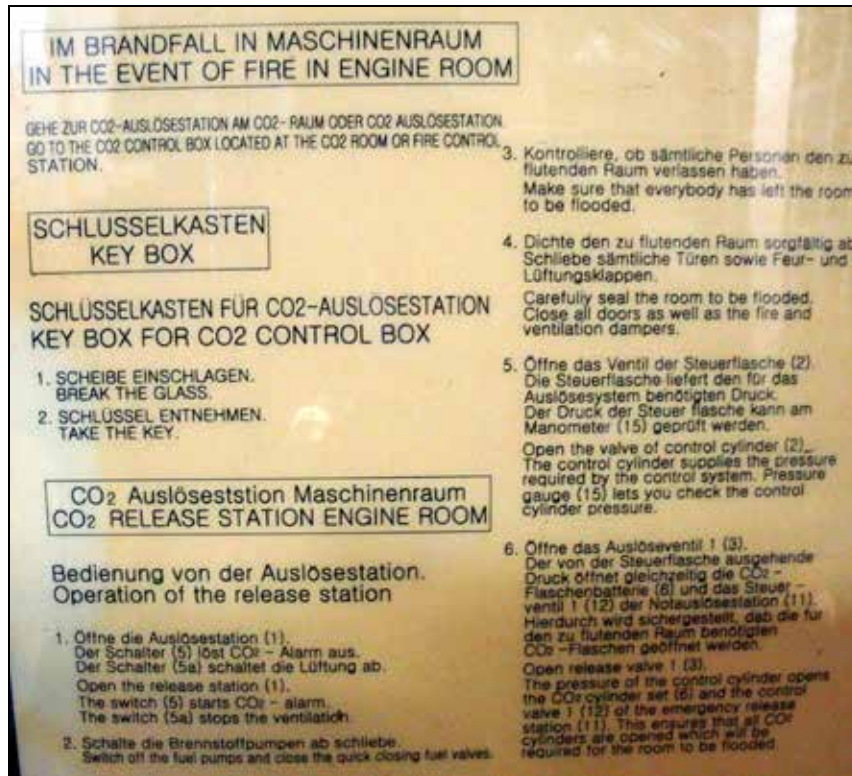


Figure 15: Description for releasing CO<sub>2</sub> for the engine room

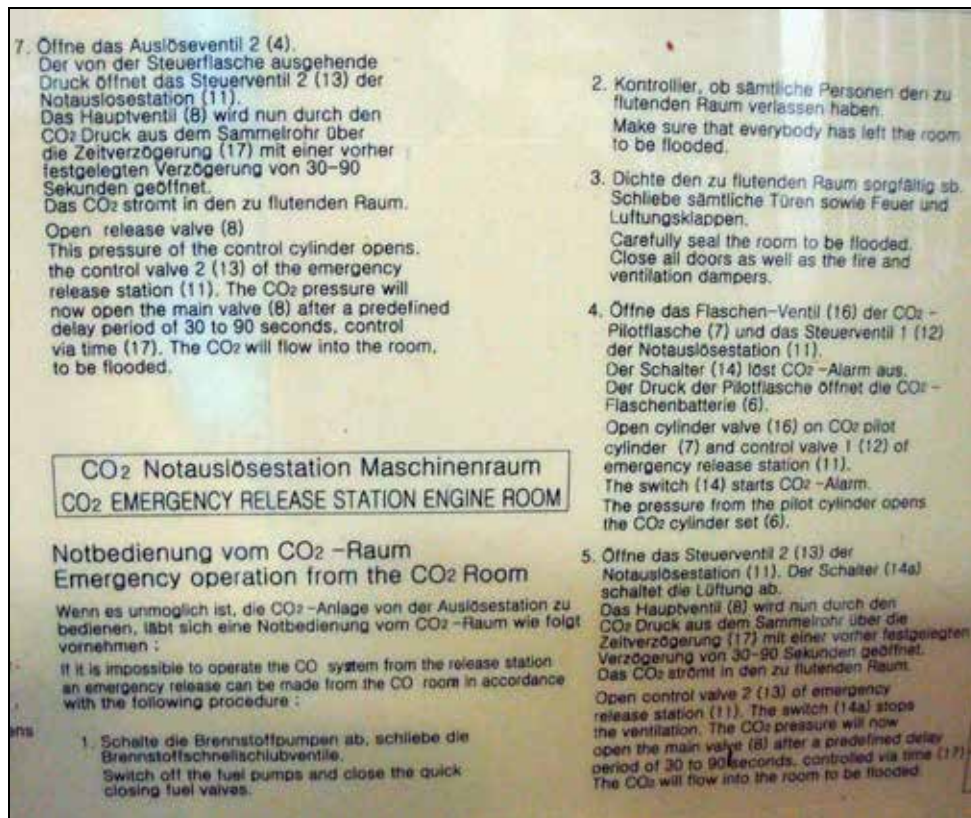


Figure 16: Description for releasing CO<sub>2</sub> for the engine room and emergency release (continued)



A schema (Figure 17) containing the outlined structure of the entire CO<sub>2</sub> system was located there together with the description for the:

- release for the engine room;
- emergency release for the engine room;
- release for the cargo holds, and
- procedures after being released.

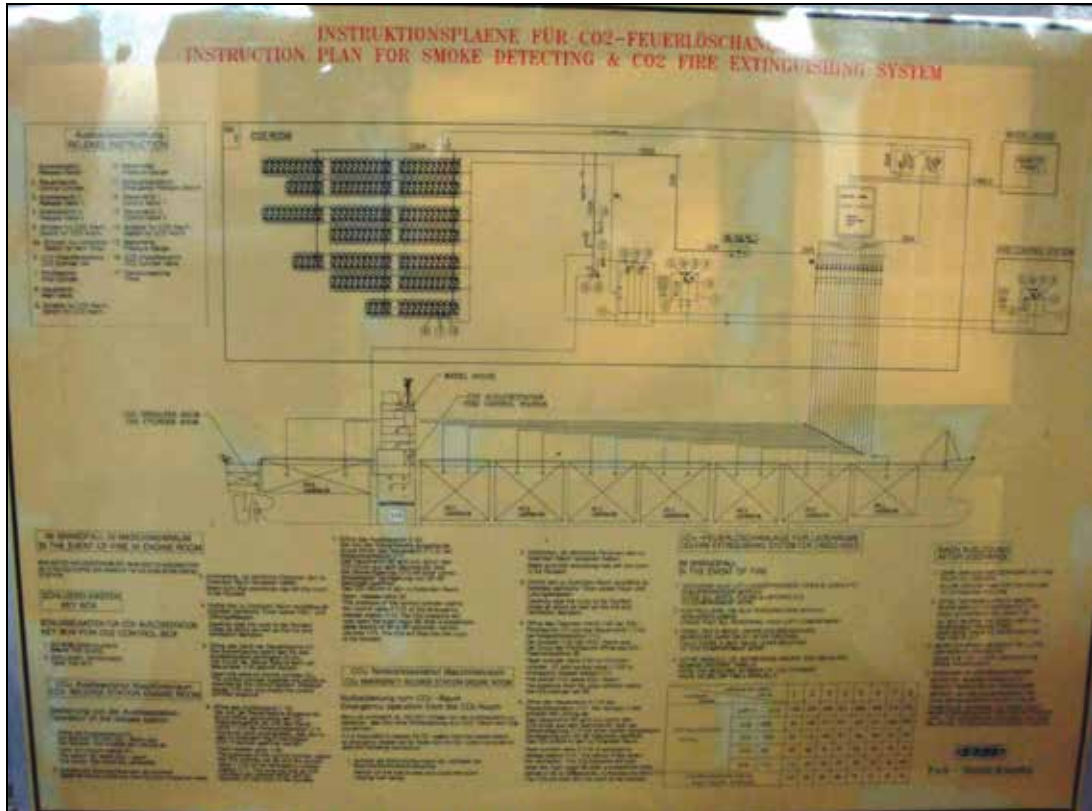


Figure 17: Schema and functioning of the CO<sub>2</sub> fire-extinguishing system

The procedure for discharging CO<sub>2</sub> into the cargo holds was also described in German and English on two other boards. These were located on the release station (alarm secured box with ball valve – Figures 18, 19 and 20) and on the sample extraction smoke detection system's switch cabinet (see Figure 8). The description on the schema was the same as the description on the switch cabinet and indicates the following procedure:

1. close all vents, doors and hatches in the affected area;
2. check whether all personnel have left the affected area;
3. open the three-way valve for the affected area, and
4. manually open the required number of CO<sub>2</sub> cylinders in accordance with the table.

Working through the steps in this sequence would have been unsuccessful because they did not include opening the ball valve, meaning no gas would have flowed between the cylinders and three-way valve. However, the description on the ball valve box (Figure 18) was correct, but incomplete in that it referred to the other plan for the next steps, i.e. opening the CO<sub>2</sub> cylinders.



Figure 18: Description of the 'cargo hold' release procedure on the ball valve box

Upon opening the box for the ball valve, a contact switch was triggered. This caused the audible CO<sub>2</sub> alarm to sound and switched off the following ventilation fans automatically:

- ventilation fans for cargo holds 1 to 8;
- ventilation fans for the passageways.

After opening the ball valve the CO<sub>2</sub> could flow to three-way valves.

The piping installed for the sample extraction smoke detection system in the cargo holds was also used to introduce CO<sub>2</sub> gas for fire-fighting. The six intake vents in each cargo hold could thus be used to flood the particular cargo hold with CO<sub>2</sub>. To achieve this, two three-way valves in the CO<sub>2</sub> room had to be turned for each cargo hold beforehand.

It should also be noted that the instructions in the CO<sub>2</sub> room described the procedure for the three-way valve as follows: "Fully down 3-way valve lever relating to the compartment fire." In fact, the lever on the MSC FLAMINIA had to be pulled upward. This also corresponded with the label on the valve itself (Figure 21).

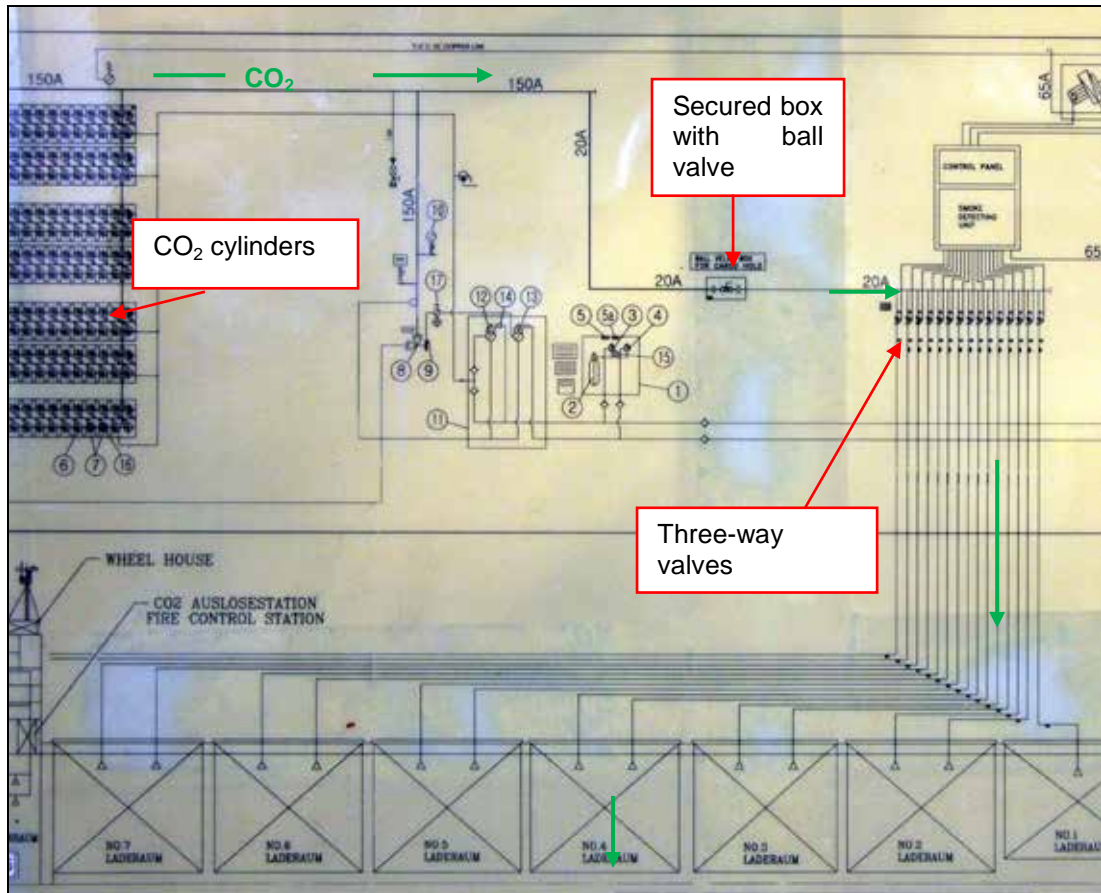


Figure 19: Excerpt from the schema – CO<sub>2</sub> for the cargo holds

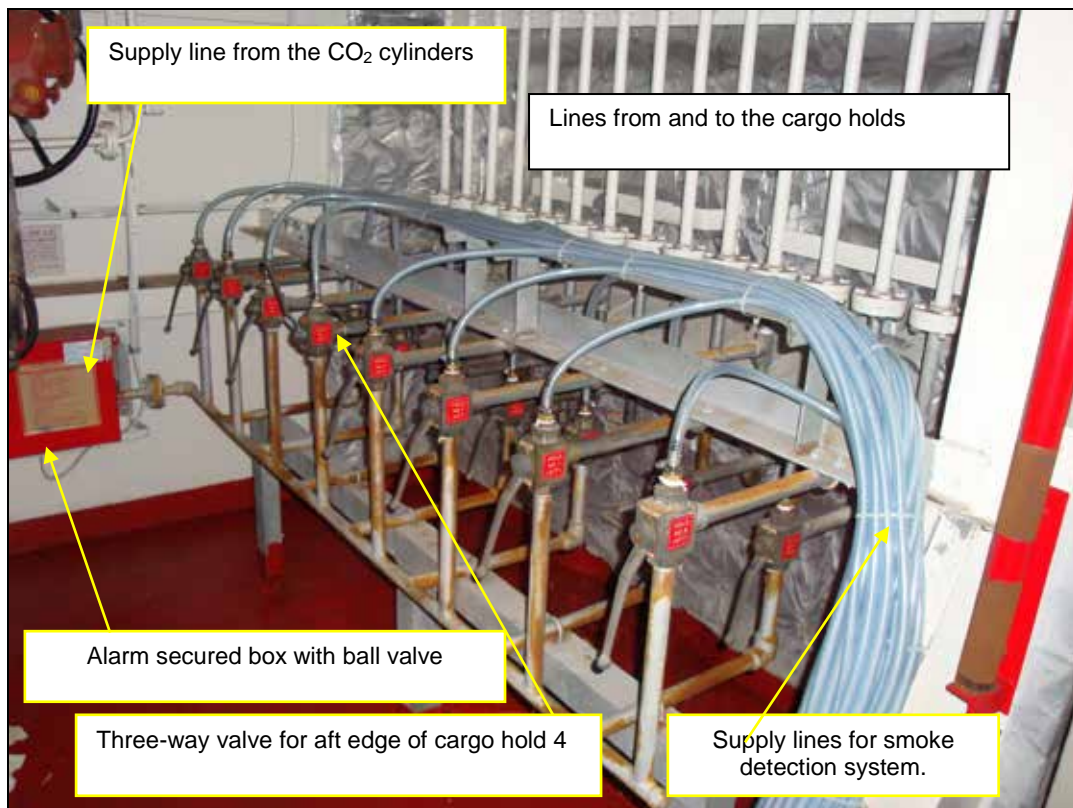


Figure 20: Part of the CO<sub>2</sub> release station for the cargo holds

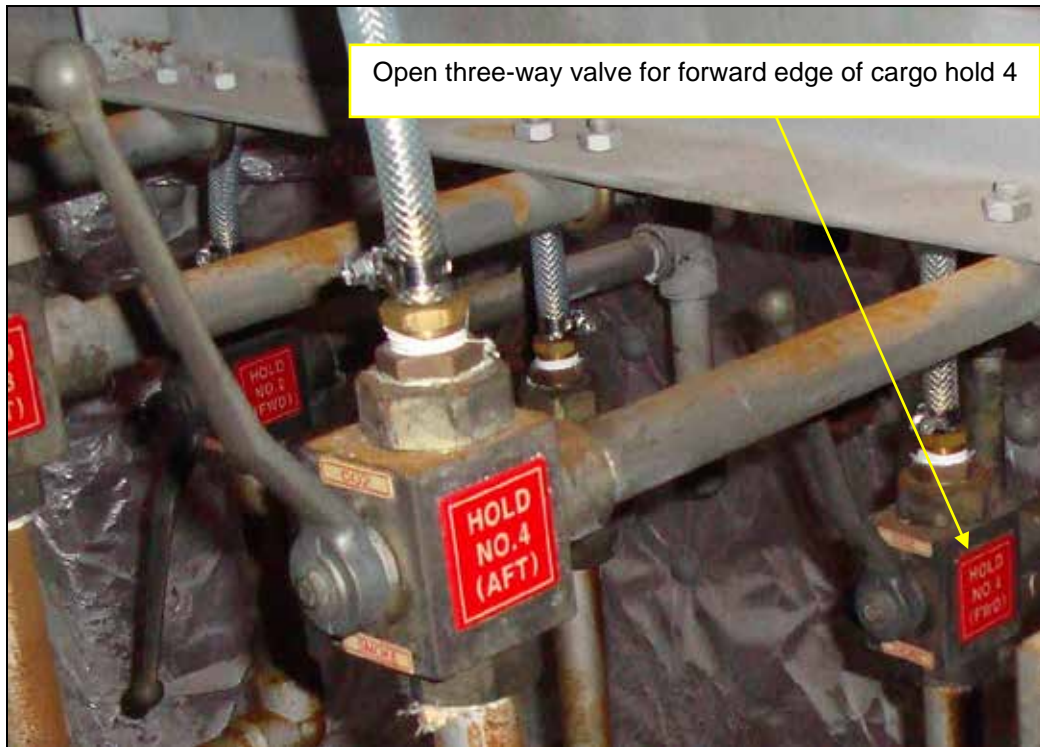


Figure 21: Open three-way valves for cargo hold 4

330 CO<sub>2</sub> cylinders were available for fighting fire in the cargo holds or engine room. Additional smaller cylinder sets were distributed throughout the ship for extinguishing in other areas. The amount of gas to be discharged could be derived from the Fire Control and Safety Plan, inter alia. This indicated that 189 cylinders should be opened for cargo hold 4. A further 32 cylinders should be triggered after a waiting period of half an hour. There was also a more specific indication from a table of the manufacturer of the CO<sub>2</sub> system (Figure 15) available in the form of a notice in the CO<sub>2</sub> room and on the bridge. Here, the amount of CO<sub>2</sub> to be discharged was dependent on the load condition of the cargo hold. According to the manufacturer's overview, 33 cylinders should be opened when the cargo hold is full. 33 additional CO<sub>2</sub> cylinders should then be opened after each interval of half an hour.

LADERAUM NR CARGO HOLD NO		1	2	3	4	5	6	7	8
ERSTAUSLÖSUNG INITIAL	AUSLÖSUNG DISCHARGE EMPTY - 24%	126	224	289	321	329	329	314	278
	25% - 49%	95	168	217	241	247	247	236	209
	50% - 74%	63	112	145	161	165	164	157	139
	75% - 90	32	56	73	81	83	83	79	70
	90% - FULL	13	23	29	33	33	33	32	28
HALBSTUNDENINTERVAL HALF-HOUR INTERVAL		13	23	29	33	33	33	32	28

Figure 22: Amount of CO<sub>2</sub> to be filled in relation to cargo hold and load condition

The BSU entrusted expert Dipl.-Ing. Lars Tober with the preparation of a report on the fire<sup>13</sup>. In the report, he looks at how effective the CO<sub>2</sub> extinguishing system is vis-à-vis the cargo holds, inter alia: "The CO<sub>2</sub> system for the cargo holds is designed such that 30% vol is available for the largest cargo hold. Flooding time is not specified. [...] group release is not specified, either. The cylinders are opened by hand using single release valves. State of the art is a supply line to the cargo holds of about 20 mm in diameter. This means that it is only possible to discharge the contents of about one 45 kg CO<sub>2</sub> cylinder/min. into the cargo hold. [...] CO<sub>2</sub> renders inert and/or its fire-extinguishing effect is only evident after the extinguishing concentration is reached. If, as in this case, at least 33 cylinders are to be used for flooding, this results in a flooding/response time of about 32 min."

After the incorrect assembly of the CO<sub>2</sub> fire-extinguishing system on MSC FLAMINIA became known, the BSU initiated further investigations for that purpose. The vessels operator NSB informed the BSU about the fact that their investigation carried out on the sister vessels MSC ILONA and MSC ALESSIA the same mounting error was detected. The vessels operator also advised the classification society of the vessel, DNV GL, of the detected error. According to DNV GL this class supervises altogether 7 vessels with a comparable system. Until conclusion of the report the classification society was not able to name the number of the vessels actually affected. However, DNV GL confirmed the plan approval carried out by them. The German supervisory authority BG Verkehr<sup>14</sup> (Ship Safety Division) was only informed by the BSU.

All the circumstances, particularly the fact that with a proper acceptance after the completion of the system, errors should have been detected in any case, require scrutiny. This will be carried out independent of this investigation. Possible safety recommendations will, if required, will be published separately.

#### **1.2.2.5 Water-based fire-extinguishing system for cargo holds**

On ships where water can be used as a cooling and extinguishing agent in the cargo holds with a stationary system, piping is integrated in the hatch cover. In the event of fire, the piping is supplied from the normal water-based fire-extinguishing system via quick-acting couplings with hoses.

Only for cargo holds that may carry dangerous goods of IMDG Code<sup>15</sup> class 1<sup>16</sup> (Explosive substances and articles) SOLAS<sup>17</sup> (Chapter II-2 Regulation 19.3.1.3 and 19.3.1.4 – Cooling and flooding)<sup>18</sup> requires the possibility of cooling cargo with water

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<sup>13</sup> Dipl.-Ing. Tober, Lars: Investigation report on the Fire on the Container Ship MSC FLAMINIA on 14/07/2012. Unpublished report, Rostock 2013. Hereinafter referred to as 'Fire report'.

<sup>14</sup> BG Verkehr – BG for Transport and Traffic.

<sup>15</sup> IMDG Code - International Maritime Code for Dangerous Goods.

<sup>16</sup> Except for Class 1.4S.

<sup>17</sup> SOLAS = International Convention for the Safety of Life at Sea. Unless otherwise stated, reference is made to SOLAS as amended in 2012.

<sup>18</sup> Applicable in accordance to SOLAS Chapter II-2 Regulation 1.2.4.1.

or flooding the cargo hold with water or other media. During the construction of the MSC FLAMINIA it was relinquished to such system and thus to the option of transport. Consequently, cargo holds 1 to 4, which were provided for the carriage of dangerous goods, could not be cooled with water. Hence, cargo hold fires on the MSC FLAMINIA could only be fought using the CO<sub>2</sub> fire-extinguishing system or by members of the crew at the scene. This is exemplary for a great number of container ships.

At least six changes per hour of air should be possible in cargo holds of ships (Regulation 19.3.4.1 – Ventilation). Since only closed containers respectively tank containers were carried in the cargo holds referred to, only two changes of air were required<sup>19</sup>.

### **1.2.3 Fire-fighting and abandoning the ship**

#### **1.2.3.1 Legal foundation for fighting the fire**

The basic technical requirements for fire protection are dealt with by SOLAS Chapter II-2 Construction: fire protection, fire detection and fire extinction. This provision describes the structural fire protection, equipment and measures for the detection of fire, as well as the technical installations and measures for fire-fighting.

SOLAS Chapter III Regulation 19 standardises emergency training and drills and states that every crew member shall participate in at least one abandon ship drill and one fire drill every month. For abandon ship drills, the alarm system must be used to summon the crew to the assembly stations. The crew should report to the assembly stations and prepare for the duties stipulated in the muster list. With regard to training and instructions, it reads: "Instructions in the use of the ship's fire-extinguishing appliances, life-saving appliances, and [...] shall be given at the same interval as the drills. Individual instruction may cover different parts of the ship's life-saving and fire-extinguishing appliances, but all the ship's life-saving and fire-extinguishing appliances shall be covered within any period of two months. Every crew member shall be given instructions which shall include but not necessarily be limited to: [...] operation and use of fire-extinguishing appliances."<sup>20</sup>

For incidents involving dangerous goods on ships during transport, the required action is laid down by the Emergency Response Procedures for Ships Carrying Dangerous Goods<sup>21</sup> (EmS Guide). This guide forms part of the IMDG Code. The

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<sup>19</sup> SOLAS Chapter II-2 Regulation 19, tables 19.1 and 19.3. See also footnote 17.

<sup>20</sup> SOLAS Chapter III Regulation 19 Nr. 4.

<sup>21</sup> MSC/Circ.1025.

EmS Guide distinguishes between the procedures in the event of fire and those in the event of dangerous goods leaking. Basically, it should be noted that in each case the Guide refers to one burning or leaking substance. The possible interactions of several goods are not included.

"The EmS Guide [...] contains:

- general recommendations having regard to the required equipment and plans/drills for emergency response;
- special guidelines for fire-fighting on board;
- ten special emergency schedules for fire-fighting (F-A to F-J);
- special guidelines for dealing with spillage, and
- 26 special emergency schedules for dealing with spillage.

In the EmS Guide as well as in the IMDG Code, all dangerous goods are classified in the relevant emergency schedule on the basis of their UN numbers<sup>22</sup>.

This means that the crew has a direct reference from the labelling of cargo or shipping documents to the recommended action. The instructions in the emergency schedules differentiate between cargo stowed below deck and on deck, packages or containers, and items of cargo that require additional action."<sup>23</sup>

In relation to the present case of a fire in a cargo hold, the key points in the EmS Guide are shown below in summary form:

- based on the toxic nature of the dangerous goods, the superstructures should be protected from smoke. Therefore, the ventilation fans should be shut-off, the superstructures closed, and possibly the ship turned accordingly;
- the safety of the defense unit is of utmost importance. Use of protective clothing and self-contained breathing apparatus is essential;
- depending on the type of cargo burning, a chemical protective suit should be worn;
- the dangerous goods affected by the fire should be determined using the EmS Fire Schedules so as then to be able to take the appropriate measures described there;
- using water to cool the areas/cargo surrounding the fire and the ship's structure is recommended;
- it is noted that reactions caused by the effect of heat can result in risk posed by other substances. Therefore, cooling should continue for many hours;
- firefighters should be made aware of the hazards of over-heated spaces and the associated risk of a sudden propagation of flame;

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<sup>22</sup> Also referred to as material number, the UN number is an identification number specified for any dangerous substances also regarded as dangerous goods. The UN number describes the cargo from which the *hazard* originates. They are issued for specific chemical compounds, groups of substances, and other goods that involve danger. Wikipedia. Information as of 28/08/2013.

<sup>23</sup> [http://www.bfr.bund.de/de/notfall\\_massnahmen\\_bei\\_havarien\\_auf\\_see\\_mit\\_gefaehrlichen\\_guetern\\_an\\_bord-61604.html](http://www.bfr.bund.de/de/notfall_massnahmen_bei_havarien_auf_see_mit_gefaehrlichen_guetern_an_bord-61604.html), information as of 10/07/2013.

- it is recommended that expert advice be sought;
- depending on the type of cargo burning and associated risk of explosion, it may be necessary to consider abandoning the ship.

### **1.2.3.2 Shipboard arrangements and equipment**

The vessel operator submitted relevant excerpts from the SMS<sup>24</sup> manual and other related documents.

Based on the records of the drills carried out, the BSU looked at the frequency of the drills and scenarios covered in the process. The investigators found that in the 12 months leading up to the accident (14 June 2011 to 14 June 2012) the three different crews on board carried out a fire drill every month. An outbreak of fire was simulated in the following locations for the drills: five in the superstructure (e.g. laundry, stairwell, sauna), three in the engine room, one in the steering gear compartment, two in the fore section (paint store, bosun's store), one in the waste disposal compartment, and one in the deck cargo (13 July 2012). Moreover, when analysing the fire drills it was found that in the past year only the last crew had carried out a fire drill relating to cargo. During the period under consideration, none of the drills involved putting into simulated operation the CO<sub>2</sub> fire-extinguishing system for the cargo holds or engine room.

The crew of the MSC FLAMINIA had been on board in its composition since the beginning of April 2012. This crew carried out four fire drills:

- 6 April 2012 fire in the superstructure: laundry;
- 25 May 2012 fire in the superstructure: B-deck;
- 8 June 2012 fire in the engine room: deck 1 port side/waste incinerator.

The investigators assume that fighting a fire on a container standing on the upper deck was practiced during the drill of 13 July 2012. The advancing defense unit extinguished all four presumed fires. This means, all these fires were not extinguished by a permanently installed system and during these drill it was not deviated from the recommended form of organisation.

According to the documentation submitted, there was no instruction for the CO<sub>2</sub> fire-extinguishing system during the period April 2012 to July 2012. Moreover, in the period prior to that there was no instruction recorded for this system back to June 2011.

Only during the fire drill on 6 April 2012 and subsequent abandoning of the ship, the entire crew was instructed in the handling of a lifeboat. This involved the boat being unlashed and swung out.

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<sup>24</sup> SMS = Safety management system; see also International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code).



It was also found that a boat manoeuvre was only carried out each month by a small part of the crew of the MSC FLAMINIA.

The group carried out boat manoeuvres on:

- 28 April 2012 port boat tested and swung out, brake test, seven participants;
- 15 May 2012 starboard boat tested and launched, boat manoeuvred, eight participants, and
- 3 June 2012 starboard boat tested and launched, release system tested, port boat then swung out, eight participants.

The same group of people carried out all three boat manoeuvres. This group included all the members of the defense unit (deck) and a member of the ship's command.

Drills of this nature involving very limited participants were noted throughout the period under consideration.

The 'Handbuch für die Ausbildung im Schiffssicherungsdienst' (manual for ship safety service training) of the Ship Safety Division (BG Verkehr), which was carried on board, met the requirements of SOLAS Chapter II-2 Regulation 15<sup>25</sup> and after the EmS Guide (see also section 3.2.3.1) and the 'Fire safety operational booklet'<sup>26</sup> of the vessel operator thus formed the basis for fire training and action in the event of an emergency. Since containers carrying dangerous goods were also located in cargo hold 4, the EmS Guide was relevant.

Dangerous cargo carried on board was brought to the attention of the crew by means of a notice. This list also contained the number of the emergency schedule associated with each item cargo.

In the event of a fire on board the MSC FLAMINIA, the crew would be divided into four teams.

Next to the ship's command unit, this was the six-member defense unit under the leadership of the second officer, and the support unit under the leadership of the second technical officer, which also comprised six members. Each unit had two breathing apparatus carriers and consisted only of members of the deck and the engine crew. Depending on the location of the fire (deck or engine), it was planned and possible to swap the function of the two teams. The fourth team under the leadership of the third technical officer was intended as a reserve team for additional tasks (additional unit). This consisted of five crew members.

The duties of the support unit were not defined in the muster list. According to that, the additional unit was responsible for establishing the closed-down state.

The prescribed fire-fighting equipment was available on the MSC FLAMINIA<sup>27</sup>. For the defense unit, this consisted of standard self-contained breathing apparatus sets (four), heat protection suits (three), and other items of equipment. No special equipment or clothing was available for members of the other teams, i.e. they wore

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<sup>25</sup> Applicable in accordance to SOLAS Chapter II-2 Regulation 1.2.2.2.

<sup>26</sup> SOLAS Chapter II-2 Regulation 16. Applicable in accordance to Chapter II-2 Regulation 1.2.2.2.

<sup>27</sup> SOLAS 2001 Chapter II-2 Regulation 17.

their normal work clothing. These were usually overalls, safety shoes, and protective helmets. The fire-fighting equipment was stored on the main deck in the safety stores on both sides of the ship.

The ship was equipped with a fire-extinguishing lance, which is not a carriage requirement so far, for extinguishing fire in a container, which can be driven into a container.



Figure 23: Fire-extinguishing lance for use on containers

The ship was also equipped with four appropriate protective suits and two additional self-contained breathing apparatus sets for use in connection with dangerous substances<sup>28</sup>.

### 1.2.3.3 NAVECS system

While reviewing the documents found on board, it was noted that the SMS<sup>29</sup> manual referred to a 'NAVECS system'<sup>30</sup>. This computerised system is a product of the company INTERSCHALT maritime systems AG. On being questioned, the company stated that the service agreement with the vessel operator had expired in 2004 for this product. The NAVECS system has since been used and maintained by the vessel operator.

Inter alia, the computer program provides assistance in determining the duties of the crew during drills and emergencies. It is intended primarily as a planning tool for drills and as a standardised decision-making tool for the ship's command in the event of an actual emergency. Consequently, the program also contains a 'Fire at sea' emergency plan. The system also includes a dangerous goods database.

<sup>28</sup> According to the specifications of SOLAS Chapter II-2 Regulation 19.3.6, applicable in accordance to Chapter II-2 Regulation 1.2.4.

<sup>29</sup> Manual, Chapter 5.11 ff. – Emergency preparedness, last updated 02/2011 and 04/2012.

<sup>30</sup> NAVECS – Nautical audiovisual emergency control support.

The vessel operator stated that the system on board the MSC FLAMINIA was complete and used there as a general rule. Since an operational log was created with this system during a manoeuvre involving fire-fighting and abandoning the ship in March 2012, and during another manoeuvre that involved fire-fighting in July 2011, the investigators assume it is used from time to time, at least. All the other drills considered during the 12 months leading up to the fire were reported on the vessel operator's own report form.

The computerised system provided a tool that in the opinion of the investigators assisted in the handling of emergencies of all kind. Moreover, in the vessel operator's SMS manual<sup>31</sup>, activation of the NAVECS system by the officer in charge of the navigational watch is explicitly required immediately in the event of an emergency before the master arrives on the bridge. Apart from that, its use was required during every drill to achieve an appropriate level of training. According to the vessel operator, a printed version was on board in addition to the computerised system.

The vessel operator provided excerpts from the NAVECS system for fire-fighting on deck and abandoning the ship. These included:

- emergency plan: Fire at sea;
- emergency plan: Abandoning the ship;
- description of the duties of the defense unit and the support unit when fighting fire and when abandoning the ship, and
- various checklists.

The description of the duties of the units formed in the event of a fire was verified using the documents submitted. The duties of the defense unit in the event of a fire in cargo hold 4 are divided into fighting the fire directly and fighting the fire in the surrounding area. The eight priorities to be observed are identical<sup>32</sup>:

1. "Proceed to maindeck from windward side with 2 Dry Powder extinguishers.
2. Set up two hoses with water spray. Cool down sides of vessel and maindeck in area of hold on fire. Proceed to fire location under protective spray<sup>33</sup>.
3. Release CO<sub>2</sub> for this hold (Release Station on Steering Gear Room (CO<sub>2</sub> room)).
4. Cool down Deckcargo and hatchcovers of this hold.
5. Check with bridge on IMO containers and EMS procedures.
6. Observe adjacent holds and engine room bulkheads, fumes, heat and smoke development.
7. If fire is extinguished keep constant fire watch.
8. Do not enter hold!"

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<sup>31</sup> SMS manual, paragraph 5.8 of Chapter 5.11 – Measures in Emergencies

<sup>32</sup> Within this report there was not an evaluative consideration of the listed points.

<sup>33</sup> Note BSU: Nozzle that produces a circular wall of water in front of the firefighter for heat protection in addition to solid-stream or directed spray.

In addition, there was another list of duties for the defense unit assisted by the support unit.

The duties of the support unit are also divided into fighting the fire directly and indirectly.

Here, the following points were to be addressed in the case of fighting the fire directly:

1. „Close all doors, portholes in superstructure. Stop superstructure ventilators and ventilators for holds by remote control on Nav. Bridge Deck and on Upper Deck.
2. In order by Command Unit close all fire damper flaps of this and adjacent holds and the superstructure according to checklist.
3. Stop aircondition plant.
4. Report to Command Unit.”

The following points were applicable in the case of fighting the fire indirectly.

1. „Stop aircondition plant.
2. Close all fire damper flaps for this adjacent holds as well as superstructure acc. to checklist.
3. Prepare fire hoses and jets on Maindeck.
4. Cool down block of container of fire, adjacent blocks and Maindeck. Open various hydrants slightly – let water run freely over deck.
5. Report to the bridge.”

It can be concluded that each description of duties was sufficiently detailed and thus have constituted a useful resource.

#### **1.2.3.4 Fire-fighting on the MSC FLAMINIA**

For the account of the fire-fighting on the MSC FLAMINIA, only a few verified times could be referred to. These are based mainly on the excerpt of the print outs of the engine monitor system and the alarm/event log. The deck log book contains no entries relating to this. Written records of the course of events were not found. The recollections of the crew members differed widely at times.

The alarm actuated by the sample extraction smoke detection system was also recorded in the alarm/event log at 054218. The fire was confirmed by the deployed rating on watch. The chief officer then sounded the general alarm.

Besides the bridge crew, only one of the two passengers was aware of the fire before the alarm. This passenger woke up before 0600 and noticed the smell of smoke. While looking from the front window of his cabin, that of the super cargo on the port side three decks below the bridge, he was able to see light yellow-brownish smoke rising in the forward section of the ship.

The crew members concerned went to the muster station after the alarm was sounded. The second officer carried out the muster because the chief officer, who was actually responsible, was still on the bridge. The chief officer arrived at the assembly station after everybody was accounted for. The chief officer, who had taken over the function of head of operation, provided an overall view of the situation. After everybody was accounted for, the members of each unit went to the areas where their equipment or assembly station was located. The breathing apparatus carriers started to don their equipment there.

While the defense unit was equipping itself, the chief officer, second officer, third technical officer, and assistant officer went forward on the starboard side. As members of the additional unit, the third technical officer and assistant officer were charged with establishing closed-down state at cargo hold 4 according to the muster list. Upon arriving at the scene, they found that the ventilation flaps for the passive ventilation were already closed on both sides of the hatch coaming. While closing the ventilation flaps for active ventilation in the crossways<sup>34</sup>, they noticed smoke escaping from between the middle hatch cover and the coaming. This was white/grey in colour and smelled strongly of chemicals. More smoke was escaping at the aft edge of cargo hold 4 than at the forward edge. After that, all the ventilation flaps for active ventilation at cargo hold 3 were also closed. The chief officer then reported to the master that closed-down state had been established and the team went back to the assembly station at the safety store. While the small team was in the vicinity of cargo hold 4, two breathing apparatus carriers of defense unit joined. Since they had still not donned heat protection suits, they were sent back to the safety store to don them.

The main engine was shut down and stopped at 0621. Where appropriate, stopping the engine was also prompted by the question contained in the 'Fire at sea' emergency plan of the NAVECS system: "Have you stopped the engine?" Control was then transferred to the ECR. The air conditioning and cargo hold ventilation fans were already turned off at this point.

After some time, the ship's command decided to discharge CO<sub>2</sub> into cargo hold 4. To this end, the chief technical officer, second technical officer, third officer, and three other crew members went to the CO<sub>2</sub> room. After consulting with the master, 34 CO<sub>2</sub> cylinders were to be opened. This corresponded to the manufacturer's table for cargo hold 4 when it is fully laden. In fact, 36 cylinders were opened. According to the alarm/event log, the alarm for the CO<sub>2</sub> discharge was triggered at 064227. Immediately before that, the ventilation fans for the cargo holds and passageways triggered an alarm.

From 064257, the alarm/event log also registered an alarm for the engine room ventilation fans. Apparently, the CO<sub>2</sub> alarm for the engine room had also been triggered, causing the ventilation fans there to turn off. This included the auxiliary fan for the main engine. Furthermore, the auxiliary boiler turned off automatically, meaning it was no longer possible to restart the main engine. Following that, the engine crew tried to remedy the resulting electrical blockage of the ventilation fan and the auxiliary boiler. In addition, there was a risk of two auxiliary engines running on heavy fuel oil failing because the fuel was no longer heated sufficiently due to the failure of the auxiliary boiler, why the viscosity of the fuel rose. All the technical officers were occupied with remedying the problems. The master was informed about the technical problems.

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<sup>34</sup> Space between the container stacks that facilitates lashing the containers, which usually has a lashing bridge above. The distance between the lashing bridges is equivalent to a 40' container. See also Figure 6.

Another alarm concerning the bilge wells on the starboard aft edge of cargo hold 4 was triggered at 064456. It indicated an 'upper level alarm (85%)' at this position.

While the CO<sub>2</sub> was acting on the fire, the second officer was tasked with deploying fire hoses on the starboard side level with cargo hold 4. Those members of his defence unit who did not carry any apparatus assisted him. The hoses, which were equipped with nozzles, were connected to the hydrants at bays 30 and 22. The hydrants were not opened. The team then returned to the assembly station and the second officer accounted for everybody again. The second officer tested the temperature of the hatch cover level with bay 26 with the back of his hand. The cover was warm to the touch.

After some time had passed CO<sub>2</sub> was discharged into cargo hold 4 again. The shipping company noted in its opinion on the draft report that the "CO<sub>2</sub> Bottle Leakage" alarms, which were recorded in the alarm/event log of the ship's engine room, stand for the points of time of releasing the CO<sub>2</sub> bottles for the cargo hold. According to that, the second release was recorded from 0707 to 0713<sup>35</sup>. This time about 24 cylinders were released. There were varying statements as to visible success after the first discharge. They ranged from "Reduction in the amount of smoke" to "Without success".

The master notified the vessel operator of the incident at about 0745. Here, information about dangerous cargo was provided in addition to the position. The chief officer obtained this information for the master from the loading computer beforehand.

Meanwhile, consisting of the technical officers and the electrical engineer, the engine crew worked on making it possible to start the main engine. The electrical blockage triggered by the engine room CO<sub>2</sub> alarm hampered all efforts to start with. Since the demand for electricity was low, auxiliary engines 2 and 3, which were powered by heavy fuel oil, were stopped precautionary. Only auxiliary engine 1, which used diesel fuel, was still running. After that, the main engine was to be restarted at the request of the bridge. To achieve this, the engine crew bridged various fuses so as to restart the auxiliary boiler.

They also succeeded in starting the auxiliary fan for the main engine, as well as another generator. The third technical officer intended to reduce the number of consumers for the auxiliary boiler start-up. Therefore, he closed the steam supply for the heavy fuel oil tanks in the passageways. In the process, he was able to see smoke towards the bow on both sides of the ship.

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<sup>35</sup> The alarm is triggered at a pressure of 25 bar, measured before the main valve, in the main pipe to the engine room. As recorded, the first release was carried out from 0643 to 0705. The third release was started at 0806. No end was recorded for the third release.

After the second discharge, instructions were given to make the fire hoses on deck ready by the master, who was still on the bridge<sup>36</sup>. The readiness of the hoses was to be reported. The fire pump was to be turned on from the bridge only after the preparations.

The chief officer then went to the assembly station to put the instruction into effect. He gave general instructions to start cooling the area around cargo hold 4. He then ran towards this cargo hold. He was followed by the second officer, the bosun, another member of the defense unit (an A/B)<sup>37</sup>, two members of the support unit (OLR 1 and OLR 2), and a member of the additional unit (O/S). None of these people were wearing breathing apparatus or special protective clothing.

While being interviewed by the BSU, the master claimed that he was waiting for the report that the hoses were made ready. He was reportedly not aware that crew members went so close to the source of the fire for this task. In his opinion, there was no need for that at this point. That is also why he had reportedly not yet put the fire pumps into operation. In contrast, the crew members involved had the impression they were prompted by the chief officer to cool the hatch immediately.

After arriving at the scene, the area in the crossway between bays 26 and 30 was to be cooled down. To this end, the hose connected at bay 30 was extended and the A/B climbed into the crossway referred to with the hose. Since the fire hose was still too short, additional hose lengths were to be collected from the fore section. Therefore, the second officer and OLR 2 went to the fore section. In the meantime, the bosun and the O/S remained at bay 30. The location of the chief officer and OLR 1 at this point is not known.

Then the explosion occurred. The BSU investigators assume the time was 080427 because according to the alarm/event log, fuel tank 4 on the port side level with cargo hold 4 triggered a 'high level' alarm at this moment.

The explosion surprised one of the witnesses, as previously he had not detected any smoke or odour. The explosion shook the ship and containers fell overboard or into the side passages.

The second officer saw how the bosun, O/S, and OLR 1 tore the burning work clothing from their bodies and then run towards him. The second officer and OLR 2, also uninjured, rendered first aid level with bay 6. This was limited to providing water and external cooling, as there was no first aid equipment in the fore section. The three casualties had suffered burns of varying degrees and were heavily covered with soot. In addition, the O/S's hand was injured.

An attempt to contact the ship's command by means of radiotelephone was initially unsuccessful. The route back to the superstructure was cut off because fallen

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<sup>36</sup> There are contrasting statements as to the number of steps (one or two) for deploying the fire hoses.

<sup>37</sup> The abbreviations of the English occupational titles are used below. A/B – able bodied seaman, OLR – oiler, O/S – ordinary seaman.

containers blocked both side passages. Due to the smoke, neither passageway was passable, either. The second officer and OLR 2 then prepared the Jacob's ladder stored level with bay 6 for deploying on the starboard side.

#### **1.2.3.5 Abandoning the MSC FLAMINIA**

The master was on the bridge at the time of the explosion. After the explosion, he saw two different kinds of smoke rising that were clearly spreading separately: one was white to light grey and the other very dark. The master was initially unable to establish radio contact with the group at cargo hold 4. The master issued an order to abandon ship because of the feared risk of a chain reaction after the explosion and due to the quantity of dangerous goods. The port lifeboat was to be used for this. The engine room crew was informed of this by telephone. No further audible alarm was triggered. The master then went to the assembly station.

At the time of the explosion, the engine crew was in different areas of the engine room and in the CO<sub>2</sub> room. Here, direct telephone notification of the evacuation of the ship only reached the third technical officer and the electronics engineer. The two other officers concluded that an order to abandon the ship had been given from the behaviour of the others and the abandoned ECR.

The lifeboat on the port side was prepared for launching. Additional water from a storage room located in the immediate vicinity was stowed in the boat. When the lifeboat was ready for lowering and probably already partly manned, it was found that containers floating in the water below the boat prevented lowering on this side of the ship. Following that, the lifeboat on the starboard side was prepared for lowering.

According to the muster list, two crew members were tasked with taking the GMDSS<sup>38</sup> handheld transceivers, the SART<sup>39</sup> buoys, and the EPIRB<sup>40</sup> buoy into the boat. This did not happen in respect of the two first items, at least.

They were still on the bridge of the MSC FLAMINIA during the first survey of the ship by the investigators.

The master established radio contact with the second officer on the fore section while the boats were being made ready. In the process, he was informed about the situation there and it was agreed, inter alia, that the second officer should prepare for evacuation from the fore section. The master later went back to the bridge and sent several mayday messages by VHF radio at 0827. In addition, a DSC<sup>41</sup> alarm was

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<sup>38</sup> GMDSS = Global maritime distress and safety system.

<sup>39</sup> SART = Search and rescue radar transponder.

<sup>40</sup> EPIRB = Emergency position indicating radio beacon.

<sup>41</sup> DSC = Digital selective calling.



triggered on short-wave (0825)<sup>42</sup>. The master established that other vessels were in the vicinity by means of the radar unit. He collected the deck log book and passports and went back to the lifeboat.

The second officer and the OLR 2 deployed the Jacob's ladder and carried the life raft, stationed at the forward edge of cargo hold 1, level with bay 6. They also made life jackets and a strong line ready. While waiting for the lifeboat, OLR 2 searched for the missing crew members. He finally found the chief officer on the port side. The chief officer had suffered burns over his entire body and a leg was broken. The chief officer was then carried to the pilot ladder on a tarp, as there was no stretcher in the fore castle.

After the crew and passengers had boarded the starboard lifeboat, the boat was to be lowered using the cable release system. This was unsuccessful to begin with. One of the officers left the boat to determine the cause. He noticed that a safety pin on the winch had not been removed, thus blocking the winch brake's remote control. During the second attempt, the bow of the lifeboat lowered faster than the stern, causing the operator of the cable release system to stop lowering. The third technical officer and the ship mechanic went back on the ship to investigate the cause. They found that part of the lashing from the Jacob's ladder's tarpaulin had caught in one of the guide rollers of the boat runner. The lashing was cut due to time constraints and not completely removed from the area of the cables, meaning part of the lashing line could catch in a guide roller close to ground level. To solve this problem, the boat had to be moved to the original stowage position. Since the boat winch had no power supply, the boat was moved back using the crank. In the process, everybody gradually vacated the lifeboat. After the boat was ready for lowering again, the master gave instructions for her to be lowered to level with the boat deck without being manned to begin with. The boat was manned again at this position and then lowered into the water without further incident. Neither of the SART buoys nor one of the GMDSS handheld transceivers were taken when the ship was abandoned.

The second officer, OLR 2 and chief officer, who they were carrying, had just arrived at the Jacob's ladder when the lifeboat reached the fore section. The bosun climbed down to the lifeboat first without any additional safeguards. The O/S and OLR 1 were secured by line while climbing down to the boat. The two uninjured crew members then deployed the life raft. The chief officer was wrapped in the tarpaulin, which was then tied up and lowered by means of a line. At the same time, OLR 2 climbed down to the life raft on the Jacob's ladder and took charge of the chief officer there. He then stayed with the casualty and cared for him. The second officer climbed down to the lifeboat last. The raft was taken in tow by the boat and both moved away from the

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<sup>42</sup> Picked up by RCC Australia and forwarded from there to JRCC Halifax as it was reportedly assumed the position of the emergency was in its SAR area. In fact, it was in the area of the United Kingdom because they were further east than 30° W.

ship. During the approach to the fore section and while the lifeboat was moving away from the ship, the crew noticed more explosions on board the MSC FLAMINIA.

#### 1.2.4 Course of the fire after the explosion

The first heavy explosion caused containers that were secured and thus permanently connected to the ship to plunge into the water. It can be assumed that after the explosion the closed-down state of cargo hold 4 no longer existed. Consequently, the fire was able to develop fully.

After the FAIRMOUNT EXPEDITION reached the MSC FLAMINIA on 17 July 2012, she immediately began extinguishing and cooling. The photographs (Figures 24 and 25) taken from on board the HANJIN OTTAWA show the condition of the ship about 72 hours after the explosion.



Figure 24: FAIRMOUNT EXPEDITION at the MSC FLAMINIA

In Figure 25, it can be seen that the fire has spread as far as into cargo hold 5, at least. The shell plating of the ship is beginning to change colour at that position. The investigators assume that the ballast water tank located there was empty. This tank spans bays 31 to 39. The upper limit of the discolouration of the shell plating marks the transition to the passageway.

Furthermore, it should be noted that the containers located on deck in the area of cargo holds 3 and 6 are starting to collapse.



Figure 25: Progress of the fire on 17 July 2012

The varying degrees of destruction found on arrival in Wilhelmshaven at the containers in cargo holds 5 and 6, bay 42 compared to bay 46 in cargo hold 6 in particular, are possibly due to the cargo stowed there. This fact was not given further consideration during the investigation by the BSU because it was of no significance to determining the cause of the accident.

### 1.2.5 Fire-fighting by the salvor

From the records submitted by SMIT, it is evident that the tug and tow moved towards the English Channel after the towing connection was established and that during this period one of the two escort tugs fought the fire. The free second tug was tasked, according to SMIT, to assist the salvage team with boarding / disembarking and for the purpose of standby services. The deployed tug thus merely prevented the fire from taking hold in the superstructure. To achieve this, water was applied using the monitors in front of the ship's superstructure and in the passage between bays 50 and 54. Fire-fighting and cooling from the outside was complicated during the voyage because the extinguishing water collected in the cargo holds due to the destroyed hatch covers and the ship started to list more than 10° to starboard. In addition, the draught at the stern increased to 19 m.

Inter alia, the action shown below was taken when staff of the salvor and firefighters from the company engaged by SMIT, Falck NuTec<sup>43</sup>, were able to enter the MSC FLAMINIA:

- restoration of the shipboard power supply so as to operate a fire pump;
- installation of a hydroshield between bays 50 and 54 that was fed by the shipboard fire pump and worked independently, and

<sup>43</sup> Renamed Falck Safety Services as of May 2013.

- moved forward on and below deck to detect and extinguish single pockets of fire. This involved the use of advanced fire-fighting equipment like a high pressure extinguishing and cutting system. Amongst other things, these were used to cut openings into containers to improve the ventilation and individual extinguishing of containers (Figures 26 and 27). In turn, this facilitated the creation of blocking positions.

Fire-fighting continued while she was made fast in Wilhelmshaven because glowing fires repeatedly reignited in the containers laden with paper and cellulose in cargo hold 7, in particular.



Figure 26: Ventilation opening in a container in cargo hold 3



Figure 27: Cut open container in cargo hold 7 with suspended nozzle

### 1.2.6 Cause of the fire

Establishing the cause of the fire at its original source was impossible due to its long duration, the considerable heat that developed in the process, and the ensuing destruction of all the containers in cargo hold 4. Furthermore, large parts of the hatch covers and the containers located on them fell into the hatch, thus concealing any evidence that possibly existed. The potential for ascertaining the cause of the fire at the scene was additionally worsened by the long stay at sea, 59 days from when the fire broke out, and the fire-fighting during that period.

Figures 28 to 31 show the condition of the ship at the time of the first survey by the BSU and the fire experts it had appointed after she arrived at Wilhelmshaven.

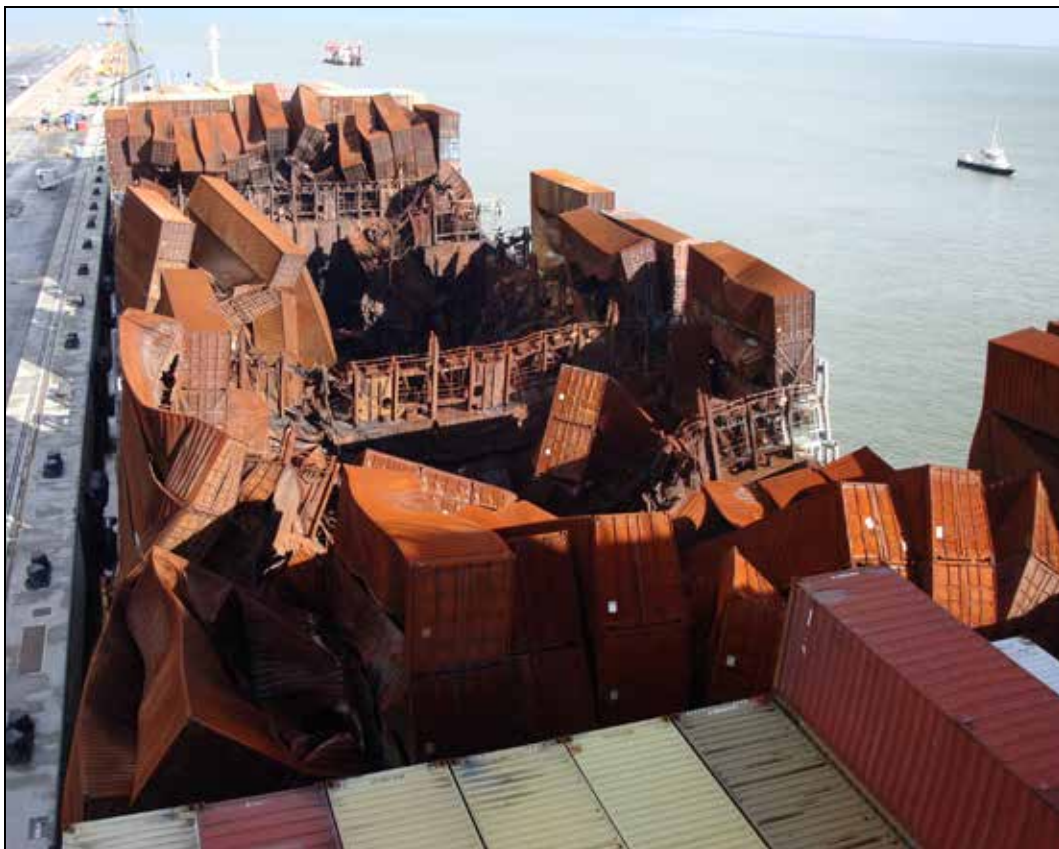


Figure 28: View forward from the MSC FLAMINIA's observation deck

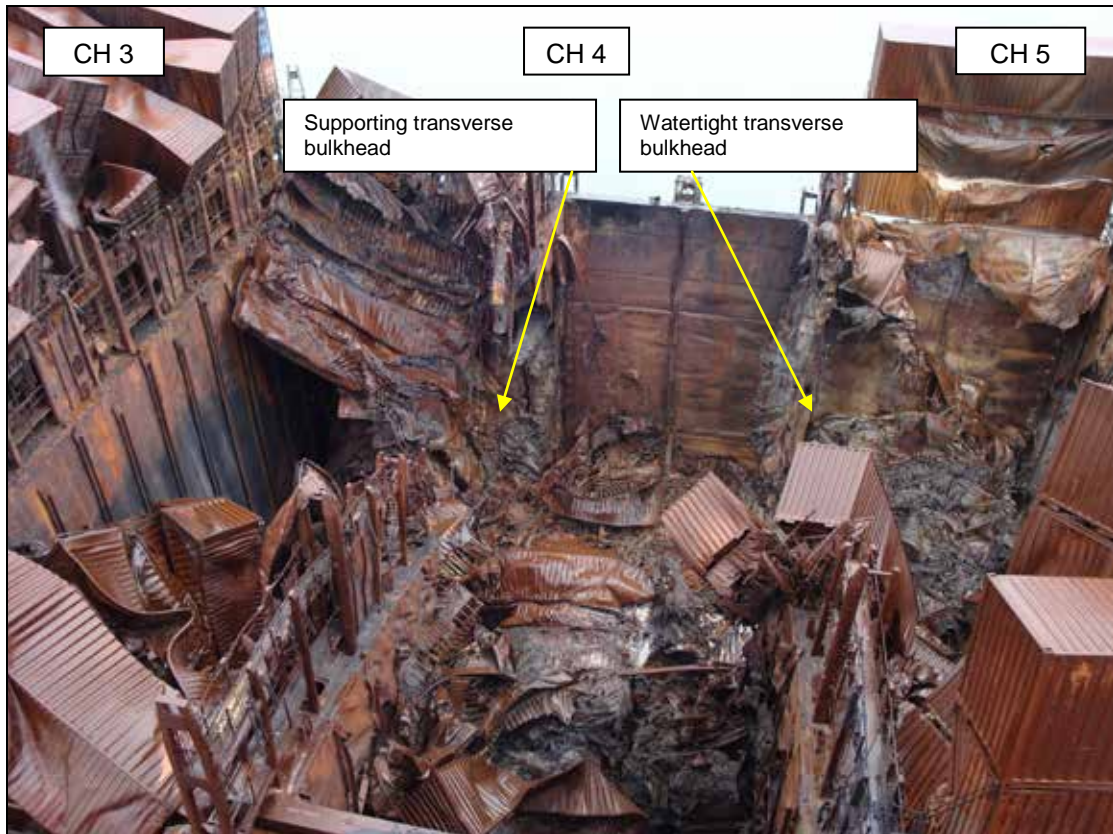


Figure 29: Cargo hold 4, view from the port side

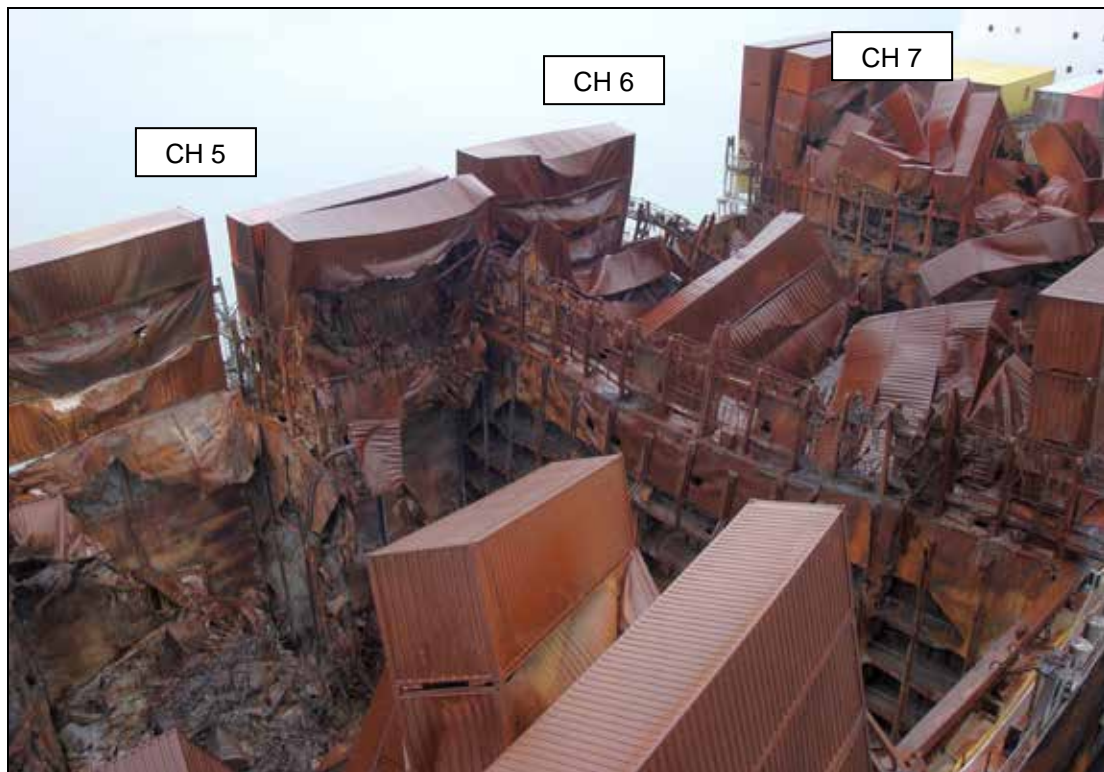


Figure 30: View of cargo holds 5, 6 and 7 from the port side



Figure 31: View through cargo hold 5 up to transverse bulkhead to cargo hold 6

### 1.2.6.1 First report on the cause of the fire

Due to the non-ascertainable factual evidence at the location of the fire, the investigation of its cause focuses on possible pointers from the cargo in cargo hold 4. The investigation was supported by the report<sup>44</sup> of chemist Dr Dana Meißner from the Institute of Safety Engineering/Ship Safety in Rostock. The report is based firstly on the assumption justified by witness accounts that the fire started in cargo hold 4, and secondly on the assumption that the cargo in the containers corresponded with the information on the shipping documents. However, the expert chose a global approach for assessing the risks posed by the cargo, i.e. all the cargo in the area of cargo hold 4 was considered to begin with.

Cargo hold 4 encompasses bays 25 and 27 in the forward section (or 26 in the event of 40' containers), as well as bays 29 and 31 (or 30) in the aft section. A total of 397 20' and 40' containers were stowed in the area of cargo hold 4, i.e. on and below deck. 262 of these containers were in the cargo hold. Hence, more than 90% of the cargo hold was in use. 25 containers were empty. Due to residual cargo, 13 of the

<sup>44</sup> Dr Meißner, Dana: Investigation into the possible cause of the fire on the container ship 'MSC FLAMINIA' on 14/07/2012 arising from the chemical and physical properties of the cargo. Unpublished report, Rostock 2013. Hereinafter referred to as 'First report by Dr Meißner'.

empty containers were declared as dangerous goods containers. All the empty containers were stowed on deck. "The remaining 372 containers carried:

- 90 with PVC suspension formolon (powder or granules)
- 63 with beer
- 24 with synthetic rubber
- 23 with wood pulp
- 16 with cars or car accessories
- 16 with cat litter
- 11 with glyphosate – intermediate product (weed control agent)
- 10 with kaolin clay (building material)
- 10 with diphenylamine
- 10 with tetrafluoroethene (refrigerant)
- 8 with titanium dioxide
- 6 with sesame seeds
- 5 with melamine
- 4 with cylinder head parts
- 4 with cotton
- 4 with wood or wooden furniture parts
- 4 with dimethylaminoethanol
- 3 with empty plastic bottles
- 3 with soy protein powder
- 3 with hair-care products in aerosol dispensers (hair spray)
- 3 with hair-care products
- 3 with plastic parts for conveyor belts
- 3 with divinylbenzene 80%
- 2 with chilli sauce
- 2 with coconuts and cashews
- 2 with cardamom
- 2 with paper board (kraftliner)
- 2 with various non-specified plastic parts
- 2 with clay tiles
- 2 with acrylamido-2-methylpropane-sulfonic acid, Na –salt 50% in water
- 2 with synthetic corundum, web mineral
- 2 with silicone products
- 2 with hydroxypropyl methylcellulose
- 2 with pentafluoroethane
- 2 with polymeric beads (non-specified)
- 2 with tetraoctyltin
- 2 with p-tertiary-butyl styrene
- 2 with polyethylene glycol (powder)
- 1 with nylon covering
- 1 with cationic hydroxyethyl cellulose
- 1 with snow clearing machinery
- 1 with isopropylamine
- 1 with dimethyl sulfoxide
- 1 with catalytic converters
- 1 with polyethylene polymer
- 1 with zinc oxide



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- 1 with nylon 6.6
- 1 with sesame oil
- 1 with car care products
- 1 with glassware
- 1 with glass wool
- 1 with tyres
- 1 with dirt traps
- 1 with heating elements"<sup>45</sup>

Hence, there were roughly 54 different goods in the area of cargo hold 4. In fact, there were several more because a number of containers had part loads with only one good being specifically declared as the content.

Figures 32 to 35 are taken from the chemical report and show the distribution of the cargo in cargo hold 4.

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<sup>45</sup> First report by Dr Meißner.

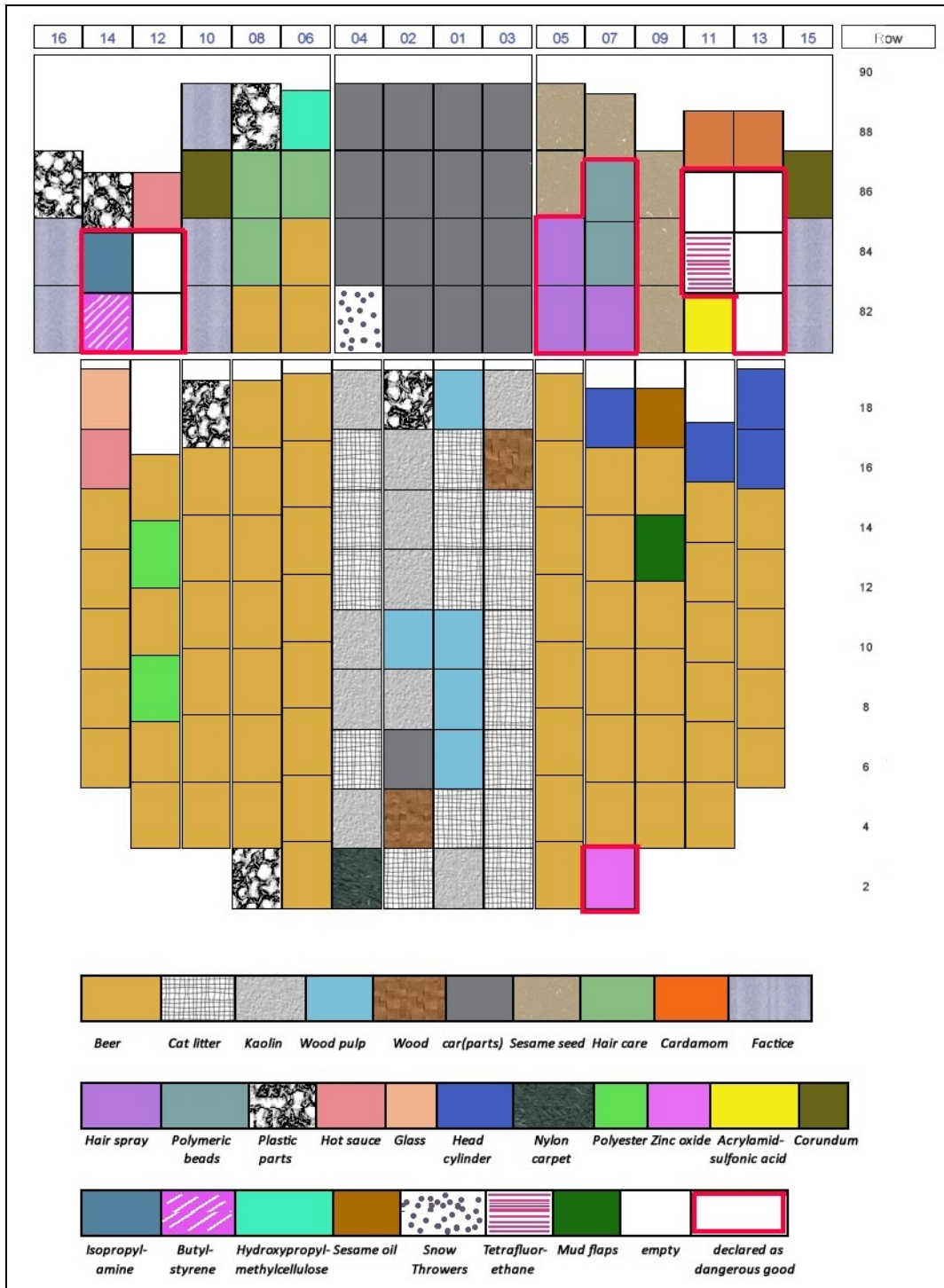


Figure 32: Distribution of the containers in bay 25

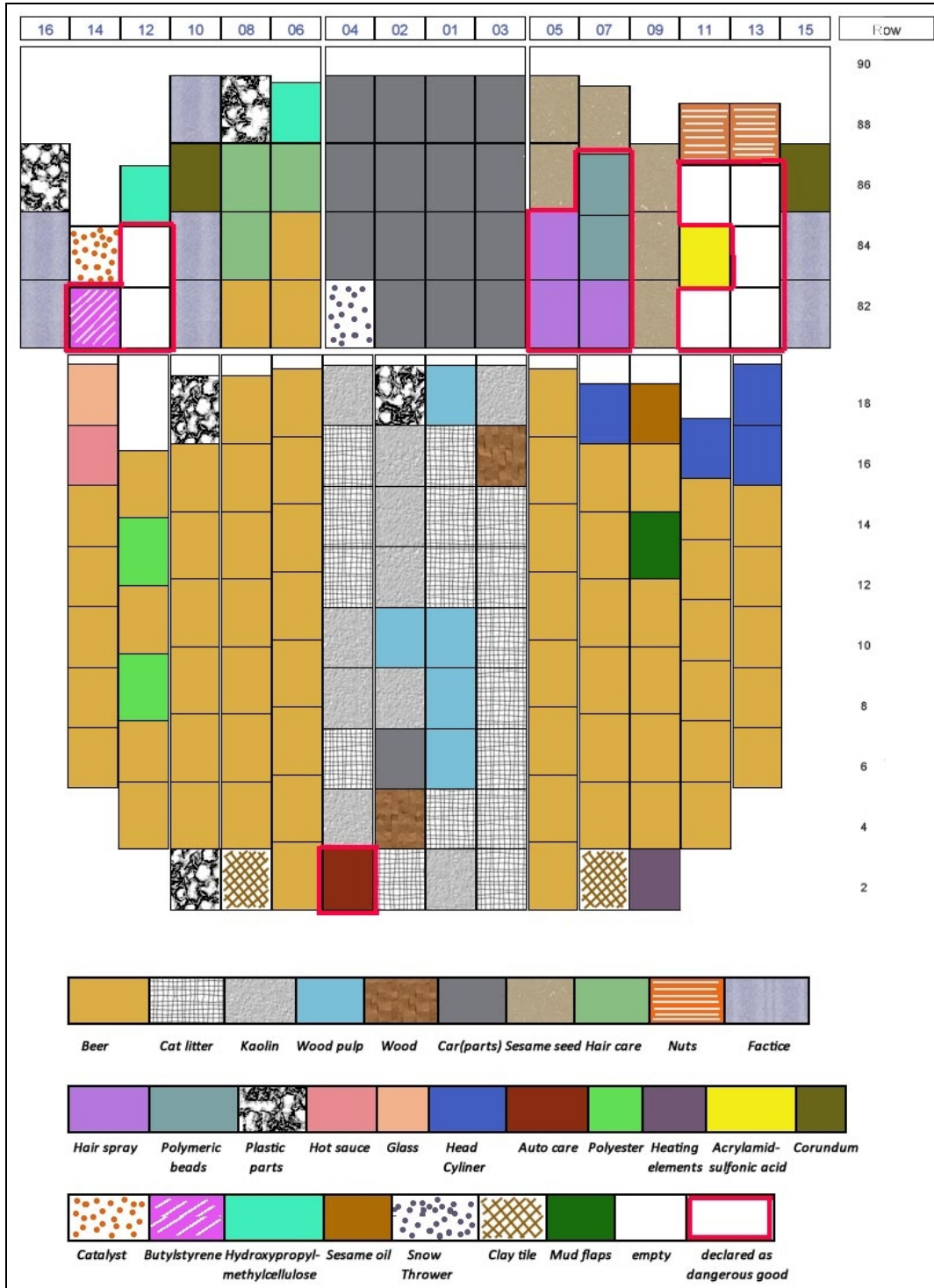


Figure 33: Distribution of the containers in bay 27

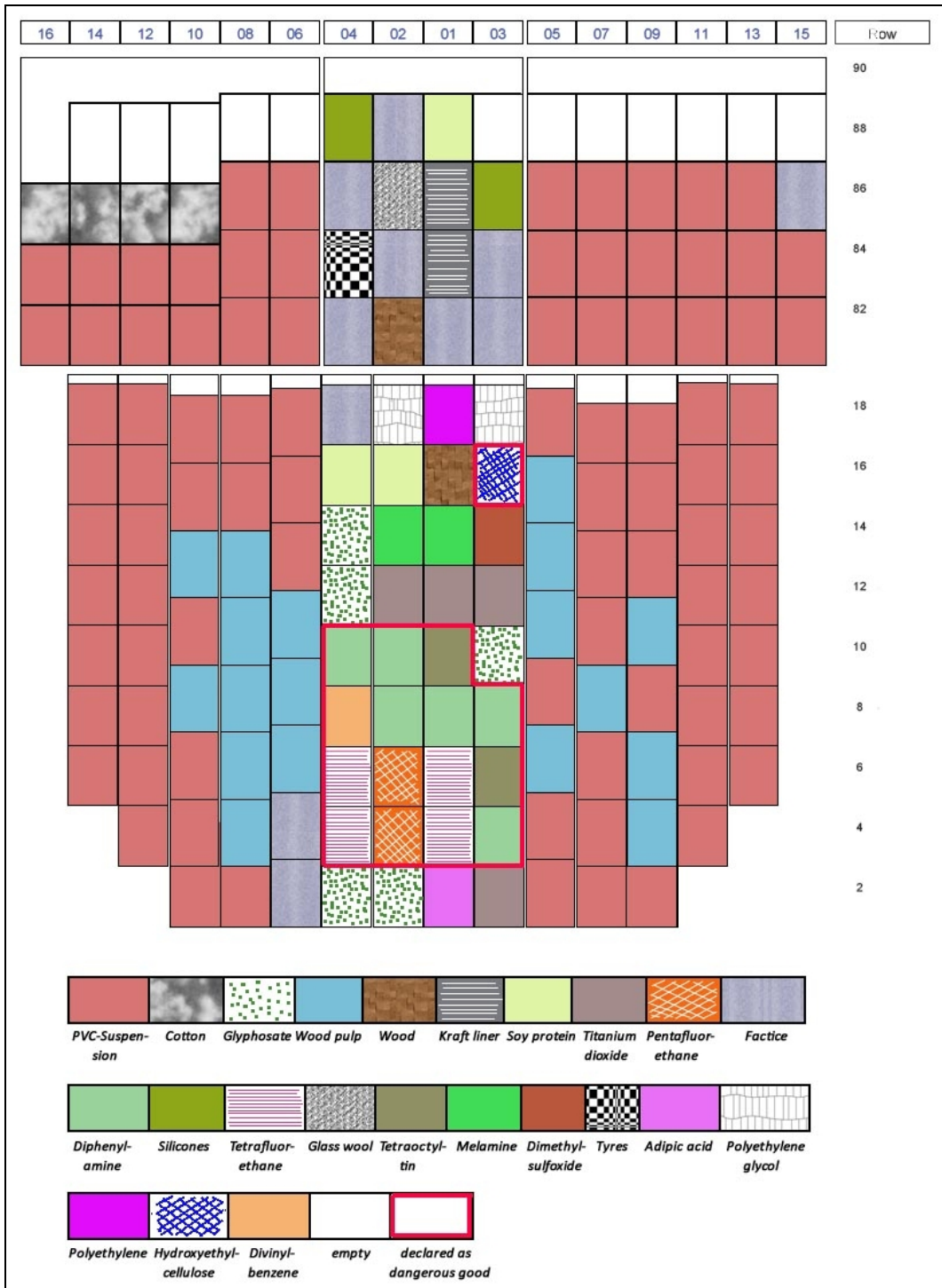


Figure 34: Distribution of the containers in bay 29



- § clay tiles, and
- § glassware

neither caused the fire nor were relevant to its course because of their physical and chemical properties. Therefore, they are not given further consideration below.

Moreover, it can be assumed with high probability that the items of cargo carried only **above** deck

- § sesame seeds;
- § cotton;
- § hair-care products;
- § plastic parts for conveyor belts;
- § paper board (kraftliner);
- § acrylamido-2-methylpropane-sulfonic acid, Na –salt 50% in water;
- § synthetic corundum, web mineral;
- § silicone products;
- § snow clearing machinery;
- § glass wool;
- § tyres, and
- § catalytic converters

did not cause the fire because the witness accounts [...] unanimously indicated that the smoke came from the lower deck area of cargo hatch 4 [...].  
[...]

The items of cargo

- § hydroxypropyl methylcellulose;
- § p-tertiary-butyl styrene;
- § Isopropylamine;
- § hair-care products in aerosol dispensers (hair spray), and
- § polymeric beads (non-specified)

were also stowed only above deck but are declared as dangerous goods. Therefore, they are included in the following investigation."<sup>46</sup>

### **(1) Ignition of very highly combustible cargo**

With regard to the ignition of very highly combustible cargo, the report states: "Items of cargo with a very low boiling point and flashpoint, as well as low minimum ignition energy can ignite even under normal carriage conditions under certain circumstances, e.g. due to

- solar radiation;
- electrostatic charge, and
- mechanically induced (minute) sparks, e.g. when metal collides

because the flashpoint can be reached or exceeded locally. To assess this scenario, the flashpoints of the relevant items of cargo have been summarised in Spreadsheets 1 to 3.

The table shows that only the four items of cargo

- § isopropylamine (dangerous goods class 3, flashpoint -37°C);
- § hair spray (dangerous goods class 2.1 – flammable gas);

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<sup>46</sup> First report by Dr Meißner.

§ car care products (product 1: dangerous goods class 2.1 – flammable gas, product 3: dangerous goods class 3 – flashpoint 37.8°C, product 4: dangerous goods class 3 – flashpoint 60°C), and  
 § dimethylaminoethanol (dangerous goods class 3 – flashpoint 39°C)

are declared as flammable liquids or flammable gases, meaning ignition of the cargo would be conceivable without an extraordinary supply of external power. Such a process is usually dependent on the cargo leaking, as ignition of the cargo within a full tank container is highly unlikely because the oxygen required for combustion is absent.

**Isopropylamine** was stowed in a tank container on deck (Figure 36)."

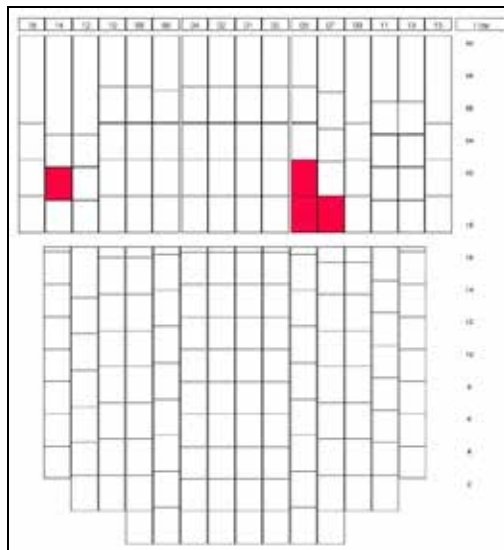


Figure 36: Stowage of highly combustible substances in bay 25; left: a tank container with isopropylamine; right: three containers with hair spray (bay 26)

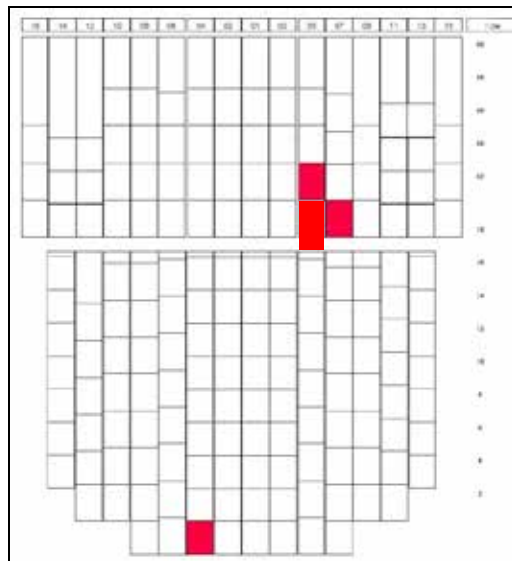


Figure 37: Stowage of highly combustible substances in bay 27; below deck: one container with car care products

"The GESTIS<sup>47</sup> substance database<sup>48</sup> indicates that the density ratio of isopropylamine gas to dry air at the same temperature and pressure is 2.04. Accordingly, isopropylamine gases possibly leaking from the tank container or vapours produced by escaping liquid isopropylamine are heavier than air and may accumulate in the cargo hatch below.

The cargo could only escape via a leak in a tank container or instruments connected to it. It can be assumed that such a leak could only have been small. Cargo leakage on a larger scale would quite probably have been noticed because the substance has a pronounced amine-like odour and irritates the respiratory system. Openings in the hatch cover through which the gas could have entered the hatch would certainly also have been only very small, if at all present. Therefore, due to the on deck stowage, it is more likely that minor instances of leakage would evaporate into the atmosphere faster than accumulating below deck. Consequently, this scenario is considered very unlikely [...].

**Hair spray** was in small pressurised gas cylinders stowed in dry van containers on deck (see Figure 36). Presumably, these were commercially available hair spray products. Even if some of them were damaged, the amount of flammable gas released can be assessed as very low. An accumulation of these gases in the cargo hatch is very unlikely (similar to the considerations for isopropylamine). An explosion inside a dry van container on deck was not observed.

**Car care products** were stowed in gaseous form in pressurised gas cylinders or liquid form in tanks in a dry van container right at the bottom of bay 27 (see Figure 37). Since the pressurised gas cylinders evidently represented smaller outer packaging (spray cans), the gas concentration of a flammable gas to leak would certainly only have been marginal if some of the packaging was damaged. However, in this case there is the possibility of a detonation inside the container, resulting in the possible development of a smouldering or smaller fire. Here, the other (liquid) products in this container have flashpoints of 37.8°C or 60°C and could have ignited relatively easily, meaning the spread of fire would be possible. However, it seems less likely that these liquid products caused the fire because the discussed flashpoints are relatively high. The properties of this mixed cargo and the slot position of this container permits this scenario to be one possible cause of the fire.

**Dimethylaminoethanol** was stowed in tank containers below deck (see Figure 38).

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<sup>47</sup> Note BSU: <http://www.dguv.de/ifa/Gefahrstoffdatenbanken/GESTIS-Stoffdatenbank/index-2.jsp>

<sup>48</sup> [http://gestis.itrust.de/nxt/gateway.dll/gestis\\_de/023480.xml?f=templates\\$fn=default.htm\\$3.0](http://gestis.itrust.de/nxt/gateway.dll/gestis_de/023480.xml?f=templates$fn=default.htm$3.0)



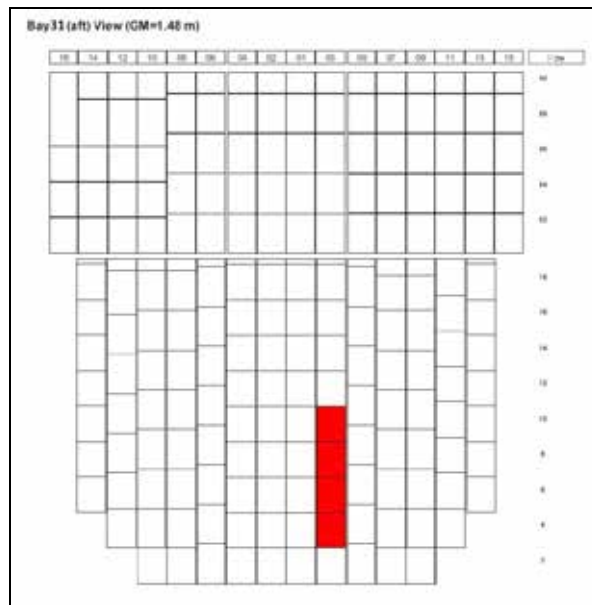


Figure 38: Stowage of highly combustible substances in bay 31; below deck: four containers with dimethylaminoethanol

At 39°C, the flashpoint of dimethylaminoethanol is already relatively high. On the other hand, the statements of the crew [...] indicate that it was *"hot and dry with water temperatures of about 24°C"* in the port of departure, Charleston. Consequently, it is quite possible that temperatures of up to 40°C would have prevailed in the cargo hatch – a temperature close to or even above the flashpoint of dimethylaminoethanol. Moreover, while being heard the crew indicated that bunker tanks were located in the area of the hatch relevant to the accident. These were kept at a constant temperature of or automatically heated up to (but specifically not beyond) 45°C. Therefore, an ignition of fumes arising from leaking cargo (dimethylaminoethanol), which resulted in the development of a detonation or smouldering fire, seems possible."<sup>49</sup>

The basic safety-related data for the cargo in the area of cargo hold 4 are shown in Spreadsheets 1 to 3<sup>50</sup> below:

<sup>49</sup> First report by Dr Meißner.

<sup>50</sup> Spreadsheets 1 to 3 are taken from the First report by Dr Meißner.

Name	Melting point [°C]	Boiling point [°C]	Flash-point [°C]	Dust explosion possible?	Transport on board	UN No	IMO/IMDG Class
PVC suspension <del>Formolon</del>	Not specified (depletion)	Not specified (depletion)	Not applicable (non-existent as liquid)	Yes	In high-cube or dry van container, powder form	-	-
Diphenylamine	52	302	153	No	In tank container, presumably liquid	3082	9
1,1,1,2-tetrafluoroethane	-101	-26	Not applicable (non-combustible)	No	In tank container, presumably liquid	3159	2.2
Titanium dioxide	1855	2900	Not applicable (non-existent as liquid)	No	In dry van container, presumably powder form	-	-
Melamine	350°	Depletion	>280	Yes	In dry van container, presumably powder form	-	-
<del>Divinylbenzene</del> 80%	-88	195	77	No	In tank container, liquid	3082	9
<del>Pentafluoroethane</del>	-103	-48.5	Not applicable (non-combustible)	No	In tank container, presumably liquid	3220	2.2
<del>Tetraoctyltin</del>	No information	268	102 180	No	In tank container, liquid	3082 according to the cargo list 1760 2788	9
<del>Dimethylethanolamine</del> Appendix 14	-59	132	39	No	In tank container, liquid	2051	8
Glyphosate – intermediate product	184.5	Depletion from 199	Not applicable (non-existent as liquid)	No	In dry van container, presumably powder form	-	-
Kaolin clay	Not determined	Not determined	Not applicable (non-existent as liquid)	No	In dry van container, presumably powder form	-	-

Spreadsheet 1: Safety-related data for the relevant items of cargo

Name	Melting point [°C]	Boiling point [°C]	Flash-point [°C]	Dust explosion possible?	Transport on board	UN No	IMO/IMDG Class
Zinc oxide	1975	Not determined	Not applicable (non-existent as liquid)	No	In dry van container, presumably powder form	3077	9
Soy protein powder	Not determined	Not determined	Not applicable (non-existent as liquid)	No	In dry van container, presumably powder form	-	-
<u>Hydroxyethyl</u> cellulose	Not determined	Not determined	Not applicable (non-existent as liquid)	Yes	In dry van container, presumably powder form	-	-
Polyethylene glycol (powder)	10 - 20	Not determined	>100	No	In dry van container, powder form	-	-
Dimethyl sulfoxide	18.5	189	87	No	Liquid in 500l drums in dry van container	-	-
Polyethylene	125 - 150	Not determined	Not applicable (non-existent as liquid)	No	In dry van container, powder form	-	-
<u>Adipic acid</u>	151 - 154	Approx. 330	186	Yes	In dry van container, presumably powder form	-	-
Nylon 6.6	257 - 267	Not determined	>371	Yes	In dry van container, presumably powder form	-	-
Sesame oil	Not determined	>350	>300	No	Liquid in tanks in dry van container	-	-
Wood or wooden furniture parts	Not determined	Not determined	Not applicable (non-existent as liquid)	No	Boards in dry van container	-	-
Empty plastic bottles probably made of polyethylene	See Polyethylene column			No	In high-cube container	-	-

Spreadsheet 2: Spreadsheet 1 (continued) – Safety-related data

Name	Melting point [°C]	Boiling point [°C]	Flash-point [°C]	Dust explosion possible?	Transport on board	UN No	IMO/IMDG Class
Steel parts	Approx. 1500	Not determined	Not applicable (non-existent as liquid)	No	In dry van container	-	-
Synthetic rubber	Not determined	Not determined	Not applicable (non-existent as liquid)	No	In dry van container	-	-
Dirt traps probably made of synthetic rubber	See Synthetic rubber column			No		-	-
Non-specified plastic parts	Cannot be determined, cargo description too imprecise		Not applicable (non-existent as liquid)	No	In dry van container	-	-
Car care products based on petroleum distillates	Various car care products		Product 3: 37.8 Product 4: 60	No	Gaseous form or liquid in pressurised gas cylinders or tanks in dry van container	P2: 1950 P3: 1268 P4: 1268	P2: 2.1 P3: 3 P4: 3
p-tertiary-butyl styrene	-38	219	81	No	In tank containers, liquid, <b>on deck</b>	NA 1993	3
<u>Isopropylamine</u>	-101	31 - 33	-37	No	In tank containers, liquid, <b>on deck</b>	1221	3
<u>Hydroxypropyl methylcellulose</u>	Not determined	Not determined	Not applicable (non-existent as liquid)	Yes	In dry van container, presumably powder form <b>on deck</b>	-	-
Hair spray	Cannot be determined, cargo description too imprecise			No	Gaseous form or liquid in pressurised gas cylinders in dry van container <b>on deck</b>	1950	2.1

Spreadsheet 3: Spreadsheet 2 (continued) – Safety-related data

## **(2) Dust explosion**

"A large percentage of the items of cargo carried in hatch 4 was in powder form and presumably packed in sacks or bags. For some of these items of cargo, the risk of a dust explosion is explicitly noted in the corresponding safety data sheets. In particular, this concerns the following items of cargo:

- PVC suspension formolon;
- melamine;
- hydroxyethyl cellulose;
- nylon 6.6, and
- hydroxypropyl methylcellulose.

Prior to the accident, the FLAMINIA sailed out of Charleston on 08/07/2012 and was at sea from that date. Such an explosion is conceivable only in close temporal proximity to loading and unloading operations when the development of dust is possible due to the movement of containers. After several days at sea, it is unlikely that airborne powder from items of cargo still exists inside the container. It is very unlikely that this scenario would cause the fire; however, it may have played a role subsequently as the fire progressed."<sup>51</sup>

## **(3) Reaction with ambient substances**

"Besides the possibility that leaking cargo ignited due to the low flashpoint, there is also a possibility that flammable gases formed or that suddenly so much heat was released that other items of cargo in the vicinity were ignited due to a reaction with ambient substances. Air (oxygen), water, iron (containers), and light (sun) are viewed as the most probable ambient substances. Spreadsheets 4 and 5 list the extent to which the items of cargo stowed in or above hatch 4 reacts with these substances. Here, the term 'react' refers to relatively rapid and violent reactions because only such a reaction process would constitute a serious potential risk."<sup>52</sup>

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<sup>51</sup> First report by Dr Meißner.

<sup>52</sup> Ibid.

Name	Reaction with air (oxygen)	Reaction with water	Reaction with iron (containers)	Reaction initiated by light
PVC suspension Formolon	-	-	-	-
Diphenylamine	-	-	-	-
1,1,1,2-tetrafluoroethane	-	-	-	-
Titanium dioxide	-	-	-	-
Melamine	-	-	-	-
Divinylbenzene 80%	Polymerisation	-	Polymerisation	-Polymerisation -Depletion
Pentafluoroethane	-	-	-	-
Tetraoctyltin	-	-	-	-
Dimethylethanol-amine	-	Formation of strong caustic lye	-	-
Glyphosate – intermediate product	-	-	Formation of hydrogen gas	-
Kaolin clay	-	-	-	-
Zinc oxide	-	-	-	-
Soy protein powder	-	-	-	-
Hydroxyethyl cellulose	-	-	-	-
Polyethylene glycol	-	-	-	-
Dimethyl sulfoxide	-	-	-	-
Polyethylene	-	-	-	-
Nylon 6.6	-	-	-	-
Sesame oil	-	-	-	-
Wood or wooden furniture parts	-	-	-	-
Empty plastic bottles probably made of polyethylene	-	-	-	-
Steel parts	-	-	-	-
Synthetic rubber	-	-	-	-

Spreadsheet 4: Reactivity of the cargo with ambient substances

Name	Reaction with air (oxygen)	Reaction with water	Reaction with iron (containers)	Reaction initiated by light
Dirt traps probably made of synthetic rubber	-	-	-	-
Non-specified plastic parts	-	-	-	-
Car care products based on petroleum distillates	-	-	-	-
p-tertiary-butyl styrene	Polymerisation	-	Polymerisation	-Polymerisation -Depletion
Isopropylamine	Decomposition	-	-	-
Hydroxypropyl methylcellulose	-	-	-	-

Spreadsheet 5: Spreadsheet 4 (continued) – Reactivity of the cargo

"According to Spreadsheets 4 and 5, the following items of cargo can react with the ambient substances – air (oxygen), water, iron or light – in a manner that would be relevant:

- divinylbenzene 80%;
- p-tertiary-butyl styrene [in the report also named as tertiary-butyl styrene];
- isopropylamine;
- dimethylethanolamine, and
- glyphosate.

**Divinylbenzene** has a tendency to polymerise easily. Therefore, it may only be carried in a stabilised condition. A stabiliser prevents polymerisation. No note as to stabilisation can be found in column [...] 'Description of Goods' of the cargo list. However, the divinylbenzene was carried only in the form of an 80% solution, which reduces the tendency to polymerise considerably. The entry of sunlight can be excluded because this cargo was carried below deck in bays 29 and 31. Polymerisation could have been initiated by contact with air (oxygen) or catalysing metals, which would only have been possible with leaking cargo (tank containers for items of cargo prone to polymerisation are usually coated to prevent contact between metals); presumably, this would have always only been small amounts. It is very unlikely that a sudden (and releasing much heat) polymerisation of this cargo would have caused the fire.

**p-tertiary-butyl styrene** has a tendency to polymerise easily. Therefore, it may only be carried in a stabilised condition. A stabiliser prevents polymerisation. According to column X of the cargo list 'Description of Goods', the p-tertiary-butyl styrene carried was stabilised. Moreover, this cargo was only carried above deck, which evidently was not the starting point of the fire. Sunlight could only have affected leaking cargo; presumably, this would have always only been small amounts. It is very unlikely that a sudden (and releasing much heat) polymerisation of this cargo would have caused the fire.

**Isopropylamine** can deplete in contact with air and develop heat, as well as release flammable gases in the process. Isopropylamine was stowed only above deck in a tank container (see Figure 36), which evidently was not the starting point of the fire. Contact with air would have been possible only if the cargo leaked, which certainly only occurred in small quantities. Due to the on deck stowage, any gases that formed and possibly released heat would have dissipated very quickly."

**Glyphosate** was carried in so-called container liners<sup>53</sup> made of a woven plastic fabric. Direct contact with the metal of the container was thus avoided.

"**Dimethylaminoethanol** provides a very caustic lye in combination with water. Dimethylaminoethanol was stowed in four tank containers in bay 31 below deck (see Figure 38). It is conceivable that a significant amount of (warm) condensate had collected on the floor of cargo hatch 4. While being heard, the crew [...] indicated that they sail from very hot areas to cooler regions.

If there was a leak in a tank container, then dimethylaminoethanol could have reached water that had accumulated and caused the formation of lye there. This dissolution in water is all that is required to release heat. However, a possible reaction between the lye that had formed and other items of cargo or even parts of the container, which could also have caused exothermic reactions (see paragraph 4), is regarded as even more critical. It is possible that cargo could have escaped through a small leak in a dimethylaminoethanol tank container for days and reacted with different items of cargo with the release of heat. This could have caused a build-up of heat, which in the end led to the huge amounts of PVC powder heating up and an ensuing release of gases. That this scenario caused the fire is considered a distinct possibility."<sup>54</sup>

#### **(4) Reaction between different items of cargo**

"A reaction between different items of cargo is another possibility for the release of large amounts of heat or flammable gases. This implies that the items of cargo can come into contact with each other. In the case of the container ship FLAMINIA's situation as portrayed, it is assumed that only gaseous or liquid items of cargo could have come into contact with other items of cargo in larger amounts via leaks in their outer packaging or tank containers. Contact between two items of cargo in solid, grain or powder form in such quantities that relevant amounts of heat could have developed can virtually be ruled out.

Items of cargo stowed above deck can also be ruled out of this investigation because it is assumed that leaking liquids or gases could not have entered the cargo hatch in relevant quantities.

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<sup>53</sup> Container liner: Sack-like structure suspended in the container, which due to its box-shaped design offers good use of the space in the container and special protection for the cargo to be carried.

<sup>54</sup> First report by Dr Meißner.



Spreadsheets 6 and 7 show the extent to which the gaseous or liquid cargo in cargo hatch 4 could have reacted **heavily** with the other cargo with the development of heat.

Spreadsheets 6 and 7 show that **dimethylaminoethanol** (DMAE) has a very high risk potential here, too.

As a strong base, this substance reacts with many other substances, especially acids or substances with acid precursors. Dissolved in a little water, the basic effectiveness of DMAE is reinforced. Based on the slot position, leaked dimethylaminoethanol could have reacted with the cargo

- PVC suspension;
- diphenylamine, and
- glyphosate

in particular, and in each case released heat.

If the DMAE had reached water that was possibly already at the bottom of the cargo hatch (see section 3), then a strong basic aqueous solution, much greater in volume than the leaked cargo, could have formed. This basic aqueous solution at the bottom of the hatch possibly also reacted with other cargo, but in a larger radius.<sup>55</sup>

Name	Reaction with 1,1,1,2-tetrafluoroethane	Reaction with pentafluoroethane	Reaction with diphenylamine	Reaction with divinylbenzene	Reaction with dimethylethanol amine	Reaction with tetraoctyltin	Reaction with dimethyl sulfoxide	Reaction with Sesame oil	Reaction with car care products
PVC suspension					XX		X		
Diphenylamine					X				
1,1,1,2-tetrafluoroethane									
Titanium dioxide									
Melamine									
Divinylbenzene 80%					XXX	X			
Pentafluoroethane					XXX				
Tetraoctyltin									
Dimethylethanolamine		XXX	X	XXX			X		X

Spreadsheet 6: Reactivity of gaseous or liquid cargo with other items of cargo in cargo hold 4 (X – significant reaction, XX – violent reaction, XXX – very violent reaction)

<sup>55</sup> First report by Dr Meißner.

Name	Reaction with 1,1,1,2-tetrafluoroethane	Reaction with pentafluoroethane	Reaction with diphenylamine	Reaction with divinylbenzene	Reaction with dimethylethanamine	Reaction with tetraoctyltin	Reaction with dimethyl sulfoxide	Reaction with sesame oil	Reaction with car care products
Glyphosate – intermediate product					X				
Kaolin clay									
Zinc oxide									
Soy protein powder									
Hydroxyethyl cellulose									
Polyethylene glycol									
Dimethyl sulfoxide					X				
Polyethylene									
Nylon 6.6									
Sesame oil									
Wood or wooden furniture parts					X				
Empty plastic bottles <i>probably made of polyethylene</i>									
Steel parts					X				
Synthetic rubber					X				
Dirt traps <i>probably made of synthetic rubber</i>					X				
Non-specified plastic parts					X		X		
Car care products					X				

Spreadsheet 7: Spreadsheet 6 (continued) – Reactivity of gaseous or liquid cargo

### (5) Development of the fire

"MSC FLAMINIA left the port in Charleston on 08/07/2012. The fire alarm was triggered at about 0550 on 14/07/2012." A violent explosion occurred shortly afterwards. The course of events indicates that chemical reactions may have occurred for days [as previously described in paragraphs 3 and 4] and that a smouldering fire spread in the process.

It is likely that after a certain temperature was reached the increasing build-up of heat relatively quickly resulted in the depletion of cargo, the large quantities of PVC suspension in particular, and that large quantities of different gases were released. PVC suspension is not an aqueous solution [...], but a PVC powder obtained via suspension polymerisation. Basically, PVC suspension is polyvinyl chloride in powder form. In addition to the PVC suspension, hatch 4 also contained additional items of

cargo capable of releasing various gases after a relatively low rise in temperature (from about 150°C). Spreadsheets 8 and 9 illustrate the gases the various items of cargo **mainly** release at a low or sharp rise in temperature, or ultimately during a fire. In the process, a large quantity of explosive gases (carbon monoxide, ammonia, alcohol, and aldehyde) could also have formed."<sup>56</sup>

The following spreadsheet refers to the cargo **in** cargo hold 4.

Name/ Data from	Gases released at a moderate rise in temperature (from about 150°C)	Gases released at a sharp rise in temperature (from about 300°C)	Gases released on combustion
PVC suspension Formolon	Hydrogen chloride (HCl)	Hydrogen chloride, chlorine oxides, chlorine gas	Carbon monoxide, carbon dioxide, hydrogen chloride, chlorine gas, phosgene, inter alia
Diphenylamine	-	Ammonia (NH <sub>3</sub> ), nitrogen oxides	Carbon monoxide, carbon dioxide, nitrogen oxides
1,1,1,2-tetrafluoroethane	-	Hydrogen fluoride	Carbon monoxide, carbon dioxide, hydrogen fluoride
Titanium dioxide	-	-	-
Melamine	-	Ammonia	Carbon monoxide, carbon dioxide, nitrogen oxides
Divinylbenzene 80%	-	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde
Pentafluoroethane	-	Hydrogen fluoride	Carbon monoxide, carbon dioxide, hydrogen fluoride
Tetraoctyltin	-	-	Carbon monoxide, carbon dioxide
Dimethylethanol-amine	-	Ammonia, alcohol, nitrogen oxides	Carbon monoxide, carbon dioxide, nitrogen oxides, aldehyde
Glyphosate – intermediate product	-	Ammonia, carbon dioxide	Carbon monoxide, carbon dioxide, nitrogen oxides, phosphorus oxides
Kaolin clay	-	-	-
Zinc oxide	-	-	-
Soy protein powder	-	-	Carbon monoxide, carbon dioxide, nitrogen oxides, aldehyde
Hydroxyethyl cellulose	-	-	Carbon monoxide, carbon dioxide
Polyethylene glycol	-	-	Carbon monoxide, carbon dioxide, aldehyde
Dimethyl sulfoxide	-	Sulfur oxides	Carbon monoxide, carbon dioxide Sulfur oxides
Polyethylene	-	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde
Nylon 6.6	-	Ammonia Hydrogen cyanide	Carbon monoxide, carbon dioxide, nitrogen oxides
Sesame oil	-	Various hydrocarbons	Carbon monoxide, carbon dioxide

Spreadsheet 8: Gases released at a rise in temperature or combustion of cargo from cargo hold 4

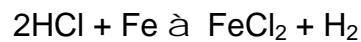
<sup>56</sup> First report by Dr Meißner.

Name/ Data from	Gases released at a moderate rise in temperature (from about 150°C)	Gases released at a sharp rise in temperature (from about 300°C)	Gases released on combustion
Wood or wooden furniture parts	-	Various hydrocarbons	Carbon monoxide, carbon dioxide
Empty plastic bottles <i>probably made of polyethylene</i>	-	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde
Steel parts	-	-	-
Synthetic rubber	Short-chain hydrocarbons	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde
Dirt traps <i>probably made of synthetic rubber</i>	Short-chain hydrocarbons	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde
Non-specified plastic parts	-	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde
Car care products based on petroleum distillates	Short-chain hydrocarbons	Various hydrocarbons	Carbon monoxide, carbon dioxide, aldehyde

Spreadsheet 9: Spreadsheet 8 (continued) – Release of gases

"It is a relative certainty that in the course of events large quantities of hydrogen chloride (HCl) [...] were released from the 90 PVC suspension containers.

In conjunction with humidity, released hydrogen chloride attacks steel (Fe), which then leads to the formation of hydrogen (H<sub>2</sub>).



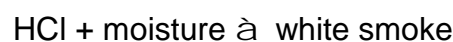
Accordingly, highly explosive hydrogen gas could have formed in the steel hatch due to the released HCl gas. Hydrogen has an extremely low minimum ignition energy. Therefore, the violent explosion after the fire-fighting was started could also be related to the thus formed hydrogen.

Moreover, due to the discharged carbon dioxide, heated PVC powder could have become airborne, causing a dust explosion (see paragraph 2).

A number of witnesses reported that they observed thick white/grey smoke when the crew was interviewed. Furthermore, the white plume is clearly visible on the first images of the burning FLAMINIA.

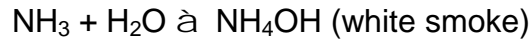
This white/grey smoke is another explicit indication of the development of hydrogen chloride or ammonia.

In conjunction with humidity, hydrogen chloride forms white smoke with an irritating chemical odour.



In all likelihood, ammonia gas [...] also formed. The two gases, hydrogen chloride and ammonia, react to form ammonium chloride [...], which sublimates and also forms grey/white smoke.

$\text{HCl} + \text{NH}_3 \rightarrow \text{NH}_4\text{Cl}$  (sublimates above 355°C and forms white smoke in the process)  
Last but not least, ammonia gas even reacts with water to form ammonium hydroxide, which can appear as white smoke:



In all likelihood, the released gases formed the highly explosive mixture that led to the explosion. There was a sufficient amount of flammable material among the remaining cargo for the thus triggered fire. Already heated, the polyvinyl chloride then started to burn. A flame developed in the process, which generated a lot of soot. Moreover, several containers with synthetic rubber were on board, which also generated a lot of soot while burning. [...] Inter alia, 23 containers with wood pulp provided the fire with more flammable material, so that ultimately the serious fire damage was able to develop."<sup>57</sup>

#### **(6) Cause of the fire**

"Analysis of the physical and chemical properties of all the items of cargo in cargo hatch 4 of the damaged container ship FLAMINIA results in the following scenarios being the most likely causes of fire:

1. a release of small quantities of flammable gases from the defective outer packaging of car care products → detonation → smouldering fire → gradual increase in the temperature of surrounding items of cargo, the PVC suspension in particular → release of large quantities of explosive gases over several days → explosion → fully developed fire;
2. leakage of dimethylaminoethanol from tank container, ignition of vapours or dissolution in possibly accumulated condensate at the bottom of the hatch and/or reaction with surrounding items of cargo with development of heat → gradual increase in the temperature of surrounding items of cargo, the PVC suspension in particular → release of large quantities of explosive gases over several days → explosion → fully developed fire."<sup>58</sup>

The expert believes that the other possible causes of fire discussed in the chemical report, such as a dust explosion, are less likely; however, they cannot be ruled out entirely.

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<sup>57</sup> First report by Dr Meißner.

<sup>58</sup> Ibid.

### 1.2.6.2 Other report on the cause of the fire

#### (1) Report on deposits in the piping system

Intertek, a company commissioned by the charterer and the vessel operator, disassembled parts of the sample extraction smoke detection system's piping in the area between the valves (see Figure 20) and the cabinet with the gauging equipment with the consent of the BSU and the public prosecutor's office.

For comparison purposes, parts of the plastic piping were taken from cargo holds 2, 4, and 8 and analysed using different methods so as to determine if various substances had been deposited on the inside of the piping. Here, a significant amount of divinylbenzene, ethylstyrene, diethylbenzene, and other associated aromatic hydrocarbons were found in the samples taken from cargo hold 4. The vessel charterer made the summary of the report<sup>59</sup> available to the BSU. The experts from Intertek did not remove and use any components from the metal piping system. Inasmuch, the opportunity to establish a possibly heightened percentage of PVC in the deposits on the inside of the piping existed only to a limited extent.

#### (2) Report: conclusion to be drawn from the deposits found

Building on the Intertek report, Dr Beeley, the expert acting on behalf of the charterer (MSC) expressed the theory that the divinylbenzene (80%) carried in three tank containers in cargo hold 4 (weighing more than 18 t in each case) reportedly caused the fire during a presentation<sup>60</sup> at the BSU. This theory was based on the aforementioned fact that a large quantity of divinylbenzene had accumulated on the inside surface of the piping samples. The expert also referred to the fact that divinylbenzene (DVB) has a tendency to polymerise. During polymerisation, the substance starts to react with itself. During carriage, a stabiliser should prevent this behaviour of the substance. However, depending on the duration of carriage and existing temperatures, this stabiliser depletes. According to the manufacturer, Deltech (U.S.), the stabiliser used, tert.-Butyl-brenzcatechin (TBC), prevents polymerisation over a period of 60 days subject to a constant storage temperature of 65°F (18.3°C). The stabiliser depletes in line with the rise in temperature. Based on the information on storing and handling the substance in the technical data sheet<sup>61</sup>, it is assumed that the stabiliser would have already depleted after 30 days if stored at above 27°C.

The manufacturer states in the safety data sheet that storage should be below 80°F (27°C).

Since the tank containers used were not equipped with an active cooling capability and based on the two assumptions that the containers were only marginally insulated and that higher temperatures prevailed during carriage, the charterer's expert

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<sup>59</sup> Dr Fletcher, Ian W.: Executive Summary Report on the Analyses carried out by Intertek MSG on Samples removed from MSC Flaminia CO<sub>2</sub> Room on 4<sup>th</sup> October 2012 [sic]. Unpublished report, Redcar, UK, 2013.

<sup>60</sup> In spite of a corresponding request, the report on which the presentation was based was not made available to the BSU in written form.

<sup>61</sup> <http://www.deltechcorp.com/deltech02/monomers/dvbtechbltn.htm>, information as of 04/07/2013.

assumed that polymerisation occurred during the voyage. The resulting heat release of 350°C was then reportedly responsible for the fire. Moreover, the occurrence of white smoke is reportedly typical to polymerisation. He referred to past events with this substance<sup>62</sup> (see Figure 39). In the case of the events that are known, it should be noted that neither an explosion nor open flames have occurred.



Figure 39: Ongoing polymerisation on a container in road transport

In its statement concerning the draft report, Deltech informed the BSU that the incident described in figure 39 occurred after a transport time of 37 days. Thereby the containers were said to have stand in the sun in a port. By evaluating the incident the precautions taken by the manufacturer were optimized. Since then no abnormalities have reportedly been determined during transports to destinations in warm countries far away. The own temperature monitoring resulted in the fact that the temperatures in the containers remained within the limit value.

### **(3) Discussion of the report: conclusion to be drawn from the deposits**

To determine the period of transport, the BSU made contact with the manufacturer (Deltech Corporation, U.S.). The manufacturer stated that the three tank containers were loaded towards the end of the evening of 21 June 2012 in Baton Rouge, U.S. At this point, the temperature of the cargo was 6.7°C.

<sup>62</sup> For example, search result for divinylbenzene on <http://www.aria.developpement-durable.gouv.fr>; event of 07/08/2006 (ARIA 32163), information as of 04/07/2013.

The course of the shipment and precise storage conditions between Baton Rouge and New Orleans are unknown. The containers were loaded onto the MSC FLAMINIA in New Orleans on 1 July 2012.

The next ports of loading were Mobile (2 July 2012), Freeport, Bahamas (4 July 2012), Savannah (6 July 2012), and Charleston (8 July 2012). Hence, up until the day of the accident on 14 July 2012, the three containers were in the transport chain for about 22 days.

According to the cargo documents, the code number of the three containers was 2275. This means that the containers had a length of 20' and a height of 8' 6". These were tank containers<sup>63</sup> suitable for the carriage of dangerous cargo at a maximum pressure of 4 bar. The containers had marginal insulation. A means (thermometer) of checking the internal temperature was on the outside. The requests sent by fax and email to different branches of Stolt-Nielsen (consignee) and to Stolt Tank Containers (shipper and the owner of the containers), as well as their global claims examiner with regard to the type of container and responsibility for checking the temperature was answered by Stolt-Nielsen USA. They stated that they are unable to give precise information about loading date and time. Furthermore Stolt-Nielsen was neither responsible for monitoring product quality, nor for the daily temperature monitoring.

To determine the outside temperatures during carriage, the recorded temperatures and degrees of cloud coverage for these areas and periods were analysed by Germany's National Meteorological Service on behalf of the BSU and made available. They indicated that the temperatures from 21 June to 1 July 2012 for the area of Baton Rouge ranged from a minimum of 21°C to a maximum of 38°C. The average temperature was no more than 32°C. The maximum temperatures recorded for the New Orleans area were similar to Baton Rouge. The minimum temperatures were slightly higher than the temperatures at Baton Rouge. Since the average cloud cover stood at 50%, even higher temperatures may have been reached on the external surface of the containers depending on their location.

The temperatures at the following ports of loading were as follows:

- |              |              |              |                   |
|--------------|--------------|--------------|-------------------|
| - Mobile     | 22°C minimum | 35°C maximum | Ø 50% cloud cover |
| - Freeport   | 24°C minimum | 33°C maximum | Ø 50% cloud cover |
| - Savannah   | 23°C minimum | 36°C maximum | Ø 50% cloud cover |
| - Charleston | 24°C minimum | 36°C maximum | Ø 25% cloud cover |

According to the log, the following temperatures prevailed during the sea voyage:

- |                |     |              |              |                              |
|----------------|-----|--------------|--------------|------------------------------|
| - 9 July 2012  | air | 25°C minimum | 29°C maximum | water Ø 26°C                 |
| - 10 July 2012 | air | 24°C minimum | 26°C maximum | water Ø 26°C                 |
| - 11 July 2012 | air | 20°C minimum | 25°C maximum | water Ø 25°C                 |
| - 12 July 2012 | air | 14°C minimum | 20°C maximum | water Ø 16°C                 |
| - 13 July 2012 | air | 18°C minimum | 23°C maximum | water Ø 17°C                 |
| - 14 July 2012 | air | 15°C minimum | 17°C maximum | water Ø 15°C <sup>64</sup> . |

<sup>63</sup> <http://www.stolt-nielsen.com/Stolt-Tank-Containers/Our-Services/Features-of-a-Tank-Container.aspx>, information as of 11/07/2013.

<sup>64</sup> Values up to 0800.



Since all three containers were stowed below deck<sup>65</sup>, solar radiation was of no relevance during the sea voyage. However, of significant importance during sea transport were the fuel tanks for heavy fuel oil on both sides of the cargo hold as these were, according to the statement of the crew<sup>66</sup>, heated to a constant 45°C and presumably influenced the ambient temperature decidedly due to the existing area. Moreover, stowage in the middle of the container stack probably prevented a rapid change in temperature.

In the course of the investigation the BSU could not obtain any information or recordings with respect to the ventilation of cargo holds or temperature gradation inside the cargo holds. The vessel operator informed that the ventilation flaps at the sides of the hatch coaming are usually left open. At the time of the outbreak of fire the ventilation flaps were closed.

The filling level of the ballast water tanks and fuel tanks in the area of cargo hold 4 at the time of the accident could not be ascertained because contrary to the operating instructions of the vessel operator<sup>67</sup>, the daily level readings were recorded neither in the engine room log nor in the bridge log. In the engine room log, only the overall values were entered as specified by the columns.

The first soundings by the salvor (12 August 2012) revealed that the port tank was empty and the starboard tank 1% full. However, the investigators assume that the two tanks were at least 50% full at the time of the accident.

The experts appointed by the BSU attended the presentation regarding divinylbenzene causing the fire by the expert of the charterer, MSC. In the statement drawn up<sup>68</sup> in relation to the above, the dependency of divinylbenzene on transport temperature was also worked out. For comparison purposes, inter alia the depletion of the stabiliser (TBC) in the similar substance styrene has been taken into account (Spreadsheet 10) and set against that of divinylbenzene (Graph 1). Assuming the linear behaviour during the depletion of TBC is similar, the characteristic shown in Graph 1 (purple line) arises on the basis of the two known values for divinylbenzene. The graph also shows that TBC depletes in divinylbenzene at lower temperatures, too. The comparative reference to Styren is seen critically by Deltech, since the TBC content was much lower. In its statement Deltech also criticized the diagram 1, since

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<sup>65</sup> See Figures 32 and 33 for stowage position.

<sup>66</sup> The BSU does not have any information about the temperatures prevailing in the tanks. However, it is to be noted, that the IMDG-Code assumes, that the temperatures in the cargo hold in direct proximity to the cargo can temporarily reach up to 55° (e.g. SOLAS 2010, chapter 7.7).

<sup>67</sup> Fleet Instructions & Fleet Announcements, 301 Cargo Holds/ tanks/ bilges, section 5.1.

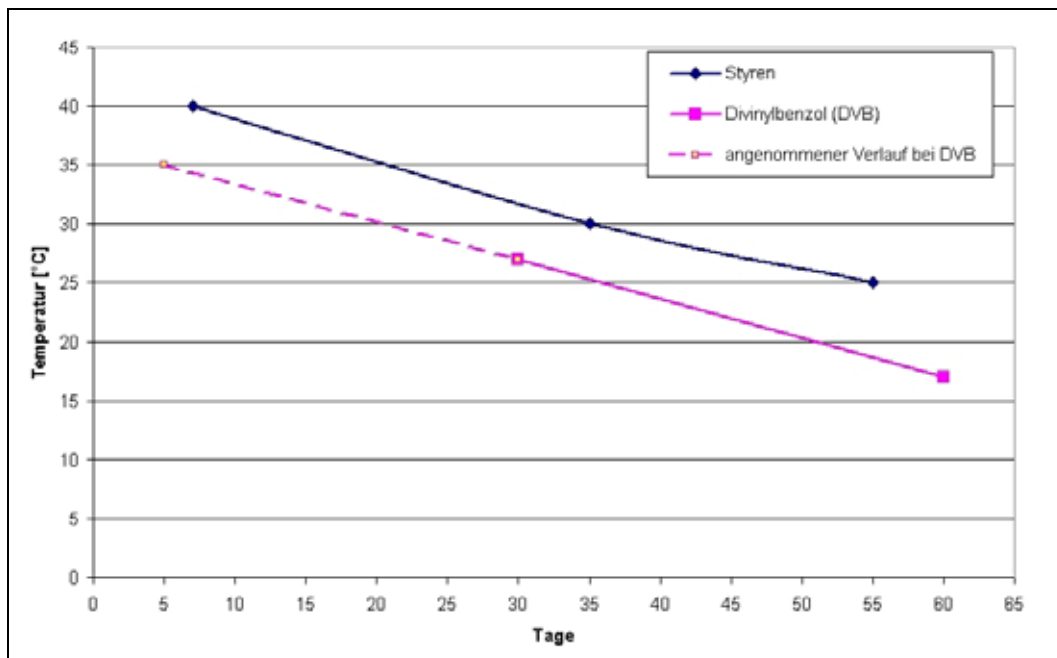
<sup>68</sup> Dr Meißner, Dana: Evaluation of the discussion with fire experts of the possible cause of the fire on the container ship 'MSC FLAMINIA' on 31/05/2013. Unpublished report, Rostock 2013. Hereinafter referred to as 'Second report by Dr Meißner'.

it would reportedly be based on numbers having another reference and furthermore on very little data. However, the BSU keeps spreadsheet 10 and graph 1 because of their basic statement.

Temperature	Depletion Days/1 ppm	TBC Content		Shelf Life
°C		[initial] ppm	[end] ppm	Assured days
25	11	15	10	55
30	7	15	10	35
40	1.5	15	10	7

Note: Oxygen inhibits polymer formation, TBC controls the oxygen depletion rate.

Spreadsheet 10: Depletion of the stabiliser (TBC) in styrene<sup>69</sup>



Graph 1: Shelf life of the stabiliser (TBC) at different temperatures<sup>70</sup>

After starting, the characteristic of the polymerisation may be different. On one hand, so-called runaway polymerisation may occur after a certain temperature threshold is reached. Here, the process accelerates automatically with a severe rise in temperature and pressure. The process takes place within a few minutes. The container may burst and the released gases may ignite. On the other hand, polymerisation may last for very long periods if the temperature threshold is not reached.

Based on the existing data, the expert does not rule out rapid polymerisation of the divinylbenzene, but does not believe it was responsible for the fire because of the following points:

<sup>69</sup> <http://www.styrenemonomer.org/2.4.3.html>, information as of 04/07/2012.

<sup>70</sup> Second report by Dr Meißner.

- one witness described the hatch cover as "lukewarm". "Such a rise in the temperature of the hatch cover must be preceded by a longer-term rise in the temperature of the entire cargo hold. A single DVB container bursting would not have had [...] such a heating effect;
- the transport containers are evidently not insulated containers [...], meaning a sharp build-up of heat in the container could not have occurred. Rather, the heat would presumably be continuously released into the environment. However, pulp was in some of the surrounding containers. This could have caused a certain build-up of heat in the vicinity of the DVB containers over time. If runaway polymerisation actually occurred, then [...] only after a continuous heat release process for hours/days due to the polymerising DVB. In this context, a smouldering fire in the adjacent pulp would also be conceivable;
- this split (non-explosive burst), possibly due to a heat-induced deformation of the DVB container only after a longer period of heat emission, is also very consistent with the behaviour of the fire alarm system. The [...] white smoke described in previous DVB accidents mainly concerns DVB that has already polymerised, comparable with extremely fine polystyrene particles. In contrast to DVB monomer, it is not explosive. This smoke presumably escaped gradually, and also for an extended period, through small leaks that had formed in the tank containers and slowly spread inside the cargo hold. Otherwise, it is difficult to explain why similar quantities of DVB were found both fore and aft in the extraction pipes [according to the charterer's expert]. As [...] described, this process may have taken a long time due to the physical properties of DVB. Had one of the DVB tanks exploded suddenly, then the fire alarm system would surely have triggered immediately and one would expect much more DVB in the aft extraction pipe, and
- the DVB containers under consideration are three 20' containers. Even if polymerisation occurred in all the containers within a short period, it is highly unlikely that all three containers exploded simultaneously and that this generated a large amount of explosive DVB gas. Heat-induced leakage in the adjacent containers and a slow release of the cargo are more likely. [...] DVB [has] a boiling point of 200°C and above. Leaking gaseous cargo would condense very quickly on the closely positioned container walls in the area. Moreover, the density of gaseous DVB is 4.5 times higher than air and it would have accumulated at the bottom. Furthermore, the escaping cargo would polymerise quickly and then exist in the form of heavy polymer smoke that was no longer explosive. It is the opinion of the expert that these facts preclude the formation of DVB-induced gas that was sufficiently volatile for the massive force of the explosion."<sup>71</sup>

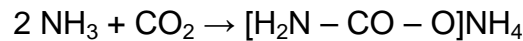
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<sup>71</sup> Second report by Dr Meißner.

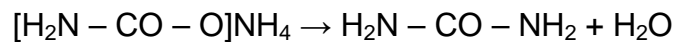
The deliberations of the expert give rise to the opinion that the DVB produced heat due to the possible onset of polymerisation. However, she believes it is rather unlikely that the intensity of the explosion is due to the flammable DVB gases. Overall, the temperature of the surrounding cargo could have increased due to a chemical reaction or smouldering fire, causing the release of large quantities of explosive gas [see paragraph 1.2.7.1 and following items]. The triggering chemical reaction may have been the polymerisation of DVB. In this context, the expert once again refers to the four tank containers with dimethylaminoethanol stowed in bay 31, which also releases much heat in a chemical reaction.

"The fact that the carbon dioxide discharged into the cargo hold did not have the desired effect is possibly another indication that the cargo hold was probably already filled with a variety of hot gases before the explosion.

At elevated temperatures, carbon dioxide can react to form ammonium carbamate or urea:



Ammonia and carbon dioxide react to form ammonium carbamate:



In turn, ammonium carbamate reacts to form urea and water.

The cargo hold contained several items of cargo, which can release ammonia when heated, inter alia:

- diphenylamine;
- melamine;
- dimethylaminoethanol;
- glyphosate, and
- nylon.

Therefore, it is conceivable that part of CO<sub>2</sub> discharged reacted in this manner.

However, the non-effectiveness of the carbon dioxide may also be attributable to the physical effect of the various gas densities. The majority of the possible explosive gases in the cargo hold are listed in [Spreadsheet 11]. Apart from propane, all the gases are lighter than carbon dioxide.

Added to that is the effect of temperature. At the time of the CO<sub>2</sub> inflow, these gases possibly had temperatures of several hundred degrees, while the CO<sub>2</sub> gas was initially very cold due to the relaxation effect. The effect of the differences in density is thus increased significantly. Convection effects were probably retarded because the cargo hold was full of containers. Therefore, it is possible that the discharged

carbon dioxide first sunk to the bottom of the cargo hold before dispersing gradually. Consequently, the hot gases in the upper area were still explosive."<sup>72</sup>

Explosive gas possibly released from items of cargo in cargo hold 4 (See also spreadsheet 8)	Density [kg/m <sup>3</sup> ]
Hydrogen	0.089
Carbon monoxide	1.25
Hydrogen chloride	1.64
Ammonia	0.77
Formaldehyde	0.82 (-20°C)
Methane	0.72
Ethane	1.37
Air (reference value)	1.29
Propane	2.019
<b>Carbon dioxide</b>	<b>1.977</b>

Spreadsheet 11: Density of gases at a pressure of 1.01325 bar and temperature of 0°C<sup>73</sup>

#### (4) Report on the final evaluation

Due to the contrasting statements, the Federal Institute for Risk Assessment (BfR) was commissioned to prepare another report<sup>74</sup>. The expert, Dr Thomas Höfer, was familiar with events on the MSC FLAMINIA in that he belonged to the group of independent experts who advised the CCME in this case. Due to this task, he was in possession of items of additional information from the cargo papers, the dangerous goods declarations in particular.

The report looks at the previously prepared chemical report. Here, the scenarios discussed therein are regarded as less likely. With regard to the substance that ultimately caused the fire, high probability has been attributed to divinylbenzene. At the same time, the expert assumes that another substance contributed to the development of the fire due to its existing specifics during carriage. This cargo is the diphenylamine, which was carried in ten tank containers.

The analysis of the stowage plan (Figures 32 and 33) shows that the diphenylamine tanks were stowed directly adjacent to and above the tanks with divinylbenzene. One of these tanks (slot 310208) even had diphenylamine tank containers stowed on two sides and in front of it.

The carriage of the diphenylamine (DPA) was made under 'UN 3082 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.' (in class 9 as a marine pollutant). "DPA is a solid (melting point about 53°C) carried in the form of pellets or in tanks, as in this case.

<sup>72</sup> Second report by Dr Meißner.

<sup>73</sup> [http://www.chemie.de/lexikon/Liste\\_der\\_Dichte\\_gasförmiger\\_Stoffe.html](http://www.chemie.de/lexikon/Liste_der_Dichte_gasförmiger_Stoffe.html).

<sup>74</sup> Dr Höfer, Thomas: Report within the framework of the investigation into the cause of the fire on the distressed container ship 'MSC FLAMINIA', assessment of the expert reports submitted to the BSU, and comments on the cause of the fire. Unpublished report. Berlin 2013. Hereinafter referred to as 'Report by Dr Höfer'.

To achieve this, it is melted at about 80-90°C<sup>75</sup>, filled into tanks and then cools down slowly. After some time and regardless of the tank's outside temperature, the mass solidifies. The tank is heated up again for unloading. Therefore, the classification<sup>76</sup> 'UN 3082, HOT, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.' is [for carriage within the United States] also proposed [...]. Based on the physical and chemical data, this cargo is not expected to ignite. However, there is a risk that this cargo will heat the environment, especially with the existing stowage of ten tank containers in an area of a hatch below deck."<sup>77</sup> Based on the information at his disposal, the expert assumes that the temperature in the tank would drop about 2°C per day after filling.

The expert concludes that runaway polymerisation set in due to the existing thermal influence on the tank containers with divinylbenzene. The heat released in the process<sup>78</sup> (over 200°C) then possibly influenced the four containers with dimethylaminoethanol stowed in the vicinity in bay 31 (see Figure 33). The spontaneous-ignition temperature of this substance is 245°C. The expert states: "Following the ignition of one of these tanks, the cargo hold would have been explosively immersed in flames and heat. The addition of CO<sub>2</sub> in the cargo hold does not have a significant impact on this occurrence for chemical reasons [see pp. 80 to 81 of the report] and had no damping effect on this spontaneous combustion."<sup>79</sup>

According to the documents made available to the BSU, the manufacturer Huntsman/Rubicon, a subsidiary of the Chemtura Corporation, filled the containers with diphenylamine between the afternoon of 21 June 2012 and the morning of 22 June 2012 near Baton Rouge. The containers were delivered to New Orleans during the period 22 to 25 June 2012 and loaded onto the MSC FLAMINIA on 1 July 2012.

During the investigation Chemtura was given the opportunity to provide more information. For the ascertainment of the real temperature gradation Chemtura assigned an independent expert from the company Willbros Engineers LLC (Willbros) to carry out a documented test series<sup>80</sup> with a DPA filled tank container. Therefore DPA was loaded into a tank container at 80°C at the same production facility. This container was put on a trailer standing in a non-ventilated and weatherproof warehouse. An empty container was placed in a distance of approx. 0.95 m next to

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<sup>75</sup> Note BSU: According to the documents (Tank Truck Inspection Sheet from 21. June 2012), provided by Chemtura on 27. August 2013, the Tank Storage temperature was 215°F (102°C) and the temperature of the loaded container (Trailer Temperature) was 160°F (71°C). The difference in temperature results from the fact that the DPA is cooled down to approx. 80°C prior to loading into the tank container.

<sup>76</sup> Note BSU: Classification according to the Department of Transport.

<sup>77</sup> Ibid.

<sup>78</sup> Reference in the report of Dr Höfer to Casson, V./Maschio, G.: Risk Analysis in Transport and Storage of Monomers: An Accident Investigation. Macromolecular Symposia 302(1) pp. 273-279. 2011.

<sup>79</sup> Report by Dr Höfer.

<sup>80</sup> Morgan, Mitchell L.: Willbros - Interim Final Report. Unpublished report. Baton Rouge 2013.

the DPA container for observing any influence in temperature the DPA container had on the empty one. To record the temperature gradation, 16 temperature probes were installed in the DPA container, at the outside of both containers and in the warehouse. The temperature readings were recorded for a period of 20 days. Both containers were of the same construction type as the ones used on board the MSC FLAMINIA.

Under the given circumstances of the test series the following can be concluded:

- The temperature inside the loaded container linearly decreased within the first seven days by 27°C and then stayed constantly at 53°C until the end of the measurement.
- The temperatures at the container shell (beneath the insulation) decreased nearly linearly and were approx. 10°C above the warehouse temperature on the 13<sup>th</sup> day after loading. Minor variations were caused by the difference between day and night temperatures.
- At the beginning of the recording, around 20 hours after loading, the temperatures at the container surface (above the insulation) were approx. 7°C to 8°C above the temperatures of the warehouse and followed the daily fluctuations. During the measurement, the surface temperature more and more aligned with the warehouse temperature.
- During the test series, no significant influence was noticed on the surface temperature of the container loaded with warm DPA. This applies in particular for the time period from the 10th day after loading onwards. In the experimental setup, the empty tank container was not thermally affected by the heat source.

Due to the lack of temperature data for the cargo holds and the different stowing situation of the containers loaded with diphenylamine in the cargo hold no. 4 the data from the measurement series might not be directly transferable to the situation on the MSC FLAMINIA. The investigators therefore assume:

- The temperature of the cargo was 160°F (71°C) inside the tank container when the containers were filled.
- The tank containers stayed in the transport chain for ten days prior to loading them onto the ship.
- The temperature inside of the tank container had decreased at the time of loading.
- After loading, the temperature on the container surface was probably not considerably higher than the temperature of the hold.
- The tank containers were stowed on the MSC FLAMINIA for 14 more days until the fire started.
- After 24 days within the transport chain, the temperature at the surface of the tank containers had probably adjusted to ambient temperature at the time the fire broke out.

## **(5) Possible explosion on deck**

The expert, Dr Höfer, does not rule out that the first explosion occurred on deck because of the rise in temperature due to the fire that had broken out in the cargo hold and/or due to leaking hot gases. Due to the distribution of the cargo, he assumes that only the cargo stowed in bays 25, 27, and/or 26 exhibited properties correspondingly dangerous to lead to an ignition and explosion. Here, the expert also

considers it possible that an actual fire broke out below deck only due to the initial explosion on deck.

The following goods come into question for an explosion on deck:

Polymeric beads, bay 26.

"The product releases flammable pentane, which disperses in the container and forms a flammable atmosphere. The release rate is dependent on temperature. In the prevailing weather conditions, it can be assumed that a flammable atmosphere existed in the vacant container space at the time the fire started (explosion limits 1.5%/7.8%). Consequently, the container potentially had explosive properties in the event of heating or ignition."<sup>81</sup>

Denatured ethyl alcohol – part-load in three 40' containers with hair spray:

"This cargo [...] involves highly flammable lighting gel (HandyFuel®) with a flashpoint of about 12°C. The gel's content includes ethyl alcohol and/or methyl alcohol (approximately 70%) filled in about 7,000 aluminium cans, each with 125 - 200 ml of flammable gases/aerosol mixtures. Experience shows that such a number of consumer products would also include defective items that cause leaks, which leaves the possibility of a flammable atmosphere inside the container open. Consequently, the container potentially had explosive properties in the event of heating or ignition."<sup>82</sup>

Aerosols – other part-load in the containers discussed above:

"Stowed directly on the hatch, this container had various flammable aerosol dispensers for consumers, including hair spray based on (over 50%) ethyl alcohol and/or propane/butane in particular. Other cosmetic hair products with a flashpoint of mainly about 2°C (but also lower) were also loaded [in the containers]. The original safety data sheets on hand for the products state that from temperatures of 50 - 60°C there is a risk of explosion (bursting) for some of the products. Therefore stowage within a temperature range of 10 - 50°C is necessary."<sup>83</sup> The possibility of defective products that could cause flammable atmospheres in the container and explosive properties exists here, too.

Tertiary-butyl styrene (see also section 1.2.8.2):

The possibility of the substance polymerising under the influence of heat, which can lead to an increase in pressure in the tank container and to explosion, exists here.

## **(6) Summary**

For a primary fire in the cargo hold, the expert Dr Meißner first identified the two causes that appear most likely. One was the car care products and the other dimethylaminoethanol. Based on the findings of Intertek, great importance was attributed to the substance divinylbenzene by the two experts acting for the BSU. The decisive factor was the substance's inherent reactive property, which is retarded by

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<sup>81</sup> Report by Dr Höfer.

<sup>82</sup> Ibid.

<sup>83</sup> Ibid.



the added stabiliser. The effectiveness of the temperature-dependent stabiliser was possibly already restricted due to the outside temperatures during land transport and the temperature in the cargo hold.

Dr Höfer introduced the transport conditions of diphenylamine into the further discussion. It is conceivable that its cargo-related heat facilitated the depletion of the stabiliser in the divinylbenzene. The runaway polymerisation that probably set in after the stabiliser had been consumed in at least one of the containers filled with divinylbenzene then led to a chain reaction in the other two containers. The polymerisation began after the consumption of the stabiliser without another 'initial' event. The heat released during polymerisation led to a rise in the temperature of the surrounding containers and the cargo hold as a whole. The explosion was then possibly triggered by the dimethylaminoethanol stowed in the vicinity, which was heated to spontaneous-ignition temperature.

Other causes and courses of the fire are also conceivable and could possibly form a connection with the level alarm of the aft bilge well in cargo hold 4 (section 1.2.4.3) at the same time. However, they are not supported by the findings of the Intertek report. The cause of the high level alarm was, due to the lack of additional evidence, not further investigated.

## **1.2.7 Carriage of dangerous goods**

### **1.2.7.1 Carriage of divinylbenzene**

This investigation report confines itself to the essential facts as regards the description of the transmission of information for the substance divinylbenzene. This is due to the fact that possibly not all documents are available or only available in the form of transmitted information and not all actual business relationships between the partners acting are known. Furthermore, the obligations of the persons acting, associated with the individual transport documents transmitted should not be direct subject of the investigation.

The investigators assume, that Stolt acted as carrier without own ships (NVOCC<sup>84</sup>) visà-vis Deltech. Stolt then acted as shipper visà-vis the carrier Mediterranean Shipping Company (MSC).

Within the framework of the investigation, and the statement concerning the draft report Deltech advised the BSU of the fact that Deltech initially forwarded a Shipper's Letter of Instruction via Panalpina Inc., the freight forwarder of Deltech, to Stolt Tank Containers B.V. (Stolt) as carrier. It contained inter alia the following information:

Divinylbenzene 80%, UN 3082, Environmentally Hazardous Substance, Liquid, N.O.S.

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<sup>84</sup> Non Vessel Operating Common Carrier.

Show temperature control instructions on Ocean BOL<sup>85</sup> <sup>86</sup>: **DO NOT STOW NEAR HEAT SOURCES: STOW ABOVE DECK FOR TEMPERATURE MONITORING:**

Several days later Deltech forwarded a Straight Bill of Lading, issued by Deltec, to Stolt. It contained the following information:

See attached Material Safety Data Sheet for emergency response information. Product is heat sensitive! Do not apply heat to conveyance during transit. If product temperature exceeds 100°F, contact Deltech immediately.

According to the information supplied by Deltech this information was intended for the road transport.

Stolt then issued an Express Bill of Lading for Deltech. This contained the following information:

**DO NOT STOW NEAR HEAT SOURCES: STOW ABOVE DECK FOR TEMPERATURE MONITORING:**

The freight forwarder acting on behalf of Stolt, BDP International (BDP), transmitted the information: “DO NOT STOW NEAR HEAT SOURCES: STOW ABOVE DECK FOR TEMPERATURE MONITORING” to MSC. The Sea Waybills<sup>87</sup> issued for Stolt by MSC did not contain the aforementioned information. The representatives of MSC pointed out, that the drafts of the Sea Waybill, forwarded to BDP before, did not contain this information either. BDP did not complain about them. MSC was furthermore of the opinion, that special instructions for the stowage including sea transport according to the IMDG-Code should have been added to the transport document for dangerous goods<sup>88</sup>.

Stolt confirmed in its statement regarding the draft report on behalf of BDP that they did not complain about the Sea Waybills. Stolt stated, that the transport information was not continuously included in the documents issued by MSC in the past

Stolt confirmed upon request that they were responsible for the issuance of the IMO Dangerous Goods Declaration (IMO DGD). Stolt determined that the following 5 points, required in Article 5.4.1.4 of the IMDG-Code, were included in the document in the correct sequence. The IMDG-Code does reportedly not require that stowing or monitoring requirements are included into the IMO DGD. On the basis of the data available MSC was reportedly responsible for the correct transport of the substance divinylbenzen. MSC in contrast expressed the view that the inquiries with respect to the “Master Bill of Lading”, transmitted by BDP and the instructions concerning the deck shipment and the temperature monitoring were never subject to the terms and conditions of transport.

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<sup>85</sup> Ocean Bill of Lading

<sup>86</sup> Bill of Lading (B/L or BOL) is a document used in the transport of goods and is a document of title.

<sup>87</sup> A sea waybill is a transport document and in no way connected to a document of title.

<sup>88</sup> IMO Dangerous Goods Declaration.

For the assessment of the carriage of the substance, Chief Inspector Roland Liedtke, Waterway Police District Lübeck-Travemünde, director of Port Safety and the Central Dangerous Goods Advisory Board of the State of Schleswig-Holstein, prepared a corresponding report<sup>89</sup> for the BSU. Further statements regarding this material were taken from the report of Dr Höfer.

The dangerous good divinylbenzene 80%, trade name 'DVB 80' was classified as  
UN 3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID,  
N.O.S., IMDG Class 9.  
Packing Group III, EMS F-A, S-F.  
Flashpoint: 77°C

The IMO dangerous goods declaration and the sea waybill contained exactly this information.

The information crucial to sea transport in the safety data sheet of the manufacturer is as follows:

- Section 14 - Proper Shipping Name: 'Combustible Liquid, N.O.S. (Contains 80 % Divinylbenzene and Ethylvinylbenzene, Stabilized), NA 1993 // PG III, Placarded Combustible' [sic].  
Note: This name does not exist in the UN numbers directory. Nonetheless, it indicates the risk posed by this substance.
- Section 3 - Emergency Overview:  
"May polymerize and autoaccelerate with explosive energy release if heated [...]. Combustible. Hot vapours are extremely flammable [...]."
- Section 7 - Handling and Storage:  
"Store in cool area or refrigerated tank away from high temperatures, hot pipes or direct sunlight. [...] Maintain bulk liquid temperature to below 80°F (27°C)."
- Section 10 - Stability and Reactivity:  
"Polymerization may occur if material is exposed to excessive heat [...]. Polymerization is exothermic and may result in auto acceleration, rapid temperature rise, increased pressure, vigorous venting of container, and fire or explosion if not arrested" [sic].

The Dangerous goods report also indicates that leaking gases can form potentially explosive mixtures (LEL: 1.1%, UEL<sup>90</sup>: 6.2%) and that the leaking liquid substance is combustible. The substance is also very hazardous to water, hence its classification as a 'Marine Pollutant/Environmentally Hazardous'.

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<sup>89</sup> Chief Inspector Liedtke, Roland: Legal opinion on the stowage of the dangerous good divinylbenzene on board the container ship MSC FLAMINIA. Unpublished report. Lübeck 2013. Hereinafter referred to as 'Dangerous goods report'.

<sup>90</sup> LEL = Lower explosion limit; UEL = Upper explosion limit.

The following aspects are also considered and evaluated in the Dangerous goods report:

1. according to the safety data sheet, the flashpoint was determined using the open cup method. However, section 2.3.3.6 of the IMDG Code states that the close cup method (c.c.) must be used. Since the user started from the idea that the information related to c.c. into the IMO DGD, he expected a higher temperature. The temperatures reached with the close cup method are, referred to various databases, at 69°C to 74°C only.
2. according to the IMDG Code, dangerous goods posing more than one hazard shall be classified to the predominant hazard. The hazards posed by DVB are
  - a. self-reactive → Class 4.1;
  - b. flammable liquid → Class 3;
  - c. environmental hazard → Class 9.

According to the risk prioritisation, self-reactive substances under class 4.1 have priority over those of classes 3 and 9.

"Classification under item 7, SELF-REACTIVE LIQUID/SOLID TYPE F, LIQUID, under UN 3229, could be made because the substance is not thermally stable and the stabiliser has a boiling point of less than 150°C."<sup>91</sup> Classification in class 4.1 would mean that the substance would have to be carried in a tank of higher quality. Moreover, only on deck stowage would be permissible. In the opinion of the expert, the classification fails due to the low heat of decomposition reached<sup>92</sup>.

However, classification under class 3 is inapplicable because the flashpoint is too high (>60°C c.c.).

Although classification was made under class 9, it does not account for the above-mentioned hazards;

3. "A reference to the polymerising properties and instability of 'DVB 80' is desirable, but cannot be regarded as binding based on applicable legislation";<sup>93</sup>
4. "For 'temperature-controlled self-reactive substances', the word 'stabilised' [according to 5.4.1.5.4 IMDG Code] is prompted as part of the shipping name. However, a legal obligation is absent here, too";<sup>94</sup>
5. according to the EmS Guide, the emergency schedule alpha applies to UN number 3082 (see also section 1.2.9). Accordingly, CO<sub>2</sub> should be used as the primary means of fighting fires in a cargo hold.  
Unless it is finely atomised, water is regarded as ineffective and should be used only for cooling. For classification under 4.1, the substance should not have been stowed below deck;
6. stowage and segregation category 'A', and thus the weakest restriction, applies for substances with UN number 3082. "In the case of this category, 'under deck stowage' is even preferred for marine pollutants according to 7.1.4.2. Having regard to the general principles of 7.1.4.1, proper stowage and

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<sup>91</sup> Dangerous goods report.

<sup>92</sup> IMDG Code section 2.4.2.3.1.1.4 – heat of decomposition  $\geq 300$  J/g. Based on the existing data the expert calculated a heat of decomposition of 175 J/g.

<sup>93</sup> Dangerous goods report.

<sup>94</sup> Ibid.

securing of marine pollutants must be made, but without compromising the safety of the ship or crew."<sup>95</sup>

Separation from other dangerous goods within the cargo or in any other manner is not necessary;

7. there is no indication in the IMDG Code that cargo transport units containing divinylbenzene should be cooled when in transit;
8. according to the documentation on hand, the tank container filling level was within the range permissible.

### 1.2.7.2 Declaration of other dangerous goods

With regard to the declaration of other dangerous goods in cargo hold 4, it should basically be noted that for some of the containers the actual content was only confirmed in the course of the investigation. The reason for this was different names in the cargo list, amongst other things. For example, in the 'Short Description of Goods' column the cargo '1,1,1,2-tetrafluoroethane' was entered under 'Chlorides, chloride oxides and chloride hydroxides'. The cargo was then named '1,1,1,2-tetrafluoroethane' in the 'Description of Goods' column. The substance was also properly named in the dangerous goods declaration (dock receipt). In fact, this substance is not a chloride, a chloride oxide, or a chloride hydroxide.

The same was true for the substance 'DMSO (dimethyl sulfoxide)'.

The incorrect designation of the two substances did not have safety-related implications.

In column I 'Short Description of Goods', another container had the description 'Adipic acid', an element used in the production of nylon. However, column X 'Description of Goods' for this container described the content as nylon 6.6. Therefore, it was not clear whether this container was carrying a precursor or the finished plastic. The subsequent submissions revealed that the container was carrying the plastic nylon 6.6."<sup>96</sup>

One other good was apparently inadequately declared. Here, the cargo glyphosate was referred to in the cargo manifest as 'Other organo-inorganic compounds-other'. "[...] using subsequent submissions, it could be identified as 'N-(carboxymethyl)-N-(phosphonomethyl)glycine' (identification number CAS 599-61-6). If it was this substance, then the dangerous goods classification was inadequate. Almost every company in Europe and also the usual internationally available safety data sheets describe the substance as corrosive to the skin as defined by class 8 packing group II. With that in mind, the container should have been declared as dangerous goods."<sup>97</sup>

Two 20' tank containers carrying tertiary-butyl styrene were stowed on deck<sup>98</sup>. "These were various butyl styrenes (TBS) carried in a chemically stabilised [...] state.

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<sup>95</sup> Ibid.

<sup>96</sup> Dr Meißner, Dana: Supplement to the investigation into the possible cause of the fire on the container ship 'FLAMINIA' on 14/07/2012 arising from the chemical and physical properties of the cargo. Unpublished report, Rostock 2013.

<sup>97</sup> Report by Dr Höfer.

<sup>98</sup> Referred to as p-tertiary-butyl styrene in the report by Dr Meißner or as Butylsteren in Figures 30 and 31.

The original safety data sheet in the possession of the BfR requires carriage at below 32°C: "Closed Containers of TBS may build up explosive pressure when exposed to heat of fires. Closed containers of TBS exposed to heat of fires may begin to polymerize in an exothermic manner leading to auto acceleration and rapid pressure increase and explosion potential" [sic]. However, references to the thus necessary distance from heat sources are not listed in the copies of the IMO dangerous goods declaration in the possession of the BfR. Instead, classification was made as 'NA 1993 COMBUSTIBLE LIQUID N.O.S.' PG 3 without specific reference to hazards and emergency responses (lack of information). According to the IMDG Code, the proper designation for sea mode would have been 'UN 1993 FLAMMABLE LIQUID N.O.S.'. The stowage of this container raises further questions because it concerns a marine pollutant that would have 'protected' stowage. There was a potential explosiveness for this container when heating up"<sup>99</sup>

### 1.2.8 Dangerous goods information available on board

The following aims to present the information about the dangerous goods in cargo hold 4 available on board on the basis of the EmS Guide. Corresponding details are provided in the 'Emergency Schedules for FIRE' section of the Guide. The responses recommended by the Guide always relate to a larger group of UN numbers.

Here, the items of cargo<sup>100</sup> diphenylamine (UN number 3082), divinylbenzene (UN 3082), zinc oxide (UN 3077) and tetraoctyltin (UN 3082 according to cargo list, UN 1760 according to European Union (EU) safety data sheet, and UN 2788 according to product information) are classified under FIRE SCHEDULE Alfa.

This contains the following recommendations:

General Comments	In a fire, exposed cargoes may explode or their containment may rupture. Fight fire from a protected position from as far away as possible.
Cargo on fire under deck	Stop ventilation and close hatches. Use cargo space fixed fire-extinguishing system. If this is not available, create water spray using copious quantities of water.
Cargo exposed to fire	If practicable, remove or jettison packages which are likely to be involved in fire. Otherwise, keep cool using water.

The items of cargo 1,1,1,2-tetrafluoroethane (UN 3159) and pentafluoroethane (UN 3220) are classified under FIRE SCHEDULE Charlie:

General Comments	Gases in closed tanks exposed to heat may explode suddenly in or after a fire situation by a Boiling Liquid-Expanding Vapour Explosion (BLEVE). Heated or ruptured cylinders may rocket. Gases listed under this schedule are non-flammable. However, some gases will support combustion though not flammable itself. Fire
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<sup>99</sup> Report by Dr Höfer.

<sup>100</sup> See also Spreadsheets 1 to 3.

may produce leakages. Most gases allocated to this schedule are hazardous to health. Some are corrosive. Create water spray. Identify the source of the fire and take appropriate action.

Cargo on fire under deck

Use fixed fire-extinguishing system.

Cargo exposed to fire

If practicable, remove or jettison packages which are likely to be involved in the fire. Otherwise, cool for several hours using water. Heated or ruptured cylinders may rocket.

A car care products part-load (222 kg<sup>101</sup>) was listed under UN number 1950 and thus contained in FIRE SCHEDULE Delta:

General comments

Gases in closed tanks exposed to heat may explode suddenly in or after a fire situation by a Boiling Liquid-Expanding Vapour Explosion (BLEVE). Crew members should be aware of the explosion hazard and take appropriate action.  
 Keep tanks cool with copious quantities of water.  
 Fight fire from a protected position from as far away as possible.  
 Extinguishing a burning gas leak may lead to the formation of an explosive atmosphere.  
 Flames may be invisible.

Cargo on fire under deck

Stop ventilation and close hatches.  
 Use cargo space fixed fire-extinguishing system. If this is not available, create water spray using copious quantities of water.

Cargo exposed to fire

If practicable, remove or jettison packages which are likely to be involved in the fire. Otherwise, keep cool for several hours using water.

However, the good dimethylaminoethanol (UN 2051) and the other car care products (UN 1268) part-load (about 4 t in total) were listed under FIRE SCHEDULE Echo:

General comments

Cargoes in tanks exposed to heat may explode suddenly in or after a fire situation by a Boiling Liquid-Expanding Vapour Explosion (BLEVE). Keep tanks cool with copious quantities of water.  
 Fight fire from a protected position from as far away as possible.  
 Stop leakage or close open valve if practicable.  
 Flames may be invisible.

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<sup>101</sup> Net weights.

Cargo on fire under deck

Stop ventilation and close hatches.  
Use cargo space fixed fire-extinguishing system. If this is not available, create water spray using copious quantities of water.

Cargo exposed to fire

If practicable, remove or jettison packages which are likely to be involved in the fire. Otherwise, keep cool for several hours using water.

In summary, it can be concluded that CO<sub>2</sub> was a suitable extinguishing agent for all the dangerous goods. The use of water as an extinguishing agent and/or for cooling was possible or actually recommended. The risk of explosion due to the effect of fire applied to all four groups of dangerous goods. The resulting need for a protected position when fighting fire was explicitly noted for three groups (A, D, E). Attention was drawn to the hazard to health caused by leaking gases in FIRE SCHEDULE Charlie, in particular.



## 2 ANALYSIS

### 2.1 Fire-fighting and abandoning the ship

#### 2.1.1 General principles for fire-fighting in cargo holds

The analysis of the fire-fighting on the MSC FLAMINIA should be preceded by some basic considerations. They vividly explain the specific problems faced when fighting fire in cargo holds.

"Fire in cargo holds is essentially determined by the types of incendiary substance. Specific differences in space usually only have a secondary effect. All types of fires can occur (e.g. flame, smouldering). This results in the possibility of larger periods for the duration of the fire.

Extensive experience gives rise to a vast amount of general information, such as:

- fires in a cargo hold can involve a single incendiary substance or a whole combination of different incendiary substances;
- therefore, next to the continuously present carbon monoxide in fumes, a large number of other dangerous gases should always be reckoned with;
- only flaming fires can be overcome using the CO<sub>2</sub> fire-extinguishing systems usually available in cargo holds. [...];
- cooling is an effective method of preventing the fire from spreading to adjacent areas;
- after flaming fires in conjunction with the formation of embers and due to hot parts, the presence of a CO<sub>2</sub> concentration capable of extinguishing in the cargo hold is an effective way of preventing another outbreak.

[...] An in-depth analysis reveals that fire in the cargo hold of a container ship is relatively rare. However, the few known and significant fires on container ships have made it clear that due to their specifics, such fires present the ship's crew with challenging tasks. The following draws attention to some identified and especially complex problems during such an event. [...]

The following case, which is conceivable in practical terms, is to be considered:

- fire started in a container in an closed cargo hold;
- the specific container is not identifiable;
- the actual cause of the fire is unknown;
- the ship has a CO<sub>2</sub> fire-extinguishing system for this hold.

It should also be considered that the fire process may develop in different ways, notably:

- as a smouldering fire or
- as an open fire, i.e. with flames.

In the first alternative [smouldering fire], toxic and also flammable gases would form there with a barely perceptible rise in temperature and consequently with no or a very

low rise in pressure over an extended period. The ship's crew has no way of detecting and thus evaluating this process. If a high proportion of carbon monoxide is released due to the carbonisation, then from a certain concentration there is a risk of detonation if a source of ignition is present.

In the case of fire with an open flame, the gas pressure in the container will increase because of the rapid development of heat. Consequently, fumes will escape from the container – which will cease to be gastight as the pressure increases – and, depending on the flow conditions in the cargo hold, reach the fire detection sensors.

This means that the ship's command becomes aware of the incident automatically at a not clearly defined time after the fire breaks out due to the fire alarm system and appropriate action is taken, such as actuation of the CO<sub>2</sub> fire-extinguishing system.

Since steel is known to lose two thirds of its strength at  $T \approx 650^\circ\text{C}$ , the temperature determines the strength of the container substantially. Consequently, depending on the weight above it, the lower container will collapse when that temperature is reached. This process, for example, then determines the further course of the fire decidedly.

In principle, this conflict can be solved only if the performance of the response equipment installed as a precautionary measure is such that imminent danger to the ship is averted, i.e. she can be returned to a safe operating condition or kept under control so that the danger can be completely eliminated with the assistance of other units at a later stage. Basically, the reliable detection and assessment of the situation is an essential prerequisite [...]. In this case, assessment presented particular difficulties. For example, important thermodynamic variables like temperature and gas concentration were not accessible to the ship's crew at the scene."

Fire-fighting becomes almost impossible due to the limited extinguishing capacity on board the ship if the closed-down state of a cargo hold no longer exists, e.g. due to an explosion [...].

[...] Taking into account all the conditions, it can only be assumed that [...] fires can be extinguished directly in exceptional circumstances [...]. This is supported by the following reasoning:

- these fires break out [...] in a confined containment. This means that although it would be possible to extinguish them in theory, the sources of fire cannot be reached by the extinguishing agents due to being completely covered;
- added to this is the fact that the fire can develop undetected inside and is recognised as such only when it breaches the containment. By then it has already passed the initial fire stage [...];
- in the existing spatial conditions, action by personnel carrying the appropriate equipment is possible only to a limited degree, if at all. Objectively, many areas of the cargo are not accessible at present.

In summary, it can [...] be maintained that during cargo fires on or below deck, the primary goal of the response is and can only be preventing the spread of fire. Direct elimination of the fire is not the main focus."<sup>102</sup>

"Due to its properties, carbon dioxide is used as an extinguishing agent in enclosed cargo areas for inerting purposes. Here, it is only partially suitable for preventing the spread of fire in a cargo area. This is primarily due to the fact that the actual source of the fire [in a container] is not directly accessible and only open flames outside the containment will be extinguished. Due to the low cooling capacity of CO<sub>2</sub>, the thermal energy is not removed from the immediate vicinity of the fire. Pockets of embers remain intact.

Hence, the use of this extinguishing agent brings about a status quo that has to be maintained for a relatively long period until the temperatures in the immediate area of the fire have dropped to values below ignition temperature. If it cannot be ensured that the effective concentration of extinguishing agent is maintained, then the fire flares up again. This is the case if [...] the hold's closed-down state is not sufficient, for example.

It may be assumed that cargo holds and areas cannot be hermetically sealed. This means that the CO<sub>2</sub> concentration inevitably decreases. The outcome of this is that generally agents always have to be found and measures always have to be taken to reduce temperatures in the area of the fire before the concentration of extinguishing agent drops to below an effective level. Therefore, in enclosed holds the spread of fire is prevented only for a limited period.

As an extinguishing agent, water is basically very well suited to preventing the spread of fire because of its main characteristics, especially the cooling effect. It may also be assumed that the general capacity of the fire-fighting system is sufficiently dimensioned for this task.

However, the effectiveness of suppressing the spread of fire will be essentially determined by how available amounts of water can be brought to the areas requiring protection. Having said that, the general accessibility of all slot positions to extinguishing water is not given. This is especially true for a large number of container slots below deck [...].

The spread can only be prevented effectively if sufficient water (full pumping capacity) can be applied to the parts of the stowage area [...] requiring protection within a reasonable period of time (about five minutes after fire detection and localisation). The accessibility of the actual source of the fire inside a container with the shipboard equipment is precluded. The extinguishing water can be used for cooling accessible container walls. Furthermore, the extinguishing water can prevent the transfer of heat from burning containers to adjacent ones and flames between

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<sup>102</sup> Hahne, Joachim and Sedlaček, Dirk: Brand im Laderaum (fire in a cargo hold). In: Handbuch Schiffssicherheit (ship safety guide), Prof. Dr.-Ing. habil. Hahne, Joachim (publ.). Hamburg, 2012, pp. 143-145.

container stacks. In particular, the following aspects influence the amount of water needed for this:

- dimensions of fire load;
- type of fire;
- application angle of water to the relevant container wall, [...];
- system pressure, length of hose, nozzle diameter, and
- education and training level of the fire-fighting personnel.

The possibility of safely applying an effective quantity of water drops sharply with the [...] the depth of the slot position in the hatch."<sup>103</sup>

## 2.1.2 Fire-fighting on the MSC FLAMINIA

### 2.1.2.1 Discovery of the fire

The crew of the MSC FLAMINIA was startled by the alarm of the sample extraction smoke detection system. There had been no indications that a dangerous situation was developing in cargo hold 4 since sailing out of Charleston six days earlier. For example, it is evident that nothing untoward was noticed during the inspection of the temperatures of the reefer containers on the previous day at about 1600 in this area.

With regard to the discovery of the fire, the fire expert acting for the BSU takes the following view: "The fire was discovered visually at a very early stage. It can be assumed that in the first stage, there was no open or fully developed fire. This is supported by the modest amount of smoke and absence of high temperatures. According to statements made by crew members at the scene, the hatch cover was no more than lukewarm [...]. The hesitant response of the fire alarm system is another indication that supports this assumption.

Furthermore, the following statements [of the crew] made several times underpin this situation:

- light whitish/grey smoke in the midship area of cargo hold 4;
- chemically undefined odour, no typical burning smell like burnt cables;
- the smoke escaped between the coaming and hatch cover, and
- no smoke at the ventilation flaps in crossways 26 and 30.

When evaluating the chemical analysis of the cargo [...], it can also be assumed that the condition in the cargo hold was still not that of an actual fire when the harmful event was detected; rather, a chemical reaction of the cargo that led to the formation of explosive gases in the cargo hold. Due to the position of the event below deck, a detailed exploration of the facts by the crew was ruled out."<sup>104</sup>

Although there had been no false alarms from the cargo holds previously, the deployment of the rating on watch to cargo hold 4 to confirm the issued alarm was understandable and conformed to usual practice.

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<sup>103</sup> Ibid. p. 149

<sup>104</sup> Fire report.

After confirmation, the general alarm was sounded immediately and the crew informed of the emergency by means of the internal communication system. The crew then manned the required stations or assembled at the muster station.

### **2.1.2.2 Fire-fighting**

After the master assumed responsibility for coordination, he altered course to keep one side of the ship free of smoke and to protect the superstructure from smoke. In addition, the entire ventilation system was turned off. This was logical and corresponded to the recommendation.

However, it is difficult to understand fully why the main engine was stopped. Although this measure is part of the NAVECS system's 'Fire at sea' emergency plan, the investigators believe that it eliminated the option of affecting the build-up of smoke on the ship and possibly the spread of fire by means of course selection. In fact there was no effect into the spread of fire.

According to the muster list, the ship's command unit consisted of the master, the chief officer, the third officer, the chief technical officer, the electronics engineer, and one A/B. The chief technical officer and the electronics engineer were based in the ECR. According to the muster list, the chief technical officer was also responsible for the CO<sub>2</sub> fire-extinguishing system. On the bridge, the A/B was assigned the role of helmsman. Accordingly, the composition of the ship's command unit corresponded with the recommendations of the Handbuch für die Ausbildung im Schiffssicherungsdienst (manual for ship safety service training). The actual performance of duties on the bridge is unclear due to the missing paper-based or VDR recordings. For example, the third officer was not on the bridge for the entire time until the ship was abandoned, as he was also seen in the CO<sub>2</sub> room and according to his own account was not called to the bridge until about 0800. This means that he was unable to comply with his duty of keeping the documents.

The extent to which the ship's command made use of the NAVECS system in its decision-making process and documentation is also unclear. Similarly, there is no certainty as to whether the ship's command consulted the EmS Guide when planning the operation to fight the fire.

Only two members of the additional unit, which according to the muster list was responsible for establishing closed-down state in and around cargo hold 4, were involved in that task. Two members of the unit (cook and steward) were involved in supporting the passengers. The unit leader left the fifth member of the additional unit at the safety store, presumably because the area requiring protection was only small. In this context, the disparity between the muster list and description of duties in the NAVECS system is once again noted. According to the description of duties in NAVECS, the support unit would have been responsible for establishing closed-down state and preparatory deployment of the fire hoses. However, the muster list was authoritative for the crew. The investigators believe this was less practicable because in the cook and the steward, two crew members belonged to the additional unit who had very little to do with the structural conditions on the ship. Inasmuch, the investigators believe that the description of duties in the muster list was not practicable. It describes the relevant allocation of duties for each defense unit (deck/engine).

However, the description of duties for the resulting support unit was absent and the duty was appointed to the additional unit.

While establishing closed-down state at the cargo holds, the crew members assigned to carry out this task found that the manually operated ventilation flaps for passive ventilation, which were located in the side passage, were already closed. It was not possible to identify the reason for this during the investigation. It was also not possible to clarify when the passive ventilation flaps were closed or whether cargo hold 4's ventilation fans were still in operation before the ventilation fans were turned off globally.

It is possible that "[...] the [existing] closed-down state [...] resulted in an intensification of the situation in the cargo hold. Due to the closed-down state, the gases could no longer dissipate in the air, possibly resulting in an increase in explosive gas concentrations. Furthermore, convection<sup>105</sup> was prevented, thus facilitating the local rise in temperature."<sup>106</sup>

With the exception of the sample extraction smoke detection system, the crew had no way of assessing the situation in cargo hold 4 in more detail using technical means. Here, the smoke detection system only delivered the information 'Smoke – yes or no', without an indication of the density of the smoke.

As regards the detection of fire in cargo holds, the fire expert commented as follows: "Safe and timely detection of potentially hazardous situations is an important prerequisite for responding effectively. Against this background, the fire alarm system required hitherto must be regarded as inadequate." The expert suggests combining various technical means (such as flame detectors, temperature monitors or temperature measuring devices) with the existing sample extraction smoke detection system to increase the probability of detection.

Due to the low amount of information available, it would only have been possible to ascertain the situation in the cargo hold at the scene. The deployment of a reconnaissance team inside the cargo hold would

- have exposed the crew members involved to great danger;
- not necessarily result in the discovery of the source of the fire due to the inaccessibility of certain areas of the cargo hold;
- not be possible due to dense smoke and therefore no visibility;
- have taken considerable time;
- have contradicted the description of duties in the NAVECS system, according to which entering the cargo hold was not allowed.

Consequently, the deployment of a reconnaissance team was not an appropriate means of obtaining knowledge about the condition of the cargo hold.

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<sup>105</sup> The introduction of energy from the smallest particles of a current.

<sup>106</sup> Fire report.

During the course of the accident, the master requested the list of dangerous goods that were on board from the chief officer so as to forward this to the vessel operator. To what extent a comparison was made with the EmS Guide or emergency schedules contained therein to check whether CO<sub>2</sub> could actually be used is not known. However, since – as with all the cargo holds on the ship – there was no means of using water for cooling in cargo hold 4, there was no alternative than to use CO<sub>2</sub>.

The discharge of CO<sub>2</sub> began in cargo hold 4 at 0642; therefore, one hour after the smoke detector actuated. After approximately 32 minutes, i.e. at about 0714, this process was technically completed.

At the time of the first discharge of CO<sub>2</sub> gas into cargo hold 4, several crew members were in the CO<sub>2</sub> room. In addition to the chief technical officer, they included three members of the support unit who belonged to the engine room personnel.

In direct temporal proximity to the release of the CO<sub>2</sub> for cargo hold 4, the CO<sub>2</sub> alarm for the engine room was actuated. This audible alarm with simultaneous shut down of the associated ventilation fans was caused by the incorrect installation of the pipework of the CO<sub>2</sub> system in the area of the control valves 1 and 2. The faulty mounting itself was not detectable by the crew. The crew members interviewed stated that they made a very extensive search for the cause of the CO<sub>2</sub> alarm. Here, special attention was reportedly given to non-functioning door contacts. However, it was reported that manipulation of these contacts did not remedy the system's electrical blockage. However, the visibly opened control valves 1 and 2, related to the CO<sub>2</sub> emergency release for the engine room, were not noticed by the crew members. The event led to that the ship was not manoeuvrable for an extended period, all the technical officers were occupied with remedying the issue, and there was an additional burden on the ship's command during a critical situation.

The investigators find it difficult to understand why so many crew members were involved in the release of the CO<sub>2</sub>. At the slow discharge velocity due to the small pipe cross-section, one or two crew members could have performed this task. Since there was no training for the release of the CO<sub>2</sub> cylinders during the voyage, it should have been left to the chief technical officer or the second technical officer.

Due to the recording of the alarm/event log it is assumed that the second release took place from 0707 to 0713. According to the manufacturer's instructions (see also Figure 22) the third release should have been discharged at about 0745.. The third discharge took place at 0806.

36 cylinders were released during the first discharge. 24 cylinders followed during the second discharge. This was not consistent with the specifications of the manufacturer. The instructions available on board recommended 33 cylinders for each discharge. However, based on the above assumption that an open fire had still not broken out, it is unlikely that this led to a deterioration of the situation. The fire expert notes: "Only an open fire outside a container or in an open container can be

fought by means of the CO<sub>2</sub> system in the closed hatch. Moreover, due to the specifics of the container load, it is not suitable as an area protection system because the container is not inerted. The spread of fire due to thermal conduction and radiation, via the largely wooden floor structure of containers in particular, cannot be prevented by means of CO<sub>2</sub>."

During the investigation, it was found that the description of the release procedure for the CO<sub>2</sub> fire-extinguishing equipment for fighting cargo hold fires was both inconsistent and on two of the three boards did not have the desired outcome. The absolutely necessary step of opening the ball valve and thus the feeder line to the three-way valves was not described on these boards. On top of that, the operating direction of the three-way valves was shown incorrectly. In spite of this the release process was carried out successfully.

The investigators assume that an adequate saturation of the atmosphere in cargo hold 4 could have been achieved with the total amount of discharged CO<sub>2</sub>. Although CO<sub>2</sub> is heavier than air, the increased ambient temperature and discharge itself probably led to a dispersion in the cargo hold. It should be noted that due to its design, the hatch cover did not seal hermetically at the contact joint. Consequently, it was possible for the CO<sub>2</sub> to escape from there. However, that would have been compensated by the additional release actions.

The fire expert also commented: "One can only speculate the extent to which the use of CO<sub>2</sub> possibly facilitated a localised concentration [of explosive gases] and/or the kinetic energy of the escaping CO<sub>2</sub> could have caused the formation of a mixture or also resuspension of the PVC dust (dust explosion). However, that it facilitated the ensuing devastating events cannot be ruled out."<sup>107</sup> In this context, the German technical regulations for occupational safety, here TRBS 2153 – prevention of ignition due to electrostatic charges - should be pointed out. They describe the potential risk associated with electrostatic charges during the leakage of gas. The risk arises when the gas flow contains solid particles or droplets of liquid. Thereby the regulation also deals with the usage of CO<sub>2</sub> as extinguishing and inerting agent and warns against the risks. For example: No. 5.3: The inerting agent may only be applied in such a manner that no dangerous charges can occur, when an already explosive atmosphere is being inerted. Formation of fog or sublimate and dispersing of dust should be avoided. Wet steam or CO<sub>2</sub> are not suitable as inerting agent in these cases. Inerting gas should be free of particles and introduced slowly and if possible through large openings. Dissolving and dragging along of dirt, condensate or sediments should be avoided. Due to the fact that CO<sub>2</sub> pipes are used for the exhaust gas detection systems at the same time, dirt, condensate or substances sticking to the pipes can be found in the CO<sub>2</sub> pipes at all times.

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<sup>107</sup> Fire report.



### 2.1.2.3 Approaching the source of the fire

Actual preparations for cooling began at about 0750 and thus approximately two hours after the actuation of the fire alarm. Here, the fire report finds: "The absence of typical fire parameters should have been [...] evaluated and interpreted more accurately. Specifically, extensive cooling should have been carried out early on to prevent the threat of the pyrolysis<sup>108</sup> or [the] hydrogen gases from igniting and/or to energetically interrupt chemical reactions. This was complicated by the ship's equipment [...] in that no drencher system was installed in the cargo hold."<sup>109</sup>

The investigators believe that the crew hoped to achieve two things by cooling. Firstly, the not designed water-based fire-extinguishing system for the cargo holds was to be offset by cooling from the outside. To achieve this, the hoses that had already been laid for cooling had to be extended further and moved into position. The circumstances indicate that the plan was to cool only the deck surface in the area of cargo hold 4. To what extent cooling the hatch cover and hatch coaming would have had an impact on the temperature variation in the cargo hold remains uncertain and the investigators estimate this to be rather low. In this respect, it is noted that containers were positioned on the entire surface of the hatch cover and therefore, a continuous application of water on the surface was hardly possible. However, the total area of the easily accessible hatch coaming is relatively low. The wing tanks, which were filled with fuel and heated, and the side passages prevented external cooling over the ship's side. Moreover, only a relatively small surface would have been reached via the side passages. Of the watertight bulkheads between the cargo holds, only the bulkhead between cargo holds 3 and 4 could have been reached directly due to the accessibility that existed there (same design as in Figure 7). Having said that, up until the time of the explosion, the crew had not prepared to cool there. Overall, the potential for effective external cooling of cargo hold 4 was limited. On the other hand, the fire should have been prevented from spreading to the containers standing on deck. Here, the wooden bottom of the containers were especially vulnerable.

The crew members that moved forward for the cooling work were assigned to all four teams. At least the composition of this team did not correspond to the usual intervention tactics, which indicate that as a member of the ship's command unit the chief officer was not required at the scene. As leader of the defense unit, the second officer should have coordinated this as according to the intervention tactics, deployment to the immediate source of the fire is reserved for the apparatus carriers of the defense unit. They are trained and dressed appropriately for that. Other members of the defense unit, the support unit, and the additional unit should have been assigned duties that involved being further away from the fire. The duties of the defense unit and the support unit were set out accordingly in the NAVECS system.

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<sup>108</sup> Pyrolysis gases form when a substance is heated until it emits flammable gases.

<sup>109</sup> Ibid.

Due to the explosion, the crew members in close proximity to cargo hold 4 suffered serious to very serious burns. None of them was wearing protective clothing at the time of the explosion and the clothing worn by four crew members caught fire.

The chemical odour of the gases escaping there had already been noticed when closed-down state was established at cargo hold 4. However, none of the crew members tasked with cooling was equipped with a breathing apparatus even though they were operating in close proximity to cargo hold 4. Here, the Handbuch für die Ausbildung im Schiffssicherungsdienst (manual for ship safety service training) states<sup>110</sup>: "The head of operations will establish the nature of the dangerous goods which have caught fire or are stowed near the seat of the fire from the cargo manifest. He will gather the information from the "Emergency Procedures for Ships Carrying Dangerous Goods (EmS)" held on board what protective equipment and which extinguishants are to be used. The defense unit equips itself for the special service. The head of operations informs the unit leader of the service task and about any special behaviour to be observed in fighting the fire." Although the fire was not being fought directly at this point, the procedures necessary in the vicinity of the source of the fire are comparable. The NAVECS system did not address the potential risk posed by toxic gases and resulting need for respiratory protection and chemical protection suits.

The actions required to prepare for cooling, as well as the planned cooling itself, necessitated being in very close proximity to the fire, even though – taking into account the whole of cargo hold 4 – its size was unknown. Here, very close proximity inevitably necessitated being in the passages between the bays (crossways). However, this opposed the recommendation in the safety data sheets of the EmS Guide, which recommended a protected position when fire-fighting due to the risk of explosion. Since there were no technical appliances that would have been available for cooling or the construction of hydroshields installed in the crossways, the crew members had to take on this dangerous task. A personnel protective spray device was not made use of during the approach to the source of the fire. This was possibly because the fire pumps were still turned off. However, the investigators assume that the explosion was of such force that the use of a personnel protective spray device would have only provided marginal protection.

During the approach in the crossways, it was found that the existing hose length was insufficient. Therefore, more fire hoses had to be collected. The hose lengths necessary to reach the other side of the ship could have been known on the basis of a realistic drill, where it was assumed that only one side of the ship is passable.

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<sup>110</sup> Chapter 4.6.6.

The casualties on the fore section could only be given provisional care because no first aid kit was available there<sup>111</sup>. The critically injured casualty was carried with the help of a tarpaulin.

### **2.1.3 Abandoning the ship and recovery by the DS CROWN**

After the small group was cut off on the fore section, its members did everything in their power to help each other and prepare for their evacuation. Here, the subsequent actuation of the life raft was very helpful because it was easier to lower the seriously injured crew member in that than in the lifeboat. In the opinion of the investigators, the actions of the uninjured crew members on the fore section were exemplary. They improvised with the resources available and made it possible for the casualties to leave the ship.

The decision of the ship's command to abandon the ship was well judged and comprehensible for the investigators. On one hand, the condition of the fire after the explosion was such that the crew could neither fight nor contain it. On the other hand, the risk to the crew due to the smoke and/or its potentially hazardous composition was obvious. This was compounded by non-availability of the main engine and several injured crew members, whose rescue from the fore section would have necessitated launching a lifeboat at any event.

Here, the fire expert commented: "Abandoning ship after the explosion can be assessed as the only logical response to the harmful event. The ensuing spread of fire through to the total cumulative damage could not have been prevented by the crew at any time with the means available."

The problems incurred while attempting to launch the port lifeboat and launching the starboard lifeboat were possibly due to the absence of part of the defense unit, because they were trapped on the fore section. Consequently, four of the eight people from the small group that attended the three lifeboat handling drills were absent. Among them were two officers and the bosun. Another participant was employed in the engine room. Although the two lifeboats were identical, the skipper of the boat on the port side participated only in the first full drill. Only two members of the small group involved in this drill belonged to the boat on the port side. They were also available for making both boats ready.

Participation of only part of the crew in the boat drills did not satisfy the requirements of SOLAS<sup>112</sup>, which states that all crew members must attend at least one abandon ship drill every month.

That the GMDSS handheld transceivers and the SART buoys were not taken onto the boats was possibly due to this fact. The people responsible for that had only participated in the first full drill.

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<sup>111</sup> According to the Ordinance on the Medical Care on Seagoing Vessels (Verordnung über die Krankenfürsorge auf Kauffahrteischiffen – SchKrFürsV), that was not necessary.

<sup>112</sup> SOLAS Chapter III Regulation 19.3.2 and 19.3.3.1. These drills should include more than one rehearsal.

The investigators attribute the forgotten safety pin and careless removal of the lashing line to lack of oversight, but also to the anxiety of the crew that had developed in the meantime. The crew of the boat may have been exposed to grave danger, if the return on board the ship would not have been so easy, if the guide roller blocked at a later stage while the boat was being lowered.

Although not an immediate subject of the investigation, the investigators are of the opinion that the actions of the crew of the DS CROWN were extremely spirited and expedient. The casualty in the liferaft was taken onto the deck together with the whole raft in an unusual but effective manner. The crew of the MSC FLAMINIA received medical attention and was assisted in all other respects. With the support of the crew of the DS CROWN and the MSC STELLA, as well as the rescue helicopter, the onward movement of the casualties to the Azores was successful.

#### **2.1.4 Examination of the shipboard arrangements**

Shipboard arrangements in this context means:

- assignment of crew members;
- implementation of training sessions, and
- implementation of drills.

The basic formation of two defense units, one for fighting fires in the engine room and one for the deck area, appears to be worthwhile if the level of manning is sufficiently large. It enables the local knowledge acquired in the course of daily work to be used effectively if there is a fire. On the other hand, the absence of a description of duties in the muster list for each support unit resulting from that was difficult to understand. This is especially true because the NAVECS system contained a description of duties for various alternatives during fire-fighting (see section 1.2.4.2). The teams evidently had the following duties during the fire drills<sup>113</sup>:

- defense unit: investigate and fight fire;
- support unit: prepare fire hoses and cool area;
- additional unit: establish closed-down state.

It is apparent that the duty of the support unit – establish closed-down state – in the NAVECS system overlapped with the duty of the additional unit in the muster list.

It is evident from the records submitted that regular training sessions were carried out throughout the period under consideration (June 2011); for example, on the failure of the steering gear or the handling of the GMDSS system. However, training on the CO<sub>2</sub> fire-extinguishing system or training with this system during a fire drill for the engine room or cargo holds could not be found. This could mean that the requirements of the vessel operator's fire safety operational booklet were not met: "The officer in charge for the use of the quick closing device/CO<sub>2</sub> system should be familiar with the system" [sic]. Moreover, the SMS manual also requires training on

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<sup>113</sup> Record of the drills on 6 April 2012 and 8 June 2012.

the fire-extinguishing appliances on board and thus reflects the requirement of SOLAS<sup>114</sup>.

The description posted at the CO<sub>2</sub> releasing station, “releasing CO<sub>2</sub> for the engine room” (figures 15 and 16) depicts the fact that the pilot valves 1 and 2 open automatically during a normal CO<sub>2</sub> release. However, the open valves were obviously not noticed. The investigators are of the opinion that this happened for two reasons. Every instruction or drill at the CO<sub>2</sub> system is only carried out in a theoretical manner because of the structure. No control element is thereby operated, and the posted description of the releasing process does not provide a possibility of comparison by means of photos due to narrative form. The acting crewmembers had apparently difficulties in making comparisons between the current and the desired situation.

The records also revealed that the same group of seven or eight members of the current crew carried out most of the lifeboat launching drills (three of four). The investigators gained the impression that uncertainties and errors emerged when the ship was abandoned on the day of the accident due to the absence of a large part of this group.

Overall, the investigators believe that the vessel operator is also responsible, at least in terms of the previous two paragraphs. The crews sent the required records of training and drills carried out to the responsible parties at the vessel operator. The shortcomings discernible from that in respect of the SOLAS requirements and vessel operator's own provisions were apparently not recognised.

## **2.2 Cause of the fire**

During the investigation, it was not possible to determine a sole cause of the fire. This was due to the condition of cargo hold 4 after the fire and the large number of dangerous goods. The report prepared by Dr Beeley, which was presented to the BSU only orally and in summary form, was not provided by MSC. Reports by the fire experts commissioned by the underwriters were not available for the preparation of this report, either, since their investigation had not been concluded and this would not be the case before the complete discharging of the affected cargo residues.

Based on the evidence on hand, it is more likely that the fire was caused by divinylbenzene than other substances. "It can be assumed that the tanks containing divinylbenzene reached temperatures of considerably more than 30°C for an extended period. Therefore, it was inevitable that the chemical stabilisation would fail after some time. According to the information and calculations [of Dr Meißner], the

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<sup>114</sup> SOLAS Chapter 2-II Regulation 15.2.2.1 in conjunction with Chapter III Regulation 19.4.1.

stabiliser (TBC) is effective for 60 days at 18°C. At 27°C, it is only 30 days and at 35°C just five days. Under these conditions, the energy releasing polymerisation had to begin in one or more of the tank containers after about a week at sea."<sup>115</sup> The presumed rise in temperature in the tank containers carrying divinylbenzene has three possible causes:

- the ambient temperature;
- the temperatures in the cargo hold due to the heated fuel tanks;
- the potentially still existing higher temperature of tank containers carrying diphenylamine stowed in the immediate vicinity.

The actual location of the explosion cannot be determined with certainty. However, existing evidence points to inside cargo hold 4. Here, the 'high level' alarm of the fuel tank on the port side of cargo hold 4 should be cited first and foremost. The investigators consider it unlikely that this alarm-signalling unit was affected by an explosion on deck. To that extent, the late start of cooling on deck was probably of no significance to further developments.

### **2.3 Carriage of dangerous goods**

SOLAS<sup>116</sup> and the IMDG Code forms the legal foundation for the carriage of dangerous goods on seagoing vessels. For ships flying the flag of Germany, the Ordinance on the Transport of Dangerous Goods by Sea (GGVSee) is also valid.

#### **2.3.1 Carriage of divinylbenzene**

The manufacturer of divinylbenzene Deltech stated as shipper vis-à-vis the carrier Stolt and their freight forwarder that special circumstances shall be observed during the transport of its products. These special circumstances were: Transport far from heat sources and on deck to enable temperature monitoring. Neither the transport documents in the possession of the investigators nor the IMO dangerous goods declaration contained such information. The containers with divinylbenzene were actually stowed under deck. The BSU also assumes that the temperatures were not controlled during carriage prior to loading on the ship. Moreover, the temperature was not controlled on the ship due to stowage in the cargo hold. Stolt as issuer of the Dangerous Goods Declaration refers to the specifications of the IMDG Code. Stolt had factually satisfied the duty of information specified in the Code<sup>117</sup>.

The reports commissioned by the BSU come to the following conclusions with regard to the carriage of divinylbenzene:

"The N.O.S. item of UN number 3082 combines a large number of substances without any indication of their particular hazards. Therefore, any associated instructions and actions are not recorded in the IMDG Code for the ship's crew. Particular hazards, such as those posed by divinylbenzene and not covered by other

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<sup>115</sup> Report by Dr Höfer.

<sup>116</sup> Chapter II-2 Regulation 19 respectively SOLAS 2001 Chapter II-2 Regulation 54 and SOLAS Chapter VII.

<sup>117</sup> IMDG Code Chapter 5.4.1.4.1.

hazard classes within the meaning of part 2 of the IMDG Code, are not taken into account. While, for example, class 5.2 or 4.1 substances at risk of self-accelerating decomposition at certain temperatures have special instructions for stowage and segregation (column 16 of the dangerous goods list, Chapter 3.2), as well as observations in respect of their properties (column 17 of the dangerous goods list) entered, there is no such information whatsoever for the crew or in the transport document in the case of UN 3082."<sup>118</sup>

"Classification of the stabilised divinylbenzene [by the shipper] as dangerous for the environment (in terms of being a marine pollutant, class 9 of the IMDG Code) and not dangerous in terms of physical and chemical risks (e.g. class 4.1 of the IMDG Code) made stowage below deck possible. References to the necessary distance from heat sources for divinylbenzene are not listed in the copies of the IMO dangerous goods declaration in the possession of the BfR. Stowage near heat sources (engine rooms, fuel tanks, warm cargo, sun, etc.) by the shipper/stevedores was thus possible. Due to sole classification and labelling as a marine pollutant, stowage protected from the sea is recommended and heat sources are not to be viewed a risk (unless other hazards are specified). Therefore, the stowage conforms to the recommendations of the international regulations for transporting packaged dangerous goods by sea.

According to the copies of the IMO dangerous goods declaration in the possession of the BfR, the emergency response recommended for divinylbenzene is specified under EmS schedule Alfa (F-A) for fire-fighting and Foxtrot (S-F) for spillage. The two emergency responses F-A and S-F are 'simple' basic recommendations that apply to marine pollutants, in particular those that can float on water. However, these instructions lead to the wrong emergency response for stabilised mixtures prone to energy releasing reactions.

Due to the stabilisation of the divinylbenzene, the emergency response specified here is misleading, even though technically it could be derived from the UN number for the cargo. A technical examination of these recommendations for emergencies would have at least resulted in the selected classification being put into question, if not also the transport requirements (e.g. refrigerated cargo).

According to the notes to column 15 of IMDG Code Chapter 3.2, the shipper has the following duty: 'For dangerous goods offered for transport under N.O.S. entries or other generic entries, the most relevant emergency response procedures may vary with the properties of the hazardous constituents. As a consequence, shippers may have to declare different EmS codes from those indicated, if, to their knowledge, such codes are more appropriate.' Apparently, this did not happen in the present case.

However, the clear and compelling need for the allocation of an emergency response from the EmS Guide together with verification in respect of the objective applicability of this recommendation for the specific cargo by the shipper are absent in the provisions of the IMDG Code for transporting dangerous goods in containers by sea. Moreover, none of the sections of Chapter 7.8 of the IMDG Code (Special requirements in the event of an incident and fire precautions) are binding under international law. Such an obligation may have prevented the establishment of

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<sup>118</sup> Dangerous goods report.

objectively inapplicable conditions of transport and the allocation of an inapplicable emergency response."<sup>119</sup>

### 2.3.2 Declaration of other dangerous goods

The vast majority of the goods in cargo hold 4 were properly declared. Only the contents of seven containers (including divinylbenzene) were incorrectly/inaccurately named or should have had further-reaching instructions due to their properties. These materials were:

- 1,1,1,2-tetrafluoroethane – incorrect name in the succinct description: ten containers;
- dimethyl sulfoxide (DMSO) – incorrect name in the succinct description: one container;
- nylon 6.6 – inaccurate description in the succinct description: one container;
- tertiary-butyl styrene – no UN number associated, incorrect property (combustible instead of flammable), possibly incorrect stowage, no indication of the necessary distance to heat sources required according to IMDG Code, associated hazards thus neglected: two containers;
- glyphosate – incorrect name, apparently ought to have been classified as a dangerous good: 11 containers, and
- diphenylamine – no mention of the property 'hot' necessary according to IMDG Code, possibly associated hazards thus neglected: ten containers.

In summary, including the three containers carrying divinylbenzene, 38 containers or 9.57% of the total number of containers (397 in the area of cargo hold 4) or 10.21% of the containers actually laden (372 containers in the area of cargo hold 4) thus exhibited shortcomings or negligence in the declaration. As regards load contents (54 general goods), 12.96% of the goods were inaccurately declared.

The hazards arising from the shortcomings or negligence vary. For example, the incorrect designation found in the case of 1,1,1,2-tetrafluoroethane, dimethyl sulfoxide and nylon 6.6 would merely have led to delays when searching with the name of the substance. However, the associated UN number would have given rise to the action recommended by the EmS Guide.

The potential risk in the case of tertiary-butyl styrene and diphenylamine is higher. The first substance referred to can polymerise when subjected to heat for an extended period. The safety data sheet requires carriage below 32°C. However, this fact is not reflected in the dangerous goods declaration because it contained no indication as to the necessary distance from sources of heat. The other substance is carried at an elevated temperature. Technically, the substance was properly declared in terms of temperature indication because the IMDG Code does not require an indication of heating. In fact, a hazardous situation could arise from stowage together with heat-sensitive goods.

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<sup>119</sup> Report by Dr Höfer.



The hazards associated with glyphosate in respect of the development of fire can be assessed as lower due to the conditions of transport found. Having said that, the probable non-declaration as a class 8 corrosive dangerous good is very serious if the substance leaks due to the damage of the container, as this would have led to an environmental risk.

#### **2.4 Fire-fighting by the salvor**

The fire experts commissioned by the BSU found, in sum, that in such a harmful event it was virtually impossible even for external units and with the use of powerful water cannons to extinguish the burning container load from the outside. It was only possible to cool the external areas and thus retard the reaction rate. The approach also consisted of creating so-called blocking positions. These thermal barriers were used to prevent or reduce the spread of fire. The containers on fire, in particular below deck and amidships on deck, had to be completely burned out under control.

With regard to the enormous spread of fire, the limits were clearly demonstrated when the FAIRMOUNT EXPEDITION initially operated alone. It was impossible to simultaneously contain the source of the fire fore [cargo hold 3] and aft [cargo holds 6 and 7] with one tug. However, containment from fore and aft was not attempted even after the arrival of the third tug. The salvor had assigned other task to this tug.

Fire-fighting could only be carried out from the windward side. To fight the source of the fire from both sides, the ship would have had to be turned into the wind. However, since the salvor sought to approach the coast and thus reach sheltered waters, this did not happen as events unfolded, either.

A decision as to what part of the ship should be primarily protected must be made when using the tugs for fire-fighting. Amongst other things, this is dependent on the cargo and hazards associated with it. In the present case, priority was evidently given to protecting the superstructure. It was not possible for the tugs to fight the fire in the containers.

Due to the extent of the fire and the associated thermals and/or high energy potential, the use of huge amounts of water was necessary to fight it. It is not known whether the salvor used special wetting agents in the process.

The deployment of firefighters and other salvage experts on the ship was necessary for the final extinguishing phase inside the burning containers and the preparations necessary on board the MSC FLAMINIA for that. Their work was heavily dependent on the weather conditions. In the period under consideration from 20 July to 31 August 2012 (43 days), the daily reports of SMIT<sup>120</sup> explicitly indicated that it was not possible to board the MSC FLAMINIA for 13 days due to the weather conditions. The ship was not entered on eight other days, either. Here, it should be noted that

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<sup>120</sup> The BSU does not have all the daily reports in its possession.

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transfers did not take place from force 6 Bft wind or, depending on the swell, force 5 Bft wind. In the period under consideration, the wind force was greater than or equal to 6 Bft on at least 16 days. It should also be noted that a team from the salvor was on the ship permanently after the situation was stabilised on board, at least from 29 August 2012.

## 3 CONCLUSIONS

### 3.1 Fire-fighting

The crew of the MSC FLAMINIA was not fully prepared for fighting a fire in the cargo hold. Accounting for everybody, the equipping of the defense unit, and the establishment of closed-down state followed the rehearsed drills. One hour then passed before the first action was taken to extinguish the fire: the CO<sub>2</sub> discharge. While preparing for the discharge of CO<sub>2</sub> into cargo hold 4, the technical safety precautions which are designed for an emergency release of CO<sub>2</sub> in the engine room were also activated. The cause for this was the incorrect installation of a part of the pipes of the CO<sub>2</sub> fire extinguishing system. That failure virtually resulted in the 'loss' of the main engine and necessitated the intense employment of all technical officers in the engine room. They first tried to detect the error. Thereby the released pilot valves 1 and 2 were not noticed. Thereby it was not noticed that the pilot valves 1 and 2 had released. Later on it was attempted to bypass the existent electric deadlock. Until the vessel was abandoned the main engine could not be rendered ready for operation completely.

The actuation of the CO<sub>2</sub> alarm for the engine room and associated loss of the main engine did not affected substantial the fire-fighting as regards personnel, as such. Although up to the start of cooling work the manpower requirement was low.

In the course of the investigation, it was not possible to clarify whether the discharge of CO<sub>2</sub> or actually its delayed use adversely affected the situation in cargo hold 4 and/or facilitated the explosion., Since no other extinguishing agent was provided for, there were no alternatives to CO<sub>2</sub> for the crew to use.

The cooling work started two hours after the fire alarm. The investigators see no reason why this could not have been started earlier. The crew could not control the temperature of the hatch covers in the middle area for reasons of stowage. Therefore, precautionary cooling work to prevent the fire from spreading to the containers on deck should have started there at a very early stage. The delayed start of cooling probably had no impact on the course of the fire or the explosion. A least, no spread of fire to the deck cargo was observed.

The findings made in relation to the composition of the team, the equipment, and the different objectives while investigating the approach to the source of the fire, as well as the points already mentioned above are considered an indication of the crew's level of training, the degree of organisation, and the ability to communicate. It is clear that the entire crew was in an exceptional situation that lay outside its previous experience. However, the investigators are of the opinion that this situation could have been offset by better preparation, amongst other things. It is likely that it had no influence on the progress of the fire in this case.

With regard to the equipment used to fight the fire, the investigation can conclude that it is only possible to come close to controlling a cargo fire on a container ship with a combination of water and CO<sub>2</sub>. Consequently, in the opinion of the BSU the need arises for a general carriage requirement for an additional water-based fire-extinguishing system without exception. The possibility of using water as an extinguishing agent and for cooling via a permanently installed system in the cargo holds is considered absolutely necessary. This applies to those cargo holds intended for the carriage of dangerous cargo, at least. Moreover, the installation of such systems on the upper deck is also considered recommendable. The possibility of cooling and the establishment of fire zones, pending the arrival of professional firefighters for example, is believed to be extremely important, especially with the increasing ship sizes.

Moreover, permanently installed equipment on the upper deck reduces the risk to the crew considerably and the crew can be given other tasks. Here, portable appliances can achieve a similar outcome<sup>121</sup>.

Due to the fact that there was no first aid kit on the fore section, the burns suffered by casualties could not be properly dressed. However, the contents of a first aid kit would not have been sufficient for the treatment of four casualties. Having said that, the investigators consider it to be very unfavourable, with the increasing ship sizes in particular, that greater distances have to be covered before primary care can be administered because appropriate material can only be obtained from the superstructure. The above can be applied to the non-existing stretcher in full. Since a basic stretcher was not available on the fore section, the seriously injured casualty had to be carried on a tarpaulin. There is currently no carriage requirement for the fore section in this respect, either.

### **3.2 Abandoning the ship**

The investigators are of the basic opinion that the approach described in the muster list of the MSC FLAMINIA, which was also reflected in the training on board, notably, the defense unit's responsibility for preparing the lifeboats, should be reconsidered. Three reasons oppose this approach. Firstly, as in the present case, the unit could be depleted or no longer available. Secondly, the unit could be so physically weakened due to the course of the operation that it is no longer able to operate. Thirdly, it could be necessary to prepare the rescue boats simultaneously. All are conceivable assumptions in an actual fire.

Mistakes can happen when, as in this case, the leaders of the other teams are not available due to other activities and corresponding guidance is thus absent. The investigators believe that an appropriate level of training can be achieved by means of drills with scenarios that differ from the norm.

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<sup>121</sup> In its statement the BMVI pointed out that Germany has proposed a Formal Safety Assessment concerning fires which are difficult to extinguish (MSC 92/26 (No. 8.8 et seq. and DSC 16/INF.2)) and fires on deck (FP 54/INF.2)(acknowledged at MSC 92).

### 3.3 Carriage of dangerous goods

With regard to the carriage of divinylbenzene, the expert Dr Höfer finds in his report that carriage that is inadequate in terms of safety is currently facilitated due to the objectively inappropriate classification of the substance in the IMDG Code. He cites three reasons for this:

1. the substance is not listed in the index of the IMDG Code. This is also true of butyl styrene (tertiary-butyl styrene), which was also carried on the MSC FLAMINIA and has similar material characteristics;
2. based on the chemical and physical properties of the stabilised substance under ideal conditions, divinylbenzene is not classified as a class 4.1 dangerous good (self-reactive substances), and
3. with the classifications recommended by the shipper, assignment of the objectively most appropriate emergency schedules (Foxtrot or Juliet) from the EmS Guide for Emergency Response Procedures would not be immediately deducible at present. Such an assignment only arises from a technical appraisal of the destabilised cargo.

The expert also finds: If the safety information provided in the manufacturer's safety data sheet in respect of packaging, establishment of the stowage requirements on board, and temperature monitoring during the voyage had been taken into account, then the carriage could not have taken place in the form actually implemented. On one hand, the IMO dangerous goods declaration would have contained other information and requirements to be observed as a result of that. On the other hand, the emergency recommendations within the framework of the EmS Guide would have been different.

"Based on the course of the accident, it appears to be worthwhile to the expert for substances that release energy, have a tendency to polymerise, and are only stabilised in sea transport using chemicals or refrigeration to be classified as a dangerous good in general. In the course of a rise in temperature, which may occur during a voyage or also an accident, such substances develop dangerous properties, which represent a significant risk to a ship. Such a requirement for the sea transport of liquid substances in ship tanks is already mandatory under international law in the IBC Code.

The establishment of closed-down state at the hatch, which is necessary in the event of a fire and the use of CO<sub>2</sub>, may have adversely affected events. The [fire report] also states:

"[...] it may be assumed that especially the ordered closed-down state could have resulted in an intensification of the situation in the cargo hold. Due to the closed-down state, the gases could no longer dissipate in the air, possibly resulting in an increase in explosive gas concentrations. Furthermore, convection was prevented, thus facilitating the local rise in temperature."

However, the critical condition possibly created by that does not stem from an inadequate response by the ship's crew, but from the stowage of a dangerous mixture in the wrong place on board without notifying the crew appropriately. The establishment of closed-down state is consistent with the emergency response

recommendations, inter alia, of the EmS Guide."<sup>122</sup> The expert is of the opinion that inaccessible stowage of the tank containers below deck would not have been permissible had classification of the substance been technically adequate.

The Dangerous goods report summarises: "The legal requirements for informing the ship's crew were observed in terms of form. The required documentation was present. In respect of the known facts, the stowage did not merit any criticism in terms of form, either. To that extent, it was not in the hands of the crew to take action to prevent the accident [in the opinion of the expert]."

This summary applies mutatis mutandis to the carriage of diphenylamine and tertiary-butyl styrene. The inherent material characteristics were not shown in the IMO dangerous goods declaration. Tremendous potential hazards can thus develop in combination with other cargo or a stowage position exposed to heat in the ship.

From that, it must be concluded that it is necessary for shippers to give a description going beyond the requirements of the IMDG Code of substances they ship. This also includes, that the other transport partner continue to use the provided information in a responsible manner. Moreover, the IMDG Code should contain a binding obligation to do so.

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<sup>122</sup> Report by Dr Höfer.

## **4 SAFETY RECOMMENDATIONS**

The following safety recommendations do not constitute a presumption of blame or liability in respect of type, number or sequence.

### **4.1 Federal Ministry of Transport and Digital Infrastructure**

The Federal Bureau of Maritime Casualty Investigation recommends that the Federal Ministry of Transport and Digital Infrastructure campaigns within the International Maritime Organization (IMO) for a further development of the regulations on dangerous goods, in order to satisfy the chemical properties of several substances or transport restrictions better. The shipper should be required to declare these properties or restrictions.

### **4.2 Federal Ministry of Transport and Digital Infrastructure**

The Federal Bureau of Maritime Casualty Investigation recommends that the Federal Ministry of Transport and Digital Infrastructure campaigns within the International Maritime Organization (IMO) for a further development of the SOLAS-Convention, in order to improve the technical requirements for the fire-fighting equipment on container vessels. At least the cargo holds intended for the carriage of dangerous goods should be equipped such that they contain the possibility to use water as an extinguishing agent or for cooling via a permanently installed system as well.

### **4.3 Federal Ministry of Transport and Digital Infrastructure**

The Federal Bureau of Maritime Casualty Investigation recommends that the Federal Ministry of Transport and Digital Infrastructure campaigns within the International Maritime Organization (IMO) for a harmonization of existing legislation with respect to the equipment and the shipboard position of first aid devices (first aid boxes, stretchers) on board of seagoing vessels. . Future rules should ensure that first aid materials are placed on board such that they are promptly available to casualties and first responders after an accident even on very large ships.

### **4.4 Operator and ship's command of the MSC FLAMINIA**

The Federal Bureau of Maritime Casualty Investigation recommends that the operator and the ship's command of the MSC FLAMINIA review the accident in respect of the measures for fighting fire. Here, attention should be given to the following points, in particular:

- organisation of the crew and the description of the duties in the muster list;
- correction of the operating instructions for the CO<sub>2</sub> fire-extinguishing system;
- implementation of realistic drills, and
- training on the CO<sub>2</sub> fire-extinguishing equipment.

### **4.5 German Shipowners' Association**

The Federal Bureau of Maritime Casualty Investigation recommends that the German Shipowners' Association request its member shipowners to ensure that first aid materials (first aid kits, stretchers) are placed on board ships such that they are promptly available to casualties and first responders after an accident even without the existence of a legal obligation and even on very large ships.

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## D. SALVAGE OF THE MSC FLAMINIA

All the ship and shore-based activities and steps of significant importance to the salvage and, in particular, determination of and voyage to the port of refuge (search for port of refuge, **Chapter 1**) are listed in chronological order below. The very detailed account of the almost two-month sequence of events from the outbreak of fire on board the MSC FLAMINIA until reaching the port of refuge in this investigation report is essential because it forms the basic prerequisite for understanding the period, perceived by the public as much too lengthy, and for analysing the causes of that (**Chapter 2**).

Sources for reconstructing the relevant facts and decision-making processes included the particulars submitted directly to the BSU (primary information) by NSB (the vessel operator), by SMIT Salvage (the salvor), and by Germanischer Lloyd (GL - the classification society), as well as the information provided to the authorities involved in the decision-making process or other agencies of the Federal Republic of Germany and involved coastal States by the parties specified on request or at their own initiative in the course of searching for the port of refuge (secondary information). In addition to the analysis of the primary and secondary information referred to, of great importance to the de facto and legal classification and evaluation of the search for the port of refuge were the statements of varying detail made by the German and foreign authorities, as well as other agencies at the explicit request of the BSU. To that extent, the key sources of information were the records and recordings of Germany's Havariekommando (CCME)<sup>123</sup> and the British SOSREP.<sup>124</sup> After the accident, the latter evolved into the lead coordination centre in respect of the search for a place or port of refuge very quickly and initially under its own momentum, later as a result of multilateral liaison and dialogue with the agreement of all parties.

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<sup>123</sup> Joint institution of the Federal Government and the Federal States. The Havariekommando (**C**entral **C**ommand for **M**aritime **E**mergencies = CCME) is responsible for the planning, preparation and implementation of measures relating to the medical response, marine pollution response, fire-fighting, assistance, and security-related salvage in complex emergencies in Germany's territorial sea and in the German Exclusive Economic Zone.

<sup>124</sup> SOSREP = **S**ecretary **o**f **S**tates **R**epresentative for Maritime Salvage and Intervention: Person appointed by the British government who is independent to the greatest possible extent and provided with comprehensive powers to monitor and possibly assume full control of especially salvage activities, so as to avert or minimise hazards to Britain's waters or coast after a marine casualty. This function is roughly comparable with that of Germany's CCME.

# 1 CHRONOLOGY OF THE SALVAGE AND SEARCH FOR A PORT OF REFUGE

14/07

The ship is in the middle of the Atlantic Ocean at the time of the accident. The following distances to the coastline demonstrate the very difficult (due to distance) starting point as regards the salvage activities to be initiated and inextricably linked search for a sheltered location and/or (final) port of refuge.<sup>125</sup>

## Distance of the ship from:

St. Johns, Canada	about 1,000 nm
San Miguel, Azores	about 650 nm
Bantry Bay, Ireland	about 740 nm
Vigo, Spain	about 890 nm
Falmouth, Great Britain	about 900 nm
Brest, France	about 930 nm
Gijón, Spain	about 970 nm

After the accident report is sent by the master to the vessel operator, its emergency team assembles and informs the relevant agencies in Germany (including the BSU), as well as the Emergency Response Service (ERS)<sup>126</sup> of GL. Its deployment is initially suspended during the course of the day for lack of sufficient information at the request of the vessel operator. In addition to the accident report to the vessel operator, the master sends a mayday call on VHF at 0827. This is received by the tanker DS CROWN and forwarded to MRCC<sup>127</sup> Falmouth in the form of a mayday relay message. MRCC Falmouth informs MRCC Bremen about the emergency call. MRCC Bremen makes the CCME aware of the marine casualty. At 1326, the accident is brought to the notice of SOSREP by a third party. SOSREP obtains more information about the accident in the course of his ensuing communication with the MCA<sup>128</sup> and/or from its coastguard incident management system (BOSS)<sup>129</sup>.

<sup>125</sup> Note: Use of the English terms **place of refuge** or **port of refuge** is common around the world. In this BSU report, the terms place of refuge (possibly also as a generic term for a sheltered location in coastal areas or in port) and port of refuge are used below for both types of refuge.

<sup>126</sup> The ERS is a service provided by the classification society that can be made use of by the vessel operator, e.g. after an accident, to obtain technical assistance and expertise regarding the condition and/or action to be taken to preserve the buoyancy of a ship.

<sup>127</sup> MRCC = **M**aritime **R**escue **C**o-ordination **C**entre: National control centre for the coordination of a sea rescue, which is part of a global network and has, inter alia, the task of picking up emergency calls made in the geographical catchment area it monitors and possibly forwarding them within or outside the network, as well as organising search and rescue operations.

<sup>128</sup> MCA = **M**aritime & **C**oastguard **A**gency: British maritime authority that performs a wide range of flag State administration tasks and exercises coastal State powers on behalf of Britain's Ministry of Transport.

<sup>129</sup> The computerised BOSS (**B**rowser **O**perational **S**ystem **S**tatus) information platform/database provides a real-time link to all other centres of the British Coastguard. BOSS provides real-time monitoring of any accident at all Coastguard centres, the MCA, and other authorised users. Statistics and reports can be generated by the system.

At this early stage, SOSREP already recognises that Falmouth Bay in southwest England could become important as a sheltered location<sup>130</sup>. As a consequence of that, he orders the MCA to monitor further developments.

At 1549, SOSREP receives information by informal means from a third party that the vessel operator has reportedly concluded a salvage contract with SMIT Salvage at the LOF 2011<sup>131</sup> conditions commonly applied internationally (SCOPIC<sup>132</sup> incorporated and invoked<sup>133</sup>).

#### 15/07

The seagoing tugs FAIRMOUNT EXPEDITION (FE) and ANGLIAN SOVEREIGN (AS) are en route to the abandoned MSC FLAMINIA. MRCC Falmouth informs EMSA<sup>134</sup> about the accident by email.

#### 16/07

The CARLO MAGNO (CM) is the third seagoing tug to be deployed to the MSC FLAMINIA.

#### 17/07

Position of the stricken vessel: approximately 48°58.1'N 024°36.7'W (drift position)

The FE arrives at the MSC FLAMINIA at about 0830 and starts to fight the fire at about 0900. Several smaller explosions occur in the area of the burning cargo. The salvage crew receives information that two containers filled with 160 drums of nitromethane, a liquid chemical that can ignite when heated and generate an enormous explosion effect, are in cargo hold 3. Fire-fighting is suspended for reasons of safety and a safety clearance of 1.5 nm implemented. The vessel operator's emergency team examines the further course of action in consultation with the salvor and external experts.

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<sup>130</sup> Sheltered location: In contrast to a berth in a port of refuge, this refers to a position *at sea*. For example, a bay protected from heavy seas where the salvor has the opportunity to stabilise the stricken vessel before heading safely to a port. This means, for example, extinguishing the source of a fire, removing cargo, and adapting trim and draught to meet the needs of a (final) port of refuge.

<sup>131</sup> LOF = Lloyd's open form: Internationally standardised salvage contract based on the usual 'no cure – no pay' principle, here as amended 2011.

<sup>132</sup> SCOPIC = Special Compensation P & I Club: Internationally standardised contractual sub-agreement (clause) that permits the salvor to apply special costs, e.g. incurred to avoid damage to the environment, on the basis of a calculation model even in the event of failure or insufficient salvage funds within the framework of a LOF salvage contract.

<sup>133</sup> Note: In accordance with the usual form and execution of the contract, the SCOPIC clause was first included in the salvage contract (passive) only in principle and according to Daily Progress Report No. 006 of the salvor put into effect by means of a corresponding written declaration by the salvor on 19.07.

<sup>134</sup> EMSA = European Maritime Safety Agency based in Lisbon. EMSA advises the EU Commission in all matters of maritime safety and protection of the marine environment, assists the Commission in the preparation, updating, monitoring and implementation of relevant legislation, and performs related inspections in the Member States, inter alia.

Belgium enters the hazmat cargo manifest<sup>135</sup> into SafeSeaNet (SSN)<sup>136, 137</sup>.

SOSREP has no information about the intentions of the salvor and no verified information about the condition of the ship and her cargo. Nevertheless, the summary findings warrant setting the internal level of urgency for allocation of a place of refuge to 'high/red'.

**18/07**

Position of the stricken vessel: approximately 48°58.1'N 024°36.7'W (drift position)

The salvor resumes fire-fighting in the afternoon.

The salvor requests a conference call with SOSREP to discuss the action taken thus far. The request is forwarded to the MCA's **C**ounter **P**ollution & **S**alvage **O**fficer (CPSO). The MCA's CPSO makes contact with the salvor. Among SOSREP and his team there is unanimity that as soon as the salvor requests the allocation of a port of refuge from Great Britain, MCA's CPSO is required to initiate the procedure necessary in this respect according to IMO Resolution A.949(23)<sup>138</sup> and Directive 2009/17/EC<sup>139</sup>.

**19/07**

Position of the stricken vessel: approximately 49°00'N 024°00'W (drift position)

The second tug, the AS, reaches the stricken vessel. Inter alia, chemists and fire-fighting experts are on board. The MSC FLAMINIA is listing severely<sup>140</sup>.

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<sup>135</sup> Hazmat = **Hazardous materials**: List of all the dangerous or polluting goods on board the MSC FLAMINIA.

<sup>136</sup> **SafeSeaNet**: Mandatory vessel traffic monitoring and information system of the Member States of the European Union, Norway and Iceland, which enables the exchange of information between maritime authorities of the States involved, inter alia by means of a centralised database, and can be drawn on as a source of information, especially after accidents. Recorded and accessible data include AIS-based real-time information about ships carrying dangerous cargo, which are heading for Europe.

<sup>137</sup> Note: In accordance with Article 13(2) of Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system, Belgium was informed from the ship after she set sail from Charleston about the dangerous cargo on board because the Belgian port of Antwerp was to be the MSC FLAMINIA's first port of destination in European waters.

<sup>138</sup> IMO Resolution A.949(23) of 5 December 2003 (agenda item 17) with the annexed 'Guidelines on Places of Refuge for Ships in Need of Assistance'.

<sup>139</sup> Directive of the European Parliament and of the Council of 23 April 2009 amending Directive 2002/59/EC establishing a Community vessel traffic monitoring and information system.

<sup>140</sup> Source: Information of SOSREP on the basis of a message from the tug FE.

**20/07**

Position of the stricken vessel: 48°58.8'N 023°14.2'W (2400)

Eight people from the salvage team board the MSC FLAMINIA for the first time for about three hours in the morning and find that the stricken vessel's ballast system is faulty. It is possible to start a generator and the fire pump and establish a so-called hydroshield<sup>141</sup> between bays 50 and 54.<sup>142</sup> At 1900, the MSC FLAMINIA is taken in tow in the direction of the interim destination at 48°14'N 010°13'W (border with the British EEZ<sup>143</sup>).

**21/07**

Position of the stricken vessel: 48°18.1'N 020°01.4'W (2400)

The FE tows the MSC FLAMINA. The AS escorts and cools from the starboard side. At 2130, the third tug, the CM, reaches the tug and tow and escorts it from there on.

**22/07**

Position of the stricken vessel: 48°35.5'N 017°6.4'W (2400)

**23/07**

Position of the stricken vessel: 48°29.7'N 014°00.4'W (2400)

The salvor roughly estimates at first that between 1,200 and 1,500 containers in three cargo holds are heavily damaged. The fire is under control but it is assumed that it could take weeks to extinguish it fully. The MSC FLAMINIA has a list of about 8°.

SOSREP is aware of the interim destination of the tug and tow (border of the British EEZ) and was informed of the following facts and intentions communicated by the salvor to the MCA, by a representative of the MCA CPSO the salvor:

- Ø the fire on board is under control;
- Ø the containers stowed on deck on hatches 3 to 6 are almost completely gutted;
- Ø part of the container load in hatches 4 to 6 is burnt;
- Ø temperatures are dropping;
- Ø the engine room and superstructure are not damaged;
- Ø cargo holds 1, 2 and 8, as well as the cargo stowed above them on deck are not affected by the fire;
- Ø it is intended to proceed eastward and head for a position 200 nm west of Land's End, and

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<sup>141</sup> Hydroshield: System consisting of hoses and/or pipes and hose nozzles, which is connected to a water supply and produces a 'water curtain' to prevent the spread of fire to the surrounding area.

<sup>142</sup> Note: For the most part, it was actually possible to prevent the fire from spreading to the last four bays in front of the ship's superstructure in this manner and thus, in particular, to the superstructure itself.

<sup>143</sup> EEZ = **Exclusive Economic Zone**: Area beyond the territorial sea that stretches from the baseline out to 200 nm and over which the adjacent coastal State has limited sovereign rights and jurisdiction recognised under international law; see Article 55 of the United Nations Convention on the Law of the Sea (UNCLOS).

- Ø the salvor would appreciate it if permission was granted to continue the voyage and proceed to a position 20 nm south of Penzance Bay, where fire-fighting in the containers and preparation of the ship for putting into a port of refuge still pending would continue.

The salvor asks MCA DCPSO SOSREP the following question as a consequence of the above facts:

*"Could you do us a favour and investigate if the proposed position in UK waters is feasible?"*

**24/07**

Position of the stricken vessel: 48°19.9'N 011°44.2'W (2400)

The MSC FLAMINIA's list and draught are increasing.

SOSREP discusses the salvor's request of 23/07 internally. There are a number of unexplained issues. SOSREP determines that the above proposal of the salvor appears to be feasible in principle, but that more information is required before a decision can be made. Inter alia, the following should be examined:

- Ø on what information did the salvor base its risk assessment?
- Ø clarification of the bunker levels and of the condition of the tanks, and verification of existing associated risks;
- Ø what risks are posed to people and the environment by the cargo?
- Ø assessment of the risk of losing control of the fire. Explosion hazards;
- Ø impact of the accident on the stability and strength of the ship.

Moreover, SOSREP is occupied with the following outstanding issues:

- Ø the salvor's motivation behind proceeding to a position 20 nm south of Penzance Bay for additional fire-fighting and stabilisation of the stricken vessel. There is no more protection against the weather at this position than at a distance of 50 nm;
- Ø has the salvor or vessel operator made contact with other coastal States – Ireland or France in particular – in respect of the question of a place of refuge, especially since their coastlines are closer and possibly provide more protection, and what is the result?
- Ø what is the salvor's current plan and what does the salvor plan for the future?
- Ø where is the ship to be unloaded after 'stabilisation'<sup>144</sup> and where is she to be repaired?
- Ø what are the salvor's options and port contacts?

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<sup>144</sup> Here and below 'stabilisation' means the preparations necessary to safely tow the stricken vessel to a port. This includes containment of the fire to the greatest possible extent, the establishment of a draught that satisfies the requirements of the port, and the elimination or reduction of a trim and a list that is too pronounced.

SOSREP considers the following:

- Ø limited number of appropriate ports on the south coast of England;
- Ø impact on the Olympic events in Weymouth/Portland;
- Ø need for the inclusion of environmental groups and local authorities in the counties of Devon and Cornwall in the decision on Penzance Bay as a place of refuge, and
- Ø environmental analysis in respect of the closest point of approach to the coast, inter alia in respect of the possible impact of toxic gases on the surrounding area. Definition of a safety zone if necessary.

The MCA's CPSO should consult with the salvor, the EU authorities, and the coastal States on the above deliberations and then submit to SOSREP a written decision as to whether the stricken vessel can be allowed to head for the position requested by the salvor (20 nm south of Penzance Bay).

25/07

Position of the stricken vessel: 48°10.3'N 010°16.7'W (2400)

The towline has been shortened. A salvage team works on board the MSC FLAMINIA for about nine hours and prepares the anchor gear for deploying, amongst other things. The ship is listing 12° to starboard.

The salvor specifies the position 49°32.5'N 005°32'W as a new destination.

In addition to contacting Great Britain, the salvor has also contacted the Irish authorities to explore whether Bantry Bay (County Cork) would be appropriate as a possible place of refuge.

The salvor asks the MCA about the possibility of anchoring within the 100-metre contour line. The MCA is in favour of a position 26 nm southwest of Lizard Point or 27 nm south of Land's End.

At 1649, the salvor reports the status of the MSC FLAMINIA to the MCA at the latter's request:

- Ø on board in cargo hold 3 are two 20 foot containers carrying nitromethane, which could explode with rising ambient temperatures and require a safety radius of one nautical mile if there is a risk of explosion;
- Ø Both containers are undamaged and the temperature in the entrance area to the cargo hold 3 is currently below 50°C
- Ø the intention for the time being is for the convoy to remain at the present position, i.e. about 200 nm south of Ireland and southwest of Land's End;
- Ø 20 tonnes of salvage equipment and a 12-member salvage team are currently on board the AS.

The salvor proposes a meeting in Southampton on 27/07 to discuss the current state of play and future options with the group of decision makers responsible (SOSREP, MCA, salvor, vessel operator, charterer, and the SCR<sup>145</sup>).

**26/07**

Position of the stricken vessel: 48°10.3'N 010°16.7'W (2400)

Once again, a salvage team works on board the stricken vessel for about nine hours.

According to the salvor, SOSREP confirms in the evening that based on the data submitted, the harbour master of Bantry Bay does not accept the ship due to the threats to the local fishing industry.

At 2144, the salvor reports the current situation on board to SOSREP and the MCA, providing the following information:

- Ø the area of cargo holds 4 to 6 and the aft area of cargo hold 3 are affected by fire and/or explosion;
- Ø the temperature is currently less than 50°C at the entrances to cargo holds 3 and 7;
- Ø the temperature is less than 100°C in cargo holds 4 to 6;
- Ø the cargo holds cannot be accessed at present;
- Ø the containers in the affected cargo holds have apparently melted into a large mass due to the fire;
- Ø there are no signs of external cracks in the shell plating;
- Ø there has been no water ingress but the cargo holds are filling with cooling water;
- Ø it is suspected that the ship's strength is weakened in the area of cargo hold 4;
- Ø calculations as to the condition of the stricken vessel are performed continuously, taking into account the findings of existing and subsequent inspections;
- Ø the engine room and all the systems there are intact and can be activated at short notice, and
- Ø a generator is in operation and supplying power to the fire pump.

With regard to the set of issues surrounding risks to health and the environment posed by the dangerous cargo on board, and to the further course of action, the salvor gives the following information to SOSREP:

- Ø relevant content and stowage positions of the containers are known;
- Ø a chemist and all necessary protective equipment are on scene.

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<sup>145</sup> SCR = **S**pecial **C**asualty **R**epresentative: Independent expert/inspector designated by the shipowner who oversees the salvage activities for the purposes of the subsequent SCOPIC procedure or settlement (see fn. 132 above; cf. No. 1 of the Guidelines for Special Casualty Representatives). The SCR must belong to a group of persons authorised by the SCR Committee. The SCR Committee is composed of 12 representatives of the International Salvage Union, the P&I Clubs, the International Union of Marine Insurance, and the International Chamber of Shipping.



27/07

Position of the stricken vessel: 48°47.3'N 008°38.0'W (2400)

The smoke emissions from cargo holds 4 and 5 have reduced considerably. MSC FLAMINIA can be entered. However, it is unlikely that it will be possible to stay on board between 30/07 and 05/08 due to the weather.

The first meeting is held at the headquarters of the MCA in Southampton. Participants from government agencies are SOSREP, as well as representatives of the MCA, the Environment Agency<sup>146</sup>, and the Republic of Ireland. Representatives of the salvor and of the charterer (MSC) maintain the interests of the MSC FLAMINIA. The SCR<sup>147</sup> and a representative of the company appointed by the salvor (TMC)<sup>148</sup> are also present.

The salvor provides information about the current situation on board and refers inter alia to the following points:

- Ø temperatures have fallen below 100 degrees at all measurement points but the possibility of a renewed increase is not excluded;
- Ø the draught of the stricken vessel has increased from 14.6 m to 16 m;
- Ø it has been possible to reduce the starboard list from 12° to 10° by trimming;
- Ø the salvor assumes that the stricken vessel will not break apart at present;
- Ø permission is sought to anchor 20 nm to 30 nm south of Penzance Bay;
- Ø a sheltered area with a depth of less than 100 metres is required so as to stabilise the ship further, carry out a damage assessment, unload the undamaged deck cargo, as well as check the hull and the impact of the fire on the condition of the ship at anchor;
- Ø barges should be used for the unloading operation;
- Ø a period of four months is estimated for the activities at anchor, and
- Ø ports of destination being considered are Zeebrugge, Rotterdam, and Antwerp.

The MCA and SOSREP are very sceptical about the plan to initially leave the stricken vessel at sea for an extended period. Moreover, the MCA believes a place of refuge in the southwestern area of the coast of England is too dependent on weather. A position on the French coast east of the Cotentin Peninsula, in the Seine estuary for example, would reportedly provide better protection. SOSREP calls for closer dialogue with the authorities in France as transiting eastward through the English Channel would mainly affect French waters.

Moreover, pursuant to Directive 2009/17/EC and the resulting need for regional cooperation<sup>149</sup>, the bordering States of Belgium and the Netherlands should be included in any future decision-making. In the meantime, SOSREP believes existing environmental hazards should be given further consideration. The risks to health and

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<sup>146</sup> British environmental authority.

<sup>147</sup> See fn. 145.

<sup>148</sup> TMC: London-based company that operates globally in the maritime sector and employs, inter alia, shipbuilders, engineers, as well as masters and provides extensive consulting services, e.g. after accidents at sea.

<sup>149</sup> Note: Although the need for regional cooperation can be inferred indirectly due to the very nature of the Directive, the BSU is of the opinion that the Directive does not contain an unequivocal call for standardisation.

the environment posed by the cargo or its mixed products should be analysed carefully. The analysis should also provide information about the size of a safety radius around the stricken vessel.

It is made clear to the salvor that a passage through the English Channel would require complete information about the status of the stricken vessel and her cargo. Therefore, the MCA requests the salvor to submit information on the current chemical air and water pollution. GL's casualty modelling<sup>150</sup> should also be submitted. Furthermore, the salvor is requested to submit a salvage plan that shows its intentions as soon as possible. It is agreed that the MSC FLAMINIA should remain in the area of her current position (150 to 200 nm southwest of Land's End) until the meeting next week at which representatives of the coastal/port States of France, Belgium, and the Netherlands are to be invited.

**28/07**

Position of the stricken vessel: 49°40.9'N 009°28.1'W (2400)

The draught of the MSC FLAMINIA has increased significantly to 19 metres.

The stricken vessel moves in a southerly direction away from the agreed waiting position due to weather conditions.

**29/07**

Position of the stricken vessel: 47°51.5'N 010°5.5'W (2400)

The towed convoy stops temporarily about 100 nm off the English coast. The salvage team carries out inspections and extinguishing work on board the stricken vessel.

**30/07**

Position of the stricken vessel: 47°28.6'N 010°45.1'W (2400)

The salvage team continues its work and inspections on board the MSC FLAMINIA, which is located about 230 nm southwest of Land's End, and endeavours to reduce the list by adjusting the trim.

The salvor has contacted the port of Gijón in Spain. The Dutch port of Rotterdam receives a formal PoR request<sup>151</sup> from the salvor under the general heading "To whom it may concern". There is also the idea of heading for Le Havre in France or Zeebrugge in Belgium. Beyond that, the salvor intends to conduct a meeting with the Rotterdam port authority within the next 24 hours.

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<sup>150</sup> GL's casualty modelling: Calculations by the classification society regarding the current and future conditions of the stricken vessel, stability and strength in particular.

<sup>151</sup> PoR request: Abbreviation chosen here and below to simplify the formal written request of the salvor to grant a **P**ort (or possibly) **P**lace of **R**efuge.

31/07

Position of the stricken vessel: 47°00.9'N 011°10.8'W (2400)

According to the salvor, the fire in cargo holds 4, 5 and 6 is extinguished. No work is possible on board the stricken vessel due to poor weather. The salvor provides information about toxic fumes escaping from the destroyed cargo but submits no specific analysis data.

Belgium has engaged MAR-ICE<sup>152</sup> to obtain assistance in assessing the situation in respect of the dangerous cargo.

France (here and below the locally competent French Maritime Prefecture in Le Havre) receives a formal PoR request from the salvor. The objective is an anchorage or berth in Le Havre.

A PoR request from the salvor is also received in Belgium (here the Belgium Port Authority Zeebrugge). For reasons of competence, this is forwarded to the Belgian and Flemish coastguard partners and the governor of the Province of West Flanders as president of the coastguard.

In the port of Rotterdam, representatives of the salvor, the Dutch coastguard and maritime administration, as well as the port meet to discuss accommodation of the stricken vessel by the port of Rotterdam. The authorities and the port state their basic willingness to accommodate the ship on condition that she satisfies the safety requirements imposed. The salvor should submit a plan, which will then be checked by the authorities and the port.

Great Britain (here the MCA) receives the following formal request from the salvor:

*“SMIT Salvage would be extremely grateful if you (UK) could give urgent consideration to our request for the Casualty to be towed to the Port of Le Havre/Zeebrugge/Rotterdam and for this to be used as a port of refuge for the ongoing salvage services.”*

SOSREP concludes that the salvor is evidently not considering a port of refuge on the south coast of England.

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<sup>152</sup> MAR-ICE = **M**arine **I**ntervention in **C**hemical **E**mergencies Network: Information network available around the clock launched by EMSA in close cooperation with the European Chemical Industry Council and the Centre of Documentation, Research and Experimentation on Accidental Water Pollution. The experts involved assist EU Member States in tackling environmental pollution at sea by providing information, risk analyses, and recommendations for environmentally hazardous items of cargo on request.

01/08

Position of the stricken vessel: 46°27.6'N 011°43.6'W (2400)

The MSC FLAMINIA is currently 330 nm southwest of the coast of Cornwall and 240 nm off the Spanish coast.

EMSA provides the first extensive risk analysis of the dangerous cargo on board the MSC FLAMINIA prepared by MAR-ICE. The analysis looks at all the containers on board the ship marked as dangerous cargo in terms of specific risk potential.

The second crisis meeting takes place at the MCA HQ<sup>153</sup> in Southampton. In addition to SOSREP, as well as representatives of the MCA and the French authorities, participants in physical attendance include the salvor and the vessel operator. Inter alia, according to the protocol of the meeting supplied by SOSREP, government agencies in Belgium, the Netherlands, and Germany (here Ship Safety Division (BG Verkehr) as Germany's flag State administration) also attend by way of video or teleconference.

The topic of debate is the formal PoR requests of the salvor to Great Britain, France, Belgium, and the Netherlands in the two preceding days.

SOSREP expresses a wish for the States involved to cooperate in finding the best solution based on applicable IMO and EU legislation.

The MCA and SOSREP still have doubts regarding a place of refuge off the coast of Cornwall because in poor weather little protection is afforded there. The four-month period estimated by the salvor for the damage analysis and stabilisation work is also called into question<sup>154</sup>.

The ports of refuge envisaged by the salvor (Le Havre, Zeebrugge, Rotterdam) require transiting the English Channel and passing through French territorial waters. In this connection, France makes clear that an inspection team must be granted access to the ship before she is permitted to pass. Moreover, they reportedly have problems with the allocation of a place of refuge in a coastal area for as long as the ship's final destination is unknown. Furthermore, the salvor has reportedly not delivered a clear assessment of the current condition of the ship thus far. A full evaluation of the condition of the ship by the classification society seems to be necessary before France would be prepared to decide on granting a port or place of refuge.

Belgium points out that the port of Zeebrugge reportedly has a draught limit of 16.5 metres. The stricken vessel must reduce her draught to 14 metres in order for the port to be suitable as a port of refuge.

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<sup>153</sup> HQ = **H**ead**q**uarters.

<sup>154</sup> In his statement pertaining to the draft of the investigation report the salvor notes, that the estimated value mentioned is based on the premise of his situation assessment dated 27.07 (s. there).

The salvor reports on the progress of the salvage work and indicates that the current weather conditions are severely hampering the salvage work and do not permit the salvage team to work on board continuously. This is reportedly also the reason why the salvor wishes to first head for a sheltered coastal area to stabilise the MSC FLAMINIA before entering a port of refuge. Inasmuch, they reportedly first considered Bantry Bay in Ireland but received a rejection from there. They mentioned that they are currently in conversation with the harbour master at Rotterdam. The charterer and owner favour Zeebrugge as a final port of refuge for logistical reasons. Other options would be Brest and a Spanish port, which has reportedly imposed a large number of conditions for permission to enter.

France stressed that Brest was ruled out as a port of refuge. The French Navy would not accept the risks attached to the entry of the stricken vessel. A thorough risk assessment is reportedly also necessary in respect of the Seine estuary (Le Havre) because of its importance to fishing and leisure craft.

The representative of the Netherlands advises that they are in close contact with the salvor and monitoring developments closely. The port of Rotterdam can reportedly accommodate ships with a draught of up to 24 metres. The Dutch government and the port authorities have a positive view as regards accommodating the stricken vessel provided the conditions are met. It is recognised that consultations concerning the passage to Rotterdam must be held with the other States.

France and Great Britain ask how long the work at a sheltered place of refuge would take at minimum and how the ship is to be secured at sea during the period in question.

The salvor stresses that the amount of time depends on the work necessary or required by the final port of refuge (for example, Rotterdam requires that the fire is fully extinguished before entering) and could be limited to four to five weeks if necessary.

The salvor is again requested to submit a plan of the actual measures necessary to stabilise the stricken vessel and the results of GL's casualty modelling to the coastal States that have received requests. This information is reportedly a prerequisite for the necessary assessment of the risks associated with towing the stricken vessel into a (final) port of refuge.

The salvor indicates that the stricken vessel's reserve stability is sufficient and her hull is in good condition; however, an in-depth inspection is reportedly necessary. The longer the ship remains at sea, the more load this will place on her strength. The current weather conditions prevent the salvage team from staying on board continuously and a thorough inspection. The calculations made thus far are reportedly not reliable until they can be verified by inspections on the ship. As a result of the conversation, the salvor agrees to submit a preliminary salvage plan within one week.

The MCA announces that it is beginning a risk assessment at potential places of refuge and requests that other States do likewise.

SOSREP announces a meeting with representatives of the vessel operator and the salvor to draw up a list of conditions that need to be met for allocation of a port or place of refuge. This list is to be passed on to France. SOSREP also agrees to act as coordinator between the salvor and coastal States. Circulation of the periodic sitreps<sup>155</sup> is to be extended to include all the coastal States involved.

The salvor wishes to continue negotiating directly with ports and maintain a dialogue with the coastal States of Great Britain, France, Belgium, the Netherlands, Ireland, and Spain.

SOSREP notes after the conference:

- Ø the agreement on a final port of refuge between salvor, charterer and owner is urgently needed;
- Ø the longer the stricken vessel remains on the open sea, the greater the risks will be to ship and environment;
- Ø even if a final port of refuge is found, the need to first allocate a place of refuge in sheltered waters where inspections can be carried out and preparations made for the stricken vessel to put into a port, as well as a safe passage there, continues, and
- Ø due to the formal request by the salvor, Great Britain is obliged to proceed in accordance with IMO and EU legislation, and in the event of a refusal to demonstrate that all options were examined and the risks and hazards of a refusal as compared to those of granting a port or place of refuge were weighed up beforehand.

Accordingly, SOSREP formally requests the MCA to initiate the PoR procedures as defined by IMO Resolution A.949(23) and Directive 2009/17/EC.

With the exception of Portland Port and Weymouth Harbour, the area between Avonmouth and Southampton is the defined catchment area. A suitable anchorage should be sought that enables an inspection of the MSC FLAMINIA and preparations for the onward voyage to the final port of refuge favoured by the vessel operator and/or underwriter. To that extent, SOSREP issues instructions that the British authorities, environmental groups, and port authorities should carry out an objective analysis of all potential places of refuge, and weigh up the advantages and disadvantages having due regard to the alternatives listed in the 'Guidelines on Places of Refuge for Ships in Need of Assistance' in Guideline 2.2 of IMO Resolution A.949(23). All findings should be documented and submitted to SOSREP in written form. As the authority responsible for the purposes of Directive 2009/17/EC, SOSREP will then decide on granting a place of refuge, in conjunction with other conditions if necessary.

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<sup>155</sup> Sitrep = **S**ituation **r**eport.

02/08

Position of the stricken vessel: 46°27.6'N 012°34.9'W (2400)

The tug and tow is located 240 nm northwest of the Spanish coast.

The salvor contacts the Portuguese port of Setubal and also submits a formal PoR request to Spain with the objective of heading for the port of Gijón.

At 1504, the MCA provides SOSREP with the copy of an email from the Netherlands, which indicates that Belgium and the Netherlands have liaised and come to the following conclusions:

- Ø both States press for a rapid solution;
- Ø entry into the Scheldt (heading for Antwerp) is prohibited;
- Ø entry into Zeebrugge is not allowed;
- Ø provided her hull is intact, the stricken vessel should be towed to Rotterdam after the fire is extinguished, and
- Ø Belgium and the Netherlands are relying on the cooperation of Great Britain and France in respect of the passage through their territorial waters.

At 1818, the central maritime authority in Portugal<sup>156</sup> (hereinafter 'Portugal') receives informal notification that the shipowner<sup>157</sup> has made contact with the port of Sines, whereupon Portugal contacts EMSA to obtain more detailed information about the stricken vessel. EMSA replies shortly afterwards, provides certain information and otherwise refers to SOSREP, since he is monitoring the situation.

At 2118, SOSREP expresses his concern to the SCR that 19 days after the accident and six days after being formally requested (27/07) to submit it in the first crisis meeting in Southampton, the salvor has still not submitted the salvage plan.

At 2250, the SCR notifies SOSREP that the hydrostatic and structural calculations are being worked on and should be sent to GL via the vessel operator tomorrow for the purpose of verification. Outcome of the calculations is that the strength and stability of the stricken vessel are more than sufficient. The reported objective is to confirm the calculations by means of an inspection on board. However, this is reportedly opposed by the weather at present.

03/08

Position of the stricken vessel: 46°06.3'N 012°34.9'W (2400)

The stricken vessel was towed in a southerly direction over the past few days and is now at a waiting position some 350 nm away from the British coast.

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<sup>156</sup> Note: The English language document provided to the BSU by the Portuguese maritime administration uses the title 'National Authority'.

<sup>157</sup> Note: It later transpires that it was not the shipowner but the charterer (MSC) that made contact.

Due to the weather conditions, the salvage team has been unable to carry out additional inspections/work on board since 30/07.

Apart from cooling from time to time, no additional salvage work is currently taking place. The stricken vessel is listing at about 10°.

Surveillance flights made by British and French aircraft confirm that the hull is intact and no pollution is escaping from the stricken vessel.

The salvor asks whether the stricken vessel may re-enter the British EEZ. SOSREP and the MCA have no objection to the stricken vessel re-approaching the coast to a distance of 150 nm. The salvor is required to communicate any significant changes.

SOSREP stresses that at no time did Great Britain order a departure from the EEZ and it was the salvor alone that decided to set course for Spain.

In his statement pertaining to the draft of the investigation report the salvor puts emphasis on the following factors:

*“Due to the weather conditions and no positive response from any Coastal State yet, the vessel set course directed by the wind and swell. As the weather was worsening, the vessel headed perhaps in direction of Spain, but never with the intention to call at a Spanish port. After all, there was no response from any of the Coastal States yet.”*

A meeting between the agent of the salvor with the harbour master, the local port and environmental authorities, and the municipal administration is held in the port of Gijón. The salvor is requested to submit detailed documentation and plans.

At 1025, the salvor submits the TMC strength calculations to SOSREP. Neither the calculations nor the statement of GL is enclosed due to a lack availability. SOSREP forwards the documents to the consulting firm LOC<sup>158</sup> for the purpose of independent scrutiny.

A meeting in Hamburg where the salvor, GL, and the underwriter wish to discuss a statement to the coastal States is planned for 6 August. In the meantime, SOSREP wishes to maintain his line of contact with the salvor, the vessel operator, the representatives of the underwriter and the other coastal States with the aim of resolving the existing problem. Preliminary results should also be delivered by the risk analysis requested by SOSREP from the MCA on 6 August.

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<sup>158</sup> Similar to TMC (see fn. 148 above), LOC (London **O**ffshore **C**onsultants) is an independent engineering and inspection agency that operates globally. Its specialists advise the shipping industry, the offshore industry, underwriters, and government agencies, e.g. after accidents.



In Portugal, the represented agencies of the Technical Commission for the Accommodation of Ships in need of Assistance (CTAND)<sup>159</sup> are informed. Portugal contacts SOSREP.

SOSREP was unaware of the activities vis-à-vis Portugal. SOSREP instructs the MCA to forward all available information to support the partners in Portugal.

At 1534, France (Préfecture Maritime France) sends SOSREP the minimum requirements for permitting the stricken vessel to pass through the English Channel:

- Ø precise voyage plan from the salvor;
- Ø GL's analysis of the condition of the ship, and
- Ø establishment of the port of destination.

EMSA provides the second extensive risk analysis of the dangerous cargo on board the MSC FLAMINIA prepared by MAR-ICE.

SOSREP receives a preliminary salvage plan. This does not differentiate sufficiently between the stabilising measures<sup>160</sup> at sea (so-called 'phase 1') and the unloading activities in the subsequent port of refuge/destination (so-called 'phase 2'). The salvor is contacted in this regard and replies that it is unable to provide any additional information until the port of destination is known.

At 2049, the salvor informs SOSREP that Rotterdam and Gijón are currently the most realistic options in terms of the port of destination.

Here, SOSREP notes: If that is the case (or the decision-making process of the salvor has now reached this point), there is no reason why the salvage plan does not address these options and the work necessary to comply with the respective conditions for entry.

**04/08**

Position of the stricken vessel: 46°46.9'N 012°37.5'E (2400)

The tug and tow is moving in a northeasterly direction. No work can be carried out on board the MSC FLAMINIA due to the weather.

Spain formally refuses to accommodate the stricken vessel in any its ports.<sup>161</sup>

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<sup>159</sup> Cross-authority commission in Portugal whose tasks include carrying out a preliminary risk analysis when a ship is in need of assistance. The Commission is composed of the Portuguese maritime authorities, as well as representatives of the navy, the environment agency, the weather service, and the national atomic energy agency.

<sup>160</sup> See fn. 144 above with regard to the term stabilising measures.

<sup>161</sup> The reasons are not known to the BSU and were not submitted even on request.

Although a formal PoR request has not been made thus far, Portugal receives the salvage plan from the salvor.

05/08

Position of the stricken vessel: 47°33.5'N 010°37.6'W (2400)

The weather conditions do not permit any further work on board the stricken vessel.

The Portuguese port of Sines receives an email from the charterer (MSC) with the following content:

*“Dear Mr D. good day,  
As per phone conversation I confirm that we<sup>162</sup> intend to tow the vessel to Sines to discharge the sound containers to further t/ship them to their final destination, therefore we ask permission to enter the National/Territorial waters and the port of Sines. We have been in contact with SMIT salvage and during the sea passage they will try to reduce the trim and the list in order to have a draft of max 16 mtrs, if this cannot be done during the sea passage we could eventually try to organize the same at the anchorage area. Once proceeding southerly and the weather improves SMIT might board the vessel and perform the above operations and further assess the condition of the vessel and cargo and keep all informed. The moment we start to tow the vessel to south it will be necessary between 5 and 7 days to arrive Sines. Let me know if anything is need from our side.  
Best Regards,  
Capt. X. X.  
Head of Operations MSC  
MSC Mediterranean Shipping Company SA”*

The port forwards the email which the salvor only became aware of due to his own statement indirectly by third parties at the following day, to the central Portuguese maritime authority<sup>163</sup>, which in turn informs SOSREP, who is surprised by this development.

Portugal notifies the salvor that under national legislation a formal PoR<sup>164</sup> request must be addressed directly to the national Portuguese coastal sea traffic control centre CCTMC<sup>165</sup> by the master of the ship on the basis of the maritime assistance service (MAS)<sup>166</sup>.

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<sup>162</sup> Note by the BSU: It remains unclear who "we" actually refers to.

<sup>163</sup> See fn. 156.

<sup>164</sup> In addition to the master (and referring to unspecified IMO resolutions), the salvor is correctly (see Guideline 2.4 of the Guidelines on Places of Refuge for Ships in Need of Assistance) named an admissible PoR applicant in a letter to MSC on the following day.

<sup>165</sup> CCTMC = Centro de Controlo de Tráfego Marítimo do Continente: VTS for nationwide monitoring of the entire Portuguese coast. Established in 2008. (In addition to the CCTMC, five regional port VTSs exist for monitoring traffic to, from, and in the respective ports.)

<sup>166</sup> Note: The strong recommendation applicable to all coastal States to provide a maritime assistance service (MAS) and the associated rules are taken from the identically named IMO Resolution A.950(23) of 5 December 2003. For details on the MAS, see comments below in Chapter D 2.2.2.

06/08

Position of the stricken vessel: 47°42.7'N 009°32.6'W (2400)

The tug and tow is situated some 250 nm northwest of the coast of Spain.

Salvage work and measurements by the chemist are performed on board the stricken vessel for about eight hours. Previously inaccessible areas of the ship are inspected to obtain a better starting point for the required stability calculations.

The request to put into Sines – made by the charterer (MSC) – is received by the Portuguese maritime administration early in the morning.

Portugal forwards this information to CTAND, EMSA, and SOSREP. The latter is requested to provide the results of the British environmental risk analysis and any other relevant documents.

SOSREP asks the salvor to confirm that MSC sought permission from the port of Sines in Portugal to enter. The salvor makes clear that this is something MSC is aiming for but that a formal PoR request has reportedly not been made. The salvor has reportedly demonstrated its continued intention to proceed to Zeebrugge or Rotterdam by altering course back in a northerly direction<sup>167</sup>.

In the afternoon, Portugal receives information about the current state of play vis-à-vis the stricken vessel and the ongoing activities in connection with the search for a port or place of refuge from SOSREP.

At 1759, Portugal essentially notifies the head of operations at MSC that in view of the outstanding PoR requests made to different States, a detailed review of the matter by Portugal would reportedly only be expedient when the other States called upon have rejected the PoR request.<sup>168</sup> Moreover, MSC is again reminded (citing unspecified IMO resolutions) that the PoR request must be made directly by the master or the salvor.

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<sup>167</sup> Note: In his statement pertaining to the draft of the investigation report the salvor emphasizes that the courses of tug and tow were not determined by intentions but instead by the weather. Therefore the aforementioned questionable conclusion might be only an interpretation of SOSREP.

<sup>168</sup> To that extent, the corresponding statement of Portugal in the questionable reply to MSC is somewhat contradictory. While a possible refusal by 'the' other – i.e. presumably all other States – is raised at first, the next sentence reads that the request would be considered when 'one' other State had refused it.

Belgium (secretariat of the coastguard) confirms receipt of the PoR request and the salvage plan to the salvor. More information about the intended voyage through Belgian waters is requested. Apart from that, they are waiting for the promised report by GL.

The salvor informs the harbour master at the port of Rotterdam about the negotiations with authorities from the various coastal States and the options for a port of refuge in the area of the European coastline being discussed.

**07/08**

Position of the stricken vessel: 47°53.9'N 009°00.2'W (2400)

The tug and tow is situated some 175 nm west of Brittany.

Representatives of GL, the salvor, the vessel operator, and TMC discuss the current condition of the stricken vessel based on the information provided from on board.

Portugal informs SOSREP and EMSA of its response to MSC on the previous day.

The salvor confirms it has received a copy of Portugal's reply to MSC and submits a formal PoR request in respect of the port of Sines in spite of the reticent position of Portugal expressed therein.

The port and terminal operators and representatives of the salvor and the charterer hold a meeting in Zeebrugge. Representatives of the Belgian coastguard do not take part in the conversation.

The port of Rotterdam notifies the salvor that accommodation of the MSC FLAMINIA is reportedly possible on condition of the "integrity of the hull" and "accessibility of a dock". Moreover, liability would have to be agreed beforehand.

At the initiative of the higher-level Federal Ministry of Transport, Building and Urban Development (BMVBS)<sup>169</sup>, the German flag State administration (Ship Safety Division (BG Verkehr)) asks the MCA if it is proceeding in accordance with Directive 2009/17/EC. This is confirmed by the MCA.

SOSREP and the Directorate Mobility and Transport of the European Commission hold a conversation in the afternoon. SOSREP agrees to keep the Commission informed.

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<sup>169</sup> Note: The designation of the Ministry was changed from BMVBS into BMVI (Federal Ministry of Transport and Digital Infrastructure) by organizational directive of the chancellor dated 17.12.2013, with effect from 21.12.2013. The designation BMVBS has been retained in this report, since this was the relevant designation at the time of the accident.

In preparation for the multilateral teleconference planned for the next day, SOSREP then contacts the salvor by email and draws up the following key topics for the forthcoming conference:

- Ø a clear statement is needed regarding the planned port of destination, its conditions of entry, and more detail as to how and with what equipment these requirements are to be met in phase 1 of the salvage plan (i.e. at sea). That MSC has made contact with ports from other coastal States regarding the granting of a PoR directly is considered unhelpful and causes additional work;
- Ø confirmation of the schedule for the necessary (preliminary) work is needed. The salvage plan is based on a period of five to ten days. France seeks confirmation that the work will not actually last for months;
- Ø in addition, written confirmation of the condition of the ship is needed from GL, and
- Ø SOSREP indicates that the financial sureties and/or guarantees need to be increased.

08/08

Position of the stricken vessel: 46°07'N 009°47'W (2400)

The tug and tow moves on northeasterly courses to a waiting position about 150 nm southwest of the British coast. Extinguishing work, inspections and measurements are taking place on board the MSC FLAMINIA.

At 0754, SOSREP asks the salvor about the results of the internal discussions with GL and the underwriter. He also asks about the current state of play regarding the choice of a (final) port of refuge.

In response to the enquiry, the salvor promises completion of the calculations of GL on the same day and intends to prepare a statement for the coastal States. The ports of Zeebrugge and Rotterdam are being (preferentially) considered as ports of refuge.

GL starts the periodic update of its calculations based on the ongoing reports on the condition of the stricken vessel by the salvor.

Portugal informs SOSREP and EMSA about the salvor's PoR request of the previous day.

The third multilateral crisis meeting takes place at the MCA HQ in Southampton. In addition to SOSREP and the MCA, participants comprise representatives of the French coastguard, the German flag State administration (Ship Safety Division (BG Verkehr)), and the harbour master of the port of Rotterdam. Representatives of the salvor, the vessel operator, GL, the underwriter, and TMC put forward the interests of the stricken vessel.

The salvor begins by giving the participants of the meeting detailed information about the continuing complicated situation on board the stricken vessel, which is compounded further by the difficult weather conditions, inter alia. The salvor then reports on its meetings with the harbour master at Rotterdam and the Dutch

coastguard concerning the conditions of entry, as well as the open discussion with the port of Zeebrugge.

SOSREP asks whether the conditions for Rotterdam or Zeebrugge can be met with reasonable effort. The salvor replies that an inspection team (including a chemist) should go on board at a sheltered anchor position, preferably in French waters, before answering this question conclusively. SOSREP stresses that the most appropriate position for the ship in respect of health hazards and environmental aspects must be found, regardless of economic factors.

Inter alia, France stresses the need for extensive knowledge about the condition of the stricken vessel, as well as the risks posed by the dangerous cargo on board, and asks for a guaranteed time frame estimated by the salvor for the work to be carried out during phase 1 (i.e. at sea before heading for a port).

In this respect, the salvor assumes the period would be five to ten days and points out that the required inspection must be based on the specific requirements of the intended port of refuge. The salvor assumes that the means of transport necessary for transferring an inspection team (helicopter or tug) could be available between the middle and end of next week.

SOSREP asks whether France would be prepared to participate in a joint inspection. France will only answer this question on the basis of the GL calculations still outstanding.

The harbour master of the port of Rotterdam stresses that it is necessary to include the Dutch authorities in the decision-making process and points out that an inspection cannot take place only just before reaching the port of Rotterdam. On this point, SOSREP notes that it is unclear whether there have already been formal discussions with the Dutch authorities. The salvor replies that there has been contact between the port of Rotterdam and the Dutch government.

France and SOSREP indicate the difficulties involved in allowing the ship to anchor in English or French waters if a Dutch team does not grant permission to proceed to Rotterdam afterwards.

The salvor and the harbour master of Rotterdam are therefore requested to submit a basic understanding that Rotterdam will accept the ship if the conditions are met.

SOSREP asks for details of the conditions of entry for Rotterdam or Zeebrugge. Among other things, the salvor stresses the need to have extinguished the fire on board the stricken vessel before entering and with regard to Zeebrugge, the local 16-metre draught limitation.

The participants agree that the salvor and ports (continue to) discuss the specific conditions of entry and make proposals regarding the performance of an inspection to control compliance with the conditions.

The salvor proposes that the next crisis meeting should take place when there is news regarding the port of destination and in relation to the issues to be clarified for approaching it.

Finally, GL agrees to send the results of its modelling and other available information to SOSREP and France.

Towards the end of the afternoon, SOSREP summarises the current state of play in Sitrep 3 and announces that he is expecting the result of the MCA assessment for the purposes of IMO Resolution A.949(23) and Directive 2009/17/EC within 24 hours. The need for the salvor to state its future planning without further delay is stressed, in particular in relation to the port of destination. Great Britain and France expect the results of the negotiations between the salvor, Belgium, and the Netherlands or their ports of Zeebrugge and Rotterdam, as the case may be. Only after that would it be possible to decide on the request regarding a (temporary) place of refuge off the coast of Britain or France.

**09/08**

Position of the stricken vessel: no entry in the salvor's daily report

The tug and tow continues to steer on a northeasterly course. Extinguishing work is taking place on board the MSC FLAMINIA. Recirculating extinguishing water in the hatches and ballast water has made it possible to reduce the MSC FLAMINIA's list to 7.5°.

Representatives of the salvor and the terminal operators under consideration for a berth meet in Rotterdam.

Due to the drawn-out search for a port or place of refuge, the vessel operator turns to the BMVBS and requests flag State support.

EMSA provides the third extensive risk analysis of the dangerous cargo on board the MSC FLAMINIA prepared by MAR-ICE. It focuses on the environmental risk posed by the dangerous cargo on board.

Portugal replies to the PoR request made by the salvor on 07/08 and repeats the (reticent) position it forwarded to MSC. In its response, the salvor accepts the position of Portugal and promises that it will keep the administration there updated on the situation as things develop.

At 1337, the SCR (at the scene) notifies SOSREP by telephone of a dangerous situation on board the stricken vessel caused by a rise in temperature to 250°C in the area of the two containers filled with highly explosive nitromethane. Appropriate fire-fighting is currently taking place with the aim of reducing the temperature. The approach up to the agreed distance from the British coastline has been stopped for the time being.

In his statement pertaining to the draft of the investigation report the salvor notes the following:  
*"There is only one SCR, which was ashore. The SCR was never on board. Salvors were not aware of this communication. No temperature rise to 250° is recorded in the Daily Progress Report for this day."*

The MSC FLAMINIA's vessel operator has issued a press release with summary information about the current condition of the stricken vessel and is trying to raise public awareness of the problem of the outstanding allocation of a port of refuge by the European coastal States. There is reportedly astonishment that in the given situation European countries would refuse entry to a German ship. The ongoing activities of the salvor, its contacts with the coastal States, specific details of the dialogue, and, in particular, the present and very dangerous deterioration of the situation on board in terms of the explosive nitromethane cargo are not addressed in the press release.

The MCA sends the result of the PoR risk analysis to SOSREP in the afternoon, in which it identifies a list of potential anchorages but not a potential port.

**10/08**

Position of the stricken vessel: no information – salvor's daily report is not on hand

Belgium (represented by the governor of West Flanders) refuses entry into the port of Zeebrugge.

At 0729, SOSREP receives the calculations of GL (as of 9 August).<sup>170</sup>

The salvor meets with other terminal operators in Rotterdam.

The BMVBS notifies the vessel operator that it would receive any flag State support necessary. Here, the report (casualty modelling) of GL is supposedly important. The vessel operator is requested to submit the decisions taken in consultation with the salvor to the Ship Safety Division (BG Verkehr).

**11/08**

Position of the stricken vessel: 48°25.2'N 010°46.5'W (2400)

The tug and tow is moving on northwesterly courses. Extinguishing work, ballast operations, inspections, and measurements are being carried on board the stricken vessel. The ship is still listing at about 2.5°.

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<sup>170</sup> The time since the accident and the request for data by SOSREP is 27 and 14 days respectively.



12/08

Position of the stricken vessel: 49°07.5'N 011°26.6'W (2400)

The tug and tow is still moving on northwesterly courses. Various salvage work is being carried out on board. The salvage team confirms that the nitromethane containers are not damaged. The work on board is suspended in the afternoon because of deteriorating weather.

Referring to the refusal of Belgium, SOSREP contacts the salvor by email at 1147 and asks whether all efforts are now directed towards complying with the conditions for entering Rotterdam or whether alternative ports are (also) sought. SOSREP also requests – in the event that Rotterdam is preferred – written confirmation that the port of Rotterdam is prepared to accommodate the stricken vessel in principle and that the Dutch authorities will accept the stricken vessel in its territorial waters<sup>171</sup>. The salvor is reminded in the email that France and Great Britain require the following documents before deciding on a (temporary) place of refuge off their coastline:

- Ø written confirmation of the port of destination and its conditions of entry;
- Ø written confirmation by the salvor that the conditions of entry will be met and the schedule for this;
- Ø updated salvage plan with detailed information on how the conditions of entry will be complied with, especially with respect to unloading and ballast operations, the number of required barges and vessels, as well as action to prevent oil pollution, and
- Ø written confirmation by the classification society.

Finally, referring to health hazards due to air pollution caused by smoke and gases, SOSREP requests the results of the chemical analysis by the chemist on scene and detailed information regarding possible safety distances to be observed. SOSREP indicates to the salvor that a clearer understanding regarding the salvor's proposed safety distance around the stricken vessel is initially required for each coastal State prior to the location of a port or place of refuge. It must reportedly be possible to assure the general public that the stricken vessel does not pose any threats.

13/08

Position of the stricken vessel: 49°50.1'N 013°26.7'W (2400)

The stricken vessel is towed in a northwesterly direction. No work can be carried out on board the MSC FLAMINIA due to the weather.

The salvor reports to the French authorities that the stability and draught of the stricken vessel are reportedly sufficiently restored so that (in this respect?)<sup>172</sup> there is

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<sup>171</sup> Note: In his statement pertaining to the draft of the investigation report the salvor additionally advised the BSU of the fact that an approval of the port of Rotterdam on 10.08. was reportedly subject to the availability and confirmation of a berth. Prior to the meeting with the Port Authorities on 13.08. discussions took place with all terminals.

<sup>172</sup> Wording in brackets: Attempt at interpretation by the BSU.

no longer any need to seek a (temporary) place of refuge at sea prior to entering a port of refuge.<sup>173</sup>

SOSREP receives the confirmation of Belgium's refusal and that efforts are focusing on the port of Rotterdam requested from the salvor on the previous day.

The salvor meets with representatives of the port and the Dutch authorities in Rotterdam to discuss the conditions for granting the berth there and their implementation thus far.

In the afternoon, SOSREP contacts the salvage master<sup>174</sup> directly to discuss the current situation on scene and the other plans. The salvage master advises that every effort is being made to minimise or stop the fire and smoke on the stricken vessel before she transits to a temporary place of refuge. Depending on weather, the estimated period for fighting the fire is approximately ten days. The salvor seeks approval to head for a position some 30 nm southwest of the British coast to transport ventilation units from the tugs to the stricken vessel next week.

After consulting with the MCA, SOSREP approves this plan and wishes to use this as an opportunity to send an inspection team to the stricken vessel at the same time.

**14/08**

Position of the stricken vessel: 50°07.8'N 015°02.7'W (2400)

The tug and tow is situated some 170 nm southwest of the coast of Ireland. It is only possible to work on board for a few hours because of the weather conditions.

The salvor makes contact with the Dutch port of Vlissingen, as well as the soon-to-be-opened new German deep-water harbour at Wilhelmshaven.

The vessel operator notifies the BMVBS that due to the existing salvage contract (LOF), it is not in a position to appoint a port of destination arbitrarily. Only the salvor could do this. Sources of fire that cannot be extinguished at sea have deterred coastal States from issuing entry or transit permits in the past. Therefore, the vessel operator asks for the support of the German government vis-à-vis the other States.

In his situation report (Sitrep 4), SOSREP makes clear that for the further course of action of the coastal States, it is absolutely necessary for the salvor to give notification of its plans for the future without further delay, in particular with regard to the port of destination.

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<sup>173</sup> Note: The only source for this assertion is the statement submitted by the French authorities at the request of the BSU.

<sup>174</sup> Salvage master: Commander of the operational salvage work on scene.

15/08

Position of the stricken vessel: 50°13.0'N 017°45.5'W (2400)

No work can be carried out on board the stricken vessel due to the weather.

The salvor makes contact with the port of Amsterdam. Amsterdam refuses entry on the grounds of population density.

The vessel operator sends the GL report to the BMVBS. The report indicates that the ship should be urgently towed into calm waters or a port of refuge.

In a telephone conversation between the BMVBS and vessel operator, a representative of the ministry states that basically, Germany wishes to provide assistance and would be prepared to provide a place of refuge if the other alternatives fail.

At 1114 UTC, the Ship Safety Division (BG Verkehr) directs the following message to SOSREP:

*"In our opinion, and based on the statement of GL that the ship can be towed safely, there should be no further delay in towing the ship into sheltered waters in the vicinity of Rotterdam.*

*It is more efficient to conduct the fire-fighting operation, pump out dangerous liquids, and unload dangerous cargo in such waters, i.e. at a (temporary) place of refuge. Moreover, we would like to draw attention to Articles 20, 20a and 20b of Directive 2009/17/EC again.*

*As recommended by our ministry, Germany would permit the ship to enter its territorial waters in the event that other EU governments do not grant permission to enter. In this case, Germany expects France, Belgium, and the Netherlands to permit safe passage through the English Channel towards a port or place of refuge in German territorial waters."*

SOSREP and the Ship Safety Division (BG Verkehr) then agree by telephone that Germany will contact the Netherlands and Belgium with regard to its proposals and SOSREP will inform France.

SOSREP appoints two independent experts with extensive international experience in the fields of salvage and fire-fighting. Both should form part of the British inspection team and report to SOSREP. France should be invited to appoint a third expert.

The salvor assumes that it will have the stricken vessel in position for the inspection on 23 or 24 August.

In his situation report (Sitrep 5) at 2200, SOSREP gives information about Germany's intervention. France wishes to examine it and provide feedback on the following day. Referring to IMO Resolution A.949(23), SOSREP also advises that preparations are currently being made to deploy an inspection team to verify the information of the salvor.

Finally, SOSREP refers to a statement by GL confirming the (current) safety of the stricken vessel but making clear that the remaining safety reserve has reportedly decreased. GL therefore recommends that there should be no further delay in towing the stricken vessel to a sheltered area.

**16/08**

Position of the stricken vessel: 49°33.7'N 019°04.3'W (2400)

The towed convoy is moving in a northwesterly direction. Once again, no work can be carried out on board the stricken vessel due to the weather.

The European Commission notifies Belgium, France, and the Netherlands that Germany will accommodate the MSC FLAMINIA if the other coastal States issue a transit permit. This should be clarified among the States.

In Rotterdam, preparations to accommodate the ship are discontinued after Germany stated its willingness to accommodate the stricken vessel.

The European Commission asks France, Belgium, and the Netherlands how long it could take each country to issue a transit permit now that Germany has declared its willingness to accommodate the stricken vessel.

At 1635 UTC, the salvor directs a PoR request to the BMVBS by email.

**17/08**

Position of the stricken vessel: 48°45.3'N 020°00.3'W (2400)

The MSC FLAMINIA is currently 300 to 400 nm away from the British coast. No salvage work can be carried out on board the stricken vessel due to the weather. The air on board is very contaminated by smoke and gases escaping from the damaged cargo. Fire-fighting is subject to limitations due to the amount of water in the ship, the risk of a renewed increase in the list, and strength factors.

A meeting involving the salvor with regard to the port of Vlissingen as a possible port of refuge is taking place in Terneuzen in the Netherlands. Zeebrugge is also being discussed as a possible port of refuge again.

In the course of a teleconference with the German authorities, the salvor and vessel operator discuss the possible granting of a place of refuge and submit a formal PoR request to Germany. Germany indicates the prospect of permission to enter. A meeting is set for 20 August in Cuxhaven.

In his situation report (Sitrep 6) at 1700, SOSREP summarises the current state of play and in this respect refers to the planned inspection of the stricken vessel off the British coast on 22 August and the intervention of Germany vis-à-vis accommodating the stricken vessel, in particular. Moreover, the situation report advises that Germany has requested the relevant coastal States (France, Belgium, and the Netherlands) to

permit passage through the English Channel in accordance with Directive 2009/17/EC. This is reportedly based on the report by GL and that of the salvor stating that the stricken vessel could be towed safely.

The results of the planned inspection on 22 August should be exchanged between the States involved to assist in their decision. SOSREP agrees to continue to act as coordinator.

**18/08**

Position of the stricken vessel: 48°14.8'N 020°12.3'W (2400)

Following the authorisation by SOSREP, the towed convoy begins to move towards the position about 30 nm off the British coast for the planned inspection.

The salvor submits to SOSREP the chemical analysis of 17 August 2012 prepared on its behalf by the Dutch consultancy MARSAC, which specialises in chemical assessments in the maritime sector. This includes the following statements:

- Ø there is no evidence to suggest that the stricken vessel's cargo will produce toxic gas clouds;
- Ø the smoke emissions from various fire sources in cargo hold 7 contain no significant toxic elements;
- Ø apart from the usual odour produced by fire, there is no threat of significant uncontrolled toxic vapours after the remaining fire sources are extinguished;
- Ø due to the ongoing chemical reactions, toxic vapours are (still) forming in the cargo holds affected by the fire; however, they largely remain in the lower lying areas of the cargo holds;
- Ø weather permitting, gas tests are carried out regularly inside or in the vicinity of the affected cargo holds in respect of various chemical compounds;
- Ø to improve air quality in the cargo holds affected, the salvor is making preparations for their extensive ventilation using technical means, and
- Ø during the ventilation (replacement of the contaminated atmosphere in the deeper areas of the cargo holds with ambient air), an area of about 400 metres around the stricken vessel in which navigation is prohibited is recommended.

SOSREP continues to insist on sampling but assumes that – unless there is a significant deterioration on board in respect of fire/explosion hazard – the risks to people are evidently limited to the area of the cargo holds and the stricken vessel as a whole.

Based on current developments, the internal hazard level of SOSREP for the allocation of a place of refuge is set to 'moderate/yellow'.

19/08

Position of the stricken vessel: 48°24.7'N 016°57.5'W (2400)

The towed convoy remains on course for Land's End. No work can be carried out on board due to the weather.

20/08

Position of the stricken vessel: 48°22.8'N 015°03.3'W (2400)

The tow is en route to Land's End. Various salvage work is being carried out on board.

Germany's CCME notifies GL of the further course of action after Germany agreed to accommodate the ship. The CCME appoints GL as technical expert.

At a meeting in Cuxhaven, the CCME requests the vessel operator and the salvor to submit a memorandum of understanding for the approach into German territorial waters. Upon instruction of the HK all meetings with German or foreign ports should be discontinued. Following that, the salvor cancels a scheduled meeting in Wilhelmshaven.

The BMVBS formally instructs the CCME to plan the MSC FLAMINIA's return to Germany.

France requests a formal German statement on the provision of a place of refuge. They would reportedly then be prepared to issue the salvor a transit permit.

A teleconference coordinated by SOSREP takes place at 1300. In addition to SOSREP and the MCA, participants include representatives of France, Belgium, the Netherlands, and Germany. Representatives of the vessel operator, the underwriter, the salvor, and TMC put forward the interests of the stricken vessel. In addition to a general exchange and confirmation of the current state of play, the conference facilitates discussing the necessary planning for the MSC FLAMINIA's forthcoming passage to Germany.

In this respect, SOSREP suggests that the salvor draw up a passage plan that provides information on the environmental safeguards, in particular. Belgium and the Netherlands have started to draw up their conditions of transit. Belgium indicates that the conditions could change depending on the outcome of the forthcoming inspection. The Netherlands and France stress that a prerequisite for a transit permit is that Germany actually accommodates the stricken vessel.

Furthermore, the organisational details of the forthcoming inspection by the team of English and French experts are discussed.

SOSREP agrees to continue to coordinate the salvage work but is of the opinion that from a certain period after adoption of the salvage plan it would be expedient to transfer this task to Germany.

It is agreed that the parties to the 'Bonn Agreement'<sup>175</sup> should communicate with regard to the air surveillance of the stricken vessel during the passage to Germany. In reply to a question as to whether Rotterdam is still under consideration as a possible final port of refuge, the salvor said: "The door is open"<sup>176</sup>.

**21/08**

Position of the stricken vessel: 48°51.1'N 012°13.8'W (2400)

The towed convoy is situated approximately 350 nm off the entrance to the English Channel and remains on course for Land's End. The draught of the stricken vessel is 16.7 m at a list of 2.5°.

At 1107, the salvor informs SOSREP that reportedly the inspection date initially set for 23 or 24 August cannot be kept due to the weather and that 27 August is now proposed.

SOSREP discusses this request in the course of the day in a teleconference with the salvor and the MCA. The salvor's justification for a further delay is not convincing and the request therefore rejected.

Germany asks SOSREP if it may participate in the forthcoming inspection.

The situation report (Sitrep 8) by SOSREP advises that Germany reportedly confirmed today that the final port of refuge will be located in German waters.

**22/08**

Position of the stricken vessel: 49°13.1'N 009°03.1'W (2400)

The MSC FLAMINIA remains on course for Land's End.

GL delivers a presentation of the technical assessment of the stricken vessel's condition at the CCME. Representatives of the salvor and the vessel operator also participate in the meeting.

France issues approval for the passage of the towed convoy en route to Germany by way of a diplomatic note verbale subject to conditions.

Germany informs all parties to the Bonn Agreement on the granting of a port or place of refuge in German territorial waters<sup>177</sup>.

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<sup>175</sup> Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, Bonn, 13 September 1983 (signatories are the North Sea coastal States of north and west Europe and the European Union).

<sup>176</sup> Note: In his statement pertaining to the draft of the investigation report the salvor refers to the fact that in addition to Rotterdam Vlissingen was reportedly also a possible option and was taken into consideration. Contacts to other ports were reportedly maintained since the salvor was said to have never received a written confirmation for the ship to be granted a place of refuge in a German port.

<sup>177</sup> In his statement pertaining to the draft of the investigation report the salvor notes that he did not receive a written confirmation from the German authorities, but was instead only informed orally during the meeting with SOSREP.

SOSREP accepts the French offer to provide logistical support for the inspection with the ship ARGONAUTE.

**23/08**

Position of the stricken vessel: 49°26.2'N 006°53.1'W (2400)

The towed convoy is situated approximately 100 nm off the British coast and is en route to Land's End. Extinguishing work at the remaining sources of fire is carried out on board the stricken vessel.

The ARGONAUTE, the French ship intended for the transfer of the inspection team, arrives at Falmouth.

The team of inspectors meets with the MCA and SOSREP to discuss the forthcoming inspection.

Elevated temperatures are found in cargo hold 3 of the MSC FLAMINIA during a German air surveillance flight (which also flew the German team of experts to Falmouth). The CCME consults various experts in the ensuing period and as a result of these discussions does not rule out a rise in temperature sufficient to cause a risk of the two containers carrying nitromethane that are stowed in the cargo hold exploding.

In its statement pertaining to the draft of the investigation report the salvor made the following remarks:

*According to reports it was difficult to transform the recordings made by the Havariekommando during an overflight into actual thermal images. The infrared images could not be taken from actual temperatures. Dark containers heated up in the sun seemed also white and therefore had a high surface temperature. Temperatures from the internal area of the cargo holds could not be derived from this.*

**24/08**

The stricken vessel is situated some 40 nm off the British coast.

Safe transfer of the inspection team to the MSC FLAMINIA is not possible on the next two days due to high swell at the originally intended position. At 1445, SOSREP grants the stricken vessel permission to move closer to the British coast (up to about 8 nm) on condition that no activities are permitted on board the ship apart from the inspection, she does not anchor, no ballast operations are carried out, and the stricken vessel moves back to her original position by August 26 at the latest.

At 1522, the CCME informs SOSREP that the German participants of the inspection teams are not allowed to board the stricken vessel due to high temperatures in cargo hold 3 in conjunction with the highly explosive nitromethane stored there. Cargo hold 3 must reportedly first be flooded up to 50 cm above the tenth container tier.



At 1556, SOSREP shares information with the lead inspector on board the ARGONAUTE. The inspection scheduled for 25 August is postponed until more information relating to Germany's concerns is available. The safety of all team members has absolute priority.

At 1653, SOSREP informs the salvor that the inspection will not take place for the time being and the stricken vessel should remain at a position 30 nm off Land's End. The inspection team remains on standby for immediate deployment.

At 1742, the CCME informs SOSREP that the provisional withdrawal of the German participants of the team of inspectors was reportedly the result of a discussion between the CCME and the navigational director of the MSC FLAMINIA's vessel operator that morning. During the conversation, they reportedly agreed that flooding the cargo hold would be the easiest and fastest way to minimise the risk posed by the nitromethane.

At 1800, SOSREP discusses the proposal of the CCME with the salvor. The salvor has made no preparations to flood the cargo hold and draws attention to the absence of a release from liability from the vessel operator and/or the cargo interests, in particular with regard to the cargo in the cargo hold to be sacrificed. The salvor also reminds that flooding the cargo hold would increase the draught of the stricken vessel. The options for a port of refuge would be complicated further if Germany decides not to accommodate the MSC FLAMINIA after all. In particular, the ports of Vlissingen and Zeebrugge are subject to draught restrictions.

At 2102, SOSREP summarises the developments and previous decisions of the day in an email to the salvor. SOSREP asks whether flooding cargo hold 3 is now planned, how long it would take, and when the stricken vessel would be ready for inspection afterwards.

At 2131, SOSREP sends the CCME an email requesting submission of the risk analysis relevant to its condition that cargo hold 3 be flooded and the facts underlying this.

At 2259, SOSREP informs all involved agencies on the current state of play in his situation report (Sitrep 10).

**25/08**

The tug and tow remains some 45 nm off the British coast.

At 0721, a representative of the vessel operator informs SOSREP that the vessel operator and the salvor are discussing the flooding operation. The salvor wishes to make its final position contingent on the outcome of the examination by the salvage master, who has been unable to go on board for several days due to the weather conditions. However, the current view of the salvor is reportedly that flooding is unnecessary. Fighting the source of the fire in cargo hold 3 would suffice. However, it has not been possible to work on board for the last few days because of the weather. Moreover, the CCME would not insist on the flooding of cargo hold 3 but regards this only as an option.

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At 0922, SOSREP contacts the CCME by email unaware of the details and/or outcome of the continuing discussions between the CCME and the vessel operator, salvor, and consulted experts. He expressed his confusion about whether the flooding of cargo hold 3 is now a condition of the CCME, or not. SOSREP therefore requests:

- Ø confirmation that the CCME requires that cargo hold 3 be flooded to minimise risk in respect of the nitromethane cargo before a CCME inspector is allowed to enter the stricken vessel;
- Ø confirmation that the MSC FLAMINIA will not be allowed to start her voyage towards Germany without a German inspection, and
- Ø submission of the risk analysis underlying the decision of the CCME.

**26/08**

The stricken vessel remains at the waiting position.

The salvage team carries out extinguishing action on the remaining sources of fire in cargo holds 3 and 7 with the escort tug. Temperature measurements are being performed on board the stricken vessel in the ship's cargo holds. The nitromethane containers are undamaged.

At 1109, the salvor informs SOSREP about the measurement readings and advises, inter alia, that the temperature of the heat source in cargo hold 3 located in close proximity to the nitromethane containers is dropping and has reportedly fallen from 128°C on 23 August<sup>178</sup> to 50°C now. Since the temperatures are dropping everywhere, there is no need to flood cargo hold 3.

At 1654, SOSREP informs the coastal States on the current state of play in his situation report (Sitrep 12).

**27/08**

The position of the stricken vessel is unchanged.

No work can be carried out on board the MSC FLAMINIA due to the weather.

At 1742, SOSREP grants permission for the stricken vessel to approach the British coast (up to 17 nm east of Lizard Point) to facilitate transferring the inspection team to the stricken vessel.

**28/08**

The tug and tow sets course for the agreed position east of Lizard Point.

At 0722, SOSREP discusses the current situation with the leader of the inspection team. The swell does not stand in the way of the inspection team's transfer to the stricken vessel. No smoke can be seen rising from the MSC FLAMINIA.

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<sup>178</sup> Note: The temperature of 128°C in the immediate vicinity of the nitromethane measured on 23 August had not been noted in the salvor's daily situation report of 23 August.

SOSREP receives current temperature readings shortly after. The temperature of the ship does not give rise to concern. SOSREP discusses the readings with France and Germany. All parties are relieved about the possibility of an immediate inspection.

At 1047, SOSREP informs the coastal States and all other parties that the CCME, France, and Great Britain gave their approval for the inspection team to enter the stricken vessel at 1010. This is reportedly on condition that the inspection be immediately aborted without consultation in the event of any safety-related concerns arising. The inspection should take about four to six hours.

At 1100, the inspection team boards the MSC FLAMINIA about 17 nm east of Lizard Point after being transferred to the stricken vessel by the ARGONAUTE.

At 1402, SOSREP receives a call from the lead inspector and is given the following facts, inter alia:

- Ø the inspection is almost finished;
- Ø no unexpected findings have been made;
- Ø cargo hold 3 is neither heated nor damaged;
- Ø the atmosphere in cargo hold 7 is marked by a moderate development of heat, and
- Ø the towing connections are currently being checked.

The stricken vessel is stabilised, the fire under control, trim and draught correspond with the requirements of GL's calculations. The MSC FLAMINIA can be safely towed towards Germany without any additional preparations. Apart from the work pertaining to the towing connection, no further precautions are required before the passage of the stricken vessel towards Germany. Based on this knowledge, SOSREP lowers the hazard level to 'low/green' in respect of the allocation of a place or port of refuge.

At 1500, the coastal States and other parties are informed about the developments of the last few days and hours, notified of the reasons for the delay of the inspection date (weather and concerns of the CCME regarding nitromethane), and discuss the preliminary results of the inspection during a teleconference. These do not represent a cause for concern. Therefore, SOSREP no longer sees the need for a (temporary) berth at sea but finds that the ship requires a suitable port of discharge. The full inspection report should be drawn up as soon as possible and then sent, to Germany in particular, as a basis for deciding on permission to enter.

The salvor should submit a passage plan for approval by the coastal States and will do so in the form of a draft without delay. The salvor refers to a draft already drawn up and the request to the coastal States to communicate their requirements. Reportedly, only France has complied with this hitherto. SOSREP replies that the requirements were already sent to Germany several days ago. The CCME advises that it has not received anything.

Each of the coastal States designate a point of contact for the submission of the passage plan and other documents. The CCME shall notify its position when the passage to Germany can be approved, which is only after all the substance analyses are on hand. SOSREP and France agree that a transit permit will only be open to consideration if the results of the atmosphere analysis are positive.

The inspection on board the MSC FLAMINIA is completed at 1600.

In the evening, the CCME sends a request to the coastal States asking whether their previous rejection of the stricken vessel will be lifted after the positive outcome of the inspection and if there is now greater willingness to accommodate the stricken vessel before a possible passage of the MSC FLAMINIA to Germany.

SOSREP notes internally that Great Britain has not refused to grant a place of refuge thus far. In fact, a number of anchorages were identified and one would have been offered had the inspection team recommended the implementation of other preparations on board before the stricken vessel transited to a final port of refuge. The inspection team confirmed that additional stabilisation is not required. The salvor and GL recommended that the stricken vessel be towed into a port as soon as possible.<sup>179</sup>

**29/08**

Position of the stricken vessel: 49°15'N 005°28'W

The towed convoy has returned to its waiting position about 24 nm south of Lizard Point.

The salvor sends a revised passage plan to the coastal States.

The Dutch maritime administration<sup>180</sup> replies to the CCME's request from the previous day as to whether they would now be prepared to accommodate the stricken vessel by email that Rotterdam Port Authority had imposed conditions on the salvor for granting a place of refuge in Rotterdam. The salvager was said to have not met this conditions for entering Rotterdam thus far and is unlikely to.

At about midday, SOSREP forwards the summary inspection report of 28/08/2012 to the coastal States and involved parties.

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<sup>179</sup> Note: SOSREP sends a corresponding reply to the CCME on 29 August.

<sup>180</sup> Rijswaterstaat.

**30/08**

The stricken vessel has taken up a waiting position about 53 nm south of Lizard Point.

The analysis of a renewed surveillance flight reveals decreased heat sources and no escaping liquids. Preparations are made on board for the passage to the Germany.

France accepts the salvor's passage plan of 29/08.

The CCME repeats the request of 28/08 because replies from France, Belgium, Portugal, and Spain are still outstanding.

Belgium replies to the CCME that its decision will be made on 31/08.

In its reply, France refers to the continued applicability of the transit permit issued on 22/08 by way of a note verbale.

**31/08**

Position of the stricken vessel: 49°33.48'N 005°33.02'W

The preparations of the MSC FLAMINIA for the passage continue.

Portugal replies to the CCME's request of 28/08 by stating it was reportedly surprised by the assertion contained therein that the coastal States have rejected the stricken vessel. The position of Portugal is reportedly still that an examination of the PoR request by the national authorities will only be considered when it is refused by other States.

Belgium answers the CCME correspondence of 28/08 with permission to pass through Belgian waters and refuses entry into Zeebrugge referring to the discrepancy between the draught of the MSC FLAMINIA (16.5 m) and the permissible draught in the port of Zeebrugge (15.5 m).

At 1157, SOSREP releases the final inspection report after the information gathered during the inspection by the multidisciplinary team of experts was discussed and coordinated among one another.

In its capacity as German flag State authority, the Ship Safety Division (BG Verkehr) contacts Great Britain, France, Belgium, and the Netherlands at about midday, stating that the German authorities have decided to start the MSC FLAMINIA's towing operation towards Germany today. Referring to the latest documentation from the classification society of 30 August, which indicates that the MSC FLAMINIA is reportedly ready for a safe towing operation, final confirmation of the transit permit or notification of any new conditions is requested by 1500.

At 1315, Great Britain issues the transit permit.

At 1414, France issues the transit permit.

Ref.: 255/12

At 1529, the Ship Safety Division (BG Verkehr) notifies SOSREP that they have received no objections from the coastal States as regards the stricken vessel's passage to Germany. Consequently, the salvor and the vessel operator should be recommended to start the towing operation at 1700.

At 1530, Belgium issues the transit permit.

At 1649, the Netherlands issues the transit permit.

In the afternoon, the salvor advises SOSREP that it is reportedly in the process of completing the technical preparations for the passage of the stricken vessel. They assume the voyage will begin on 2 September.

#### 01/09

The tug and tow is still in the waiting position at the entrance to the English Channel. The final preparations for the towing operation are being made on board.

The salvor submits the final passage plan.

#### 02/09

At 1215, the MSC FLAMINIA starts her passage to Germany.

#### 03/09 to 09/09

In spite of difficult weather conditions at times, the tow proceeds according to plan, reaches German territorial waters at about 0637 CEST on 08/09, and makes fast at the intended berth, surrounding which is a large cordoned off area, in the soon-to-be-opened container terminal of the new deep-water harbour in Wilhelmshaven at 1812 CEST on 09/09.

#### 10/09 to 14/03/2013

In the course of a complex process in which minor interventions by the fire brigade with participation of a fire fighting crew and experts of the company Falck Nutec and further forces are still necessary to fight localised sources of fire, the stricken vessel is unloaded and cleared of debris from 27/09 onwards.

The sequence of the single steps of unloading were previously calculated and defined by the Emergency Response Service of the GL in order to ensure the firmness of the ship's hull in every intermediate step. Furthermore, some 35,000 tonnes of contaminated extinguishing water are pumped out of the ship and transferred to a specialist company from Denmark for proper disposal.

The competent German state and federal authorities approve the MSC FLAMINIA's departure for the Romanian repair yard in Mangalia after seaworthiness is (provisionally) restored and compliance with various environmental conditions.

#### 15/03/2013

The MSC FLAMINIA starts the voyage to Romania under her own steam.

## 2 ANALYSIS

### 2.1 Preliminary notes

A complete analysis of the factual, technical, and especially the legal grounds for the decision-making processes and results of the search for a place or port of refuge for the MSC FLAMINIA would require a very extensive examination of the complex set of facts, the provisions and recommendations at international level and those at national level in force within the States involved, and, not least, the positions and sensitivities of the coastal States concerned and all the other parties.<sup>181</sup> Added to that would be a thorough assessment of international salvage law, especially the very specific contractual arrangements and questions of liability usual in this respect. This is an absolutely impossible task for the BSU, in particular against the background of providing the general public with an investigation report within 12 months of the accident, amongst other things.<sup>182</sup> Indeed, in individual cases, the possibility to depart from the one-year limit basically exists and the BSU was forced to make use of this because of the very complex investigation into the possible causes of the fire. With regard to further delays in publishing the investigation report for the purpose of a deeper analysis of the search for a port of refuge, it is important to remember that in spite of the great and indisputable importance of the issue, and the understandable interest the general public has in answers to the related questions, dealing with the associated issues can only be a secondary aspect of the BSU's investigation of the very serious marine casualty involving the MSC FLAMINIA.

In accordance with Article 9 SUG, official maritime safety investigations in Germany to implement European and international requirements primarily facilitate determination of the circumstances and causes of a marine casualty, as well as the factors that contributed to one. Consequently, the focus of the investigative work is clearly to review and analyse the events immediately surrounding a *marine casualty* (primary event). Nevertheless, as far as the BSU devotes its efforts to the issue of the search for a port of refuge in the course of its investigation, it does not do this within a legal vacuum, but due to the inseparable factual connection between the primary incident and the hazards and risks to the stricken vessel and especially to the European coastline that at least could have resulted from this in the weeks that followed.

In addition to the legal grounds already discussed, there is another related argument supporting the limited engagement of the BSU with the issue of the search for a port of refuge, which is impossible to separate from the facts. The lessons that can be learned from the accident (here primary event) must be made available to the general public and the shipping industry as soon as possible to prevent such or

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<sup>181</sup> By way of example and to demonstrate the complexity of alone the *legal* foundation for allocating a port of refuge, see the more than 400-page dissertation 'Der Zugang zu Nothäfen und sonstigen Notliegeplätzen für Schiffe in Seenot' (access to ports and other places of refuge for ships in distress at sea) by Inken von Gadow-Stephani from 2005.

<sup>182</sup> See Article 28(1) SUG and Article 14(2) of Directive 2009/18/EC with regard to the one-year limit.

similar incidents in the future<sup>183</sup>. Based on the universally applicable hazard potential of certain items of cargo identified in the course of the investigation of the fire on the MSC FLAMINIA, that appears to be very urgently required.

Finally, the BSU's handling of the set of issues surrounding the search for a port of refuge merely on a summary basis is also justified by the fact that a clear picture is painted by the chronological sequence of events alone. The facts serve as an immediate reminder to the shipping industry, the administrations, and especially policy makers of the various States, the EU, and the IMO that the existing legal framework has proven to be limited when it comes to coping with disasters at sea of the magnitude of the MSC FLAMINIA. However, whether or how this framework can be changed is primarily a question of European and international maritime policy, and therefore cannot be the task of the BSU or of this investigation report.

For the aforementioned reasons, the subsequent analysis of the search for a place of refuge is limited to a summary consideration of the relevant international and European legislation, and the evaluation of whether and to what extent the coastal States involved observed it. Following that, the question of how the action of the parties responsible for the ship (salvor and the MSC FLAMINIA's vessel operator) influenced the duration, substance and outcome of the search for a port of refuge for the stricken vessel, and consequently the decision-making processes of the coastal States involved, is considered. Finally, the involvement of Germany in its dual role of flag State and the coastal State that ultimately granted a place of refuge will be looked at briefly.

## **2.2 Legal foundation for searching for a port of refuge and its application to the MSC FLAMINIA accident**

The allocation of a port or place of refuge for the MSC FLAMINIA was not in the context of preserving human life. In consequence, it was not a so-called 'distress based on emergency', meaning the existing right of access to a place of refuge recognised in customary international law and especially the requirements of the SAR Convention<sup>184</sup> are not applicable. Instead, the international legal foundation for access to a place or port of refuge by the MSC FLAMINIA can be found in the 'Guidelines on Places of Refuge for Ships in Need of Assistance' annexed to IMO Resolution A.949(23) of 5 December 2003, and additionally laid down in IMO Resolution A.950(23), also of 5 December 2003, on the provision of a MAS. Additionally applicable within the scope of EU law is Directive 2009/17/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2002/59/EC establishing a Community vessel traffic monitoring and information system. Summaries of the three legal foundations are presented below and their consideration in the case of the MSC FLAMINIA examined.

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<sup>183</sup> See also Chapters 14.4 and 25.1 of the internationally binding Casualty Investigation Code; IMO Resolution MSC.255(84).

<sup>184</sup> SAR (Search and Rescue) Convention: Convention on Maritime Search and Rescue.



### **2.2.1 IMO Resolution A.949(23)<sup>185</sup>**

Except in cases of so-called 'distress based on emergency', the resolution of the International Maritime Organization (IMO), which is not internationally binding but should merely be treated as recommendatory, deals with any situation that may involve the loss of a ship and/or a risk to the environment or vessel traffic and therefore the vulnerability of a ship can be assumed (so-called 'distress based on necessity'). The search of the MSC FLAMINIA, which was on fire and at risk of foundering, as well as the risk of pollution posed by her and parts of her cargo clearly fall within the scope of Resolution A.949(23).

However, it should be emphasised that the resolution confirms that a (sheltered and thus near the coast) place of refuge basically represents the best means of combating risks to or posed by the stricken vessel<sup>186</sup>. Having said that, the IMO resolution also stresses that the allocation of a berth near the coast or a port can pose significant risks to the coastal or port State affected.<sup>187</sup> Accordingly, Guideline 1.7 of the 'Guidelines on Places of Refuge for Ships in Need of Assistance' states, verbatim:

*“Therefore, granting access to a place of refuge could involve a political decision which can only be taken on a case-by-case basis with due consideration given to the balance between the advantage for the affected ship and the environment resulting from bringing the ship into a place of refuge and the risk to the environment resulting from that ship being near the coast.”*

Hence, in each particular case, the IMO resolution calls on coastal States to weigh up the benefits the ship concerned and the environment would derive from the allocation of a place of refuge on one hand, and the (additional) environmental risks posed by the stricken vessel being near to the coast, on the other.

Consequently, Guideline 3.12 of the 'Guidelines on Places of Refuge for Ships in Need of Assistance' does not provide a right (enforceable under international law) of access to a place of refuge:

*“When permission to access a place of refuge is requested, there is no obligation for the coastal State to grant it, but the coastal State should weigh all the factors and risks in a balanced manner and give shelter whenever reasonably possible.”*

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<sup>185</sup> See von Gadow-Stephani, 'Der Zugang zu Nothäfen und sonstigen Notliegeplätzen für Schiffe in Seenot' (access to ports and other places of refuge for ships in distress at sea), Springer-Verlag, Berlin Heidelberg, 2006, pp. 385 ff.

<sup>186</sup> See Guideline 1.3 of the Guidelines on Places of Refuge for Ships in Need of Assistance.

<sup>187</sup> See Guideline 1.4 of the Guidelines on Places of Refuge for Ships in Need of Assistance.

Laid down is merely the strong recommendation that the coastal State requested to assist carry out a thorough risk assessment and provide a place of refuge if possible. In other words and to sum up, it should therefore be noted that IMO Resolution A.949(23) seeks an entitlement of the flag State (and with that the stricken vessel) to a correct decision on access to a place of refuge based on the discretion of the coastal State requested to provide assistance, which is endorsed by international law. As a general rule, the decision to refuse or grant a place of refuge should be taken only after open-ended and careful consideration of the arguments for and against doing so in the case in question.

### **2.2.2 IMO Resolution A.950(23)**

IMO Resolution A.950(23) accounts for the fact that it is very helpful to provide the master or the salvor of a ship in need of assistance with a unique point of contact in the coastal State requested to provide assistance, which in turn informs the agencies in the coastal State responsible for combating risk about a request for assistance.

Therefore, the IMO resolution recommends that coastal States establish a 24-hour MAS, which serves as a permanent point of contact between the ship, the salvor, and the competent authorities of each coastal State when a ship requires assistance but is not in distress as defined in the SAR Convention.

It should be emphasised that the MAS is not or should not be responsible for the operational coordination of a request for assistance – a salvage or the provision of a place of refuge, for example – or for making decisions in that regard. Its primary task is 'merely' to act as a link between the stricken vessel requesting assistance and the competent agencies of the coastal State in question<sup>188</sup>, and, inter alia, to receive and direct corresponding requests of the master and/or salvor, who in cases of doubt may not gain an immediate overview on what agency in the respective coastal State in question has functional responsibility. However, for reasons of practicability each coastal State may specify that the tasks of the MAS be discharged – without a merging of the different objectives – by the MRCC of the particular State (see Guideline 1.2 of Annex 2<sup>189</sup> to the Resolution).

Guideline 1.3 of Annex 2 to the Resolution enables neighbouring coastal States to combine their resources and establish a joint MAS. Finally, Guideline 1.4 enables coastal States to operate more than one MAS if necessary.

In Guideline 2.1, the governments of coastal States are requested to notify the IMO of the establishment and contact details of their MAS. In Guideline 2.2, the IMO Secretariat undertakes to collect and periodically publish the particulars in a circular.

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<sup>188</sup> See Guideline 3.1, in particular Guideline 3.1.1 of Annex 2 to Resolution A.950(23).

<sup>189</sup> Note: 'Annex 2 Guidelines on Maritime Assistance Service (MAS)'.

Here, the BSU notes that – at least on the website of the IMO and thus readily accessible to vessel operators and salvors, in particular – such a publication could not be found. With some effort within the very extensive and generally difficult to navigate website of the IMO ([www.imo.org](http://www.imo.org)), it is only possible to find 12 circulars of the IMO Maritime Safety Committee (MSC) under the index number 'MSC.5'<sup>190</sup>. These provide information on the establishment of the MAS of a single Member State together with contact details, i.e. not in the form of a summary. They start with MSC.5/Circ. 1 of 30 July 2004, which contains MAS information from the Governments of Denmark, the Netherlands, and Sweden, and currently<sup>191</sup> end with MSC.5/Circ. 12 of 4 July 2013, which contains amended MAS information from the Government of Croatia). The circulars referred to provide information on the MASs of 18 States, including 13 EU Member States. Consequently, it appears that IMO Resolution A.950(23) has been put into effect nationally by only a few countries in the ten years since its adoption.

### 2.2.3 Directive 2009/17/EC<sup>192</sup>

An essential regulatory element of Directive 2009/17/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2002/59/EC establishing a Community vessel traffic monitoring and information system (hereinafter 'EU Directive') is the inclusion of IMO Resolutions A.949(23) – and thus the 'Guidelines on Places of Refuge for Ships in Need of Assistance' – and A.950(23) – 'Maritime Assistance Services' – in Community law by means of Articles 20a and 20b of the EU Directive. Member States were required to transpose the EU Directive into national law by no later than 30 November 2010. Therefore, the recommendations of the IMO resolutions referred to, which are not internationally binding, including the request to grant a place of refuge when the accommodation of a ship is considered the best way of preserving human life and the environment, have at least in certain areas become a mandatory legal requirement in the EU and thus in all the coastal States involved in the case of the MSC FLAMINIA.

A problem in the transposition of the IMO resolutions (or recommendations) into EU law results from the fact that Article 20a in conjunction with Article 20b of the EU Directive could give rise to the questionable conclusion that the guidelines of the IMO resolutions should be observed by a single Member State only when a ship is already in its coastal waters when the request to grant a place of refuge is made:

Article 20a 'Plans for the accommodation of ships in need of assistance' reads, inter alia:

*"Member States shall draw up plans for the accommodation of ships in order to respond to threats presented by ships in need of assistance in the waters under their jurisdiction, [...]"<sup>193</sup>*

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<sup>190</sup> See link (information as of 15 August 2013):

[http://www.imo.org/blast/mainframemenu.asp?topic\\_id=1058](http://www.imo.org/blast/mainframemenu.asp?topic_id=1058).

<sup>191</sup> Information as of: 15 August 2013

<sup>192</sup> Note: Directive 2009/17/EC 'only' concerns an amendment to Directive 2002/59/EC, which remains in force. However, since the port of refuge issue only became a subject of regulation in the 2009 Directive, reference is made predominantly to the amending directive (2009/17/EC) below.

<sup>193</sup> Emphasised by the BSU.

Article 20b 'Decision on the accommodation of ships' reads:

*"The authority or authorities referred to in Article 20(1) shall decide on the acceptance of a ship in a place of refuge following a prior assessment of the situation carried out on the basis of the plans referred to in Article 20a. The authority or authorities shall ensure that ships are admitted to a place of refuge if they consider such an accommodation the best course of action for the purposes of the protection of human life or the environment."*<sup>194</sup>

The – on the face of it – great practical importance of the transposition of the *recommendations* of the IMO into *requirements* within the EU coastal States, in particular that of the second sentence of Article 20b of the EU Directive is, in fact, qualified by the explicit reference to Article 20a. If a stricken vessel is not or does not have to be permitted to enter the territorial waters in the first place, then in cases such as that of the MSC FLAMINIA the (going beyond the recommendatory nature of the IMO guidelines) requirement to adhere to plans, which following the letter of the law were developed only on the basis and premise of responding to hazards caused by ships already located in the territorial waters, inevitably becomes superfluous.

The requirements of Articles 20a and 20b of the EU Directive, which go beyond implementation in EU law of the IMO resolutions relevant to the granting of a place of refuge, are thus irrelevant, possibly even counter-productive, for a considerable number of potential accident scenarios when the EU law is interpreted to the letter. Member States are given the impression that they would only have to take proper responsibility for a stricken vessel if the accident occurred within their jurisdiction. Inasmuch, the current EU law limits – presumably unintentionally – the IMO guidelines instead broadening them in accordance with the actual purpose and objective.

Another fundamental problem with the existing EU Directive, which is almost as and possibly even more serious, is that it incomprehensibly, especially with a view to the sense and purpose of the idea of European unification, dispenses with providing for a harmonised procedure for the event that the search for a place of refuge involves several Member States, which, as demonstrated by the accident involving the MSC FLAMINIA, is in no way only theoretical. Indeed, important and very helpful instruments are provided owing to or on the basis of the EU Directive, which can also or just after a request for assistance make valuable contributions to crisis management. The SafeSeaNet and the MAR-ICE network, for example. However, mechanisms and procedures that would ensure a concerted, coordinated, and consensual approach by the coastal States requested to grant a place of refuge are absent.

In this context, the option provided in the second sentence of Article 20(3) of the EU Directive ("*They may meet at any time on account of specific circumstances.*") can in no way be regarded as a sufficient and effective means of communication between

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<sup>194</sup> Emphasised by the BSU.

coastal States, especially since it concerns a 'may' provision without any further clarification<sup>195</sup>.

The obligation of the Member States and the Commission arising from Article 23d of the EU-Directive to cooperate with each other in drawing up plans to take over vessels in distress, where required, is also insufficient as normative guideline in terms of regulating basic and structural administrative aspects of a search for a place of refuge affecting several EU States, reliable, effective and in general. On the one hand the wording of the norm is vague and neither regulates the procedure to be observed in drawing up "concerted plans" nor unsolicited rights concerning this matter. And on the other hand does the regulation, on purpose or accidentally, exclusively apply to vessels in "distress". That means that the regulation contrary to the aforementioned discussed Articles 20, 20a and 20b of the EU-Directive, covers not all cases of providing a place of refuge for vessels in distress.

That it is quite possible to oblige Member States to adopt a common strategy in dealing with tasks that may affect several Member States at the same time by means of a European Directive is demonstrated by Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector, for example. Rules for cooperation between States in the course of a marine casualty investigation affecting several Member States are established in Articles 7 and 10 of this Directive, in particular.

Finally, existing EU law and its legislative and/or practical form also exhibits a considerable weak spot in terms of the MAS. Article 20(1) of the EU Directive requires that Member States designate one or more competent authorities that have the required expertise and powers, at the time of the operation, to take independent decisions concerning the accommodation of ships in need of assistance on their own initiative. Moreover, the first sentence of Article 20a (3) requires publication of the names and contact addresses of the authorities referred to and the designated authorities for the reception and procession of warning messages.

The issue here as regards the MAS is that the establishment of national points of contact is not fully addressed in the first sentence of Article 20a (2) of the EU Directive in spite of an explicit reference to (the relevant) IMO Resolution A.950(23). Member States are merely prompted to designate authorities "*responsible for receiving and handling alerts*" (Article 20a (2)(a) and to designate the "*competent authority for assessing the situation and taking a decision on acceptance or refusal of a ship in need of assistance in the place of refuge selected.*" (Article. 20a (2)(b)).<sup>196</sup>

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<sup>195</sup> In its statement pursuant to the draft of the investigation report the EU-Commission noted, that it implemented Article 20 Section 3 of the EU-Directive by setting up a "Cooperation Group for ports of refuge", in order to assist in clarifying the technical and operative aspects with respect to ports of refuge. This group was said to have met three times yet.

<sup>196</sup> Note: Emphasised by the BSU.

Accordingly, it is hardly surprising – at least on the basis of the IMO circulars (MSC.5) referred to above – that a MAS as defined in the recommendation of IMO Resolution A.950(23) has evidently not been established or the implementation of the IMO recommendation regarded necessary in every coastal State of the EU.<sup>197</sup>

Moreover, in this respect it should be noted that the wording in the EU Directive – again probably unintentionally – tends to limit the objective of the IMO resolution rather than promoting it.

In conclusion, that the EU Directive lays down the publication of the contact details of authorities responsible for the decision on granting a place of refuge in the Member States, but fails to ensure that the information in question from all the Member States is made readily accessible to the general public in a concise form, merits criticism<sup>198</sup>. Again, the website of EMSA can be referenced for comparison and in relation to the investigation of marine casualties. The national investigative agencies and/or relevant contact points can be determined there very easily and quickly.<sup>199</sup>

#### **2.2.4 Compliance with legal requirements by the coastal States**

Since no obligations of (EU) coastal States to grant a place of refuge can be derived from the EU Directive in the case of the MSC FLAMINIA, i.e. a ship outside European coastal waters, beyond the recommendations laid down in Resolution A.949(23), an isolated or additional examination of the decision-making processes in the coastal States on the basis of existing EU law is superfluous. Therefore, an examination of whether the coastal States requested to provide assistance have complied with their legal obligations is made solely on the basis of IMO Resolution A.949(23), which 'only' lays down a strong *recommendation* to carry out a thorough risk assessment.

In the context of a critical examination of whether the European coastal States requested to provide assistance sufficiently satisfied the guidelines of IMO Resolution A.949(23) in respect of the MSC FLAMINIA accident, a distinction between must be made between each of the States. First of all, and contrary to public perception, it should be stressed that by no means did all the coastal States refuse to accede to a request for a place of refuge when Germany became actively involved and initiated the return of the MSC FLAMINIA to Germany on 15 August 2012 as a result of the vessel operator approaching the BMVBS in its capacity as flag State. At this point, only the coastal States of Ireland, Belgium, and Spain had dropped out of the group of coastal States under consideration for a place of refuge.

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<sup>197</sup> As regards the EU, the Member States of Estonia, Lithuania, Great Britain, Spain, Italy, Malta, Greece, Cyprus, Romania, and Bulgaria had published no MSC circulars on the establishment/contact details of MASs as at 15 August 2013.

<sup>198</sup> Cf. footnote 195: One of the main purposes of the so called "Cooperation Group" is according to the statement made by the EU-Commission the preparation and updating of lists with the contact points for the authorities responsible for the provision of refuge for ships in distress. Thus this Group deals also with discussing an already existing platform such as SafeSeaNet for exchanging information and publishing a list of contact points with the Member States.

<sup>199</sup> See link (information as of 15 August 2013): <http://www.emsa.europa.eu/contact-points.html>.

Ireland's negative decision as regards Bantry Bay of 26/07/2012 requires no further discussion in respect of IMO Resolution A.949(23) because this was done – as far as the BSU is aware – as a result of informal approaches by the salvor to Ireland without a previous formal PoR request of the salvor.

Similarly, Belgium's decision of 10/08/2012 to refuse the salvor's formal PoR request for access to the port of Zeebrugge of 31/07/2012 need not be discussed in detail because it was evidently taken on the basis of objective assessment criteria and, in particular, indisputable navigational reasoning (the MSC FLAMINIA exceeded the port's draught limit).<sup>200</sup>

With regard to the formal PoR request by the salvor of 02/08/2012 addressed to Spain vis-à-vis Gijón, which was refused in relation to all ports as early as 04/08/2012, the BSU is not in possession of any evidence as to whether this decision was preceded by discretionary considerations within the meaning of the guidelines of IMO Resolution A.949(23), and if so, which.<sup>201</sup> However, it is doubtful that the Spanish authorities acted in accordance with the IMO resolution since only two days can hardly be regarded as a sufficient period for conducting a thorough risk analysis. That is all the truer because the information necessary for a risk analysis of the actual hazards potentially posed by the stricken vessel was still not completely known or sufficiently verified at the time in question. What is more, as far as can be determined by the BSU, Spain made its decision without any exchange with SOSREP, who possessed the most information about the situation of the stricken vessel.<sup>202</sup>

Indeed, France, which received a formal PoR request from the salvor in relation to Le Havre on 31/07/2012, stressed great reservations regarding the granting of a port or place of refuge for various reasons in the ensuing multilateral crisis talks. However, only after the initiative of Germany did it see no further need to conclude internal evaluations formally with an official result and/or offer to the salvor. The same applies to the Netherlands, which the salvor formally requested – also on 31/07/2012 – to grant a place of refuge in Rotterdam.

Neither France nor the Netherlands can be reproached because this process of consideration persisted in the two States until the intervention of Germany. It was objectively impossible for the competent authorities of the two countries to perform a conclusive and reliable risk assessment for the purposes of IMO Resolution A.949(23) until the evaluation of the risks to and posed by the stricken vessel – which was verified by the independent inspection of the team of experts – had been carried out.<sup>203</sup>

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<sup>200</sup> Note: Although various figures can be found in different sources in relation to the draught requirements at Zeebrugge, these are all in the proximity of a mean value of 16 metres and thus in an area where the MSC FLAMINA could have been lightened only without a risk premium, if at all.

<sup>201</sup> A corresponding request by the BSU to the Spanish authorities went unanswered.

<sup>202</sup> Note: Although there is no legal requirement to consult with SOSREP or, for example, the flag State, an exchange of information with other States requested to grant a place of refuge seems to be an absolutely logical component of a comprehensive risk analysis.

<sup>203</sup> As already discussed, this took place on 28/08/2012.

Great Britain took up a special position in the search for a place of refuge. Shortly after the accident involving the MSC FLAMINIA, the locally competent SOSREP recognised that an urgent need to allocate a place of refuge, possibly in British territory, may develop with regard to the risks posed by the stricken vessel due to the exposed geographic position of the British Isles.

In reverse, the salvor initially and on its own initiative concentrated its efforts to obtain coastal State assistance on Great Britain. The first outcome of the communication between SOSREP and the salvor was an informal request by the latter on 23/07/2012 to grant the MSC FLAMINIA a temporary place of refuge off the south coast of England so as to stabilise her there.

It was already clear to SOSREP beforehand, and even more so afterwards, that sooner or later a risk assessment as defined by the guidelines of IMO Resolution A.949(23) would need to be carried out. Therefore, SOSREP took the precaution of making contact with the MCA, as well as local environmental groups well before the salvor's formal PoR request on 31/07/2012 for a (temporary) place of refuge off the coast of England. Furthermore, SOSREP requested continuous and meaningful information from the salvor and the classification society regarding the condition of the ship and risks posed by her and her cargo.

The intentions/plans of the salvor and the wish for these to be submitted were also a subject of the permanent communication between SOSREP and the salvor. Finally, SOSREP formally instructed the MCA to perform a comprehensive risk analysis with the aim of identifying and allocating a place of refuge in accordance with IMO Resolution A.949(23) and Directive 2009/17/EC on 01/08/2012.

The outcome of the work of the MCA and SOSREP was that designation of a (temporary) place of refuge off the south coast of England was considered justifiable. On the other hand, a (final) port of refuge was never seriously considered due to the lack of eligible ports in the area of south England.

However, the explicit allocation of a temporary place of refuge by Great Britain became unnecessary as a result of the survey of the stricken vessel by the British, French, and German experts on 28/08/2012, when it was found that the MSC FLAMINIA no longer needed a temporary sheltered position at sea but that the best solution would be to tow the stricken vessel directly into a port as soon as possible and without delay.



Portugal's position that its duty to make a discretionary decision existed only after (all?)<sup>204</sup> the other States had rejected the MSC FLAMINIA is problematic and cannot be reconciled with the guidelines of IMO Resolution A.949(23), in which a priority-setting approach cannot be found. Having said that, it must at least be emphasised that Portugal cannot be accused of – in breach of Resolution A.949(23) – flatly denying the MSC FLAMINIA a place of refuge from the outset without a previous process of consideration. Moreover, Portugal, too, would in any case only have been able to bring a process of consideration to its conclusion after the inspection of the stricken vessel on 28/08/2012.

### **2.2.5 Interim findings**

In summary, it can be determined that the long period of time between the outbreak of fire on board the MSC FLAMINIA and reaching German territorial waters cannot be attributed to insufficient compliance or – referring to Spain – non-compliance with the recommendations contained in IMO Resolution A.949(23) by the relevant European coastal States. A sound basis for actually concluding the thorough risk assessment required by the IMO with a result that was reliable was absent up until the international inspection on board the stricken vessel on 28/08/2012, the late date of which was not within the control of the European States.

From the perspective of the BSU, the shortcomings of Directive 2009/17/EC already discussed in terms of not providing cross-EU Member State binding procedures for allocating a place of refuge for a ship in distress outside the EU that requests access to a coastal area or port within the EU are worthy of great criticism. However, the existence of such coordinated procedures would not have changed the fact that underlying data verified by an inspection would obviously have been essential for a far-reaching decision on granting a place of refuge and for the thus required thorough cross-State risk analysis.

Finally, it should be stressed in this context that due to the very dedicated overarching coordination of the coastal State activities taken on at least in certain areas by SOSREP, the multilateral conferences and communication, and not least due to the agreement of Great Britain, France, and Germany on a joint inspection of the stricken vessel, the above shortcomings of existing EU law at issue were at least mitigated considerably by the pragmatic action of the countries that were involved in that regard.

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<sup>204</sup> Portugal's statements on this issue are inconsistent.

A weak point in the guidelines of the IMO and provisions of the EU governing the allocation of a place of refuge arises from the fact that a readily accessible and concise publication of the contact details of MAS contact points and/or the agencies responsible for allocating a place of refuge in the Member States exists neither at IMO level nor in the area of the EU. The establishment and operation of such services is of little use to the ship's commands, vessel operators, and salvors seeking assistance as long as it is only possible to locate the appropriate contact details with great difficulty.

### **2.3 Responsibility of the salvor and vessel operator for the time spent searching for a port of refuge**

It remains to be examined whether the salvor or the vessel operator can be held accountable for the long period of time that passed until the stricken vessel made fast in Wilhelmshaven. With regard to the parties responsible for the ship, the BSU has made a conscious decision not to differentiate between the activities of the appointed salvor and the vessel operator of the MSC FLAMINIA. Contractual constraints between vessel operator and salvor, as indicated by the vessel operator while liaising directly with the BMVBS, in no way alter the fact that both companies acted within their particular remit without any discernible differences and as a result were, especially on the basis of their particular legal status and the rights and obligations associated with that, in fact – as far as can be determined by the BSU – amicable representatives of the MSC FLAMINIA vis-à-vis the coastal States during the search for a port of refuge.<sup>205</sup>

The detailed chronology of events set out above shows that it was very difficult and time consuming for the vessel operator and salvor to obtain an overall view of the stricken vessel's dynamically evolving situation due to the initial conditions in respect of distance, the adverse weather, and not least the complexity of both the fire and the needs on board the MSC FLAMINIA resulting from that. The salvor required some time before the actual condition of the stricken vessel was reliably determined and it was possible – on that basis and with the help of the calculations of GL and participation of other experts – to give a reliable prediction of the developments on board, which is objectively comprehensible.

On closer examination of the chronology of events by the BSU, the appearance that the search for a port of refuge was reportedly at least initially not pursued with the necessary vigour deliberately, possibly even for reasons of profit on the part of the salvor, is not supported. Although it is true that the salvor gradually addressed formal

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<sup>205</sup> Nonetheless, if the actions of the salvor, in particular, are explicitly described or evaluated below, the BSU in no way means or intends to attribute legal accountability. The role of the charterer, which with its activities vis-à-vis Portugal evidently wanted to press ahead with the search for a port of refuge single-handedly in the meantime, is not questioned further by the BSU because in the end it had no significant effect on the course or total duration of events.

requests for the granting of a place of refuge to the coastal States only in the period 30 July to 7 August 2012, it must not be forgotten that after reaching the stricken vessel the salvor had to first determine her situation and perform an internal examination of the alternative courses of action open to consideration. Moreover, the aforementioned formal requests were preceded by informal requests to Great Britain and Ireland on 23 and 25 July 2012.

Indeed, and particularly ex-ante view made from the outside and in parts gives the impression that the efforts of the salvor vis-à-vis the granting of a place of refuge were uncoordinated, contradictory, and ill conceived. However, it is necessary to put the activities of the salvor in the context of the rapidly evolving events on board the stricken vessel, but also the several informal contacts of the salvor, subsequently hardly reconstructable in detail, to the ports and authorities in the coastal States. Finally it is to be taken into account that the salvage company did not have the possibility to refer to certain procedures and norms due to the aforementioned weaknesses and deficits of the international regulations and EU-Regulations, as far as those exist, since these are not binding for the concerned States or only to a limited extent.

It must first be stressed that the course of the fire on board the MSC FLAMINIA was very erratic, as demonstrated by the above chronology of events. The load situation typical to large container ships and, in particular, presence of numerous containers carrying dangerous and in part highly explosive cargo, the stricken vessel's considerable distance from a coastline at the beginning, the initially unchecked and uncertain spread of the fire, and the indeterminable effects of the fire on the stability and strength of the stricken vessel for an extended period objectively presented the salvor with a major challenge.

However, the salvor's initial limitation to informal approaches to Ireland, SOSREP, and specific ports in the apparent belief that the allocation of a place of refuge could be taken for granted is difficult to understand when viewed objectively<sup>206</sup>. Precisely because of the stricken vessel's particular and very dynamically evolving situation and the unmistakable hazards from the outset for the ship, and more so for a coastal area she would make for, it should have been clear to the salvor, a very experienced leader in its field that operated globally, that the granting of a place of refuge would require a comprehensive risk analysis made on the basis of a reliable pool of data.

Moreover, the salvor's temporary idea of unloading the stricken vessel at sea over a period of some four months must be rated as rather ill conceived, even if this was possibly only considered an alternative and consequence of the previous unsuccessful efforts in finding a place of refuge.

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<sup>206</sup> In its statement pertaining to the draft of the investigation report the salvage company pointed out that it was granted a place of refuge in the past just on the basis of an informal inquiry by the harbour master responsible for the Bantry Bay (Ireland). That's why he decided to take an informal approach first.

Similar in size to the MSC FLAMINIA, a look at the salvage of the MSC NAPOLI<sup>207</sup>, which was involved in an accident in the English Channel on 18/01/2007 and deliberately grounded on the south coast of England in Lyme Bay on 19/01/2007, is sufficient to recognise that the plan to cope with the accident involving the MSC FLAMINIA mainly at sea could hardly have been preceded by a thorough risk analysis.

This is vividly demonstrated by the fact that at the time it took until 17/05/2007, therefore four months, to simply unload the MSC NAPOLI, which was 'only' loaded with 2,318 containers, resting on the seabed and thus in a fixed position, and more importantly neither on fire nor at risk of exploding.<sup>208</sup>

Finally, it is difficult to understand why the salvor seemed to assume initially that communication with the port or terminal operator envisaged was preferential for steering to a port of refuge. In his statement pertaining to the draft of the investigation report the salvor argues in this context, that in some cases the (previous) search and finding of a proper berth and the agreement with a commercial terminal operator was required by the Port Authorities before granting permission to enter the port<sup>209</sup>.

The salvor should have been aware that – at least in the European judicial area – such a far-reaching decision as to accommodate a large container ship laden with a wide variety of dangerous goods and that had been subjected to a major fire and explosions cannot be made and put into effect without the close and consistent inclusion of the authorities responsible for the coastal protection of the particular coastal State.

In this respect, the salvor cannot use for justification the fact that – at least as far as can be determined by the BSU – neither the IMO nor the EU has published a readily accessible (MAS) contact list on the internet. A competent salvor that operates globally can be expected to research information and keep it in a regularly updated list within the systems of its organisation so that the relevant MAS contact details or the contact details of the authorities in the various coastal States responsible for requests for assistance if no MAS is in place can be given immediate, priority consideration in requests for assistance.

To sum up, there are many indications that the focus of the salvor's logistical considerations was on practical and economic factors in the first few weeks after the accident and that it underestimated the understandable and foreseeable reservations and safety concerns of the coastal States. However, in spite of these findings, it can

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<sup>207</sup> At 275 metres in length and with a container stowage capacity of 4,419 TEU, the MSC NAPOLI is actually smaller than the MSC FLAMINIA.

<sup>208</sup> The entire salvage of the stricken vessel lasted until 29 July 2009, therefore 924 days.

<sup>209</sup> According to the statement made by the salvager none of the terminal operators inquired was very much interested in granting the MSC FLAMINIA to moor. This was due to the uncertain timetable of the operations after the mooring (discharging the containers, stowage and disposal of cargo, intervention by public authorities) and the concern of an economic impact as regards the regular operations. Hence it was, for example, only possible to have the prospect of being granted a berth within a restricted time frame. This berth would have required shifting the cargo to barges and the transfer and stowage of the cargo to another agency.

be assumed that the at times contradictory and hesitant approach of the salvor was not a deciding factor in terms of the long period up until a place of refuge was granted in Germany. Even if the salvor had made the formal PoR requests earlier and not, for example, temporarily based its considerations on a four-month unloading phase at sea, reliable data verified by an official inspection and calculations would have been needed by the coastal States in order to carefully consider and answer them. As demonstrated by the chronology of events, it would have been virtually impossible to gather such rapidly evolving information and, in particular, have the indispensable assessment of the stricken vessel performed by a team of experts to verify it, significantly earlier.

#### **2.4 Germany, the flag State and the coastal State to grant a place of refuge**

Represented by the Ship Safety Division (BG Verkehr), which is responsible for the duties of the flag State administration, Germany attended the second and third crisis meetings organised by SOSREP and the MCA on 1 and 8 August 2012 in Southampton. Therefore, it was included officially, although rather passively to begin with, in the discussions on the granting of a place of refuge between the salvor and coastal States as from 1 August 2012.

After the vessel operator approached the Federal Ministry of Transport, Building and Urban Development (BMVBS), to which the Ship Safety Division (BG Verkehr) is subordinated, on 09/08/2012 on the grounds of Germany's flag State responsibility, the ministry undertook to provide comprehensive flag State support, including granting a place of refuge within its jurisdiction if no other State was prepared to, after consulting with the Ship Safety Division (BG Verkehr).

On 15/08/2012, the Ship Safety Division (BG Verkehr) formally notified SOSREP of Germany's position. Made in the middle of the risk analyses for the purposes of IMO Resolution A.949(23) in the coastal States requested to assist (France, Great Britain, and the Netherlands), this landmark step gave the considerations, which were in flux and for objective reasons still completely open at this point, a new direction.

Indeed, the initiative of Germany, which under international law quite rightly took action vis-à-vis the granting of a place of refuge to the MSC FLAMINIA, which enjoyed the protection of its flag<sup>210</sup>, did not lead to an abrupt end of the salvor's efforts to find a place of refuge outside Germany. Moreover, the risk analyses in Great Britain, France, and the Netherlands were not discontinued. On the contrary, initially and particularly with regard to the necessary inspection of the stricken vessel by an international expert team, they were actually stepped up.

Nevertheless, the further course of events unequivocally supports the fact that France, and especially the Netherlands – which was home to the most promising place of refuge (Rotterdam) until the initiative of Germany – took Germany's

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<sup>210</sup> See von Gadow-Stephani, 'Der Zugang zu Nothäfen und sonstigen Notliegeplätzen für Schiffe in Seenot (access to ports and other places of refuge for ships in distress at sea)', pp. 14 ff. and p. 387.

intervention as a very welcome opportunity to dispense with the final assessment of their own responsibility for granting a place of refuge.

This accusation cannot be levelled at Great Britain because the findings of the international inspection, i.e. the assessment that the stricken vessel could enter a port of refuge without taking up an interim position at sea, rendered the provision of a place of refuge in a coastal area obsolete.

Whether, in the final outcome, the German initiative actually speeded up the MSC FLAMINIA's entry into a port of refuge significantly can only be speculated. What is clear is that it would have been absolutely impossible for the inspection of the stricken vessel, which was crucial to all further considerations, to take place before 28 August 2012. Presumably, the negotiations with Rotterdam or the Netherlands, as the case may be, on accommodating the stricken vessel would have been brought to a successful conclusion after that without Germany's intervention. However, it is not possible to estimate how long these negotiations would have taken in retrospect.

Taking into account the outcome and supported by a seriously taken flag State responsibility, the intervention of Germany was the right decision. Based on the results of the inspection of the stricken vessel, the calculations of the classification society, and the information of consulted experts in cooperation with the salvor, the very judicious and proficient actions of the CCME and German authorities guaranteed the safe movement of the MSC FLAMINIA to Wilhelmshaven and subsequent management of the risks posed by the stricken vessel and her cargo.<sup>211</sup>

## **2.5 Overall result**

A very superficial examination would attribute the long period between the outbreak of fire on the MSC FLAMINIA and making the ship fast in Wilhelmshaven to lapses by the salvor and coastal States or shortcomings within the relevant European and/or international framework for granting a place of refuge.

It is true that existing EU law, in particular, exhibits considerable shortcomings in cases where a place of refuge within the EU has to be granted to a ship in distress outside the European coastal States. The regulations also exhibit major omissions in respect of communication, coordination, and decision-making between the States both at the level of the IMO, but even more so at the level of the EU, which sees itself as a pioneer for cross-State cooperation. Ironically, a coordinated procedure that is mandatory, standardised to the greatest possible extent and which duly accounts for the interests of the various States, the vessel operator, and the salvor has not been provided for the important case where several (EU) States could grant a place of refuge.

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<sup>211</sup> Note: Since the movement of the MSC FLAMINIA to Wilhelmshaven was based on a carefully determined and verified pool of data and in respect of the passage through German territorial waters competent organisation and handling by the CCME and the salvor, the politically motivated objections regarding putting into Wilhelmshaven voiced in the media mainly by local German politicians must be rated as unfounded and made on the basis of lacking expertise.

It is also true that during the search for a place of refuge, the salvage company did not always – especially at the outset – give sufficient attention to the reasonable reservations and concerns of the coastal States, and that its approach was very partly devoid of structure.

However, the legal frameworks of the relevant EU-legislation and the apparently different procedures to adhere in the individual Coastal States rendered it very difficult, even almost impossible, to follow a uniform and consistent conception when searching for a place of refuge. The procedure of some administrations in the Coastal States to instruct the salvor at first to agree on a berth with terminal operators organized by private business before considering the rules and procedures for entering the port, leads inevitably to time consuming parallel negotiations with unpredictable outcome.

The varying degrees of readiness of the various coastal States to assume responsibility for the fate of the MSC FLAMINIA may also be criticised. However, this is also a logic consequence of the lack of legal requirements. If Flag States take a critical look and refuse to provide a place of refuge for a damaged vessel carrying a cargo of harmful substances, which happened to a certain extent regarding the case involving the MSC FLAMINIA, it is not surprising that Coastal States “not affected” will respond reluctant upon a request for granting a place of refuge.

Finally, that the important and meaningful MAS concept loses impact because – as far as could be determined – readily accessible MAS contact details from every coastal State that provides such a service have not been published on the internet is open to criticism. In this context, it is also inconceivable that existing EU law has dispensed with making MAS contact points clearly and unequivocally mandatory in the EU area.

All these aspects, which must not be overlooked and should be subject to further review by the parties involved, do not alter the fact that a significantly earlier return of the MSC FLAMINIA to a port of refuge was virtually impossible owing to objective obstacles (considerable distance from a coastline at the beginning, complex course of the fire, particular risks due to dangerous cargo, weather conditions, need for a thorough risk analysis and its validation by an international team of experts prior to a decision). That applies even more when one considers that the British SOSREP made a decisive contribution to preventing a standstill or even deterioration in the situation of the stricken vessel or affected coastal areas with his continuous, mediatory, coordinating approach that focused on moving events forward constructively at all times.

Finally successful, in cases of doubt the handling of the accident should constitute evidence *in favour of* rather than against the objective merits of the long period leading up to the MSC FLAMINIA being made fast at a port of refuge.

### 3 CONCLUSIONS

The investigation into the salvage of the MSC FLAMINIA in the context of the underlying de facto and legal conditions has revealed that in this specific situation, a significant reduction in the period of time between the outbreak of fire on the ship and making her fast at the port of refuge was objectively impossible, even when ignoring the flawed (European) legal requirements. It is at best conceivable that following the inspection of the stricken vessel on 28 August 2012, a few days may have been saved if the MSC FLAMINIA did not have to be towed to Wilhelmshaven, but that the geographically more favourable ports of Le Havre or Rotterdam had provided a place of refuge.

That the existing European legal framework is not sufficient to ensure swift allocation of the objectively most appropriate place or port of refuge after a ship has an accident at sea is not altered by the fact that the absence of binding rules for an orderly interaction of the coastal States involved in the case of the MSC FLAMINIA only had – if at all – a very small influence on the eight-week period between the fire and making the stricken vessel fast at the port of refuge.

Adopted, in particular, to lend much greater efficiency and practicability within the jurisdiction of the EU to the essence and purpose of the IMO resolutions on granting places of refuge and on providing a MAS, the applicable EU Directive (2009/17/EC) only fulfils this purpose partially. Moreover, by only adopting them partially in (binding) EU law, the Directive effectively thwarts the recommendations made by IMO Resolution A.950(23) in respect of the establishment of a MAS in coastal States, for example. The linking of the requirement to prepare plans for the accommodation of ships in need of assistance to events *in* waters over which the particular EU coastal State has jurisdiction is also not appropriate.

Above all, that the EU Directive fails to provide adequate and effective mechanisms for a coordinated approach by all Member States able to grant a place of refuge in an emergency merits criticism. This shortcoming is felt at the latest when a Member State has drawn up complex emergency plans, but in the specific case and as a result of the proper execution of its emergency plan and ensuing thorough risk analysis arrives at the objectively justified decision that it is unable to provide a place or port of refuge due to draught restrictions in the eligible ports, for example. On this issue, existing EU law has no answer regardless of whether an accident occurs inside or outside waters under the jurisdiction of a Member State.



Recital 22 of Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system already states, verbatim:

*"Since the objectives of the proposed action, namely the enhancing of the safety and efficiency of maritime traffic, cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved at Community level, the Community may adopt measures, in accordance with the principle of subsidiarity as set out in Article 5 of the Treaty. In accordance with the principle of proportionality, as set out in that Article, this Directive does not go beyond what is necessary in order to achieve those objectives."<sup>212</sup>*

Although it is true that Directive 2009/17/EC does not actually go beyond the objectives set out therein, it also does not go far enough to achieve those objectives. Instead, it stops halfway in relation to the need to help ships in need of assistance off the European coastline. It is not expedient that Member States open to consideration for the provision of a place of refuge possibly 'pass the buck' to one another in the event of an accident. It is also not expedient in the event of an accident that under certain circumstances a salvor has to simultaneously or successively enter into drawn-out, concurrently held negotiations with the laboriously identified agencies responsible – or possibly those that merely believe they are responsible – in various Member States, which may then drag on unsuccessfully, accepting the possibility of a massive deterioration in the condition of the stricken vessel.

The BSU recognises that although highly desirable, placing such a far reaching-decision as the allocation of a place of refuge in the hands of one cross-State institution provided with extensive powers is hardly realistic within the EU in political terms. However, it should at least be ensured under a harmonised procedure that those Member States, which due to their geographical position or legal rules relating to the flag are open to consideration for decision-making on the provision of a place of refuge, agree as soon as possible on whether in the specific case it is appropriate for a State – and if so which – to take charge of coordinating requests for the allocation of a place or port of refuge addressed to several States after an accident.

The coordination function should be organised so that all the Member States open to consideration always have the same knowledge about the situation. Moreover, it could also include designating and controlling the employment of international expert teams for assessing the risk situation of the stricken vessel, which would be of equal interest to all the States involved.

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<sup>212</sup> Note: Since Directive 2009/17/EC, which is relevant to the port of refuge issue, only amends Directive 2002/59/EC (or supplements it by the point referred to) but does not repeal the recital quoted here, the recital constitutes a definition valid for all the items to which it relates, thus fully encompassing the additional provisions of Directive 2009/17/EC.

The voluntary and exemplary efforts of the British SOSREP in dealing with the MSC FLAMINIA accident, who proceeded in precisely the manner set out above, has shown that a central point as defined above, which oversees and, for example, provides crucial support to the handling of PoR requests by individual Member States by distributing information and organising multilateral crisis meetings, is both necessary and possible.

## 4 SAFETY RECOMMENDATIONS

The following safety recommendations do not constitute a presumption of blame or liability in respect of type, number or sequence.

### 4.1 European Commission

The Federal Bureau of Maritime Casualty Investigation recommends that the European Commission develop further the regulations on granting a place of refuge drawn up for Member States. A policy should be included in the existing regulations that ensures coordinated and targeted procedures with the aim of arriving at a decision, which meets with the acceptance of all parties as far as possible, after an accident and in the event of a request to grant a place of refuge being addressed to several States. Furthermore, the regulations of the European Union concerning granting a place of refuge ought also to include cases in which an accident has occurred outside the European Union.

### 4.2 European Commission

The Federal Bureau of Maritime Casualty Investigation recommends that the European Commission step up implementation of IMO Resolution A.950(23) on the establishment and operation of MAS contact points in European Union law. In this context, the European Commission should also act to ensure that a public information platform is established at IMO and, in particular, EU level and/or that such existing platforms as GISIS<sup>213</sup> or Equasis<sup>214</sup> are extended so that the MAS contact details and possibly the contact details of other authorities responsible for receiving and/or handling requests for assistance may be readily found.

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<sup>213</sup> GISIS = Global Integrated Shipping Information System: Database of the IMO open to anyone after registering that provides access to information on various areas of international maritime policy and administration.

<sup>214</sup> Non-commercial database launched by the EU and the maritime administrations of France, Singapore, Spain, Great Britain, Japan, and the United States Coast Guard, which is open to anyone after registering and, inter alia, provides an overall view of the world merchant fleet and, for example, information on the results of port State control activities.

## E. SOURCES

- Investigations by the Devon and Cornwall Constabulary
- Investigations by the central criminal investigation department of Police Inspectorate Stade and by Waterway Police Stade
- Written statements
  - Ship's command
  - Vessel operator
  - Classification society, including the papers of GL's Emergency Response Service
- Witness accounts
- Excerpts from the MSC FLAMINIA's deck log book and the engine room log, as well as copies of other certificates and documents from the ship
- Cargo documents and stowage plans from the MSC FLAMINIA
- Report by Germany's National Meteorological Service
- Nautical chart, Federal Maritime and Hydrographic Agency (BSH)
- Documentation, Ship Safety Division (BG Verkehr)
  - Handbuch Schiffssicherungsdienst (manual for ship safety service training)
  - Ship file
- Documents of the Central Command for Maritime Emergencies (CCME), Cuxhaven
- Documents and situation reports of the Secretary of State's Representative for Maritime Salvage and Intervention (SOSREP)
- Conversation between BSU investigators and SOSREP (Hugh Shaw) on 6 November 2012 in London
- Daily reports (Daily Progress Reports) of the salvor, SMIT SALVAGE
- Statements by Belgian, French, Dutch, Spanish, and Portuguese agencies
- Mar-ICE: Dangerous Container Risk Assessment, Reports 1 and 2
- Dissertation by Inken von Gadow-Stephani, 'Der Zugang zu Nothäfen und sonstigen Notliegeplätzen für Schiffe in Seenot' (access to ports and other places of refuge for ships in distress at sea), Springer-Verlag, Berlin Heidelberg 2006
- Documents from Chemtura Corporation/U.S. on the cargo diphenylamine
- Dipl.-Ing. Tober, Lars: Investigation report on the Fire on the Container Ship MSC FLAMINIA on 14/07/2012. Unpublished report, Rostock 2013
- Dr Meißner, Dana: Investigation into the possible cause of the fire on the container ship 'MSC FLAMINIA' on 14/07/2012 arising from the chemical and physical properties of the cargo. Unpublished report, Rostock 2013
- Dr Meißner, Dana: Supplement to the investigation into the possible cause of the fire on the container ship 'FLAMINIA' on 14/07/2012 arising from the chemical and physical properties of the cargo. Unpublished report, Rostock 2013
- Dr Meißner, Dana: Evaluation of the discussion with fire experts of the possible cause of the fire on the container ship 'MSC FLAMINIA' on 31/05/2013. Unpublished report, Rostock 2013

- Dr Höfer, Thomas: Report within the framework of the investigation into the cause of the fire on the distressed container ship 'MSC FLAMINIA', assessment of the expert reports submitted to the BSU, and comments on the cause of the fire. Unpublished report. Berlin 2013
- Chief Inspector Liedtke, Roland: Legal opinion on the stowage of the dangerous good divinylbenzene on board the container ship MSC FLAMINIA. Unpublished report. Lübeck 2013
- Dr Fletcher, Ian W.: Executive Summary Report on the Analyses carried out by Intertek MSG on Samples removed from MSC FLAMINIA CO<sub>2</sub> Room on 4<sup>th</sup> October 2012 [sic]. Unpublished report, Redcar, UK, 2013

In accordance with § 27 Para. 3 SUG all persons and agencies in Germany and abroad affected by the content of the investigation report were given the opportunity to comment on facts and conclusions relevant for determining the cause of the accident within a period of 30 days, specified by the binding law, prior to the preparation of the investigation report (hearing). 17 of the 49 addressees took advantage of the opportunity to comment. These were among others:

EU-Commission, BMVI, BG Verkehr – Ship Safety Division, DNV-GL, VDR, the Human Environment and Transport Directorate (Ministry of Infrastructure and the Environment) of the Netherlands, Vessel operator NSB, Charterer MSC, salvage company SMIT Salvage B.V., Stolt Nielsen USA Inc., Deltech Corporation and Chemtura Corporation.