Danish Maritime Accident Investigation Board

MARINE ACCIDENT REPORT
July 2014

BRITANNIA SEAWAYS
Fire on 16 November 2013

The Danish Maritime Accident Investigation Board
Carl Jacobsens Vej 29
DK-2500 Valby
Tel. +45 91 37 63 00

E-mail: dmaib@dmaib.dk
Website: http://www.dmaib.com

Outside office hours, the Danish Maritime Accident Investigation Board can be reached on +45 23 34 23 01.

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Front page: Deck area after fire. Source: DMAIB

The marine accident report is available from the webpage of the Danish Maritime Accident Investigation Board http://www.dmaib.com.

The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth that carries out investigations with a view to preventing accidents and promoting initiatives that will enhance safety at sea.

The Danish Maritime Accident Investigation Board is an impartial unit which is, organizationally and legally, independent of other parties

Purpose

The purpose of the Danish Maritime Accident Investigation Board is to investigate maritime accidents and to make recommendations for improving safety, and it forms part of a collaboration with similar investigation bodies in other countries. The Danish Maritime Accident Investigation Board investigates maritime accidents and accidents to seafarers on Danish and Greenlandic merchant and fishing ships as well as accidents on foreign merchant ships in Danish and Greenlandic waters.

The investigations of the Danish Maritime Accident Investigation Board procure information about the actual circumstances of accidents and clarify the sequence of events and reasons leading to these accidents.

The investigations are carried out separate from the criminal investigation. The criminal and/or liability aspects of accidents are not considered.

Marine accident reports and summary reports

The Danish Maritime Accident Investigation Board investigates about 140 accidents annually. In case of very serious accidents, such as deaths and losses, or in case of other special circumstances, either a marine accident report or a summary report is published depending on the extent and complexity of the events.

Contents

1. SUMMARY 4
2. FACTUAL INFORMATION 5
   2.1 Photo of the ship 5
   2.2 Ship particulars 5
   2.3 Voyage particulars 6
   2.4 Weather data at the time and location of the accident 6
   2.5 Marine casualty or incident information 6
   2.6 Shore authority involvement and emergency response 6
   2.7 Information about the ship management 7
   2.8 Information about the manning 7
   2.9 The site of the accident 8
3. NARRATIVE 8
   3.1 Background 8
   3.2 Departure and initial part of the voyage 9
   3.3 Weather conditions and related considerations 9
   3.4 The outbreak of the fire and the firefighting 12
   3.5 Disturbances by alarms 17
   3.6 The cargo on the weather deck 17
   3.7 Securing the cargo on the weather deck 19
   3.8 Passengers 21
   3.9 Explosion in the electrical store 21
   3.10 Bilge problems on the main deck and in the lower hold 21
4. ANALYSIS 21
   4.1 The outbreak of the fire 21
   4.2 The firefighting 22
   4.3 Disturbances by alarms 22
   4.4 Stowage and securing of cargo on the weather deck 22
5. CONCLUSIONS 23
6. PREVENTIVE ACTIONS TAKEN 24

1. SUMMARY

On 14 November 2013 at 1810 hours, BRITANNIA SEAWAYS departed from Sørreisa, Norway, on a voyage to Bergen, Norway, loaded with military equipment, vehicles and a number of tank containers and flatracks[1] with jerrycans containing petrol and aviation/jet fuel. In addition, there were 12 passengers, all military personnel, on board.

The weather forecast for the planned voyage predicted gale and storm, and during severe rolling a tank container on the forepart of the weather deck loosened from its lashings and caused damage to some jerrycans. Eventually, leaked petrol was ignited by sparks generated by one or more tank containers that slid across the deck, steel against steel. The fire quickly spread to other jerrycans and tank containers on the forepart of the weather deck and became immense.

The firefighting effort was successful because the ship's officers and crew were able to expediently exploit and manage the resources available under adverse circumstances.

No one was injured and there was no pollution of the environment.

The report contains information about the preventive actions taken.

Time information in this report is the ship's local time, i.e. Norwegian time.

[1] Portable, open-topped, open-sided units that fit into existing below-deck container cell guides and provide a capability for container ships to carry oversized cargo and wheeled and tracked vehicles.
Source: Dictionary of Military and Associated Terms. US Department of Defense 2005.

2. FACTUAL INFORMATION

2.1 Photo of the ship

Figure 1: BRITANNIA SEAWAYS
Source: DFDS

2.2 Ship particulars

Name of vessel:	BRITANNIA SEAWAYS
Type of vessel:	Ro-Ro cargo ship
Nationality/flag:	Denmark, DIS (Danish International Register of Shipping)
Port of registry:	Copenhagen
IMO number:	9153032
Call sign:	OZTS2
DOC company:	DFDS A/S
IMO company no. (DOC):	0310102
Year built:	2000
Shipyard/yard number:	Fincantieri-Cant. Nav. Italiani S.p.A.-Ancona/6022
Classification society:	Det Norske Veritas
Length overall:	197.82 m
Breadth overall:	25.90 m
Gross tonnage:	24,196
Deadweight:	11,089 t
Draught max.:	7.50 m
Engine rating:	21,600 kW
Service speed:	21.50 knots
Hull material:	Steel
Hull design:	Single hull

2.3 Voyage particulars

Port of departure:	Sørreisa, Norway, 14 November, 1810 hours
Port of call:	Bergen, Norway, 17 November, 1520 hours
Type of voyage:	National
Cargo information:	Military vehicles and equipment, petrol and jet fuel
Manning:	20
Pilot on board:	Not at the time of the accident
Number of passengers:	12 (military personnel)

2.4 Weather data at the time and location of the accident

Wind – direction and speed:	Storm, westerly 25 m/s
Wave height:	10 m
Visibility:	Good
Light/dark:	Dark
Air temperature:	4 °C

2.5 Marine casualty or incident information

Type of marine casualty/incident:	Fire
IMO classification:	Less serious
Date, time:	16 November 2013, 1910 hours
Location:	North Atlantic
Position:	61°47.0 N–003°06.9 E
Ship's operation, voyage segment:	In passage
Place on board:	Forepart of weather deck
Consequences:	Burned fuel cargo and damaged military equipment, including military vehicles, moderate damage to ship's construction

2.6 Shore authority involvement and emergency response

Involved parties:	JRCC Stavanger
Resources used:	Royal Norwegian Navy frigate HELGE INGSTAD, helicopters, Nordic Maritime Incident Response Group, shore-based firefighters, supply, rescue and service vessel STRIL POLAR
Speed of response:	Prompt acknowledgement by JRCC Stavanger at 1910 hours, rescue helicopter on site at 2025 hours, and the frigate HELGE INGSTAD on site at 2130 hours
Actions taken:	Firefighting assistance
Results achieved:	Fire on board was extinguished

2.7 Information about the ship management

Master:	Certificate of competency STCW II/2. 40 years of age. Served in the company for 18 years, one of which as a master and one week on board this ship.
Chief officer:	Certificate of competency STCW II/2. 34 years of age. Served at sea for 17 years, four of which as a navigational officer in the company and one week on board this ship.
Chief engineer:	Certificate of competency STCW III/2. 47 years of age. Served at sea as an engineer for 22 years, 18 of which in the company and two of which as the ship's chief engineer.

2.8 Information about the manning

According to the ship's Minimum Safe Manning Document issued by the Danish Maritime Authority on 11 May 2011:

Grade/capacity	Certificate (STCW regulation)	Number of persons
Master	II/2 (unlimited)	1
Chief engineer	III/2	1
Senior officer	II/2 (unlimited)	1
Senior officer	III/2	1
Junior officer	II/2, III/1	3
Able ship's assistant	II/4	3
Cook		1

The crew consisted of:

Grade/capacity	Number of persons
Master	1
Chief officer	1
2nd officers	2
Chief engineer	1
2nd engineers	2
Electrician	1
3rd engineers	2
Bosun	1
Able ship's assistants	3
Ordinary ship's assistants	2
Motorman	1
Cook	1
Stewards	2

2.9 The site of the accident

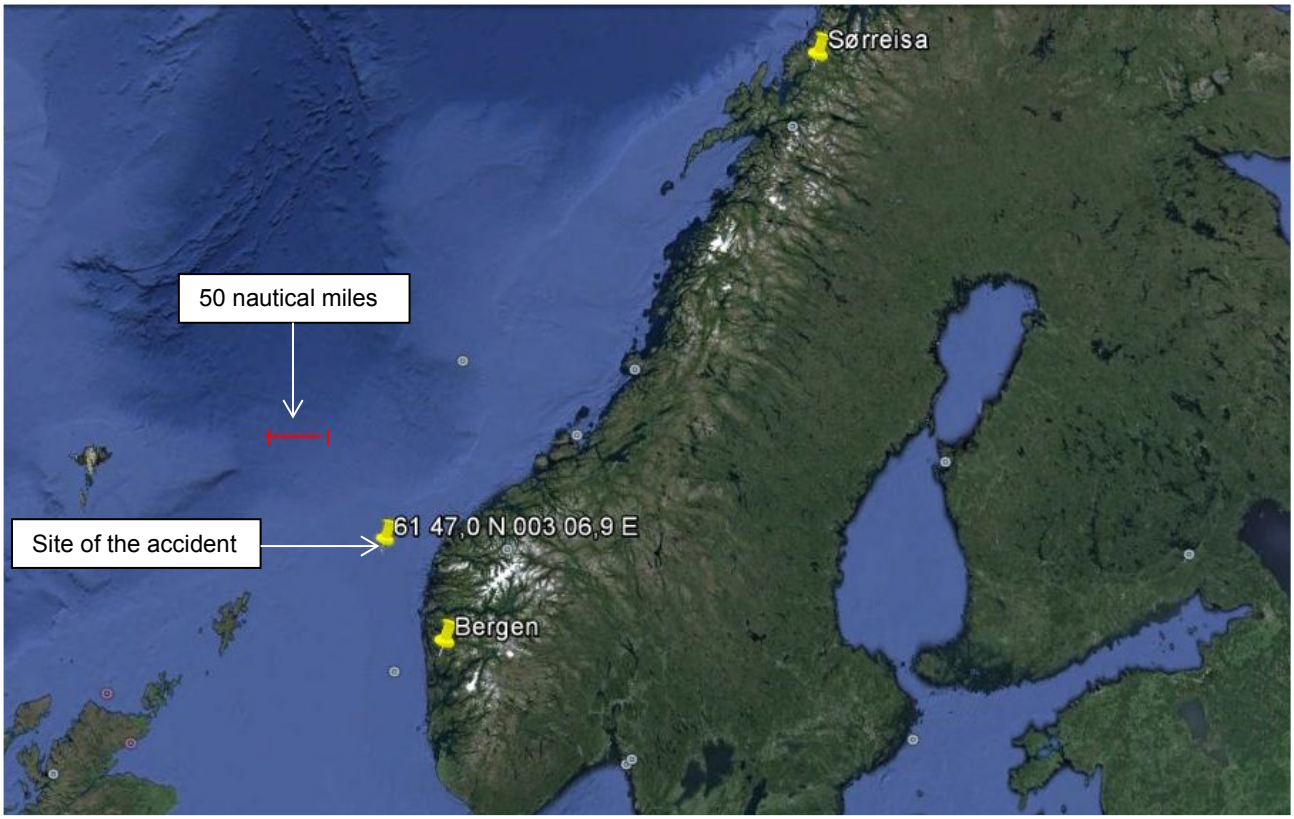

Figure 2: Site of the accident
Source: Google Earth

3. NARRATIVE

3.1 Background

The ro-ro cargo ship BRITANNIA SEAWAYS was generally operating in a scheduled service between ports in Northern Europe. It had valid international statutory certificates and a trading permit for trade within the GMDSS Sea Areas A1, A2 and A3.

In mid-November 2013, the ship was sub-chartered by the Norwegian Ministry of Defence which had entered into a voyage charter with Defence Command Denmark on 14 October 2014 to carry military vehicles, equipment and army personnel from Sørreisa in the northern part of Norway to Bergen as a part of a military exercise.

An element of the military exercise was a rendezvous with a Norwegian naval ship HELGE INGSTAD en route to Bergen.

The army personnel, 12 in numbers, were on board as passengers accompanying the military equipment.

The ship was mainly manned by its regular crew. The master and the chief officer were normally engaged on a sister ship and joined BRITANNIA SEAWAYS one week prior to this accident.

The military equipment, vehicles, containers and flatracks were stowed and lashed by army personnel under supervision by the ship's crew.

The weather forecast for the planned voyage predicted gale and storm.

3.2 Departure and initial part of the voyage

On 14 November 2013 at 1810 hours, BRITANNIA SEAWAYS departed from Sørreisa, Norway, on a voyage to Bergen, Norway.

At departure, 20 crewmembers, one pilot and 12 passengers were on board. All passengers were military personnel. The pilot disembarked five hours after departure.

The ship was loaded with military vehicles on the closed cargo deck (main deck). On the forepart of the weather deck, 23 military vehicles, six tank containers (20 foot), 11 flatracks (20 foot) with other containers, and nine flatracks (20 foot) with 20 litre jerrycans were stowed in one layer.

Prior to departure, the cargo had been lashed and secured by Norwegian military personnel, supervised and checked by the ship's ratings, duty officers, chief officer and master, respectively. Initially, the vehicles on the weather deck were lashed by three lashings each. However, due to the expected adverse weather conditions the master required that at least four lashings were used on each vehicle. The flatracks were secured by six lashings each. All lashing and securing was carried out according to the company's cargo securing manual and the chief officer's and the master's experience. However, because of the cargo's different shape and size it was not secured uniformly and additional lashings were mounted as found appropriate. The vehicles in the foremost part of the weather deck were lashed upon the initiative of the Norwegian military personnel. Usually, the ship's crew did not lash regular-sized vehicles.

3.3 Weather conditions and related considerations

The master had obtained weather forecasts from a Norwegian meteorological institute YR.No that forecasted gale and storm in the area for the planned voyage: On 15 November 2013, a storm from south-west, 25 m/s and 6 metre sea, of short duration and peaking at about noon. This storm would be followed by gales and another storm, about 28 m/s and 8 metre sea, from west-south-west to hit the area north of Svinøy in the late afternoon and evening of 16 November 2013.

The master himself had about one year's experience with this type of ship and no personal experience of the ship's performance in adverse weather conditions. He therefore telephoned a colleague who had several years of experience with this ship to hear about his experiences. This confirmed his own assessment to carry out the voyage as planned.

According to the ship's original voyage plan, the ship was to maintain a relatively low speed, i.e. about 11 knots. According to the charter, the ship was to maintain an average speed of 14 knots, and speed higher than 16½ knots had to be agreed with the charterer.

However, in view of the weather forecast, the master decided to deviate from the original voyage plan and keep a higher speed of about 18 knots straight after departure and then ride out the first storm at a slow speed of about 6 knots on the planned course at which the ship could be steered effectively and minimize the impact of the adverse weather. This would make it possible to pass through the area where the second storm was predicted, and south of Svinøy, before this storm would hit.

The master tried to obtain contact with the charterer through four different contact persons to clear this matter, however in vain. He therefore made an entry about his decision in his voyage report to the charterer.

A further advantage of this revised plan was that the ship's crew had time available to check the lashings 12-15 hours after departure and before they would meet the first storm.

Thus, in the morning of 15 November 2013, the cargo on all decks was re-inspected by the ship's deck crew and the army personnel for safety reasons. As the weather was getting rough, the ship's movements in the sea increased. The army personnel had no maritime experience at all, and they were only used to check the cargo on the closed main deck. Extra lashings were added where it was deemed necessary and possible. The chief officer checked that all lashings were in good condition.

Figure 3: BRITANNIA SEAWAYS in rough weather, 1309 hours on 15 November 2013
Source: DFDS

At about 1000 hours on 15 November 2013, the weather conditions deteriorated. The sea was getting rough and the ship began rolling and pitching in the seas (figure 3). The master forbade all access to the weather deck to avoid personal injury. The ship's speed was reduced to about 10 knots and later on to about 6 knots. In late afternoon, weather conditions improved and the ship's speed was increased to 12-14 knots. The ship proceeded towards the traffic separation scheme (TSS) Off Runde and the master was confident about his revised voyage plan.

On 16 November 2013 at about 0900 hours, whilst the ship was heading 220° towards the TSS Off Runde and the wind had increased, it was observed from the bridge that one tank container adjacent to a flatrack with jerrycans in the forward row on the weather deck had shifted slightly, about one foot (figure 3). This indicated that the lashings on that tank container had slackened. During the day, it could be observed that the aft part of the tank container moved a little from side to side. The master deemed it unsafe for the crew to enter the weather deck to add lashings and secure the cargo.

At 1600 hours, in a storm of 24 m/s from south-west, the ship entered the TSS Off Runde on a southerly course. This implied impacts to the ship from waves of 6-8 metres on the starboard beam and caused the ship to roll up to 20-30° and instantly three tank containers on the forward part of the weather deck shifted as the ship was rolling – first to port side then to starboard and henceforth about 30-40 cm from side to side.

Due to the heavy rolling, the course was altered from south to south-west against the wind and sea and the speed was reduced to 6-8 knots which had a positive effect on the ship's movements as the rolling was reduced. For the next few hours, the storm was increasing.

Figure 4: Containers on forward part of weather deck, having shifted as a result of the ship's movements
Source: DFDS

It was observed from the bridge that two jerrycans were lying on the deck between the flatrack and the tank container that had initially shifted. The jerrycans had loosened from their lashings, obviously because they had been hit by the tank container. At 1630 hours, the chief engineer reported to the master that there was a smell of fuel from the deck areas. There was not much wonder at where the smell came from. The jerrycans were probably damaged and leaking, but it did not cause any serious concern, because at that time the ship was slamming so hard in the heavy seas and large amounts of sea water were washing over the bow. It was therefore believed that the fuel from the jerrycans would be diluted, thus creating no hazard to the safety of the ship.

The chief officer and the master discussed the option of deviating from the original plan, taking a pilot and proceeding in sheltered waters for Bergen. The master saw no significant reason to change the voyage plan, as a change of course would be inexpedient considering the impact from sea and wind. There were no cost-related conditions under which one option should be preferred to the other, considering the expense of using a pilot versus having an increased fuel consumption in the adverse weather situation.

The master decided to maintain the south-westerly course until 1900 hours. At that time, the ship would approach an oil field, which made it necessary to change course. After the change of course, the storm and the sea would be abaft the beam which would lessen the rolling of the ship. The master warned all crew and passengers to be prepared for the planned change of course at 1900 hours, because it could be foreseen that this would create severe rolling. Eventually, more containers began shifting and finally the containers that first shifted from side to side were no longer kept in position by any lashings (figure 4).

Even though the master was not worried about the smell of fuel on deck, because he was convinced that the leaked fuel would be diluted and washed overboard by sea water, he was still aware of it. So he consulted the chief engineer to be reassured about any possible differences between this ship and the sister ship, which was normally under his command, with regard to a possible usage of the sprinkler system below the shelter on the forward part of the weather deck.

3.4 The outbreak of the fire and the firefighting

Just before 1900 hours, the master and the chief officer who were both on the bridge observed sparks/flames from two lorries that were stowed on the starboard side of the weather deck. One lorry was carrying a plug-in reefer unit, so the sparks/flames were believed to originate from damage to the power supply cable for that unit. Therefore, the duty engineer was requested to switch off the power for reefer plugs on the weather deck in order to reduce the risk of this unit igniting any leaked fuel. Hence, no more sparks were observed from that part of the weather deck.

However, bearing in mind the sparks and the leaking jerrycans on the deck, the sprinkler system was started for the section under the shelter of the forward weather deck in order to wash away any fuel that may have leaked from damaged jerrycans. This section of the sprinkler system was then kept operating continuously.

At 1905 hours, a guard vessel from the nearby oil field called on VHF channel 16. This call was acknowledged and it was agreed that BRITANNIA SEAWAYS should alter course shortly in order to keep a safe distance to the oil field. It was then announced via the PA system to the crew and passengers that a turn to port would soon be initiated and severe rolling could be expected during the turn.

Then the turn to port was initiated in order to get the sea on the starboard quarter, and during the turn the ship had the sea abeam and was rolling severely, again up to 20-30°.

At 1910 hours, the master and the chief officer could clearly observe from the bridge that the containers on the forward part of the weather deck were sliding across the deck, some of which hit into the flatracks with jerrycans.

As the containers slid across the deck, steel against steel, they created powerful sparks that instantly ignited leaking fuel from the jerrycans and created high flames. Within a few seconds, some jerrycans exploded and fuelled the fire. The scenario was also observed from the drivers' mess room by the military personnel.

Simultaneously, the master activated the fire alarm and announced via the PA system to the crew that there was a fire on the weather deck and that all crew should muster according to the emergency instructions. He then transmitted a mayday distress on the VHF, channel 16, announcing a fire on board. The mayday distress was immediately acknowledged by the Norwegian coast radio station Rogaland Radio.

The chief officer left the bridge and went to the deck office to lead the firefighting. The passengers went to the drivers' mess room where they received life-jackets and were instructed by catering personnel. The crew mustered according to the fire muster list and the firefighting was initiated. The fire was fought using fire hoses from the walkways on the port and starboard side and from the top of the wheelhouse. As the fire was going on in the ship's port side forward, and the wind was blowing on the starboard side, only the firefighters on the port side were exposed to smoke and used air breathing apparatuses.

Heat radiation from the fire hindered the firefighters in getting close to the immense fire. Furthermore, the heat caused the web lashings on all other cargo units on the weather deck to burn or melt, whereafter all units could slide across the deck and create damage and leakage to fuel containers and jerrycans, thereby enhancing the fire. The sprinkler system in the section below the accommodation was started, and the window sprinklers on the wheelhouse windows were started because the fire rapidly developed and the flames became up to 30 metres high, and the heat radiation from the flames could be felt inside the wheelhouse.

In the beginning of the fire development, the ship was still rolling severely which initially impeded the firefighting. But as soon as the turn to port had been completed and the ship had achieved a south-easterly course, the rolling almost stopped. It was soon realized that the water jet from the top of the wheelhouse had no effect and it was therefore brought to an end. After a brief reorganization of the firefighting teams, the fire was continuously fought from each walkway and from the weather deck, abaft the cargo units. Furthermore, the sprinkler system was still in function on the forward part of the weather deck.

The master alerted the company DFDS' crisis management team and kept them continuously informed about the development by several calls on SAT-C and mobile phone.

Because of reports about smoke on the main deck, the sprinkler sections on that deck were activated. Not all sections simultaneously, but one at a time.

JRCC Stavanger maintained VHF contact with BRITANNIA SEAWAYS. The master recognized that several ships, some of which were supply ships from the nearby oil field, reported they would stand by for assistance. Soon, helicopters were also approaching the ship.

At about 2000 hours, JRCC Stavanger requested to evacuate all passengers/non-essential persons on board. When the rescue helicopter arrived, at 2025 hours, the ship was requested to reduce its speed to about two knots, and by doing so the ship lost its steerage and slowly turned into a southerly course and began rolling again which caused danger to the firefighting crew. Therefore the speed was increased again and the ship turned into a south-easterly course again, and the helicopter was informed that the ship could not maintain the requested speed of two knots.

The helicopter crew replied that it would be possible to evacuate the passengers if the ship turned into a northerly course. However, the master refused to make any attempts to turn the ship into a northerly course, because this would hinder the ongoing firefighting due to severe rolling, and the flames would be driven astern and hence against the firefighters and the ship's superstructure, etc. because of the wind. This would, in the master's opinion, involve a clear hazard to the ship and those on board. Furthermore, as long as the ship maintained a south-easterly course, there was no immediate risk to the military personnel or any other persons on board. The master's decision was accepted by the JRCC and the intended evacuation was cancelled. Therefore the military personnel remained on board.

Figure 5: The fire, at an early stage, snapshot from a video recorded from the bridge
Source: DFDS

Figure 6: The fire, at a later stage, snapshot from a video recorded from the bridge
Source: DFDS

At 2113 hours, the sprinkler pump failed. However, this did not create any immediate problem as the sprinkler system was supplied from the fire main instead.

At some time between 2100 and 2130 hours, when the fire no longer developed and was relatively under control, the chief officer was on the bridge having a brief talk with the master about the situation. The chief officer praised the firefighters for their efforts, but he also drew attention to the fact that several of them had been working committedly and hard for hours with the firefighting. They were exhausted, soaking wet and cold and it would probably be necessary to make some sort of rotation between them, making it possible to have a break to put on dry clothes and possibly get a cup of coffee and some food.

At that time, the firefighting consisted of three-four stationary fire hoses which simply had to be held. And bearing in mind that there were 12 trained military passengers standing by in the drivers' mess room, wearing clothes considerably better suited to withstand the cold and water than the overalls the crewmembers had donned when their own firefighting suits were soaked, the master and the chief officer decided to ask if there were some volunteers among the passengers who would help with the firefighting.

There were quite a few who volunteered. The idea was that the soldiers joined in as part of the ship's own teams so that there was a soldier and a crewmember at each fire hose. The commanding officer of the military personnel joined the master on the bridge to assist in the organization of the co-operation between the ship's crew and the military personnel.

The master knew from serving in passenger ships and crowd management courses that passengers can be divided into "strong" and "weak" passengers. There are passengers such as children, elderly, people with disabilities who need special help. And there are strong passengers who can be used as a resource, if needed. The master remembered from a course, among other things, that soldiers in uniform were used to illustrate "strong" passengers.

Figure 7: The fire, at a late stage, almost extinguished, snapshot from a video recorded from the bridge
Source: DFDS

The frigate HELGE INGSTAD, a Norwegian navy ship that was supposed to meet BRITANNIA SEAWAYS, arrived and took the position as the On-the-Scene-Commander at 2130 hours. At approximately that time, the firefighting crew began using foam together with water in the firefighting efforts. In fact, the foam had no or little effect as the foam was flushed away by water and wind.

At about 2230 hours, there were no more visible flames, and at 2235 hours, the master called the company's crisis management team and informed that there had been no visible flames for about five minutes.

As there were no more flames, it was suggested from the frigate HELGE INGSTAD that more foam equipment and air breathing apparatuses were supplied from that naval ship. The master welcomed this and such equipment was lifted on board BRITANNIA SEAWAYS via helicopter at 2253 hours. This had become possible as there were no more flames that could endanger such helicopter operations, but it was not yet deemed safe to lift firefighting personnel from HELGE INGSTAD to BRITANNIA SEAWAYS.

At 2308 hours, it was discovered that there had been an explosion in an electrical store in the port side below the forecastle. In that store, a remote control plant and alarm station for miscellaneous machinery were installed, and among other disturbances the explosion in the electrical store also caused numerous highly disturbing alarms on the bridge and in the engine control room. It was not possible to enter the electrical store because no personnel were available who could be allocated for that purpose.

When the fire was believed to be extinguished, the standby rescue helicopters in the area reported about hot spots in containers and in the fire-damaged area on the ship that could be located by thermography. This aided the firefighters in their attempts to cool by means of water.

At 0036 hours, HELGE INGSTAD requested BRITANNIA SEAWAYS to change its course to 70° in order to follow into sheltered waters at Rekstafjorden, south of Florø, where the firefighting vessel STRIL POLAR would be waiting, ready to assist. The firefighting vessel had been requisitioned by the shipping company's crisis management team.

The change of course would imply that the wind and sea would come from abaft the beam on the port side instead of abaft the beam on the starboard side, which was acceptable in the given situation, and the ship followed HELGE INGSTAD.

The wind and sea had significantly decreased and eventually it was possible to fight the fire also from the weather deck, the part that was not loaded with any units. From this point, the firefighting was organized with six fire hoses, two from the port side walkway, two from the starboard walkway and two from the weather deck aft of the fire.

At about 0050 hours, the chief officer and two engineers, all dressed in complete firefighting outfits, entered the electrical store for inspection. About 30 minutes later, they returned and reported to the master that the fire had been extinguished in that compartment, but there had certainly been an explosion that had blown two watertight doors, and there was an ingress which they believed came from a leakage in the ship's hull. The latter, however, they could not observe, and it caused no immediate concern because the electrical store was situated some three-four metres above sea level.

At about 0200 hours, the firefighting vessel STRIL POLAR was alongside BRITANNIA SEAWAYS and gave a warning to remove all personnel from the deck and began supplying huge quantities of water from fire monitors. The firefighting by the firefighting vessel and the firefighting personnel's efforts proved effective. Therefore, at 0234 hours, the master instructed most of the crew and officers to get some rest in order to be fit for relieving other crews and officers later on.

From HELGE INGSTAD it was reported that the hull of BRITANNIA SEAWAYS had been examined from the outside. No holes were found, but according to thermography there was still a hot spot on the port side forward.

Crewmembers checked the situation on the main deck and the lower hold and found about 40 cm water in the lower hold and about 20 cm water on the main deck. The ship had about 2° list to port side and it was not possible to keep up with the bilge pumps because of problems with the remote control of the bilge system valves as a consequence of damage to the remote control plant in the electrical store. Therefore, at 0328 hours, STRIL POLAR was requested to stop deploying more water by monitors and the ship's own sprinkler system was also stopped in order to not increase the effect of free liquid surfaces on board. At this time, the only signs of fire were smoke from two containers on deck and the above-mentioned hot spot.

One of the engineers was dedicated to deal with the bilge problems and the master requested portable bilge pumps from HELGE INGSTAD in order to get rid of the water and hence of the free liquid surfaces on the main deck and in the lower hold.

At 0425 hours, a dinghy from HELGE INGSTAD lifted two portable bilge pumps and three firefighters from shore to BRITANNIA SEAWAYS. At that time, the above-mentioned engineer had actually solved the temporary problems with the ship's own bilge system, and it functioned well.

The firefighter's team leader was briefed by the master about the incident and the actual situation, and at the same time, a helicopter arrived with another special trained marine firefighting and salvage team of six men. Also this team was briefed by the master about the situation.

The firefighters inspected the containers on the weather deck and found two containers that were still developing heat. They decided to penetrate the containers in order to flood them with water. However, their firefighting equipment, special designed to penetrate a container, was not effective for that purpose. It was not possible to penetrate the containers effectively by means of fireman's axes, and the special designed spears did not fit with the ship's couplings and could not be connected to the ship's fire main. Therefore the firefighters used angle grinders and cut holes in the containers and flooded them by water.

At 0700 hours, the firefighters inspected the electrical store together with the master. They found no fire in the store room and no hull defect, but it was evident that there had been an explosion and there was much water. The water appeared to come via ventilation ducts and an emergency escape.

The fire was finally extinguished at 0800 hours. From the OSC HELGE INGSTAD the search and rescue operation was declared finished and shortly after the three shore-based firefighters disembarked. The other team of six firefighters remained on board at their own request, as they were based in Bergen.

BRITANNIA SEAWAYS took a pilot, continued the voyage in sheltered waters with all machinery functions in manual mode and arrived in Bergen on 17 November 2013 at 1520 hours.

3.5 Disturbances by alarms

Throughout the entire course of events, the bridge team was disturbed and highly stressed by the sound of countless fire alarms, which made it extremely difficult to concentrate.

Even though the alarms were acknowledged continuously on the bridge, it was not possible to keep up paying attention to the incoming alarms.

Because of the very high pace of incoming alarms and the distracting noise, there was a desire to be able to switch off the alarm sounders for the sake of effective communication and not being unduly stressed. But there was no such possibility. For a period, a crewmember was engaged in acknowledging fire alarms only to stop the sound without being able to reflect on any other possible alarms.

3.6 The cargo on the weather deck

The cargo on the weather deck consisted of military vehicles, tank containers, flatracks with containers and dry goods and a large number of 20-litre jerrycans on flatracks (figures 8 and 9).

The fuel tanks and the jerrycans contained petrol (UN No. 1203) with a flashpoint of ÷43°C and aviation/jet fuel (UN No. 1863) with a flash point of 38°C.

On the forward sheltered part of the weather deck were stowed:

- 20 military vehicles.

Abaft these vehicles, on the open part of the weather deck, were stowed:

- one lorry carrying a refrigerated container with medical equipment,
- one tank lorry with aviation/jet fuel,
- six tank containers on flatracks with aviation/jet fuel,
- nine flatracks each with 70 jerrycans containing petrol and 150 jerrycans containing aviation/jet fuel,
- one flatrack with dry goods,
- eight flatracks with containers, a major part of which contained dangerous goods,
- one 2-in-1 container.

Furthermore, there were two small containers containing lubricants.

In total there were:

- about 630 jerrycans containing about 9,500 litres of petrol,
- about 1,350 jerrycans containing about 20,000 litres of aviation/jet fuel,
- about 55,000 litres of aviation/jet fuel in the tank containers and in one tank lorry.

The jerrycans and also the tank containers were approx. three quarters full.

Three tank containers were provided with protective frames and three tank containers were without frames. The protective frames were not compulsory but facilitated handling by fork lifts, etc.

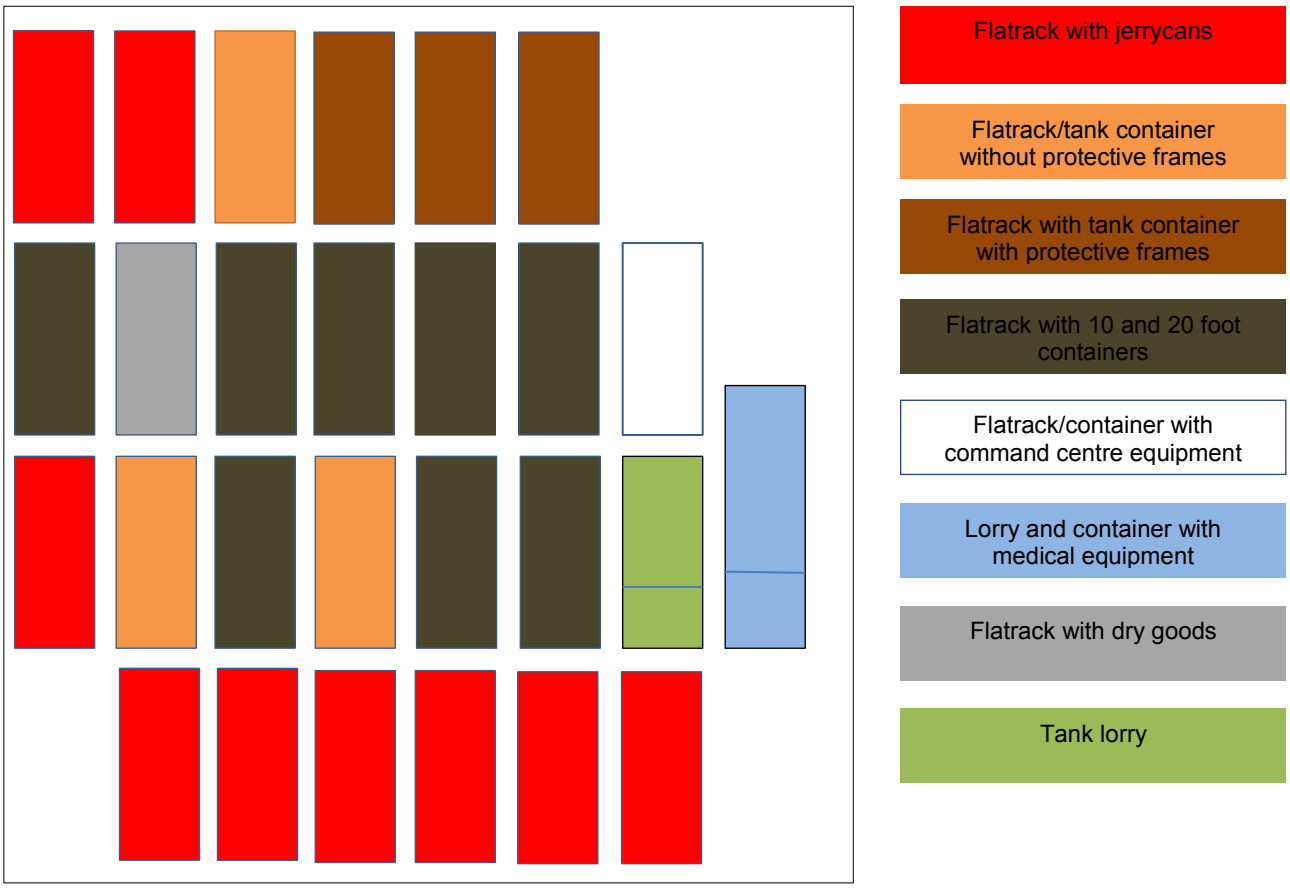

Figure 8: Arrangement of cargo on the open part of the weather deck
Source: Norwegian Military Police

Figure 9: Cargo on weather deck
Source: DFDS

3.7 Securing the cargo on the weather deck

The cargo was stowed and secured, not uniformly, by personnel from a military transport unit assisted by the military personnel who later joined the voyage as passengers. It was carried out under supervision by the ship's crew, duty officer, chief officer and the master to ensure that it was carried out to the standard and quality that corresponded to the ship's cargo securing manual and the crewmembers' experience.

In general, the cargo securing manual was considered of little or no use. It was considered made only for compliance and with no operational value for the crewmembers. Instead the crewmembers relied on extensive operational experience in cargo securing on Ro-Ro ships. It made use of normative language that was underspecified e.g. *"good seamanship"*, *"sufficient"* and *"appropriate".* Furthermore calculations were used that was supposed to be *"obvious"*:

> *"The sliding force, which is reduced by a frictional component, shall be balanced by lashings in accordance with the equation below:*
> *Transverse Sliding* $M \times g \times (\sin \varphi - \mu \times \cos \varphi) \leq CS1 \times f1 + CS2 \times f2 + \ldots + CSn \times fn$
> *From the equation above it is obvious that friction alone can delay sliding to some degree."*[2]

The crewmembers would not, within a short timespan before departure, be able to make these sorts of calculations before departure. Therefore, the crewmembers relied on their experience.

However, one section in the manual was found useful, namely the "Rule-of-Thumb Method" that addressed practical issues, which presented themselves on a daily basis. The shipping company had attempted to create a cargo securing manual from a user perspective, but it showed virtually impossible to get approved if it did not follow the model guidelines[3] adopted by the IMO.

[2] BRITANNIA SEAWAYS' Cargo Securing Manual, page 25
[3] MSC/Circ.745 guidelines as amended by MSC/Circ.812, MSC/Circ.1026 and MSC/Circ.1355.

The master realized that, even though he had never before experienced stowage of jerrycans in that way, the jerrycans seemed well secured by web-lashing straps on the flatracks. Because the cargo consisted of various types of vehicles and flatracks with various types of containers etc., the securing of the cargo was not uniform.

Some flatracks were placed on anti-slide mats of rubber material and some were not.

Figure 10: Examples of securing of cargo on aft part of the weather deck
Source: Norwegian military police

Figure 11: Examples of securing of cargo on aft part of the weather deck
Source: Norwegian military police

3.8 Passengers

The military personnel, all of whom were army soldiers, joined the voyage as passengers. Upon embarkation, they were received on the deck from where they were guided to the passenger corridor and their cabins. They were instructed, in case of any alarm, to go to the passenger mess room where they would be given instructions and guidance. Subsequently, they were instructed about where to find life-jackets and immersion suits and to familiarize themselves with the general safety instructions that were posted on the inside of the door to the cabin.

Some of the military personnel have stated that they were given no or inadequate safety instructions about fire, escape ways, life-jackets, etc.

3.9 Explosion in the electrical store

During the fire, a powerful explosion occurred in an electrical store in the port side below the forecastle. The explosion had blown out two watertight doors leading to that compartment and caused damage to, among other things, a remote control plant.

It was first believed that it was a backdraft, but it was actually a petrol fume explosion. Petrol and water had come into the electrical store via a ventilation duct which had been damaged on deck by a flatrack moving from side to side due to the severe rolling. The petrol fumes were ignited by electrical sparks in a switchboard when the water level in the electrical store had become high enough to cause short circuits.

3.10 Bilge problems on the main deck and in the lower hold

The ship's bilge system was designed with remotely controlled hydraulic valves. These valves were operated by an integrated, computerized machinery control and alarm system with seven outstations, situated in different places in the ship one of which was in the electrical store.

The explosion in the electrical store caused interruption in the entire computerized machinery control system, which meant that monitoring and operation of all machinery needed to be carried out manually on site, and that the valves in the bilge system could not be operated just like that. However, an engineer managed to find out that one computer outstation (remote control panel), situated in the cargo control room, was still functioning and could be used to operate the necessary valves in the bilge system. Thereby it became possible to discharge water from the lower hold and the main deck by the ship's own equipment and the portable pumps were not needed.

4. ANALYSIS

4.1 The outbreak of the fire

In the adverse weather conditions, the securing of the cargo could not withstand the forces induced by the severe rolling of the ship. A tank container slid across the deck and hit and damaged one or more jerrycans on a flatrack next to it, causing a leakage. More containers slid across the deck and the friction created powerful sparks, which at some point was observed to ignite leaked petrol from the damaged jerrycans, causing the fire and explosions.

There was observed sparks/flames from two lorries on the starboard side of the weather deck. It is likely that the sparks originated from a damaged power supply cable or the starting batteries, which were other potential sources of ignition of the leaked petrol in combination with the severe rolling of the vessel. However, it was not *observed* to be the source of the ignition.

4.2 The firefighting

The fire broke out on 16 November 2013 at approx. 1910 hours and was very intense for about five hours. The ship's officers and crew, assisted by military personnel, managed to contain the fire on the forepart of the weather deck and a confined space below deck on the port side.

The master had a good opportunity to observe and monitor the fire and follow the progress of the firefighting that was directly visible to him. Therefore, he had first-hand knowledge about the unfolding events - i.e. the cause of the fire, the extent of the fire and how the firefighting efforts progressed. Furthermore, his own experience in firefighting and knowledge about the ship type enhanced his ability to make decisions such as whether to evacuate the military personnel or not.

Other crucial factors that led to a favourable outcome of the fire was the ship management's ability to co-operate and find solutions to specific problems, such as utilizing the manpower of passengers who were supposed to have special qualities and abilities, dedicating one certain experienced engineer to solve a problem with the remote operation of the bilge system and keeping relevant parties outside the ship informed.

4.3 Disturbances by alarms

Because of the very high pace of incoming alarms and the distracting noise they make, there was a desire to be able to switch off the alarm sounders for the sake of effective communication and not being unduly stressed. But there was no such possibility. It takes manpower and concentration to operate and acknowledge alarms, and in this case the multiple alarms were a distraction more than an aid to officers and crew. It illustrates that the design feature of the monitoring and alarm systems that perform well in normal situations is not necessarily a help when handling a complex emergency situation – to some degree quite the contrary. Although it was not a determining factor in this accident, it will limit the crewmembers' cognitive capabilities and the prioritizing necessary for handling an emergency situation.

The disturbance that alarms can cause in an emergency situation has also been addressed by DMAIB in another accident report[4].

4.4 Stowage and securing of cargo on the weather deck

The securing/lashing of the cargo was mainly carried out by military personnel who were not experienced in this kind of work on ships. The work was supervised, checked and re-inspected by the ship's crew and officers to ensure that it was carried out to the standard and quality that corresponded to the ship's cargo securing manual and the crewmembers' experience. In this context, one should bear in mind that the lashing and securing manner described in the ship's manual will in many situations differ from the way it is in reality carried out. The cargo securing manual is only a guidance which leaves room for interpretation and adaptation to the actual lashing situation, which is seen in the language used in the manual, e.g. *"good seamanship"*, *"carried out properly", "appropriate securing"* and *"due attention"*.

Furthermore, in the manual there are several references to calculations on forces that act on the cargo that the crewmembers will not be able to verify with the information they have readily available – especially when the cargo is secured shortly before departure.

In the manual the lashing of rolling cargo, such as trailers, was described in some detail, while the lashing of other types of cargo units was not. In these situations the crewmembers had to rely on their own expertise and experience from similar situations that had proved successful. As the crewmembers had information about the forthcoming adverse weather situation, they paid specific attention to the strength of the lashings.

[4] EMMA MÆRSK - Flooding of engine room on 1 February 2014.

The crewmembers strategy was to secure the cargo with additional lashings and not to evaluate the effectiveness of the existing lashings according to the manual. This is an indication of how difficult it was for the crewmembers to use the information in the manual in relation to their specific situation.

Rough sea and severe rolling may cause intense sideward forces to deck cargo, and the impacts to the cargo cannot always be precisely calculated and predicted by the crewmembers as suggested in the cargo securing manual, because the variables are too numerous. The equipment used for lashing was primarily web-lashings and to a lesser degree chain lashings. It is uncertain how the first tank container incidentally loosened and began sliding on the deck. When it had become loose, it slid back and forth and bumped into containers and flatracks that eventually also became loose.

How effective the lashing on the other cargo was before it was hit by the sliding tank is also uncertain. As the fire started, the situation deteriorated because web-lashings, which are generally effective under normal conditions, were not resistant to fire and thus came loose as the fire progressed.

The weather conditions were such that access to the weather deck involved a risk of personal injury so the crewmembers could not re-establish the cargo lashings.

5. CONCLUSIONS

During the voyage from Sørreisa to Bergen in adverse weather conditions, the cargo lashing came loose and the cargo started to shift on the deck. A fire broke out in petrol that was leaking from damaged jerrycans stowed on flatracks on the forepart of the weather deck.

The approved cargo securing manual proved not effective for mitigating the risk of the cargo shifting. This was mainly due to the normative approach that the manual had to cargo securing and it did therefore not mitigate the challenges facing the crewmembers on a daily basis.

There were more potential sources of ignition: electrical sparks from batteries on tank containers and vehicles and sparks created mechanically by friction between tank containers and the deck. However, the petrol was observed being ignited by powerful sparks generated by one or more tank containers that, in rough sea and severe rolling, had loosened in their lashing and slid sideways on the deck, steel against steel.

The jerrycans, from which petrol was leaking, were damaged by the impact of the sliding tank container next to the flatrack with jerrycans. The fire quickly spread to other jerrycans and tank containers on the forepart of the weather deck and intensified.

The firefighting effort was successful because the ship’s officers and crew were able to expediently exploit and manage the resources that were and became available under adverse circumstances. Furthermore, the decision-making of the on board management was favoured by a good overview of the deck area and could therefore continuously evaluate the situation. Despite the desire for a temporary change of course to evacuate military personnel, it was also essential that the ship was kept on a course ensuring that flames, heat and smoke blew over the ship’s port side, away from the rest of the ship.

The fire alarm system proved to provide little or no overview of the emergency situation. As the amount of alarms accumulated and continued, the mental and practical workload of the officers on the bridge increased. Thus, the fire alarm system became a burden to the adaptive behaviour rather than an aid. This issue has come to the attention of the investigation board before and in connection with ongoing accident investigations.

6. PREVENTIVE ACTIONS TAKEN

After the fire, a meeting was held on board the ship with the participation of the ship's officers, crew and a representative from the company. Here, the incident and the immediate lessons learned were reviewed.

The shipping company changed to another telephone company because it had experienced insufficient reliability by the former telephone company during this incident.

A group of the company's fire experts consulted the Emergency Services College of the Danish Emergency Management Agency to review equipment that could benefit firefighting efforts in any other situations that may arise. Thorough analysis and tests within the company are ongoing and it is expected that this will lead to further purchase of equipment for the company's vessels.

Weather route guidances for DFDS' ships operating on special voyages are being used to support the master and the crew.

In addition, initiatives have been taken on board on the basis of the lessons learned from this accident and, to the extent that they might be useful in other ships, they will also be implemented there.