



**The Bahamas
Maritime Authority**

THE COMMONWEALTH OF THE BAHAMAS

M.V STENA SPIRIT

IMO NUMBER: 7907661

OFFICIAL NUMBER: 8001927



**Report of the marine safety investigation into a fire on the
vehicle deck in the outer approaches to Gdynia, Poland on
31 August 2016**

The Bahamas conducts marine safety or other investigations on ships flying the flag of the Commonwealth of the Bahamas in accordance with the obligations set forth in International Conventions to which The Bahamas is a Party. In accordance with the IMO Casualty Investigation Code, mandated by the International Convention for the Safety of Life at Sea (SOLAS) Regulation XI-1/6, investigations have the objective of preventing marine casualties and marine incidents in the future and do not seek to apportion blame or determine liability.

It should be noted that the Bahamas Merchant Shipping Act, Para 170 (2) requires officers of a ship involved in an accident to answer an Inspector's questions fully and truly. If the contents of a report were subsequently submitted as evidence in court proceedings relating to an accident this could offend the principle that individuals cannot be required to give evidence against themselves. The Bahamas Maritime Authority makes this report available to any interested individuals, organizations, agencies or States on the strict understanding that it will not be used as evidence in any legal proceedings anywhere in the world.

This marine safety investigation was conducted by the coastal State according to the provisions of the Polish State Marine Accident Investigation Commission Act and in accordance with the IMO Casualty Investigation Code MSC.255(84). The Bahamas Maritime Authority participated in the marine safety investigation and duly recognised as a substantially interested State. We would like to thank the State Marine Accident Investigation Commission for producing this report and their continued cooperation.

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SMAIC

STATE MARINE ACCIDENT
INVESTIGATION COMMISSION

FINAL REPORT

60/16

serious marine casualty

**RO-PAX FERRY
STENA SPIRIT**

truck fire on a car deck
at the approach to the port of Gdynia
on 31 August 2016

August 2017



The investigation of a serious marine casualty of the passenger ro-ro vessel STENA SPIRIT was conducted under the State Marine Accident Investigation Commission Act of 31 August 2012 (The Journal of Laws of 2012 item 1068 and 2015 item 1320 and 2017 items 60 and 1215) as well as norms, standards and recommended procedures agreed within the International Maritime Organisation (IMO) and binding the Republic of Poland.

The objective of the investigation of a marine accident or incident under the above-mentioned Act is to ascertain its causes and circumstances to prevent future accidents and incidents and improve the state of marine safety.

The State Marine Accident Investigation Commission does not determine liability nor apportion blame to persons involved in the marine accident or incident.

The following report shall be inadmissible in any judicial or other proceedings whose purpose is to attribute blame or liability for the accident referred to in the report (Article 40.2 of the State Marine Accident Investigation Commission Act).

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Table of contents	page
1. Facts	3
2. General Information.....	4
2.1. Ship Particulars.....	4
2.2. Voyage information.....	5
2.3. Accident information.....	5
2.4. Shore Services and Rescue Action Information	6
3. Circumstances of the Accident	7
3.1. Effects of the fire on the cargo	16
3.2. Effects of the accident on the vessel.....	19
4. Analysis and comments regarding factors that contributed to the accident with regard to the investigation results and expert opinions.	20
4.1. Mechanical factors.....	26
4.2. Human factors (errors and omissions).....	33
4.3. Organizational factors.....	36
4.4. Structural fire protection of the ship.....	39
4.4.1. Protection of pipelines with pressurized flammable liquids	45
4.5. Analysis of the ship safety plan.....	47
5. Description of investigation findings, including the identification of safety issues and conclusions.....	56
6. Safety recommendations.....	61
6.1. Ship-Owner of the Stena Spirit.....	61
6.2. Classification Society	63
6.3. Port State Control (PSC).....	63
6.4. Minister relevant for maritime economy matters	64
7. List of photographs	64
8. List of figures	67
9. List of abbreviations used	68
10. Source of information	68
11. Composition of the accident investigation team	69
Annexes	69



1. Facts

On 31 August 2016 the *Stena Spirit*, ro-ro passenger vessel, was underway her regular voyage from the port of Karlskrona, Sweden, to the port of Gdynia, Poland.

Several minutes before reaching the "GD" buoy, a fire alarm was activated at the bridge as a result of a smoke detected on the car deck No. 3 in the aft part of the ship. A watchman was sent to the indicated location who, after arriving there, determined that the smoke was caused by a refrigerator truck parked next to the left ramp.

At 06:47, after on passing the "GD" buoy, the master arrived at the bridge. Chief officer informed about activation of a fire detector. Additionally, an electrician and safety officer were sent to check the refrigerator truck. They reported to the bridge that the smoke comes from the V-belts of the truck refrigerator unit's drive and that the refrigerator had been disconnected from the ship's electrical supply and that there was not fire hazard. For removal of the smoke from the cargo bay ventilation system was activated.

After several minutes, the watchmen who remained on the car deck next to the truck noticed fire on the truck's roof, next to the refrigerator unit. He tried to put out the fire with a powder fire extinguisher, but did not succeed. Due to thick smoke, he left the car deck and reported by phone to the bridge that the refrigerator truck caught fire.

The ferry crew commenced the fire-fighting operation. To put out the fire, a drencher system (water sprinklers) for fire protection of car decks was used. The fire on board of the ferry was reported to the fire department and the Gdynia Harbour Master's Office.

Due to a very thick smoke on decks and in staircases as well as at assembly points inside the ship, the ferry passengers were evacuated to external decks Nos. 10, 11 and 12 in the fore part of the ship.

At 07:35 the fire had been suppressed. The ship moored at the wharf without mooring winches which were inoperative due to damages caused by fire. The fire brigade boarded the ship and went to the fire location.

At 07:57 the passengers were allowed to leave the ship. After 20 minutes, the stern ramps were opened to allow firemen waiting on the wharf to board the ship and to fully extinguish the fire of the refrigerator truck. At 08:20 the last passengers disembarked the ship and the fire fighting operation was completed within 20 minutes.

In the evening on the same day the *Stena Spirit* left Helskie II wharf and sailed to the ship repair yard in Gdańsk to carry out an inspection and repairs after the fire.



2. General Information

2.1. Ship Particulars

Ship's Name:	Stena Spirit
Flag:	Bahamas
Shipowner:	Stena Bermuda Line Ltd, Hamilton (Bermuda)
Operator:	Stena Line Scandinavia AB, Göteborg (Sweden)
Classification society:	Lloyd's Register
Vessel type:	passenger ro-ro
Call signal:	C6ZK8
IMO number	7907661
Gross tonnage:	39193
Year of build:	1988
Power:	29419 kW (4 × Sulzer - 16ZV40/48)
Width:	30.82 m
Length overall:	175.41 m
Hull material:	steel
Minimum crew:	53 persons
VDR recorder:	Consilium



Photograph No. 1. The "Stena Spirit" ro-ro passenger ferry

2.2. Voyage information

Ports en route:	Karlskrona (Sweden)
Port of destination:	Gdynia (Poland)
Type of navigation:	international
Passengers and cargo:	551 passengers, 91 vehicles (trucks and cars)
Manning:	95 Poles, 1 Ukrainian

2.3. Accident information

Type:	serious marine casualty
Date and time of event:	31.08.2016 06:39 LT (04:39 UTC)
Geographical position of the accident:	$\varphi = 54^{\circ} 32,285' N$; $\lambda = 018^{\circ} 42,917' E$
Geographical area of the accident:	Gdańsk Bay – internal waters, port of Gdynia, Helskie II wharf
Nature of the water region:	internal waters
Weather during the event:	wind W 5° B, sea state 3, very good visibility, air temperature $16^{\circ} C$, water temperature $17^{\circ} C$
Operating state of the ship during the event:	ferry en route to the port with passengers and vehicles, port entry manoeuvres
Place of the accident on the vessel:	car deck No. 3, ro-ro loading bay next to the port side stern door (Figure No. 1)

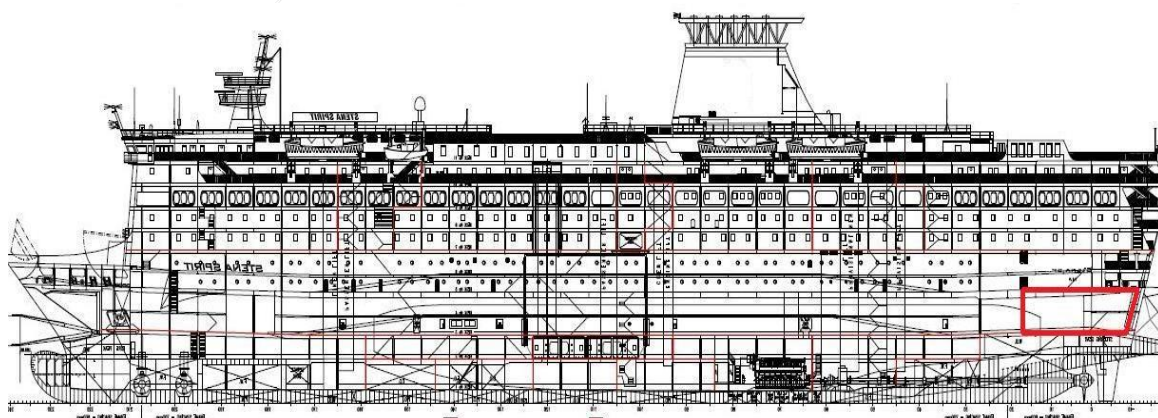


Figure 1. Area directly affected by fire (port side view)

Human factor affected:	vessel crew and passengers, nobody was injured
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Effects of the accident on the cargo:	damaged, burnt refrigerator unit, as well as cargo section of the refrigerator truck and frozen fish load, burnt truck cabin, burnt tarp of adjacent truck
Effects of the accident on the vessel:	damaged (broken and deformed) 2 or 3 segments of existing hydraulic system piping at a place just over the burnt truck, damaged piping of the water drencher system, fresh water system, ventilation ducts, burnt and damaged electrical cabling, burnt lighting fixtures, overheated hydraulic system piping for opening of the stern ramp, damaged detectors and cables of the smoke detection system, damaged CCTV cameras, deformed floor steel plate of car deck No. 5
Effects of the accident on the environment	no marine pollution occurred

2.4. Shore Services and Rescue Action Information

The firefighting operation was carried out by the Port Fire Brigade of Zarząd Morskiego Portu Gdynia S.A. and brigades of the State Fire Service. 3 heavy, 1 medium fire engine and 1 special-purpose vehicle arrived at Helskie II wharf. Additionally, an ambulance of the State Emergency Ambulance Service and six Police vehicles arrived at the scene.

The first fire engine arrived at the wharf at 07:27, after 9 minutes from receiving the call. After the ferry moored at the wharf, two firemen brigades equipped with breathing apparatuses used the passenger entrance to board the vessel and, assisted by the crew members, reached the car decks No. 5 and No. 3 where the crew were carrying out the fire fighting operation. At the scene, the firemen found that the fire had already been suppressed by the vessel's drencher system. Their role was limited to searching car decks for any persons present.

After the crew opened the ship's stern ramp, the shore-side firefighters finished extinguishing the truck fire to ensure the fire was extinguished and no remnants of smoldering material remained inside the cab of the truck and secured the fire location against re-ignition.



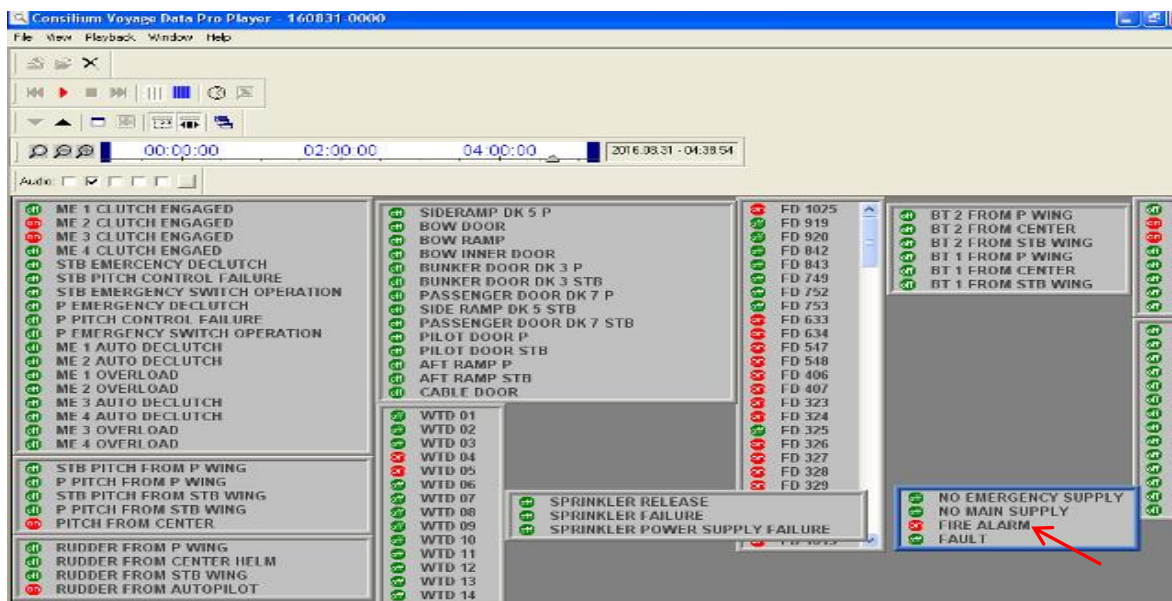
Photograph No. 2. Extinguishing the fire of a refrigerator truck onboard of "Stena Spirit"

3. Circumstances of the Accident

On 31 August 2016 morning, the vessel *Stena Spirit* was approaching the port of Gdynia in accordance with the ship's itinerary. The officer of the watch, watchman (helmsman) and chief officer were present on the bridge.

At 06:38:54 an alarm was triggered in the fire alarm control panel on the bridge as a result of activation of a smoke detector in zone 110 located on the car deck No. 3 in the aft part of the ship.

The officer of the navigational watch instructed the seaman (watchman) responsible for waking up the crew before manoeuvres via the radio (UHF) to go to a car deck No. 3 and to check the situation in the aft part of the ship.



Photograph No. 3. Fire alarm recorded by the VDR

At 06:41:00 the engineer on watch from the engine control room reported to the bridge via telephone that a fire detector was activated on the car deck. In response, the watch officer informed him that a watchman had already been sent to check the car deck No. 3 at the ship's stern.

At 06:43:10 the watchman reported to the bridge by phone that he had located smoke above and around a refrigerator truck parked in front of the stern ramp (door), on the port side next to the central bulkhead (drawing No. 2 and photograph No. 4).

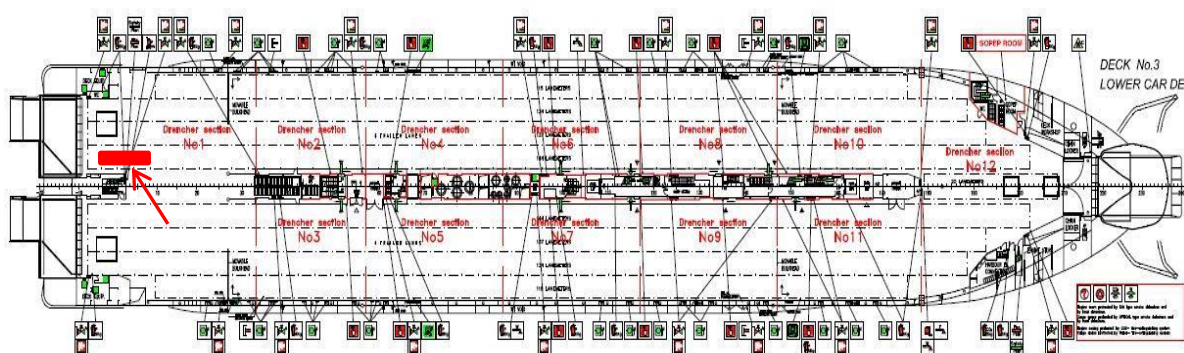


Figure 2. Refrigerator truck position on car deck no. 3

Instructed by the officer of the watch, the watchman disconnected power supply of the truck's refrigerator unit from the ship's electrical system in the distribution cubicle located on the wall of the companionway to the steering room.



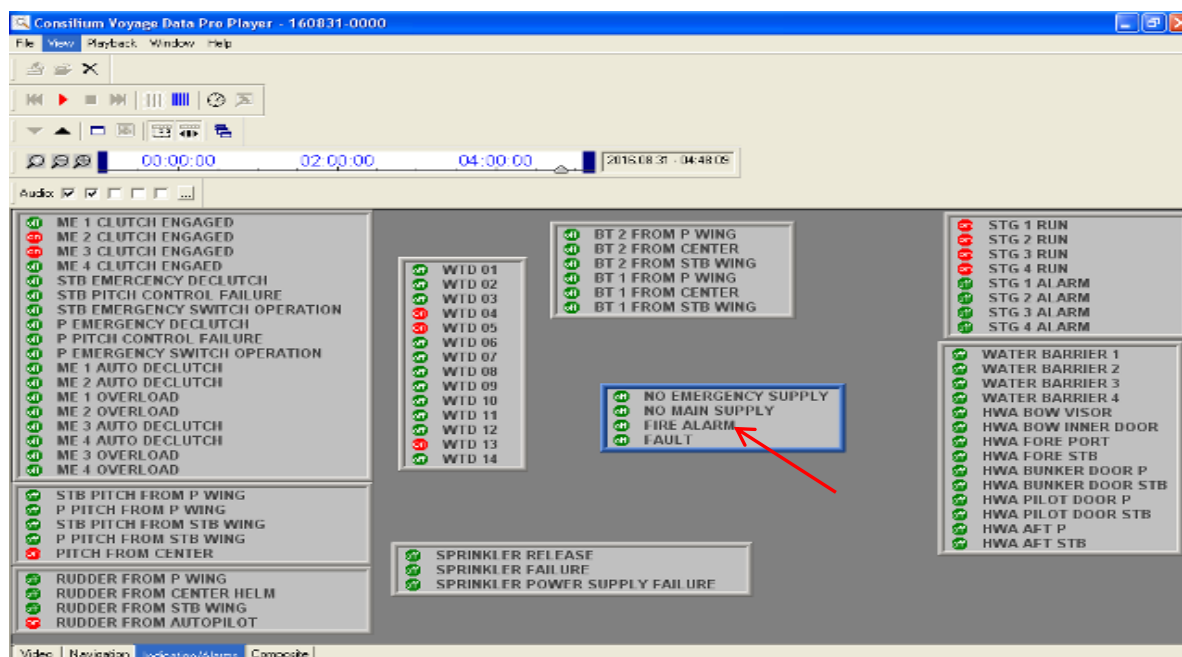
Photograph No. 4. Watchman next to the refrigerator truck in smoke fumes

The officer of the watch informed the ship's electrical engineer by phone to come to the car deck to check the cause of the smoke coming from the refrigerator truck.

After passing the "GD" buoy at 06:47:34, the master came to the bridge. The chief officer and the officer of the watch reported to the master on the activation of the fire detector and presence of smoke on the car deck No. 3.

The master ordered another, detailed inspection of the area from which the smoke originated to check for any smouldering fire. Additionally, he instructed that the inspection be assisted also by the ship's safety officer who, by then, had also come to the bridge.

At 06:48:09 the officer of the watch managed to separate the fire zone 110 in the fire alarm control panel on the bridge and, thus, to deactivate the fire alarm (photograph No. 5).



Photograph No. 5. Deactivated fire alarm recorded by the VDR

Next, the watchman present on the car deck, together with the officer of the watch on the bridge, attempted to switch on the ventilation in the cargo hold to remove the smoke that was present there. The captain stopped these activities and instructed them to wait until the ship safety officer completes the inspection ordered by the captain.

At 06:50 the electrical engineer arrived at the scene on deck no. 3 next to the refrigerator truck; the safety officer arrived soon after. Neither of them found any signs of fire, except for presence of smoke. After several minutes, they reported to the bridge that the smoke originated from the refrigerator unit, more specifically its drive's v-belts and that burnt rubber can be smelled, as well as that there was no fire hazard on the car deck.

When the crew members were checking the deck in the area of the refrigerator truck, the smoke grew thicker and flames could be seen on the image recorded by CCTV camera No. 07 which were reflected by the ceiling on the right side of the truck (photograph No. 6).



Photograph No. 6. Flames recorded by the monitoring camera

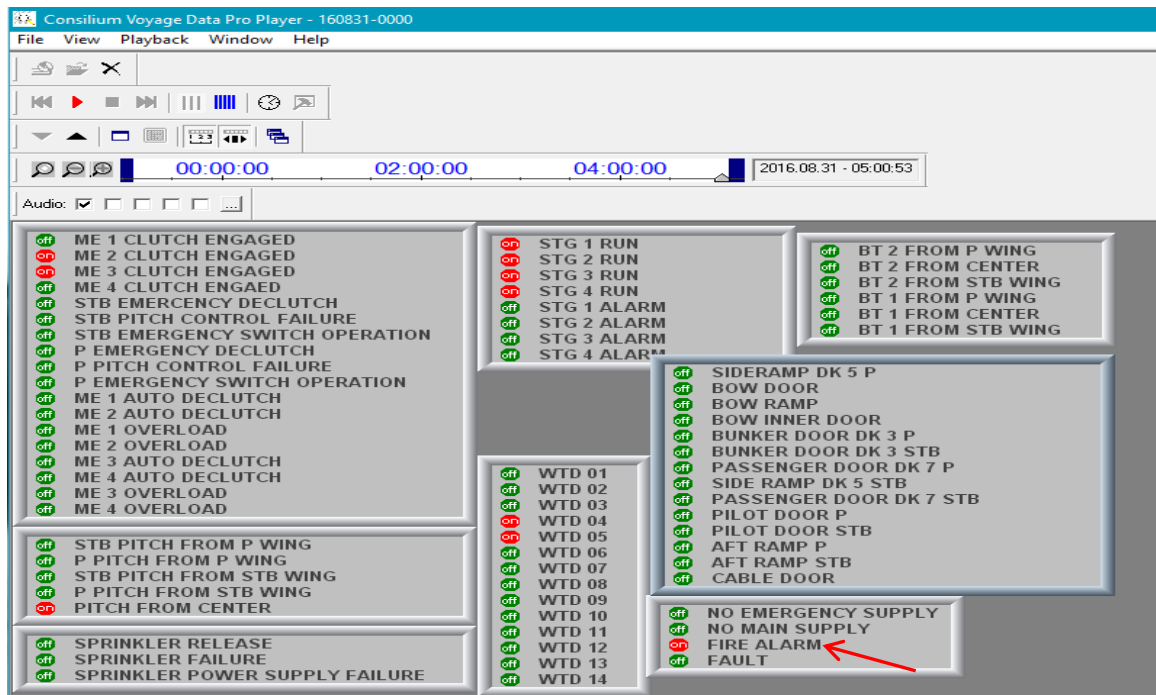
At around 06:54 fans were switched on at car deck no. 3 to remove the lingering smoke from the area.

At 07:00:41 when the ship was entering breakwater heads of the port of Gdynia (photo No. 48), the watchman noticed flames on the truck roof (photograph No. 7). He tried to call



Photograph No. 7. Watchman notices flames on the truck roof

the bridge on the VHF operating channel, but did not succeed. After several seconds, the VDR recorded activation of a fire alarm which switched off the ventilation on the ship.



Photograph No. 8. Another activation of the fire alarm recorded by the VDR

Meanwhile, the officer of the watch and the senior officer attempted to switch on the ventilation on deck no. 3. Furthermore, the officer of the watch tried for almost 2 minutes to contact the watchman in the cargo hold, but he did not succeed. The fire developed considerably and covered the entire width of the truck's roof (photograph No. 9).



Photograph No. 9. Flames on the truck roof

The watchman, not being able to contact the bridge via radio (VHF), started to extinguish the fire with a 50 kg transportable powder extinguisher. He attempted to put out the fire approaching from the rear, left side of the truck, but powder jets did not reach the area of the flames.



Photograph No. 10. Watchman attempting to suppress the fire using a powder fire extinguisher

At 07:03:15 the officer of the watch noticed major smoke presence on the CCTV display and suggested that the ventilation be switched off.

Due to dense smoke, the watchman was forced to leave the car deck and, at 07:03:44 informed the bridge via radio (VHF) that the refrigerator truck was on fire. Before that, he also managed to activate two manual fire alarm call points.

At 07:04:00 the master instructed the officer of the watch to send immediately the crew to start the fire fighting operation and, subsequently, to man the drencher system stations at the stern. Ventilation and 230V power supply systems at the stern had been switched off.

At 07:05 the vessel past the pilot wharf. At 07:08 the fire alarm for the ferry crew was announced with the vessel's public address system. The master instructed the crew to activate the drencher system in sections 1 and 13. Also, the fire pump was switched on.

At around 07:10 dense smoke started to enter the car deck no. 5 in the aft part on the port side, via the ventilation inlets (photograph No. 11).



Photograph No. 11. Smoke on the car deck no. 5 recorded by camera No. 16

At around 07:12 the engineer officer of the watch activated the water drencher system, manually opening the valves for sections Nos. 1 and 13 at the drencher station. Shortly, he was joined by the second engineer. Due to major smoke presence on the staircases inside the ship, he had to use a breathing apparatus to reach the drencher station. Additionally, cooling of the deck no. 5 located directly above the burning truck was commenced with two water streams from the water hydrant system.

Due to crew noticing passengers trying to descend to car decks, an announcement was made at 07:14 forbidding the passengers to descend to these decks.

At around 07:16 the smoke from the car deck no. 3 reached the reception area on deck No. 7. At 07:16:50 the general alarm was automatically activated on the ship. The master ordered that passengers assemble at muster stations in the fore part of the ship.

The fire was reported to the fire department and Gdynia Harbour Master's Office. Vehicles of the Port Fire Brigade, State Fire Service, a team of the State Emergency Ambulance Service and Police vehicles were sent to the ship's mooring place.

At 07:19 the master ordered the crew to activate additional sections Nos. 2 and 3 of the water drencher system on deck no. 3 and, after several minutes, also sections Nos. 14 and 15 on deck no. 5 adjacent to the fire zone from the fore, in order to prevent propagation of the fire to other vehicles.



Because the smoke from the ro-ro deck increasingly penetrated to the passenger rooms (including muster stations), posing a hazard to passengers, at 07:27 the master ordered evacuation of the passengers from the inside the ship to the external deck no. 10 and, after another several minutes, to external decks nos. 11 and 12. Passenger ports on both sides were opened to ventilate and remove smoke from the room next to the reception area.

The vessel started to approach the mooring point stern-first. At 07:31 the master received the information that mooring winches at the stern were inoperative and that the ramps would not be open. The safety officer again instructed the passengers not to go to the ferry's car decks due to presence of a thick smoke.

Around 07:35 the fire on the vessel was brought under control. The ship moored port side at the wharf. The master kept the ship alongside the berth with running engines. Two brigades of firemen boarded the ship through the passenger door. The firemen equipped with breathing apparatuses were guided by the crew to the car deck no. 5 and, subsequently, they came down to deck no. 3. Working in dense smoke and water showering from above (from the sprinkler system), the firemen searched the car deck no. 3 for any person that could be left there. Nobody was found.

At 07:50 the master informed the ship operator about the fire. After two minutes, the mooring winches at the stern were switched on. The water drencher system on deck no. 5 was switched off and, after several minutes, the vehicles from this deck started to disembark the vessel. At 07:58, the evacuation of passengers from the ship commenced.

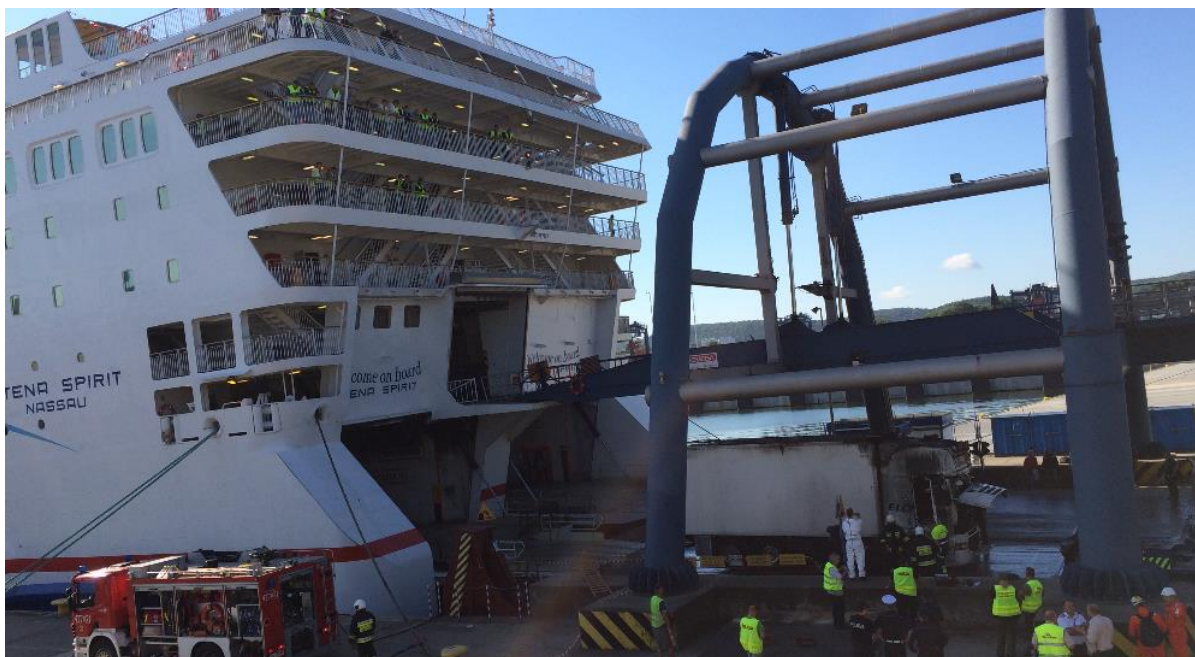
At 08:18 the crew managed to open the starboard and port side stern ramps. Using a water and foam attack line extended from the fire engine, the firemen completed extinguishing the fire in the refrigerator truck's cabin where fire was smouldering and flames fed by insulation and flammable materials of the driver's cabin were still present. To reach the driver's cabin, the firemen had to break the windscreen and side windows.

At 08:20 the evacuation of passengers was completed. After 10 minutes, the vehicles from the deck no. 3 started to disembark via the starboard side stern ramp. At that time, the fire in the truck cabin re-emerged as a result of access of fresh air. The fire service continued to fight the fire by pumping foam into the driver's cabin (photograph No. 2).

Subsequently, the truck with blocked brakes was dragged by two road tractors from the cargo hold to the wharf where it was finally extinguished.

At 08:40 the fire fighting operation was finished. After another two hours, all vehicles had disembarked the vessel.

After completion of the fire fighting operation, the classification society's representative arrived at the ship and carried out a post-accident inspection to determine the condition of the ship after the fire. The inspector representing Lloyd's Register found that the damages do not require the vessel's class to be suspended and the ship may resume operations after necessary repairs and retesting witnessed by the classification society's inspectors.



Photograph No. 12. The "Stena Spirit" after removing the refrigerator truck to the wharf and completion of the fire fighting operation

3.1. Effects of the fire on the cargo

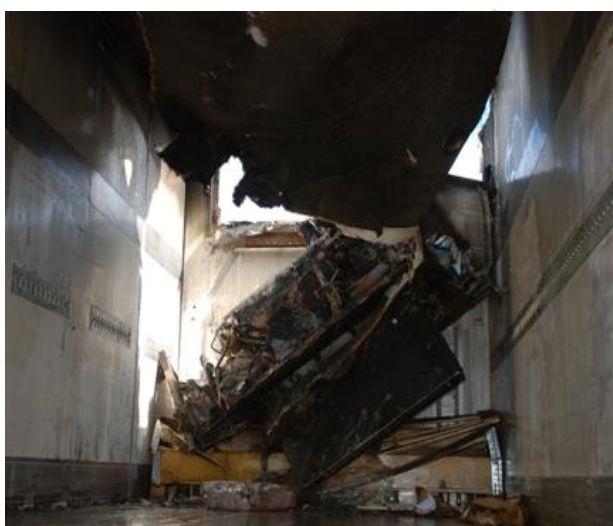
As a result of the fire, two trucks loaded on the car deck no. 3, next to the left stern ramp of the *Stena Spirit* were damaged: a Polish SCANIA refrigerator truck and a Romanian DAF truck.

The fire covered the roof and top part of the rear wall of the refrigeration chamber of the refrigerator truck. The refrigeration chamber was covered with polyurethane insulation and laminate (photograph No. 13). The trailer of the refrigerator truck, the refrigeration trailer with an independent refrigeration unit suffered virtually no damages due to the fire.



Photograph No. 13. Burnt vehicle roof with damaged refrigeration unit

The damage included the fastening of the refrigeration unit installed on the vehicle roof. The burnt unit fell on the cargo¹ loaded into the vehicle (photograph No. 14).



Photograph No. 14. Burnt refrigeration unit on the truck trailer floor

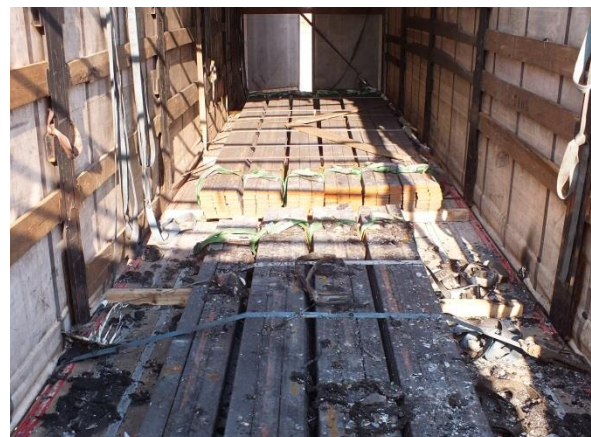


Photograph No. 15. Burnt driver's cabin of the refrigerator truck

¹ The refrigerator truck contained a cargo of frozen fish in cardboard boxes arranged on wooden pallets. A temperature of approx. – 22° C was maintained in the refrigeration chamber.

The interior of the driver's cabin was burnt. The fire spread to the cabin via the sunroof which was damaged by flammable material leaking from the vehicle cargo compartment's ceiling. The cabin ceiling and wall insulation was burnt. Two rows of seats were present in the driver's cabin (photograph No. 15). In the second row, a bunk bed with a mattress was installed. On a second row seat, the driver's computer (laptop) with a connected charger and an electric kettle were found. The computer and charging devices have been completely damaged (photographs Nos. 35 and 36). In the front of the cabin on the driver's side, the refrigerator temperature recorder was installed. It also has been destroyed by the fire.

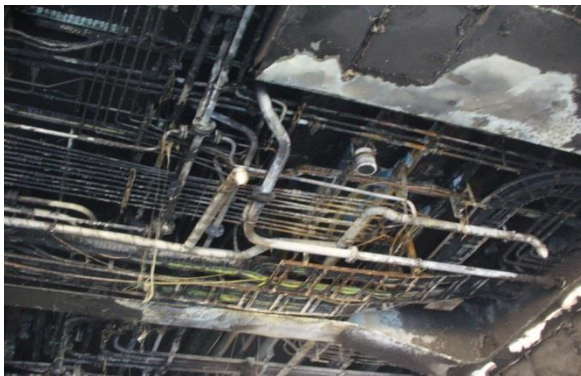
The damages to the second truck that stood next to the truck from which the fire originated were limited to burnt tarpaulin covering the walls and roof of the trailer and partially burnt front wall (photograph No. 16). The cargo transported by this truck – steel rods and plates - was not damaged by the fire.



Photograph No. 16. Burnt tarpaulin of the truck parked next to the refrigerator truck and its cargo

3.2. Effects of the accident on the vessel

The fire caused damages to the vehicle room (cargo hold) on deck no. 3 and on deck no. 5. Under deck no. 5 which constitutes the ceiling of the cargo hold on deck No. 3, apart from extensive charring and deck paint scaling in the port side stern area over the place where the refrigerator truck stood, electric cables, ventilation ducts and hydraulic system pipelines have been charred and damaged (photograph No. 17).



Photograph No. 17. Ceiling of the car deck No. 3; ship systems damaged by fire



Photograph No. 18. Car deck no. 5; burnt paint spots and deformed deck plate

Two spots of burnt paint located around 2 meters away from each other were visible on deck no. 5, indicating the location of fire and high temperature sources that caused the deck deformation (photograph No. 18).

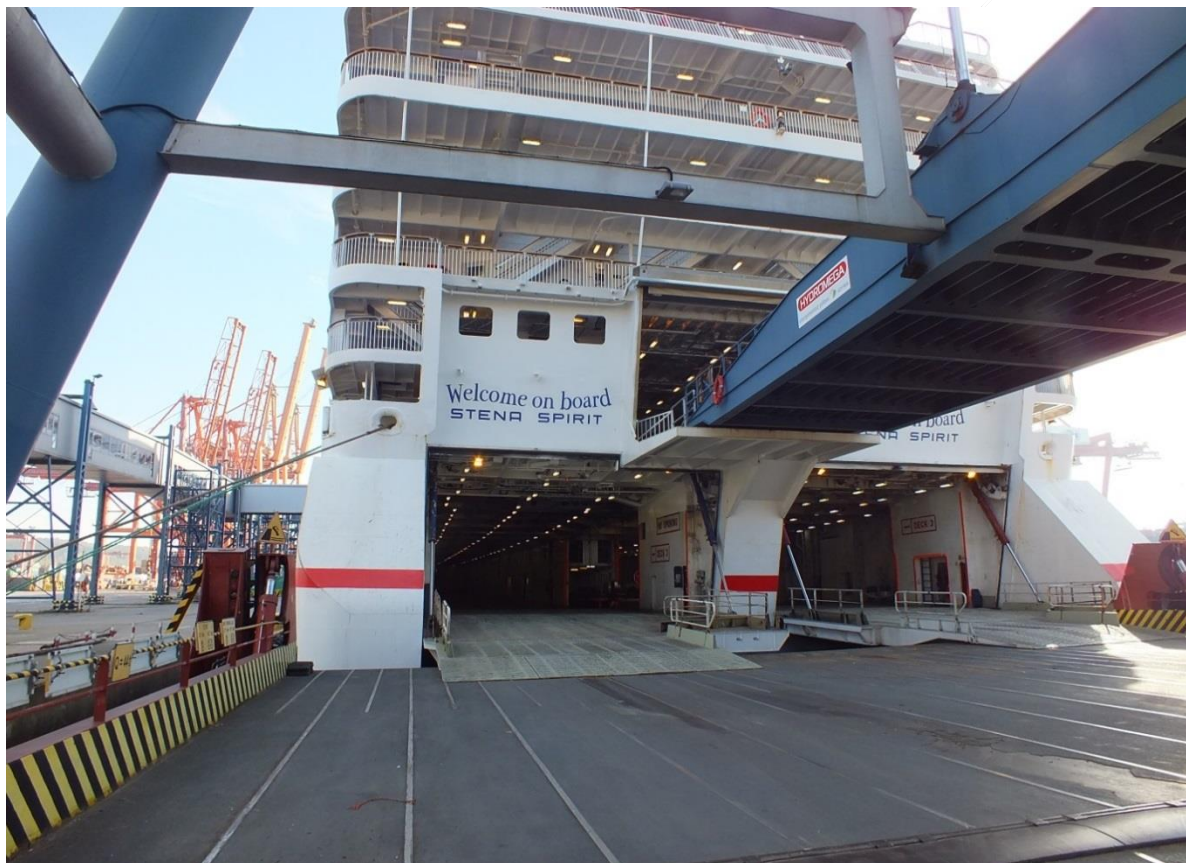
The scope of ship damages included pipeline systems and electrical systems, including: control of the forward and stern ro-ro ramps, hydraulic system of the mooring winches on the port and starboard side, lamps and cables of the ship's stern lighting system, loudspeakers and cables of the public address system in the aft part of the ship, detectors and cables of the smoke detection system in the ro-ro hall at the stern, ventilation operating indicators in the engine room and on the car deck in the engine control room, hotel supply lift No. 10, monitoring in the engine control room, passenger lift in the fore part of the ship, ro-ro hall stern door hydraulic system, stern hydraulic system of the mooring winches, sprinkler system pipelines, pneumatic system in the aft part, freshwater system pipelines and ventilation ducts of the ro-ro space at the stern.

After the fire, the ship was removed from commercial operations and headed for repairs at a ship repair yard. The repairs, replacement and inspections, as well as tests of the ship's damaged systems took around 10 days.

4. Analysis and comments regarding factors that contributed to the accident with regard to the investigation results and expert opinions.

The cargo holds for transport of road vehicles onboard of the *Stena Spirit*, also referred to as ro-ro spaces or ro-ro holds (defined in the SOLAS Convention as special category spaces) cover two levels: lower deck no. 3 and upper deck no. 5. The spaces of respective decks are separated symmetrically with service spaces containing staircases, lifts and storage space.

In the aft part of the lower deck, two hydraulically-operated stern doors (ramps) are located which are used by vehicles to embark and disembark the vessel. The entry to the upper car deck takes place via the upper ramp from the wharf platform (photograph No. 19).



Photograph No. 19. View of the car decks of the "Stena Spirit".

The cargo spaces for the transport of vehicles comprise the main horizontal zone spanning the entire length of the vessel which should be separated from other spaces with horizontal and vertical divisions with fire resistive rating of at least class A-0 which means that the divisions should be fire- and smoke-tight, to prevent passage of smoke and flame until the end of a 1 hour standard fire test.



The fire protections of the cargo spaces of *Stena Spirit* include a water drencher system divided into sections which are manually activated from the section valve control station, as well as a permanent fire detection and alarm system equipped with smoke and heat detectors², manual call points and fire alarm control panel located on the bridge. On the car decks, hydrant valves with fire hoses, portable fire extinguishers and transportable firefighting units are arranged.

The flaps of the air inlets and outlets for the ventilation of the ro-ro spaces are located on the open deck. Remote controls of the ro-ro space fans are located, in accordance with the fire protection plan, on the bridge, in the engine room and in the station No. 2 at the deck No. 6, and also additionally on the deck no. 3 near the starboard stern door.

The firefighting equipment including 16 sets of protective clothing and breathing apparatuses is distributed between five fire stations arranged at various main vertical zones of the ship.

On the day of the accident, the ship had a valid class and passenger vessel safety certificate (Annex 1). Permanent firefighting systems of the vessel and firefighting equipment such as fire extinguishers, breathing apparatuses and escape respirators (full list provided in Annex 2) had valid technical inspection certificates issued by a maintenance contractor.

The drencher system in the ro-ro spaces had been undergoing periodic inspections carried out by the crew, as confirmed by the entries certifying completed inspections of respective sections, in accordance with the PMS available from the ship's computer program.

The firefighting systems and firefighting equipment were in good condition, as confirmed by positive results of recent technical inspections conducted in accordance with the rules applicable at seagoing vessels.

The accident course of events was recorded by the ship's monitoring system³. The ship was equipped with sixteen CCTV cameras installed at various points of the ship (photograph No. 20). The fire was recorded by four cameras (marked with respective symbol ). First camera (No. 7) which recorded the fire most clearly was located in the aft part of the deck No. 3 under the ceiling, at the ship's centerline and covered the refrigerator truck from the back, at certain angle.

² The vehicle deck no. 3 where the fire occurred was equipped with smoke detectors, while deck no. 5 was equipped with both smoke and heat detectors.

³ The commission received the portion of the CCTV film covering the period between 06:30 and 07:10 on 31 August 2016 that was of crucial importance for investigation of the accident.



Photograph No. 20. View recorded by all 16 internal CCTV cameras of the "Stena Spirit" on 31 August 2016 at 06:30 ship time

The second camera (No. 13) was located in the aft part of deck no. 3 on the starboard side, under the ceiling, next to the starboard side door. The third camera (No. 14) was located in the aft part of deck no. 3 on the port side, pointed directly at the deck next to the left stern door, closest to the fire location. The fourth camera (No. 16) was located in the aft part of car deck no. 5 and was pointed at the upper stern door.

At around 06:34, the camera No. 07 of the ship's CCTV system recorded an image of smoke and at 06:35:23 of the first flames above the truck standing on the car deck no. 3,



Photograph No. 21. Flames above the refrigerator unit on the truck roof

next to the port side stern door of the ship, in its right, fore part, probably coming out from the refrigerator unit.

The flames above the truck were visible for a certain period of time and, at 06:38:54 when the smoke detection alarm was activated at the bridge, the fire on the image captured by camera No. 7 was already visible clearly enough that it could not have been overlooked and disregarded by the person checking the ship CCTV images.



Photograph No. 22. Flames above the truck recorded by camera No. 07 immediately after activation of the fire alarm

The officer of the watch on the bridge, after having identified the place where the smoke occurred (section 110, deck no. 3, stern) and sending a watchman to the event location should have, at the same time, evaluated the situation in this place based on the CCTV cameras.

The smoke from above the truck started to spread and, after several dozen seconds from activation of the fire alarm, was recorded by camera No. 14 pointing from above at the stern door in front of the first row of trucks standing there (photograph No. 23).

The increasingly dense smoke and intensifying fire were visible for the next couple of minutes, after which the flames disappeared and the smoke diminished. During this phase of the fire, the watchman who entered the cargo room, could have not noticed the flames on the truck's roof.



Photograph No. 23. Image from camera No. 14 pointing at the stern door next to which first three trucks stood

When the watchman called the bridge for the first time (at 06:43) and reported on the discovered smoke, thick smoke engulfed camera No. 14 (photograph No. 24), obstructing the view around the door and the truck to the right (at the ship's port side).



Photograph No. 24. Billows of smoke recorded by camera No. 14

After the master arrived at the bridge at 06:47, one of the officers reported that the smoke on the car deck is visible on the monitor. If, at that very moment, the officers at the bridge had a closer look at the images recorded by other cameras, not just from camera No. 07 which showed the truck from behind and at a certain distance (on which the smoke presence was

relatively minor), they would have noticed smoke with rotating scales of paint which fell off the ceiling and other items carried by hot smoke, recorded by camera No. 14 located next to the port side stern door, as well as showing the smoke already in front of the trucks standing at the stern next to the starboard side door, recorded by camera No. 13 on the starboard side.



Photograph No. 25. Smoke entering the space in front of the vehicles standing next to the starboard side stern door

For more than 15 minutes, from the master's arrival at the bridge until 07:03:15 when the officer of the watch approached the display screen and noticed major smoke presence recorded by camera No. 07, nobody either at the bridge or in the engine control room analyzed the images captured by the other CCTV cameras.



Photograph No. 26. CCTV images on the screens on the bridge (left) and in the engine control room (right)

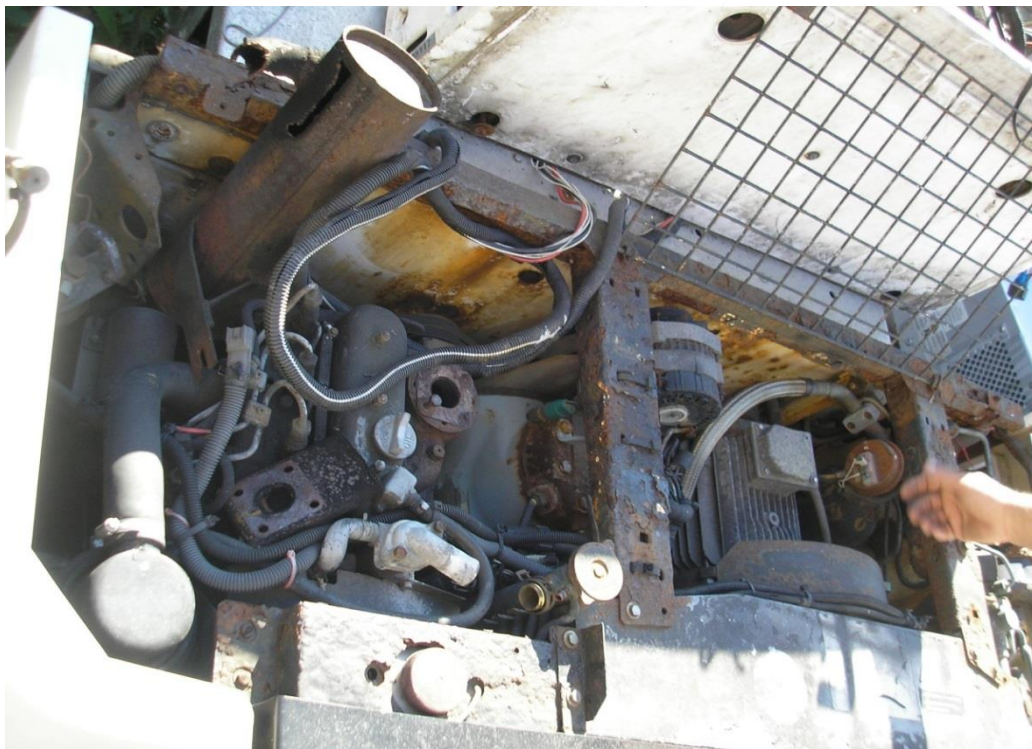
Monitoring the images from camera No. 07 was probably not too frequent, because since around 07:00 the refrigerator truck roof was burning with full flame (which can be clearly seen in photograph No. 9) and the fire was not noticed by the crew on the bridge.

Furthermore, at 07:02:50, still before receiving the information from the watchman in the cargo space that the truck was on fire, the image from the damaged camera No. 14 was lost which also went unnoticed by the crew.

4.1. Mechanical factors

The commission determined that the fire onboard *Stena Spirit* started on the truck roof in the place of the refrigerator unit⁴, on the right side of the truck. The fire appeared during the operation of the refrigerator unit as a result of damage to one or more of its components.

A typical truck-mounted refrigerator unit comprises an internal combustion engine, alternator, coolant compressor and electric motor. All components are mounted on a steel frame installed in the cavity of the truck cooling chamber's roof. To ensure cooling by air during driving, the refrigerator unit is not equipped with any shield on top, except for a grate.



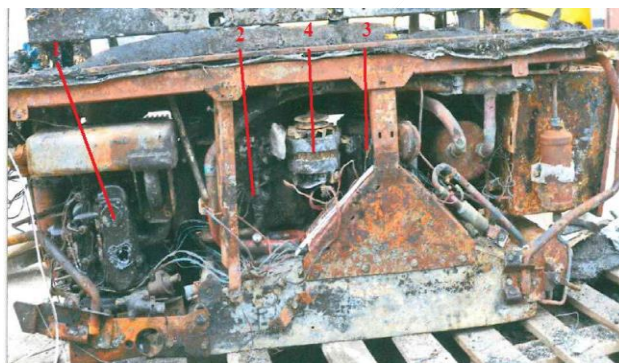
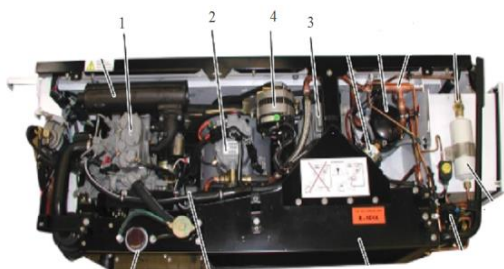
Photograph No. 27. Typical truck-mounted refrigerator unit

The fuel for the combustion engine is fed by a fuel pump located directly on the truck fuel tank, whereby the unit itself is not equipped with a separate fuel tank and its design does not

⁴ Current valid certificate of technical inspection was provided for the truck. The refrigerator unit underwent technical inspection less than a week before the accident. The commission noted that the inspection concerned only the combustion engine of the unit's drive (and included replacement of filters and oil) and did not cover the replacement or inspection of the belt gear drive or its components.

use any materials supporting combustion. In case of transporting the refrigerator truck on a ferry and use of the ship's power supply system, the refrigeration unit is not provided with any alarms warning about malfunctions. It is virtually impossible for the vessel crew to check whether a refrigeration unit works correctly due to the fact that it is impossible to check readouts from the recorder in the driver's cabin, as then cabin remains locked during the transport onboard of the ferry⁵.

Refrigeration unit of the SCANIA truck (maker: Carrier Supra 850 Nordic – its main components are shown in photograph No. 28) suffered considerable damage during the fire (photograph No. 29) and, after the fire, was taken away from the refrigeration chamber.



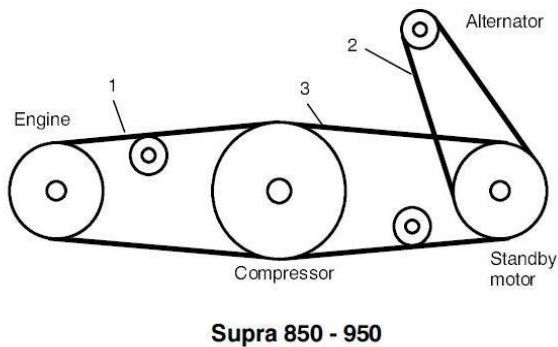
Photograph No. 28. Carrier Supra 850 refrigeration unit; its respective components are marked as follows: 1 – Diesel internal combustion engine, 2 – cooling compressor, 3 – electric motor, 4 – alternator



Photograph No. 29. Burnt refrigeration unit and truck's cargo space

The drive transmission between the electric motor, cooling compressor, Diesel internal combustion engine and the alternator is effected via a belt gear equipped with belt wheels, 5 V-belts and 2 V-belt tensioners.

⁵ The ferry crew during their patrols in the vehicle space that were conducted in accordance with procedure No. SOM-0050 every 1.5 hour, did not notice any signs of smoke or malfunctioning of the refrigeration unit.



- 1- Engine to compressor V-belt
- 2- Alternator V-belt
- 3- Standby motor to compressor V-belt

Figure 3. System of V-belts of the belt gear drive transmission of the Carrier Supra 850 refrigeration unit

A specialized refrigeration unit inspection after the fire showed⁶ that one of the compressor drive V-belt tensioners was completely blocked (photograph No. 30).

Blocking of the belt wheel of the V-belt tensioner could cause friction generating large amount of heat that resulted in the ignition of the belt's rubber material and occurrence of open fire, causing the ignition of the unit's plastic components. This caused the fire to propagate to refrigeration chamber's insulation and entailed damage to vessel system components installed under the cargo space ceiling. The rubber V-belts were fully completely burnt, with only a small remnant of a charred V-belt surviving the fire (photograph No. 31).



Photograph No. 30. Blocked belt wheel of the V-belt tensioner



Photograph No. 31. Charred portion of the V-belt

Defective operation of the refrigeration unit belt gear drive caused overheating and melting of insulation of the electric conductors, resulting in short-circuits and, consequently, open fire. The fragments of wires from the refrigeration unit's electrical system bearing signs

⁶ Damage assessment No.: 1818959284-200. The report was prepared by an expert from DEKRA Automobil GmbH from Hamburg, after conducting the examination on 14 November 2016.



of fire in the form of melted copper and charred insulation showed in the detailed crystallographic examination⁷ that the sample of electrical wire bundle in the structure of collected metallographic sample is characteristic for melting occurring in oxygen-rich atmosphere, i.e. one that is present before a fire breaks out. This suggests that the fire could occur as a result of occurrence of short-circuit currents, e.g. as a result of refrigeration unit overload during its operation with a faulty V-belt tensioner.

The entire refrigeration unit together with electrical equipment and control cubicle was installed in a steel frame mounted inside the roof of the refrigeration chamber, behind the driver's cabin. The refrigerated cargo chamber was covered with polyester and fiberglass laminate with polyurethane foam and glass mat. These materials are fire-retardant, however after reaching certain temperature, they become flammable and generate large amounts of heat and smoke.

A factor contributing to propagation of the fire to the ceiling of the vessel's vehicle space was the proximity between the truck's refrigeration unit and the cargo space ceiling and vessel systems and pipelines suspended under that ceiling (approx. 40 cm).

The flames spreading in the area of the truck's refrigeration unit reached the systems located under the vessel cargo space ceiling after ca. 20 minutes. Directly above the truck, there was a large number of hydraulic steel pipelines connected with screw joints, including those related to mooring winch and stern door drive systems⁸. As a result of vibrations propagated by the hull structure to the pipelines and due to high temperature, depressurization of pipeline joints could occur and leaking oil could ignite upon contact with hot refrigeration unit components⁹.

Analyzing probable causes of flaring up in the second stage of the fire Commission took into consideration possibility of creation of the mixture of flammable gases as result of rising

⁷ Opinion No. E-met-26/16 of the Central Forensic Laboratory of the Police.

⁸ These pipelines were, according to crew's clarifications, not used at the time of accident and were inoperative; their former function during previous years of ship operations was to lower and raise vehicle side decks in the vehicle cargo space No. 3. Although the pipes were decommissioned, inside these not used pipes it could remain some old hydraulic oil, which has not been removed from them.

⁹ After disconnection of the refrigeration unit's power supply, the fire from the V-belt should diminish and the temperature should be reduced. Considering the fact that the refrigeration unit and the refrigeration chamber roof contained virtually no flammable materials, it is highly probable that the flammable material supporting the relatively small fire for ca. 20 minutes in its initial phase was oil dripping down from a leaking hydraulic pipeline. The pipelines were not secured with any protections against potential oil leak. The hydraulic systems of the ship were filled with RANDO HDZ 32 oil. Based on Material Data Safety Sheet, item 9 (Physical and chemical properties), the ignition temperature of this oil equals 196°C, while spontaneous ignition temperature, based on general information available for hydraulic oils equals approx. 300°C.

temperatures but rejected it as not likely to occur. In opinion of Commission, it is highly likely that it was the contact of the hydraulic oil with hot components of the refrigeration unit that caused the second phase of the fire, when the temperature of hot oil exceeded its spontaneous combustion temperature¹⁰.

While the fire in its first phase was relatively minor and was developing slowly for more than a dozen minutes (and it could have been easily extinguished), in its second phase the fire developed rapidly. The images from two CCTV cameras reveal something similar to an explosion, clear flashes and sparks falling on the floor, as well as flames reaching the ceiling of the vehicle space across the entire width of the vehicle's roof (photograph No. 9).

The "explosion" was probably caused by hydraulic oil pipeline eruption above the fire location, with the leaking oil feeding the fire that spanned the entire width of the vehicle's roof. The fire temperature was high enough to cause the paint to burn and the deck steel plate to deform directly above the fire source (photograph No. 18).

As a result of the fire, the electric cables suspended under the ceiling were burnt and part of the hydraulic pipelines were damaged (photographs Nos. 32 and 33).

The damage to the pipelines consisted of their deformation, loosening of fasteners as well as mechanical circumferential rupture which caused them to be unsealed.



Photograph No. 32. Damaged hydraulic system pipelines

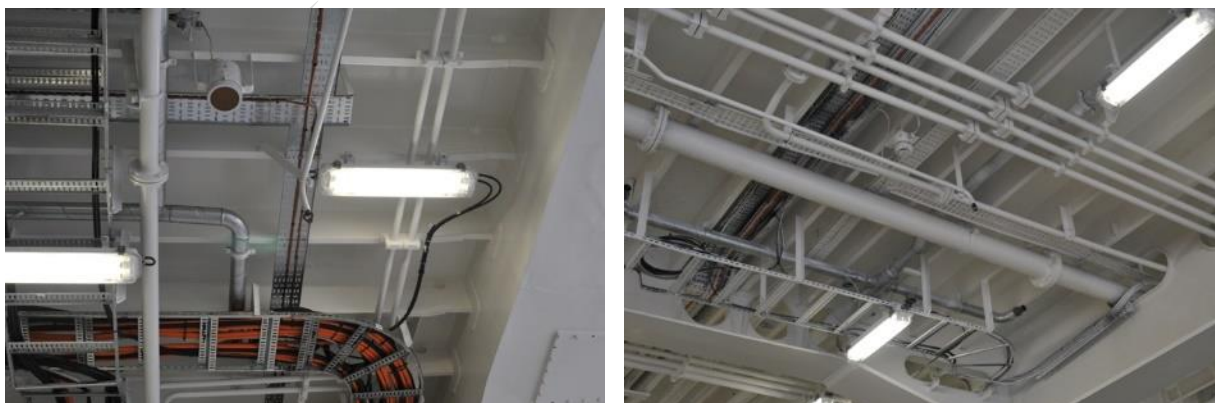
¹⁰ Such scenario of development of the second phase of the fire is highly probable, as during the operation of the vessel, the hydraulic pipelines and their connections most like have never been leak-tested. During inspections, in order to confirm or renew vessel class, such tests were not required by the classification society.

As a result of the fire, probably further hydraulic oil pipelines cracked and leaked oil that, in turn, maintained the fire in another spot on the vehicle roof which is confirmed by the second spot of burnt paint on deck no. 5 (photograph No. 18).



Photograph No. 33. Hydraulic pipeline cracked and deformed as a result of the fire

Part of the pipelines, including the piping of an inoperative hydraulic system formerly used for operation of the car side decks, were disassembled during the repairs of the ship at the repair yard, as shown in the photographs taken after the repairs (photograph No. 34).



Photograph No. 34. Ceiling of the car deck no. 3 in the place of the fire

Immediately after the fire was put out and the refrigerator truck removed from the cargo space, the firemen did not notice the oil leaking from the pipelines under the ceiling either on

the vehicle roof or on the deck; this is most probably due to the fact that the oil had leaked and burnt completely and, if it reached the deck, too, probably due to the fact that it could have been washed away by water from the operation drencher system and from the fire hose jets.

After the analysis of the effects of fire in the truck cabin, the Commission rejected a possibility that the fire was caused by electric devices found in the cabin, i.e. plugged-in laptop charger or electric kettle (photographs Nos. 35 and 36). The damages in the truck cabin were caused, in the Commission's opinion, as a result of fire propagation from the refrigeration unit to the rear part of the driver's cabin and from above through the damaged sunroof.



Photograph No. 35. Plugged electric device charger (pilot light on)



Photograph No. 36. Burnt computer (laptop)

The commission also excluded a possibility that the fire was caused by damage or short-circuit in the ship's power supply system. The electric cables to connect and power the refrigeration units of refrigeration trucks were arranged along the ship under the cargo space ceiling, on cable reels. The plug and plug socket were not damaged after the fire, were in good technical condition and could not pose a fire hazard (photograph No. 37).



Photograph No. 37. Electric cables with plugs for connection of a refrigeration unit to ship's power supply system and truck's socket for cable connection



4.2. Human factors (errors and omissions)

The Commission found that the errors made by the crew during the first phase of the refrigeration unit fire were decisive to the development and course of events of the fire. Erroneous qualification of smoke presence as only the result of malfunction of the belt gear's belts allowed the fire to develop at ease for around 20 minutes.

Based on collected evidence, including the information from the VDR and CCTV records, the Commission found that the activities of the crew related to the firefighting operation were inadequate to the occurring fire hazard.

The crew did not observe the images captured by CCTV cameras on which smoke and fire were visible for 3 minutes and became aware of the fire only when the smoke detection system had been activated. After activation of the smoke alarm on the bridge and identification of the area where the detector was activated, the crew failed to implement adequate and professional actions.

Despite sending 3 crew members to the fire location in the vehicle space, who stood next to a burning vehicle, for around 15 minutes they failed to take any actions to determine the source of fire and to extinguish it. None of them attempted to determine the source of smoke present above the vehicle roof or to evaluate the hazard, e.g. by climbing to the box in the vicinity of the truck, to its left (seen on the photographs).

The relatively small, initial fire which developed for more than a dozen minutes and identified by the crew as smoke caused by the truck refrigeration unit's V-belts, could have been easily extinguished, if it has been properly evaluated¹¹.

When after more than a dozen minutes the fire developed into a second phase and propagated rapidly, no crew member was present around the truck for about 4 minutes. By then, the fire had become so clear (flames reaching the ceiling across the entire width of the truck's roof) that it could not have gone unnoticed even from the far end of the vehicle space or on the image captured by the CCTV cameras. No crew member observed the CCTV images at that time

In the Commission's view, after detection of smoke, a fire fighting team should have been formed and sent to the fire location equipped with breathing apparatuses and protective

¹¹ Analyzing the actions of the crew, the Commission tried to find answers to question why the crew, despite disconnecting the ship's power supply to the truck, did not reflect upon the fact that the amount of smoke in the cargo space increased and why the crew did not look for the source of the smoke, instead trying to remove the smoke using the ventilation system. The Commission did not find such answer based on the crew's clarifications or collected evidence.



clothing to the truck engulfed in smoke, ready to undertake adequate firefighting activities. The place of origin of the smoke, i.e. the refrigeration unit, should have been covered with firefighting agent and isolated from cables and ship system by covering with e.g. fire blanket, suppressing oxygen access and protecting ship systems under the ceiling against the impact of high temperature.

If the crew acted in the manner described above, the fire would not develop into second phase, i.e. damage to hydraulic pipelines and leak of the oil that additionally supported the fire and, consequently, the damage to ship systems.

After identification of the smoke source, the crew also failed to call the truck driver to open the cabin and obtain any information related to fire hazard, including but not limited to potential flammable materials in the driver's cabin. If the driver had been called to the car deck, the firemen would not have to break into the truck's cabin later at the wharf to extinguish the materials still smoldering there.

In the Commission's view, the omission of the crew was that the crew did not prevent the passengers to enter the car deck during the firefighting operation. At 07:06 by when it had been known that the truck was on fire (duty watchman reported to the bridge on the ineffective truck extinguishing efforts using the fire extinguisher), passengers with their travel luggage could be seen at the stern in the area of the open upper stern door on deck no. 5 as images captured by the CCTV camera shown.

A sudden surge of dense smoke from the ventilation ducts from deck no. 3 occurred just three minutes later in the exact place where the passengers had stood. If the smoke appeared there several minutes earlier, it would pose a major hazard to the health of these passengers.



Photograph No. 38. Passengers in the vehicle space on deck no. 5 during the firefighting operation, in the place where smoke was appearing

In the view of the Commission, it was a serious error of the crew to attempt to remove the smoke from the vehicle space by activating ventilation (air supply and air extraction) without determining the source of the smoke beforehand. According to generally recommended practice of firefighting, until it is confirmed that the fire had been completely extinguished, no ventilation in the space concerned should be activated and the air inlets to such space should remain closed. The crew members not only did not fail to comply with these rules, but they also disobeyed the master's instructions, who ordered that particular attention should be paid when activating the ventilation system.

After activation of the drencher system, the crew did not close the ventilation outlets from the vehicle space which caused the smoke to flow to the open deck and allowed air supply to the fire.

One of the instructions issued to the crew from the bridge was to engage the drencher system. Apart from sections No. 1 and 2 necessary to fight the refrigerator truck fire on deck no. 3, also section No. 3 on the same deck was engaged, further followed by sections Nos. 13, 14 and 15 on deck no. 5.

Such activation of additional sections is against the rules of operation of the drencher system. The system is normally designed so that due to limited output of the feed water pump and available power, it allows for simultaneous operation of two adjacent sections, not



multiple or all sections at the same time. This is caused by limitations in the drencher system feed water pump, as well as selection of pipelines and nozzles. Simultaneous activation of several (in this case – as many as six) sections causes the water output to divide among a larger number of nozzles, thus reducing the required water spraying intensity and pressure at the nozzles within the section which is located directly above the item (vehicle) to be extinguished, thus rendering the extinguishing ineffective.

Engaging several sections was not in line with ship's own procedures, as it does not ensure minimum required water supply intensity¹². In the Commission's view, the ship's crew were unaware of the limitations concerning simultaneous activation of a maximum of two sections that would ensure effective extinguishing of the fire¹³.

4.3. Organizational factors

The organizational factors that affected the course of events related to detection, spreading and extinguishing of the fire were, in the Commission's view, as follows: lack of detailed procedures for the crew in the event of a refrigerator truck fire, lack of (interruptions in) communication on the VHF radio operating frequency in the vehicle spaces at the ship's stern, equipment of this space with only smoke detectors, lack of device onboard of the ship to adequately assess fire hazard, such as IR imaging camera and lack of adequate escape routes from the vehicle spaces.

Lack of detailed procedures for the crew in the event of a refrigerator truck fire resulted in a situation that crew activities to detect the source of the smoke was carried out at discretion of person sent for this purpose to the car deck and was inadequate to the hazard existing upon detection of the smoke from the refrigerator unit in the truck.

The *Stena Spirit* had available emergency response procedures for the crew collected in the Safety Management Manual of the ship and in related documentation. The emergency response procedure in the event of a fire in the ro-ro spaces is defined in the following

¹² Based on the applicable requirements set out in the IMO A.123(V) (Recommendation on fixed fire extinguishing systems for special category spaces) the minimum water supply intensity to ensure effective fire extinguishing should be 5 l/min/m² of surface area of the space protected against fire. It is a value admissible on existing vessels (such as *Stena Spirit*), but it was increased thrice for new-built ships and is equal to 15 l/min/m².

¹³ The ship's drencher system operation manual defines that during extinguishing of a fire in vehicle rooms, only two system sections may be supplied with water any given time.



procedures: SMM-0241 (*Fire Car Deck - General*), SOM-0158 (*Use of Drencher Facilities on Car Deck*) and DS-0715 (*Fire Outside Engine Room*)¹⁴.

In the Commission's view, these procedures are too general. They do not provide a detailed procedure in the event of various types of fire emergency (e.g. refrigerator truck fire). Procedure No. SMM-0241 (*Fire Car Deck – General*) refers in its content to a fire hazard that may arise during transport of refrigerator trucks, but only by reference to other documents contained in the Safety Management Manual. One of these documents is the procedure No. SMM-0187 (*Refrigerated Units*), but its content covers only the matter of connection of refrigeration units to the ship's power supply system and time at which they should be disconnected, and does not cover the crew's behavior in the event of a fire.

The ship's procedures do not define when a situation may be considered an emergency – whether it is after the detection of first signs of fire, such as smoke, or only after the fire source had been identified in the form of fire, high temperature and smoke.

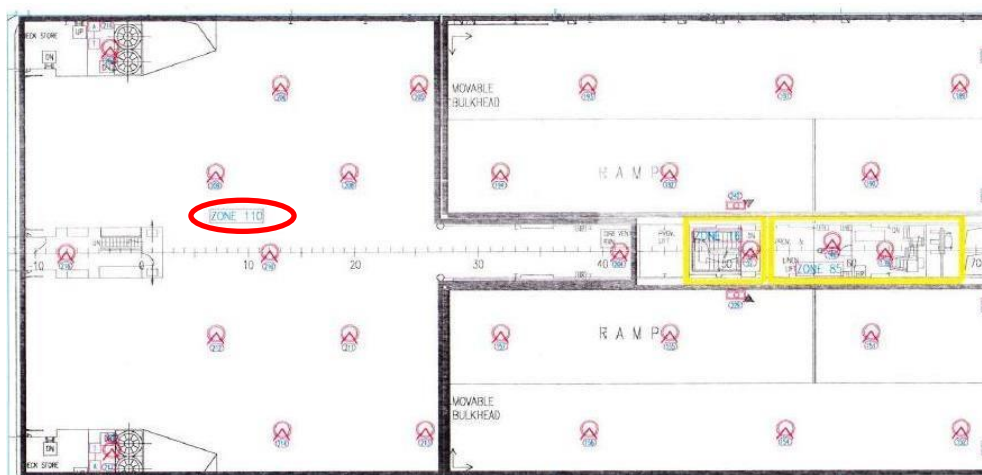
In case of the investigated refrigeration truck fire, it took almost 20 minutes between the moment of smoke detection by the watchman and emergence of an open fire over the vehicle (photograph No. 9). The crew members who were present next to the vehicle took virtually no actions. After those 20 minutes, when rapid fire appeared, it was no longer possible to control the fire with hand-operated firefighting equipment.

The existing ship procedures did not stipulate the necessity to close all fire dampers and ventilation inlets to the vehicle space immediately after the fire occurs, in order to shut-off the access of air that maintained the fire and to prevent ingress of smoke to open decks on which passengers could have been present.

Reading the data from the VDR of *Stena Spirit*, the Commission noticed that the communication between officers on the bridge and crew members at the aft part of the car deck No. 3 was difficult and had been interrupted several times due to insufficient range of VHF radio waves in this area. It follows from the communications by the crew on the bridge that the problems with communication on the ship were known previously and had not been solved. In the Commission's view, the difficulties in ensuring adequate communication after detection of the fire contributed to the fact that the firefighting operation was not fully effective.

¹⁴ The ship procedures are appended as Annexes 6-9.

The Commission is of opinion that installation of only smoke detectors on the car deck no. 3 (no heat or flame detectors installed), although this is not required by the rules, could contribute to the delay in activation of the fire alarm. As it follows from the images captured by the CCTV camera, the fire over the refrigerator truck appeared 3 minutes before the activation of smoke detectors. Furthermore, in the fire zone No. 110, there were no detectors on the starboard and port side in the aft part of the ship (close to the stern doors), as they were located more than a dozen meters further towards the bow, starting with the frame No. 7. This also most probably contributed to the delay in their operation (photograph No. 39).



Photograph No. 39. Arrangement of smoke detectors on the car deck no. 3 – aft part, in the place where the smoke detector was activated - zone 110

In the vehicle spaces, adequate evacuation routes should be ensured for passengers and, at the same time, access for firemen to transported vehicles during firefighting and rescue operations.



Photograph No. 40. Trucks parked close next to each other on deck no. 3



Photograph No. 41. Fireman squeezing between the truck and a wall



During the fire fighting and rescue operation, the firemen from the Port's Fire Brigade, with dense smoke and operating drencher system and visibility reduced to approx. 1 m, wearing breathing apparatuses and protective clothing, were forced to search vehicles after it became known that two car drivers who had been earlier sent to the car deck were not accounted for. The firemen considered the conditions of this operation as extremely difficult, primarily due to lack of adequate access to vehicles which were arranged in rows that were too close to each other.

Based on the reports from shore service firefighters taking part in this operation and photographs taken after the fire, the Commission found that there were no evacuation routes designated in the vehicle space.

The Commission is of opinion that an adequate-width escape routes arranged between the rows of transported vehicles are essential during the fire fighting and rescue operation on the car decks.

4.4. Structural fire protection of the ship

Based on the analysis of the fire (smoke) propagation effects and analysis of the fire protection plan of the *Stena Spirit*, questions arise as to whether the walls and doors of the ship which constitute divisions between the vehicle space and other rooms of the ship indeed ensure fire safety. According to the Commission, they fail to meet the requirements of the SOLAS 74 Convention regarding structural fire protection¹⁵.

The smoke from the vehicle space moved to the passenger rooms, posing a hazard to passenger safety. Penetration of smoke from the cargo space to the staircases and further to passenger rooms could have resulted from lack of tightness of doors, cable penetrations and ventilation ducts located in the vehicle spaces, caused by their inadequate structure or it resulted from maintaining the door to the vehicle space open (photograph 42) and of the passenger lift doors being open which allowed the smoke to flow from the cargo space to staircases and to the lift.

¹⁵ In accordance with the requirements of regulation No. II-2/37.1.2 of the SOLAS 74 Convention (for ships existing, in accordance with amendments introduced under the MSC.24(60) resolution, defined in Regulation No. 41-2.6.4, the special category spaces should meet the requirements set out in Regulation II-2/37 - amendments of 1981), the vertical divisions enclosing special category spaces should be isolated as required in table 26.1 for category (11) spaces, while the horizontal division (decks), as required in table 26.3 for category (11) rooms. It means that all walls and decks surrounding a special category space, including the doors and cable, piping, etc. penetration should be of at least class A-0, i.e. in accordance with the definition laid down in regulation II-2/3(c) they should prevent passage of smoke and flame until the end of a 1-hour standard fire test.

After the activation of the fire detection system, the blocked entrance door to the vehicle space was unlocked automatically. According to the information obtained from the crew, the passengers waiting to enter the car decks to their cars, started to open the doors and enter the space which could result in smoke flowing to the staircase. Such design solution of the fire detection system is inadequate, as it poses a risk of exposing passengers to effects of fire in a vehicle space.



Photograph No. 42. Automatically closed door dividing the car deck from the staircase to passenger rooms

Due to smoke presence, the master decided to evacuate the passengers to muster points. It means that the staircase with doors and lift shafts did not provide adequate class A-0 fire resistance or that the doors from the vehicle spaces to the staircases could remain open for a certain period of time. Irrespective of why the smoke penetrated to further spaces, the ship's fire protection plan does not indicate that the walls with doors separating the staircases from the vehicle spaces are class "A" divisions.

Based on the readout of the voice recorded by the VDR, the Commission determined that already at the initial fire stage, the reception hall area being a crucial point of contact with passenger, was contaminated with smoke. The reception hall on deck no. 7 was contaminated with smoke from the staircase to car deck no. 3 and, probably, via the passenger lift shaft.

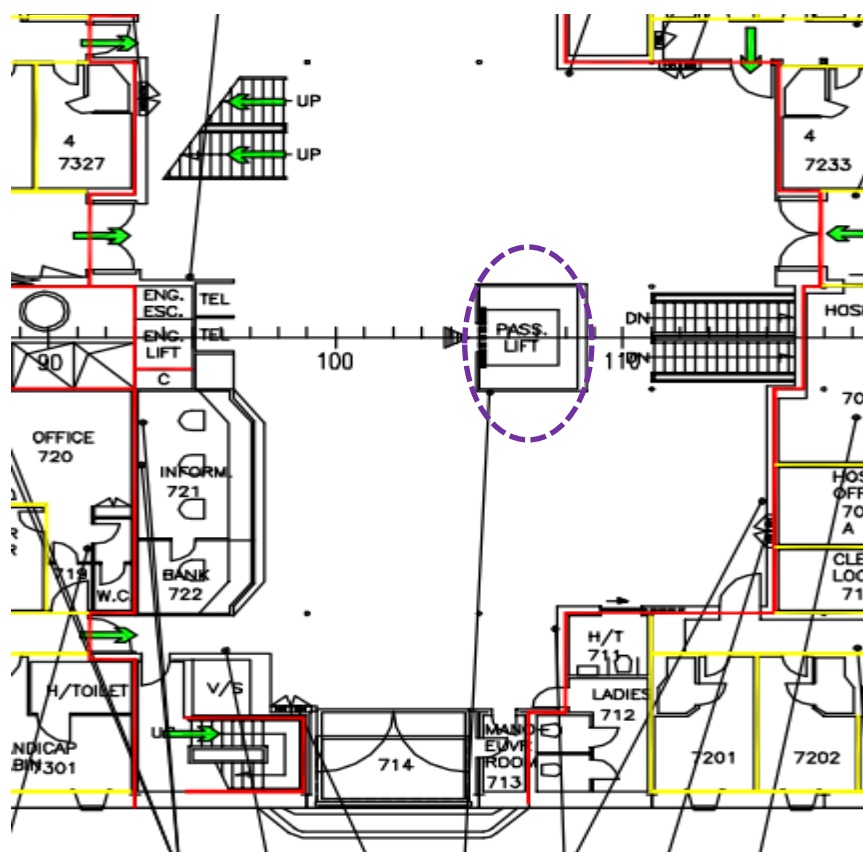


Figure 4. Deck no. 7: Passenger lift shaft (frames 105-109) in the reception hall is not marked as the class "A" division

The staircase on the car deck no. 3 and lift shafts are not, according to the fire protection plan, separated vertically with class "A" divisions.

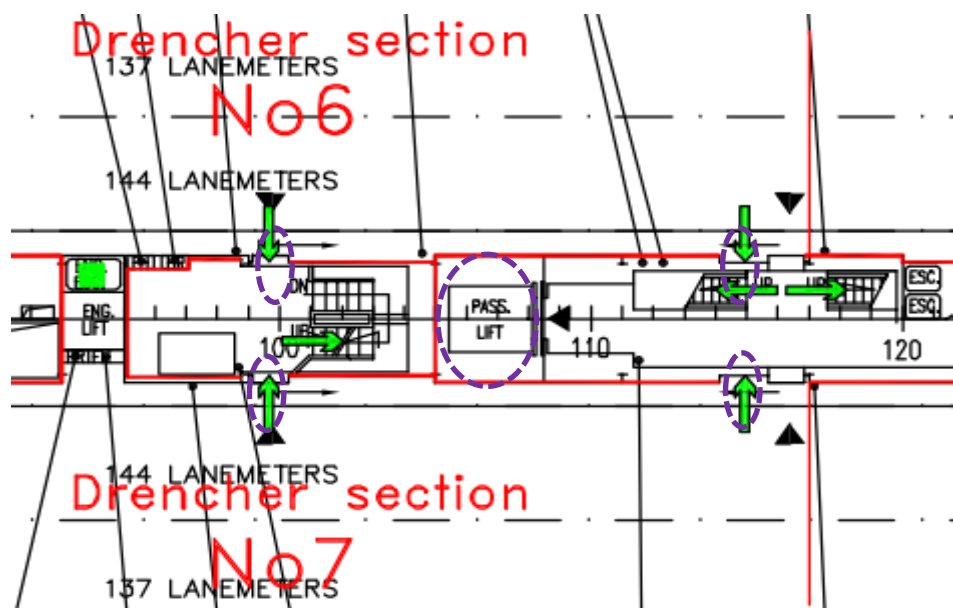
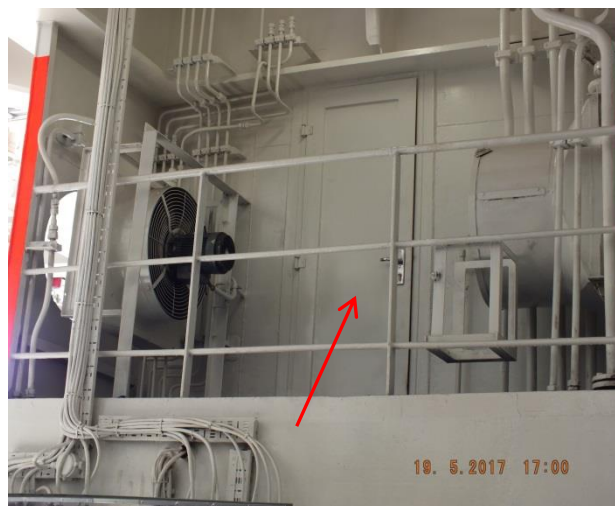


Figure 5. Deck no. 3: doors to staircases and passenger lift shaft are not marked as the class "A" divisions

As a result of the smoke, exit doors from the space with electric device cabinets (above the steering gear room) to deck no. 4 in the aft part of the ship have become charred. It means that the doors were not of class A-0 fire resistance and, therefore, that the ship structure did not comply with the requirements of the SOLAS Convention.



Photograph No. 43. Charred door in the electric equipment room



Photograph No. 44. Door on the deck side (after repairs)

On the fire protection plan of the ship, the walls and doors separating the room with electric equipment from the vehicle space are not marked as class "A" divisions.

The smoke from the vehicle spaces was escaping to the open deck at the stern (photograph No. 11). It may mean that the crew failed to close the air outlets from the vehicle spaces at the

stern either by omission or because the closing mechanisms of fire dampers in the ventilation ducts (remote controls of such dampers) were inaccessible due to effects of the fire, i.e. presence of smoke in these rooms.

According to the fire protection plan, the fire dampers of the ventilation ducts and their controls are located in spaces inside the cargo rooms which are not separated with class "A" divisions (example of such space is shown in figure No. 6 and in photographs Nos. 43 and 44) which means that the walls are not air-tight and that the smoke may flow into these spaces. This again means that the design of the walls of these spaces does not meet the requirements set out in the SOLAS Convention.

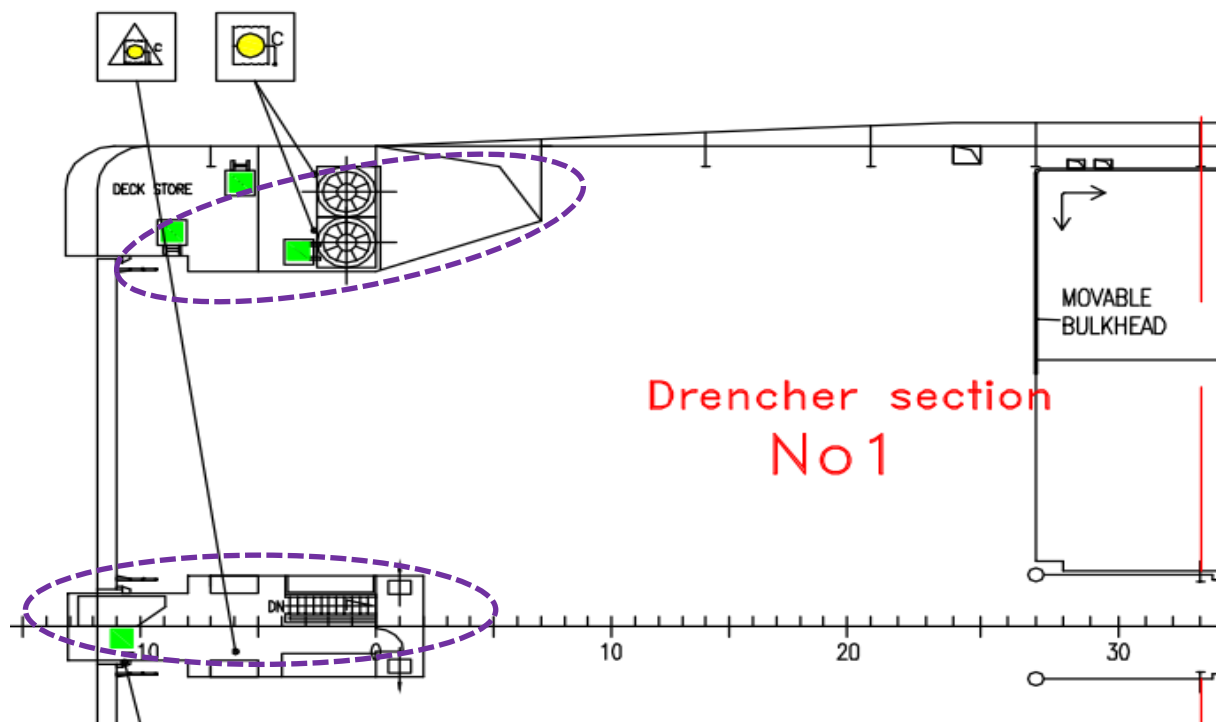
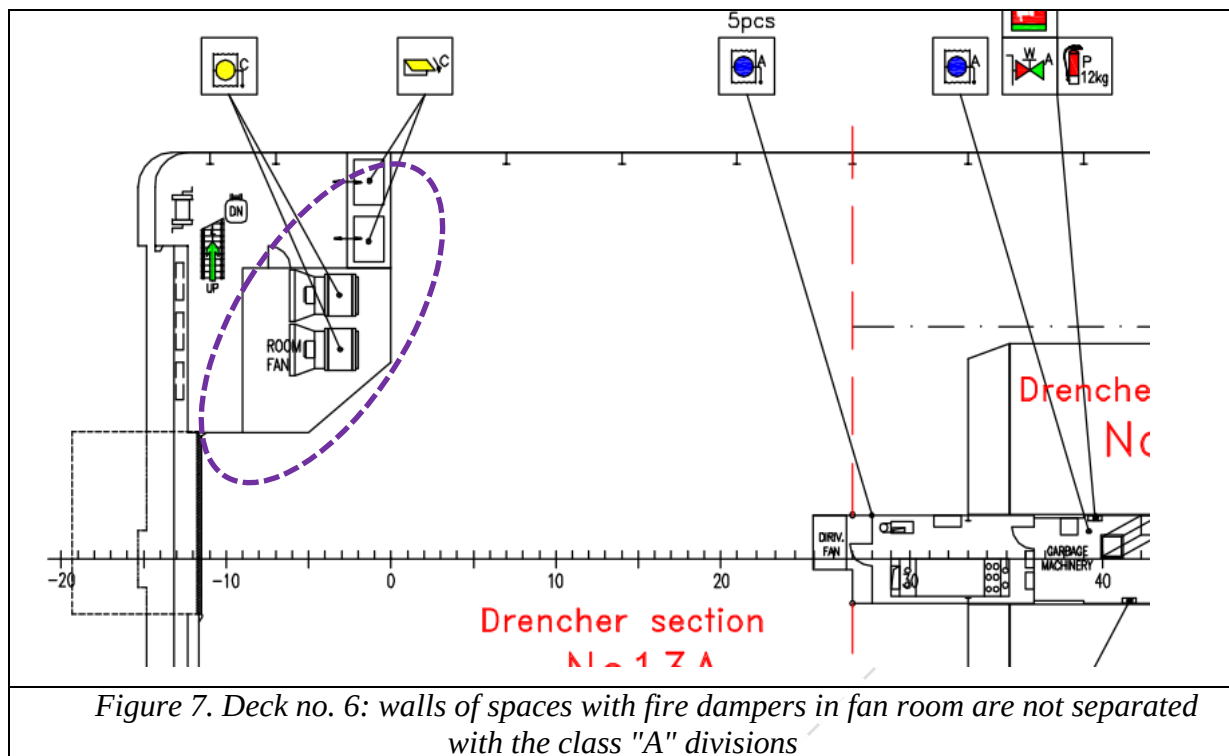
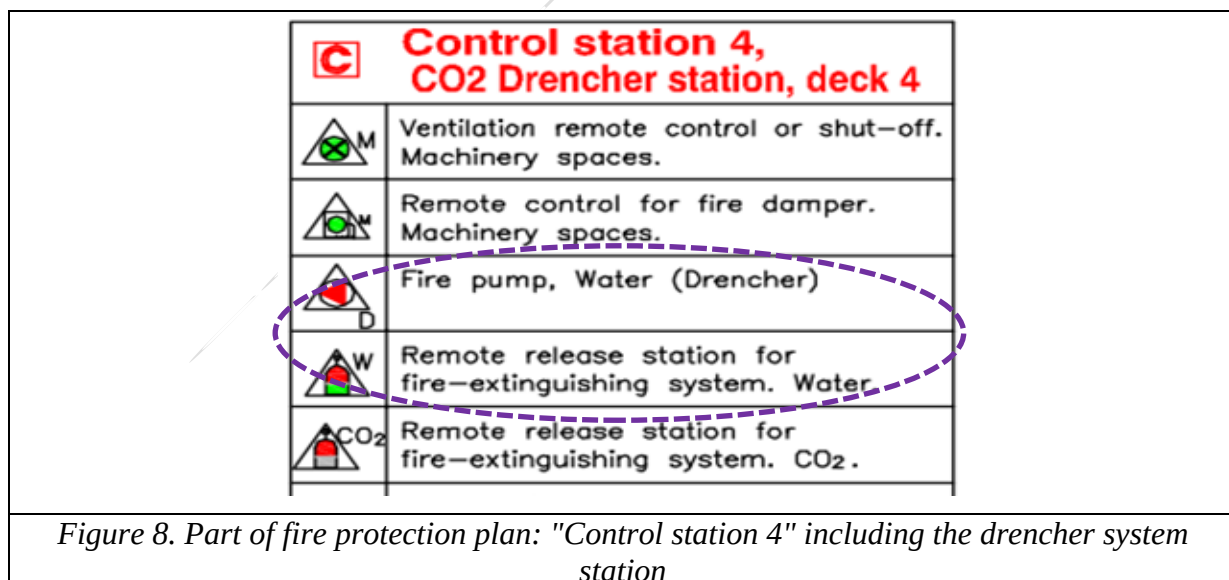


Figure 6. Deck no. 4: walls of spaces (under the cargo space ceiling) with fire dampers in vehicle space ventilation ducts are not separated with the class "A" divisions

Similarly on deck no. 6, according to the fire protection plan the fan room walls at the stern are not separated from the cargo space with class "A" divisions which may have caused the smoke to penetrate to the cargo space to this deck.



According to the fire protection plan of the ship, the drencher station is located on deck no. 4 at frames 125-143 in the ship's centerline and is provided with entrance doors directly from the staircase.



Both the entrance doors to the staircase from the car deck and the door separating the station and staircase are not marked as class "A" which may lead to a conclusion that the staircase and drencher station does not meet the requirements of the SOLAS Convention.

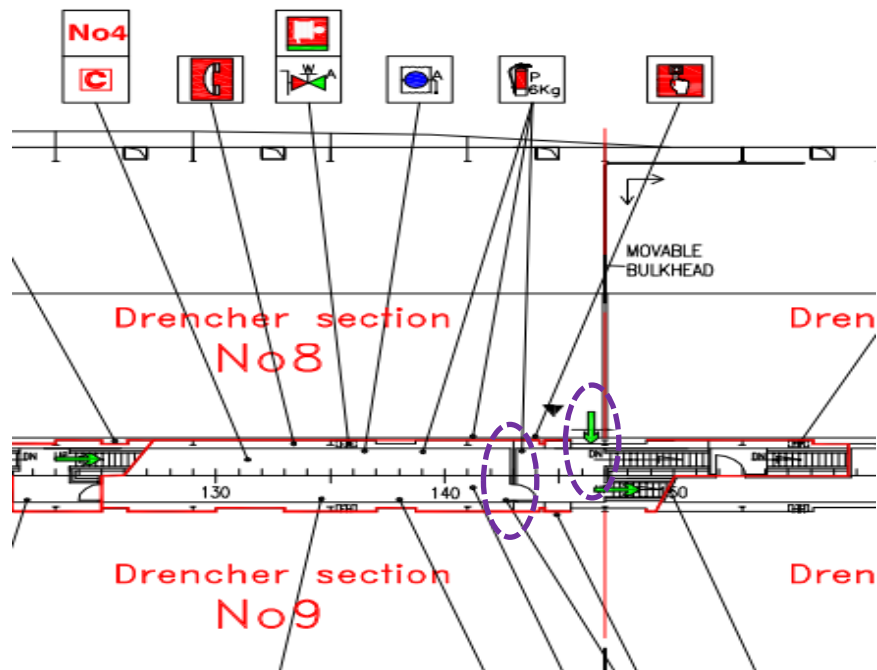


Figure 9. Deck no. 4: entrance door to the staircase from the car deck and wall with doors at frame No. 143 separating the drencher station from the staircase are not marked as the class "A" divisions

Because the wall and door designs as well as the lift shaft casing which constitute a division of the vehicle space from other spaces of the ship could have not formed a class "A" division, they consequently may have not ensured adequate fire protection.

In the opinion of the Commission, the ship should have been inspected by a recognized body in the scope of verification of structural fire protection for conformity to requirements of the SOLAS Convention and the discovered non-conformities should have been removed. It is indicated that during the inspection in the vehicle space, a "fake smoke" is used and, after overpressure is created in this room, potential leak points are identified through which the smoke may penetrate to adjacent spaces.

4.4.1. Protection of pipelines containing pressurized flammable liquids

On the ferry *Stena Spirit*, hydraulic pipelines with pressurized oil (ca. 250 bar) were routed in the vehicle spaces and were not provided with any protections against oil leaks to vehicles being transported.

In the stern part of the ship where the vibrations from e.g. propellers are transferred to the ship structure, the pipeline joints are particularly susceptible to depressurization and leak of oil under high pressure onto transported vehicles.



Photograph No. 45. Hydraulic system pipelines routed under the ceiling

The SOLAS'74 Convention in its Regulation No. II-2/33 entitled "Liquid fuel, lubrication oil and other flammable oil systems" in item (c) "Arrangements for other flammable oils" states that: *Arrangements for the storage, distribution and utilization of other inflammable oils employed under pressure in power transmission systems, control and activation systems and heating systems shall be such as to ensure the safety of the ship and persons on board. In locations where means of ignition are present, solutions must be at least comply with the requirements specified in sub-paragraphs (a) (iv) (2) and (a) (vi) and with the provisions of subparagraph (a) (viii) in respect of strength and design, of this Regulation.*

Despite the fact that the Convention does not say explicitly about securing by covers of hydraulic pipelines leading inside the vehicle spaces, against the oil spill on the transported cars, however, bearing in mind the threat that could pose oil leaking directly to potential ignition sources of transported vehicles, it is reasonable that pipelines, other than those manufactured as completely welded (ie. jointed couplings), are protected by shelters against leakage of oil.

4.5. Analysis of the ship safety plan

With a view to the date of keel laying of the ship *Stena Spirit*, ie. 31 August 1981, a ship construction and equipment for fire protection should meet the requirements of Chapter II-2 of SOLAS 1974., as amended, and the ship safety plan for the part concerning the fire protection should be made under Regulation II-2/15.2.4 of the Convention of 2000 (Resolution MSC 99(73)), and reflect the fulfilment by the ship of all the applicable requirements.

On the day of the accident the ship was posted safety plan (Annexes 2-4) covering fire protection, stamped by Lloyd's Register EMEA stamp "EXAMINED" for compliance with Regulation II-2/15.2.4 of SOLAS, dated 10.04.2013 (photograph No. 46)¹⁶.

Following that analysis, the Commission found numerous deficiencies and unconformity on the plan with the requirements of the SOLAS Convention. The plan does not show that the vessel meets the requirements of the SOLAS'74 Convention, as amended, and does not contain all the necessary information. There is a lack of certain symbols required in accordance with IMO Resolution A.952(23), cited in the Convention.

 Lloyd's Register EMEA A member of the Lloyd's Register group Copenhagen Design Support Office EXAMINED EXAMINED and found to be in compliance with the International Conventions for the Safety of Life at Sea 1974 (as amended) Chapter: II-2 Regulations: 15.2.4 Chapter: III Regulations: 6, 7, 21, 22, 24, 26, 34 DAD No.: S/1103713 Date: 10.04.2013 Initials: MHE This document has been processed electronically and it is therefore valid without any signature.			
C	REV. DATE	2013-03-25	UPDATED AND REBUILD
B	REV. DATE	2011-06-18	UPDATED AND REBUILD
A	REV. DATE	2009-01-22	Lifebuoy dk3&dk5, Liferaft only for practice dk10
 LEXIDOR MARIEHOLMSGATAN 54 415 02 GÖTEBORG TEL.+46 31 7076099 www.lexidor.com	DATE	2013-03-25	SHIP/PROJECT STENA SPIRIT
	SCALE	1:200	DECK No. 10 - 12, Profile
 Stena Line			TITLE FIRE PROTECTION APPLIANCES & STRUCTURAL FIRE PROTECTION PLAN Life Saving Appliances & Means of Escape route plan

Photograph No. 46. Ship fire protection plan with a stamp of Lloyd's Register EMEA

¹⁶ On the basis of information from Lloyd's Register, an earlier version of the plan, revision B, with no difference regarding fire protection was approved by the Swedish Authorities (former State Flag Authorities) in June 2011.



The Commission has formulated eight fundamental comments to the ship fire protection plan.

- I. The plan does not show the division of the vessel into main vertical and horizontal zones, separated by the main fire resisting divisions (MVZ) and does not determine numbers of these zones to enable their identification. In case of the fire zones marking and identification is important so that the crew can carry out the evacuation of passengers from the area covered by the fire to another zone. In addition, no indication of the zones makes it impossible to assess whether each main vertical zone is provided with the required number of sets of fireman's outfit and emergency escape breathing devices.
- II. The plan does not determine all the required "A" class fire divisions between the different compartments (regions) of the ship, for example: staircases, machinery spaces, the engine room, the emergency generator room, the paint locker, as well as the walls of the superstructure – with passenger compartments adjacent to the weather deck constitutes escape routes and lifesaving means.
- III. In "A" class fire divisions the self-closing doors are not shown, required in the main fire divisions, staircases and the entrances to the engine room; there is no symbol of such doors on the plan as well as symbol of watertight doors.
- IV. In the machinery spaces and special category spaces there are not shown the primary and secondary escape routes; on the open decks there is not shown the direction of escape to the lifesaving means.
- V. On the plan, there is no information that the accommodation spaces, corridors and staircases are equipped with an automatic sprinkler system; not showing the location of the sprinkler system sections and location of sprinkler section valves.
- VI. The plan does not show the location of ventilation fans serving individual areas of the ship with their identification numbers.
- VII. There is lack of information about the year of construction of the ship, the number of passengers carried, carried out modernization of the ship and if the ship met the requirements contained in the retroactive amendments to the SOLAS Convention.
- VIII. The drencher station is not shown properly on the plan. The numbering of drencher system sections on a fire protection plan does not comply with the numbering of these sections on the operating instructions of this system.

Over a dozen examples of non-compliance of the information on ship's fire protection plan with the requirements of SOLAS 74 Convention for the ship, the Commission gives below.

1. **Main vertical zones and horizontal zones.** The SOLAS 74 in Regulation II-2/18 (a) states: *The hull, superstructure and deckhouses shall be subdivided into main vertical zones by "A" Class divisions.* On the ship's fire protection plan of the vessel, some walls, as well as practically all the doors in the class A walls separating the staircases from the car room are not marked as class "A". On the plan there is also lack of numbering of the main vertical zones.

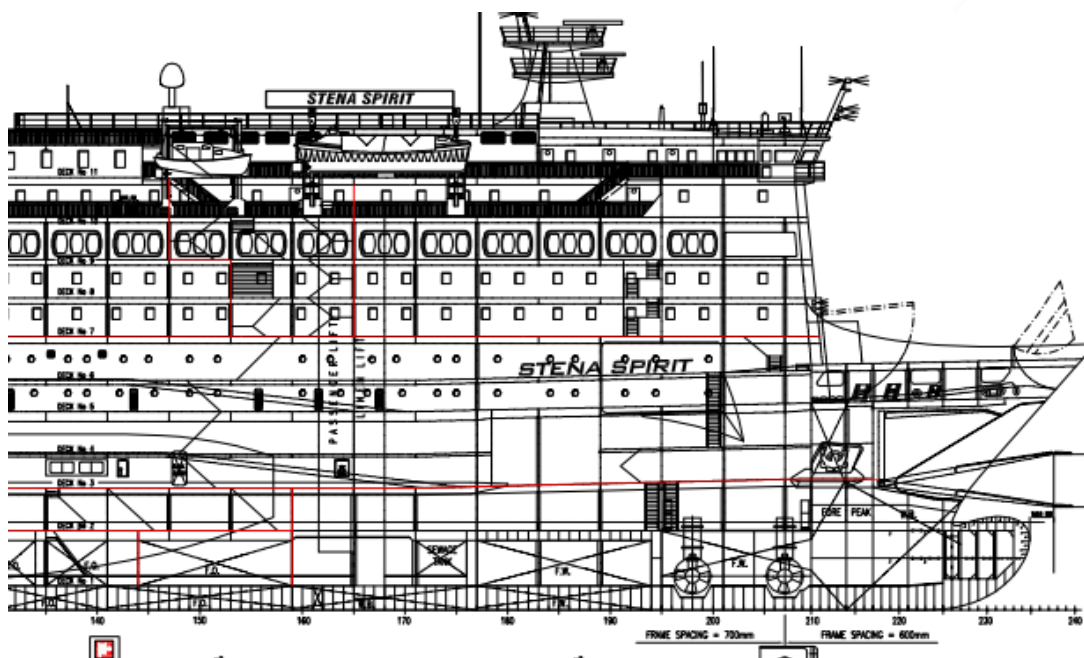


Figure 10. Longitudinal section of the ship "Stena Spirit": main vertical zones are not shown

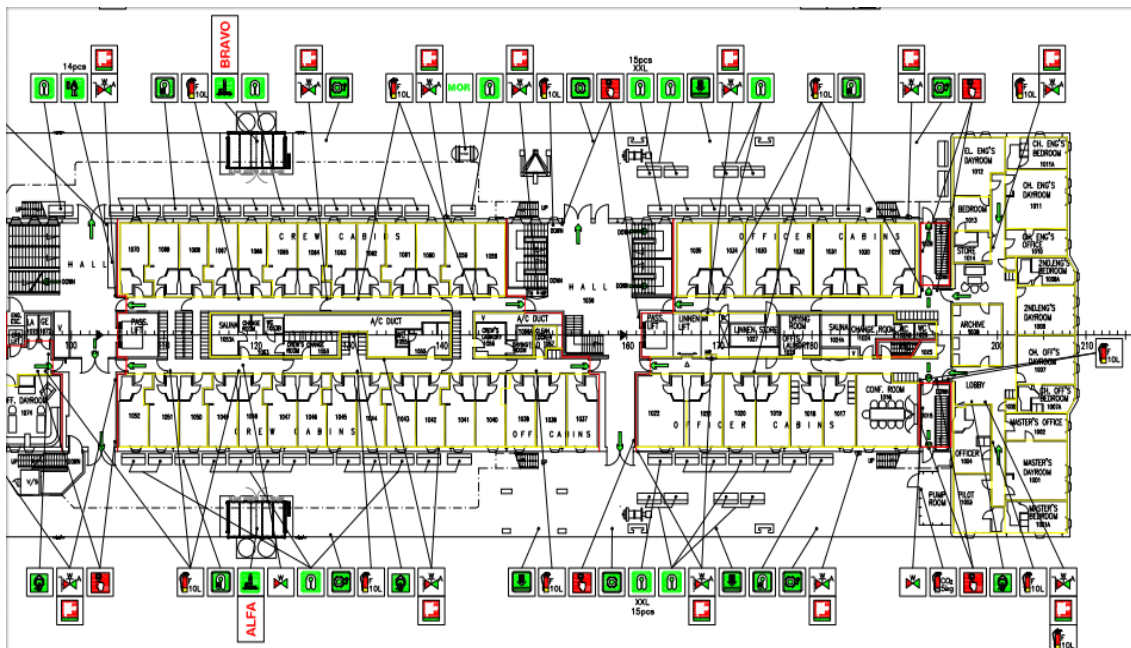


Figure 11. Deck no. 10: no marking of main vertical zones

2. **Fire resistance of decks and walls (1).** The SOLAS'74 Regulation II-2/20, Table 1 specifies that the stairways (cat. 2) should be separated from the special category spaces (cat. 11) (i.e., vehicle spaces on board passenger ships) by "A-30" class divisions. On the plan such divisions should be marked with a red line. On decks no. 3 and no. 5 not all walls of the stairways are separated by such divisions.

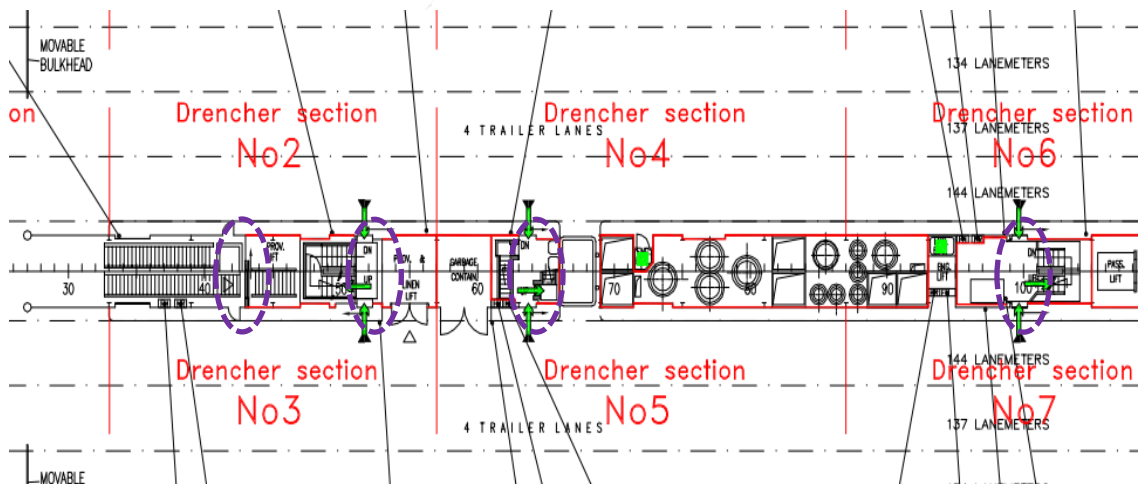


Figure 12. Deck no. 3: no marking of walls and stairways door as the "A" class division

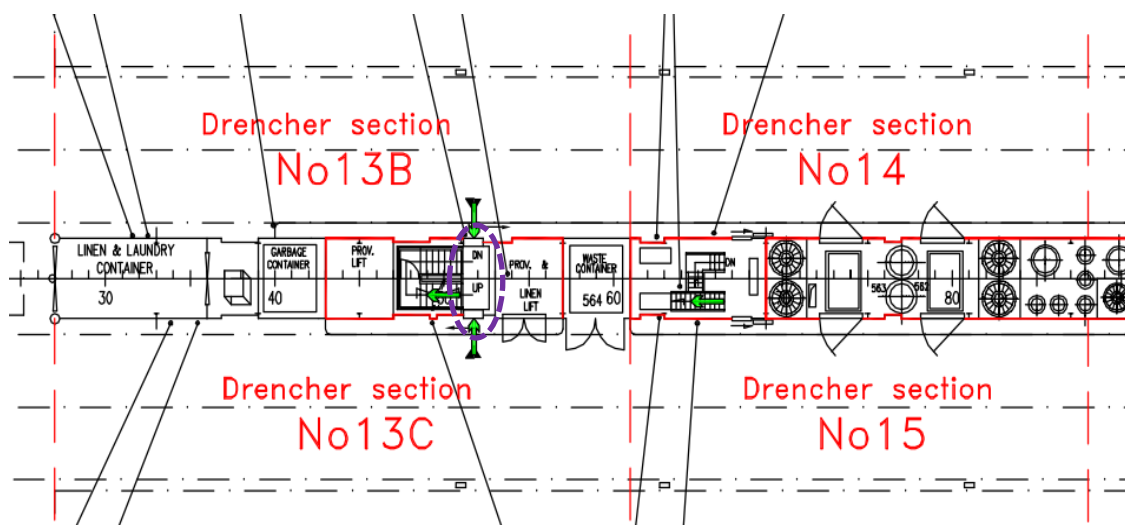


Figure 13. Deck no. 5: no marking of walls and stairways door as the "A" class division

3. **Fire resistance of decks and walls (2).** The SOLAS'74 Regulation II-2/20, Table 1 specifies that auxiliary machinery spaces (cat. 10), such as steering gear room, should be separated from the special category spaces (cat. 11) by "A-0" class division. On the plan such divisions should be marked with a red line. On deck no. 3 the walls and door leading to the steering gear room are not marked in such a way.

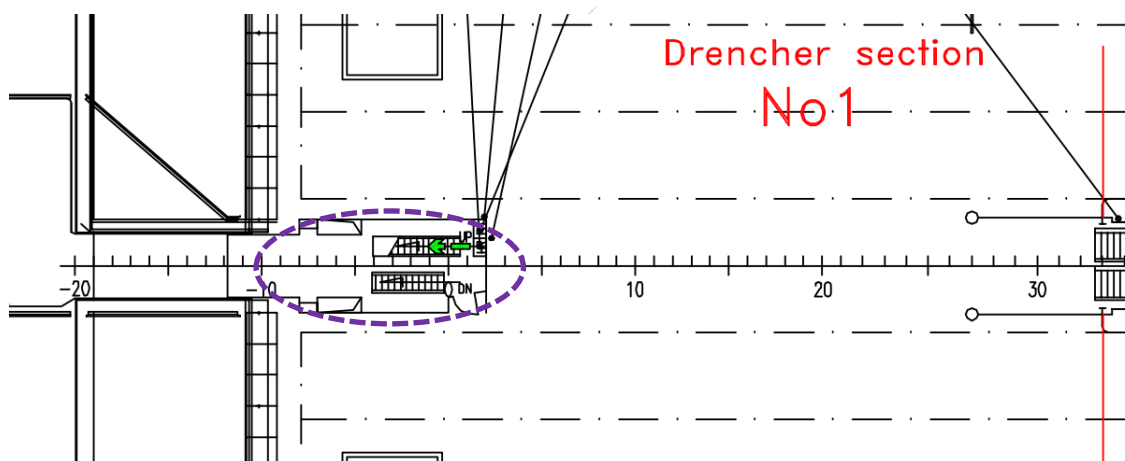


Figure 14. Deck no. 3: no marking of walls and doors of the companioway to the steering gear room under deck as the class "A" division

4. **Fire resistance of decks and walls (3).** The SOLAS'74 Regulation II-2/20, Table 2 identifies that the emergency generator room, taken as a control station (cat. 1) must be separated from the staircase (cat. 2) and the open deck (cat. 5) by "A" class division. On the plan such divisions should be marked with a red line. On deck no. 11 the wall and a door to the emergency generator room are not indicated in that way.

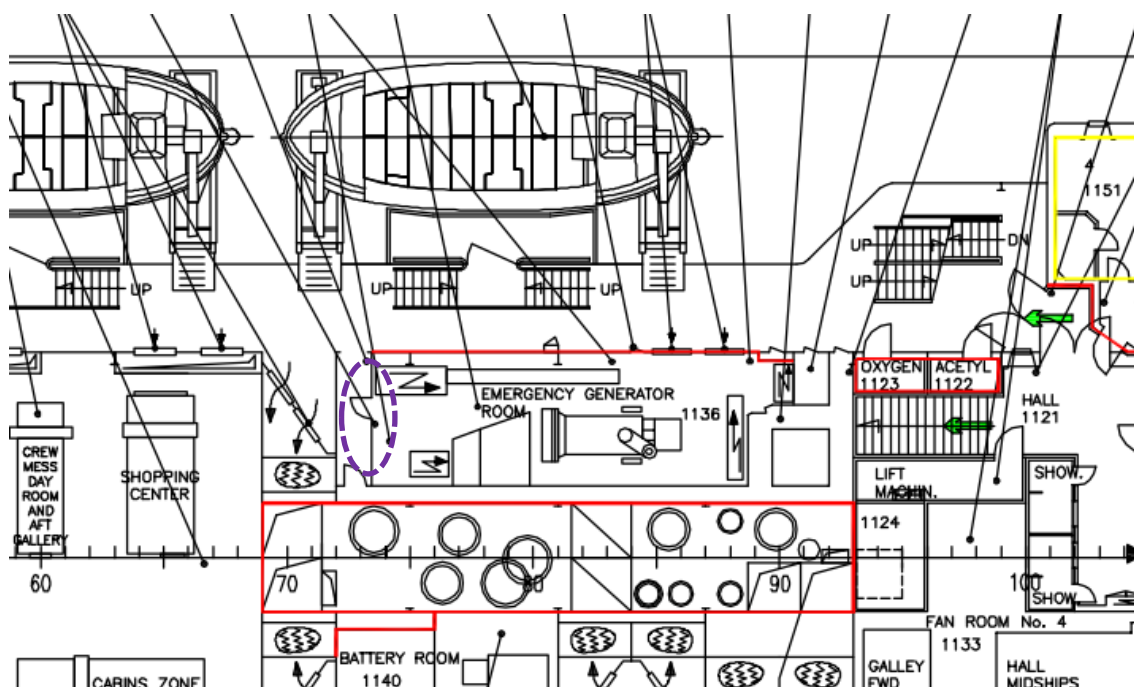


Figure 15. Deck no. 11: no marking of the walls and doors of the emergency generator room as the "A" class division

5. **Fire resistance of decks and walls (4).** The SOLAS'74 Regulation II-2/20, Table 2, provides that the paint store (cat. 14) and a fan room (cat. 10) should be separated from each other and from the open deck (cat. 5) by "A" class divisions. On deck no. 11 the walls and doors of these rooms are not marked as class "A".

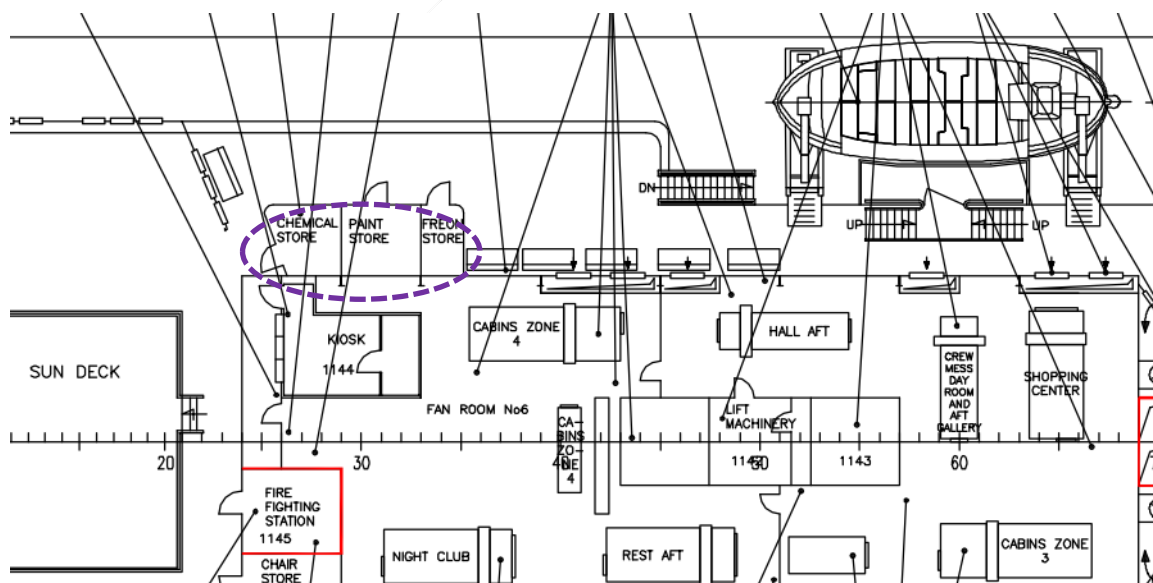


Figure 16. Deck no. 11: no marking of the walls and doors of the paint store and a fan room as the "A" class division

6. **Fire resistance of decks and walls (5).** The SOLAS'74 Regulation II-2/20, Table 2, provides that the walls of the superstructure with the passenger compartments (cat. 6), and machinery spaces (cat.10) adjacent to the open deck which forms an open escape routes and embarkation stations (cat. 4) should be an "A" class division. On decks nos. 11 and 10 the walls and doors in such spaces are not marked as a class "A".

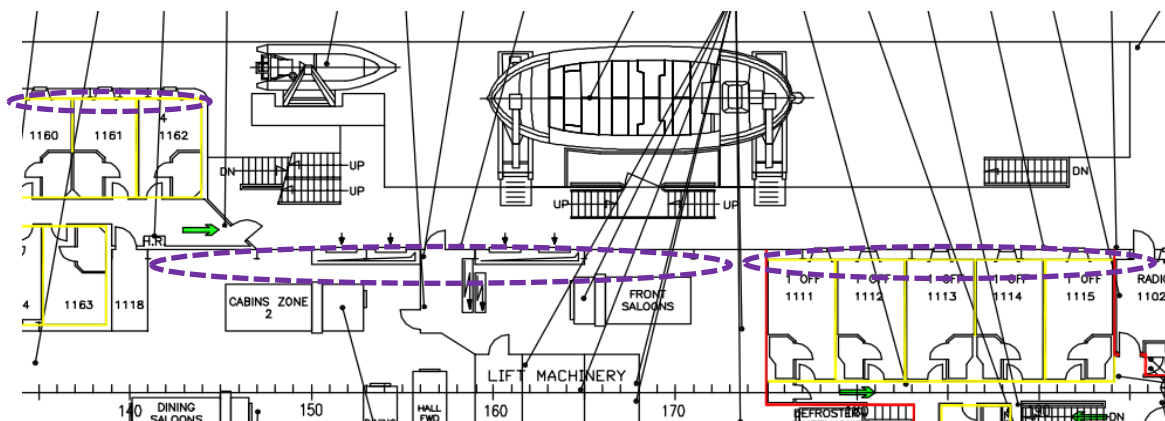


Figure 17. Deck no. 11: no marking of walls and doors of the superstructure crew and passengers rooms as well as walls of the fan room as the "A" class divisions

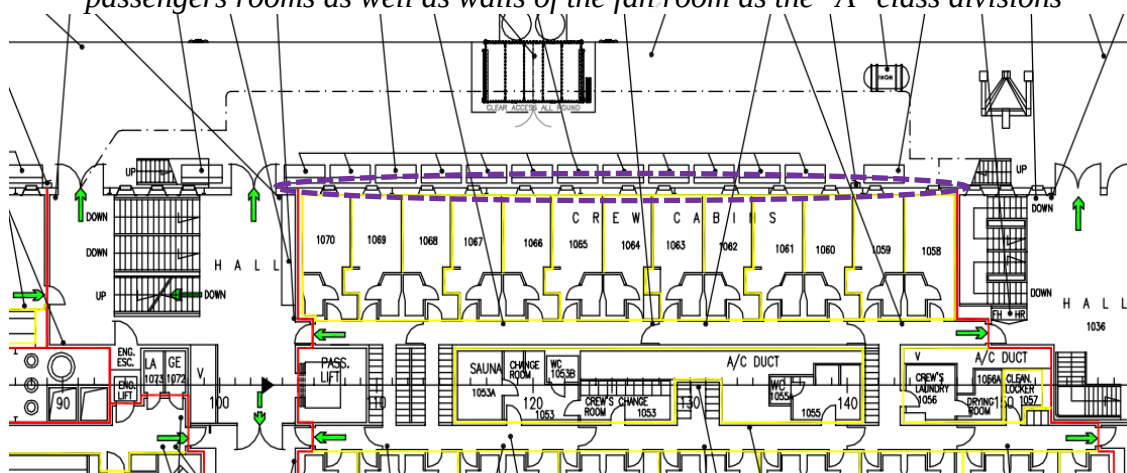


Figure 18. Deck no. 10: no marking of walls and doors of the superstructure with crew cabins as the "A" class divisions

7. **Openings in "A" class divisions.** The SOLAS'74 in Regulation II-2/23 (f) says: *Fire doors in main vertical zone bulkheads and stairway enclosures, other than power-operated watertight doors and those which are normally locked, shall be of the self-closing type.* On the fire protection plan of the *Stena Spirit* none of the doors are marked as a self-closing type and there are no symbols of such doors.

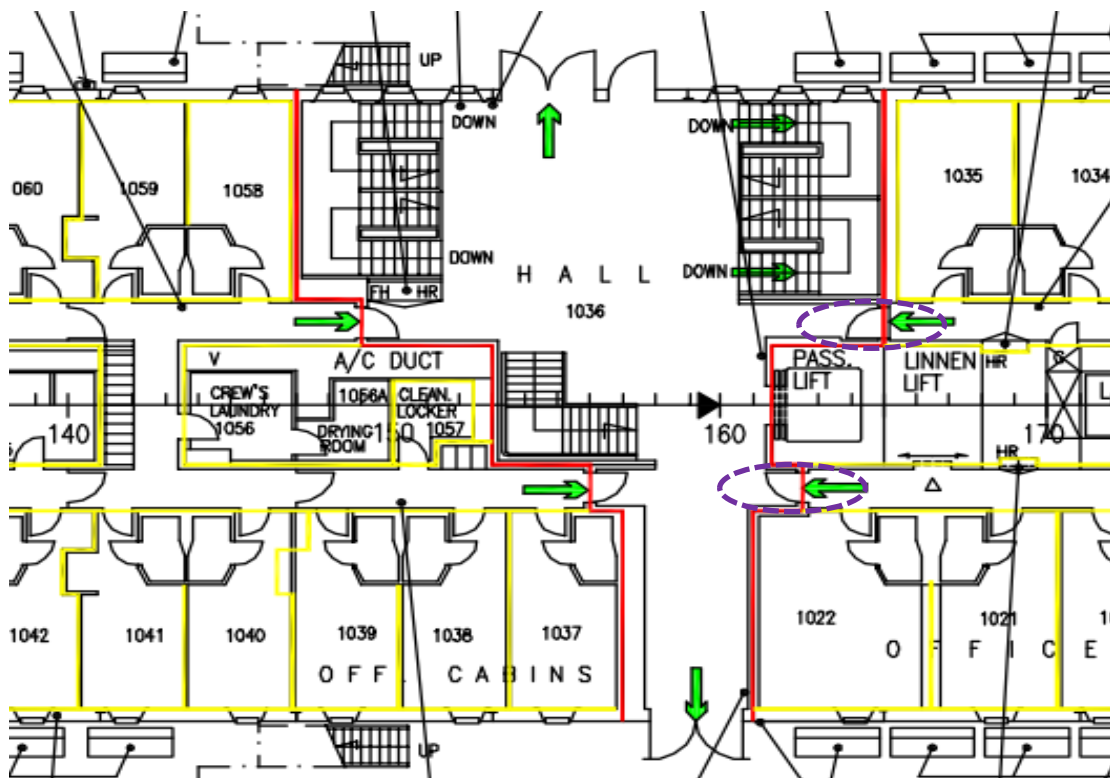


Figure 19. Deck no. 10: no marking of the door as being of self-closing type in the walls and in the division which should be marked as the separation of the main vertical zones

8. **Escape routes.** The SOLAS'74 in Regulation II-2/21 (f) (b) (i) provides: *In special category spaces the number and disposition of the means of escape both below and above the bulkhead deck shall be to the satisfaction of the Administration, and in general the safety of access to the embarkation deck shall be at least equivalent to that provided for under subparagraphs (a)(i), (ii), (iii), (iv) and (v) of this Regulation (it means the same as for the passenger and service spaces where the crew is normally employed).* The fire protection plan of the *Stena Spirit* does not show on deck no. 3 and no. 5 designated routes of escape along the spaces between the rows of vehicles (Figure 20).

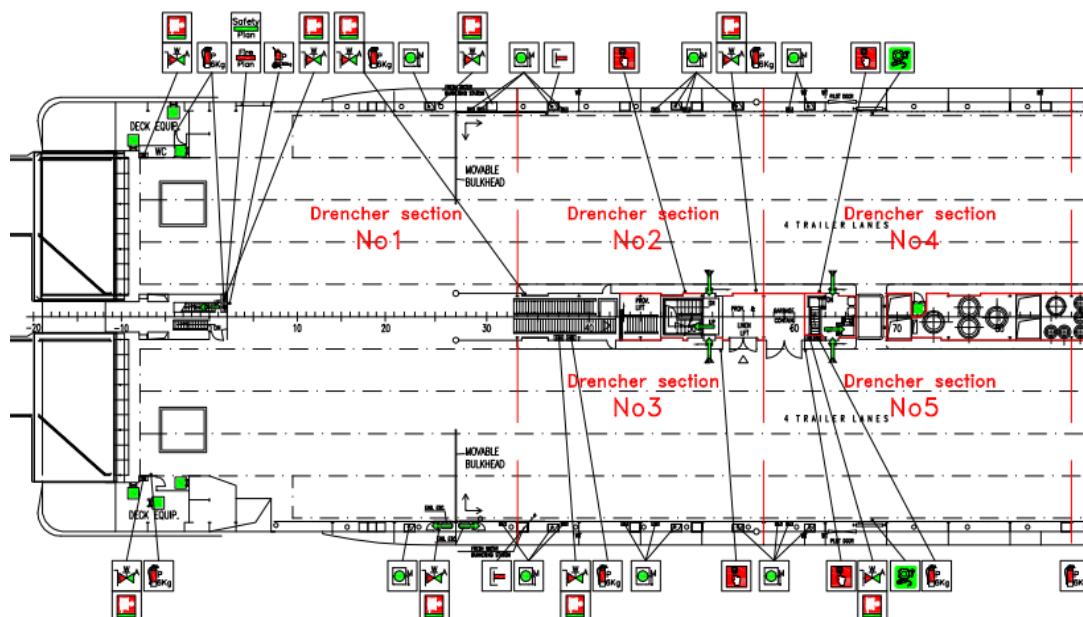


Figure 20. Car deck no. 3: lack of designated escape routes leading along the space between rows of vehicles

9. **Fire protection plan, general requirements (1).** SOLAS Convention of 2000 in the Regulation II-2/15.2.4 requires the plan to show that the accommodation spaces, corridors and staircases are equipped with automatic sprinkler system, together with the location of the section valves of the system. The ship's plan shows no such system.
10. **Fire protection plan, general requirements (2).** SOLAS Convention of 2000 in the Regulation II-2/15.2.4 requires the fire protection plan to show the arrangement of the fans in vessel's spaces, together with the identification number of ventilation fans serving each section of a ventilation. The plan of the *Stena Spirit* shows no such information.
11. **Fire protection plan, general requirements (3).** The fire protection plan on board should show equipment items that allow for operation of the fire extinguishing systems. The IMO Resolution A.952(23) "Graphical Symbols for Shipboard Fire Control Plans" specifies the symbol "Water spray system valves". The ship's fire protection plan in fire control station No. 4 on deck no. 4 lacks the symbol of the water sprinkler system.

The above deficiencies and unconformity on the fire protection plan of the *Stena Spirit*, verified and stamped by the classification society, posted and available on the vessel may indicate lack of diligence of the institution responsible for the conventional supervision, acting on behalf of the Authorities of the flag state.



5. Description of investigation findings, including the identification of safety issues and conclusions

As a result of conducted examination, the Commission found that the fire on the car deck of *Stena Spirit* resulted from the damage of a refrigeration unit of a truck and was caused by blocking of a V-belt tensioner belt wheel during the unit's operation and ignition of belts or as a result of short-circuit currents due to overload of the unit during operation with a faulty tensioner that consequently led to ignition of the electrical system of the refrigeration unit.

Fire development and its spread to the ceiling of the cargo space No. 3 was most likely caused by the hydraulic oil leaking from the ship's depressurized pipeline; the oil acted as the fuel supporting the fire.

The Commission also considered other possible causes of the refrigerator truck fire, such as electrical equipment left switched on in the driver's cabin and the short-circuit in the ship's electrical system feeding the refrigeration unit, but the Commission found them to be unlikely.

Errors made by the crew during the first stage of the fire regarding identification of smoke source, led to a situation in which a small fire of refrigeration unit built of non-flammable materials developed within about 20 minutes into a dangerous fire which completely destroyed the refrigerator unit, damage to the cargo transported by the truck, partial burning of the truck cabin and, after spreading to the ship's cargo space ceiling, also the damage to her systems routed under the ceiling.

The consequence of said fire was bursting of several hydraulic lines with oil which, dripping on the vehicle roof, increased the energy of the fire and generated the high temperature. The burning insulation of the vehicle's refrigeration chamber roof and insulation of ship's cables routed under the ceiling resulted in generation of thick smoke which filled the vehicle space in the ship's aft part and, after certain period of time, migrated to passenger rooms, posing a hazard to passengers and ship crew. The smoke was major to the extent that it was necessary to call passengers to muster stations (inside the ship) and to evacuate them to external decks.

The Commission examining the course of events during the first phase, when the smoke occurred and the fire detector was activated on the car deck, found as follows:

- 1) the crew did not perform a visual inspection of the refrigeration unit, particularly the front right side of the truck where the fire was visible, and their actions were limited to disconnecting ship's power supply to the unit, concluding that the smoke was



generated only by the V-belts of the truck refrigeration unit drive; the crew did not call the driver to check the truck cabin;

- 2) both on the bridge and in the engine control room, no regular monitoring of the CCTV system was carried out both before and after activation of the fire detector on the car deck no. 3; the image from camera No. 07 available on the displays clearly showed the fire on the right side of the refrigerator truck and the image captured by camera No. 14 (in front of the port side stern door, close to the source of fire) showed major smoke presence already two minutes after the activation of the fire alarm;
- 3) disregarding of the hazard or conviction on lack of realistic fire hazard the real risk of fire resulted in a situation in which the fans on the car deck were activated, thus supplying air to the (then, still small) fire and development of large and quickly spreading flames.

In the first phase of the fire, no other possibilities of isolating and cooling of the refrigeration unit and probably smoldering materials of the refrigeration chamber insulation that generated the smoke were used, which would have prevented the second phase of the fire.

Analyzing the course of events in its second phase, the Commission concluded that:

- 1) the crew undertook the firefighting operation too late, only after the fire had rapidly developed;
- 2) the fire on the car deck no. 3 caused major smoke presence in the corridors, staircases and passenger muster points and the crew was forced to use breathing apparatuses to reach the valves station of the drencher system;
- 3) the firefighting operation carried out by the ship's firefighting team could not be effective due to limited access to the burning roof of the refrigerator truck and impossibility to eliminate the source of the fuel that maintained the fire, as well as due to inadequate equipment of the ship's firefighting team¹⁷;

¹⁷ The Commission noted the incomplete clothing of some members of the firefighting team, lack of helmets and firefighting clothing (instead, they wore shorts and T-shirts) which suggests inadequate training on the ship or overlook of the existing hazard by these crew members.



Photograph No. 47. Port Fire Brigade firefighters and members of the ship's fire-fighting team

- 4) the water drencher system was activated too late and in an incorrect manner according to ship's procedures and, therefore, it was unable to extinguish the fire; however, this system managed to suppress the fire and prevented the fire from spreading to other vehicles located nearby; owing to the fact that the ship had just entered the port, the fire could be put out by the land-based Port Fire Brigade and, thus, it did not cause even greater damage and did not entail significant losses.

The fire on the *Stena Spirit* ferry posed a serious hazard not only to the ship herself, but also to the port terminal due to damage to the ship's sensitive equipment (control systems and mooring winch hydraulics) during port entry and mooring manoeuvres. Fire of a single vehicle in the cargo space should not have caused such major hazard to passengers who had to be evacuated from muster stations to open deck. This may suggest defects in ship design such as: insufficient structural fire protection and insufficiency of systems affecting the safety of the ship.

On the *Stena Spirit*, the design of walls and doors constituting fire divisions of the vehicle space from other spaces of the ship, did not form adequate "A" fire class divisions, as shown

in the fire protection plan and, thus, did not ensure adequate fire protection. The smoke from the vehicle space escaped to staircases and corridors, and later even to the passenger rooms on deck no. 9 which were designated muster stations.

In the vehicle spaces in the aft part of the ship, pressurized hydraulic oil pipelines connected with screw joints, exposed to vibrations, were not equipped with shields against oil leaks onto transported vehicles.

No adequate escape routes were designated on the ship in the vehicle spaces, forcing the firemen carrying out the fire fighting and rescue operation to work in extremely difficult conditions, reducing the effectiveness of the operation.

The fire was detected by the crew when the ship was entering the breakwater heads of the port of Gdynia.



Photograph No. 48. Camera No. 01: view from the bridge at the entrance to the port of Gdynia

The crew was preparing for manoeuvres or was on their way to manoeuvre stations. The passengers waited to disembark the ship and, seeing port buildings around, were unaware of the hazard. Many drivers were preparing to enter the vehicle decks, waiting at the door (photograph No. 42) or trying to open them to see if they could reach to their vehicles, allowing the smoke from the cargo space to enter the passenger rooms. This probably further obstructed the crew's firefighting operation.

In the ship management system, there were no procedures for emergency situations such as fire during port entry manoeuvres. There were procedures for a fire in the port (included in



SMM-0241), but these related mainly to establishing communication with third parties (fire service, port authorities, shipowner) and evacuation of passengers and crew from the ship.

The lack of such procedures could have complicated the handling of the operations, however as regards the presence of smoke in the passenger rooms which could have been caused by the open door to the car deck, it could have been avoided by temporarily assigning one person from the hotel service to each exit door to the car decks that would prevent drivers from exiting to the car decks and that would prevent unnecessary opening of doors and letting the smoke to the staircase.

The Commission concluded that the fact that the ship's crew did not interested in the CCTV system for a considerable period of time after fire alarm release and did not observe the images from the camera located in the room in which the flames on the truck roof were visible may suggest the lack of adequate risk management procedures in emergency situations. The Commission is of the opinion that the ship procedures should include an obligation to regularly check the CCTV camera images after activation of any significant alarm, including fire alarm.

The Commission also found that the crew did not have adequate knowledge and experience regarding fire hazards. During the fire fighting and rescue operations, the crew committed multiple omissions, such as: late commencement of firefighting actions, activation of ventilation without making sure that the fire had been extinguished, failure to shut-off ventilation openings in the cargo space. The crew did not prevent the passengers to enter the vehicle spaces being in danger of fire.

As regards the issue of supervision of classification society over *Stena Spirit*, the Commission considers that it was insufficient, and lack of requirements regarding periodic leak testing of hydraulic systems and design flaws of these systems contributed to the development of fire and damages caused in its effect. The ship fire protection plan examined by a classification society inspector for compliance with the requirements of the SOLAS Convention contained significant deficiencies and nonconformities.

After the fire, the *Stena Spirit* did not undergo major ship inspections, among others in the scope of structural fire protections, condition of fire divisions and doors, ventilation ducts, etc. to determine why the smoke from the fire on deck no. 3 migrated to the vehicle space on deck no. 5, to the open deck and to passenger rooms. The repair of damages after the fire



ended without identification and removal of technical causes which affected the development and results of the fire.

The extent and size of the damage to numerous critical ship systems, as given in paragraph 3.2, by the fire of a single vehicle in the cargo space may indicate faulty design solutions and inadequate protection of ship systems. According to the Commission there is ground to accept the thesis that after the fire the construction defects of the ship have not been eliminated so they can contribute to similar fire in the future.

6. Safety recommendations

According to statistics, including those kept by the European Marine Safety Agency (EMSA), the number of fires on ro-ro ships has not gone down over the past years. These fires are much more dangerous and difficult to contain due to the open cargo spaces of the ships and the types of cargo transported, which includes cars, semi-trailers, and railroad cars, whose malfunction or bad technical condition may be the reason of a fire.

The State Marine Accident Investigation Commission has deemed it justified to formulate safety recommendations, which are a proposal of activities that may contribute to the prevention of similar accidents in the future, and to distribute the recommendations to the relevant entities. In addition to sending the recommendations to the ship-owner and its classification society, the Commission also sends those recommendations to the maritime administration of the ship's flag state - the Bahamas to get acquainted.

6.1. Ship-Owner of the *Stena Spirit*

The State Marine Accident Investigation Commission recommends that the ship-owner, Stena Line Scandinavia AB, should:

- 1) subject the *Stena Spirit* to an inspection with a view to verifying the compliance of her structural fire-protection with the requirements of the SOLAS'74 Convention, and remove any instances of a lack of compliance;
- 2) carry out an inspection of the ventilation system in the public passenger spaces, in order to detect the reasons of the occurrence of excessive amounts of smoke inside the ship, at the passenger assembly stations, during the accident;



- 3) correct the fire protection plan for the ship, by adding of the missing graphical symbols of IMO Resolution A.952(23), so as to ensure that the plan contains all the necessary information to reflect the ship's compliance with the applicable requirements of SOLAS 74 Convention, as amended;
- 4) designate, in the cargo spaces used for vehicles, evacuation routes (designated walkways) with the necessary width (a minimum of 600 mm is recommended), to lead from the farthest place in the room to the evacuation door of the space, in order to ensure a safe evacuation of the passengers of the transported cars, and to enable access to the cars for the rescue team, in case it is necessary to undertake firefighting and rescue activities;
- 5) develop emergency procedures pertaining to the firefighting action to be undertaken in the case of a fire breaking out in a cargo space used to transport vehicles. The procedures should identify all the activities to be carried out by the crew after a fire has been detected, including: switching off the ventilation system, closing the ventilation ducts, start-up the relevant section of the drencher system, closing and securing the passenger staircase entrance doors;
- 6) add in the crew procedures pertaining to the loading of refrigerator trucks onto the ship and the supervision of them during the cruise (SMM-0187), or in the fire patrol procedures (SOM-050) the requirement to instantly summon the driver of the vehicle after smoke (fire) has been detected and the vehicle has been identified as the source of the smoke (fire);
- 7) include in the ship's procedures and emergency task lists (the scopes of responsibility of individual crew members) additional tasks to be undertaken by the crew when fighting a fire while the ship is preparing for manoeuvres, or is undertaking port entry manoeuvres;
- 8) provide the crew additional firefighting training and fire drills, delivered by an institution certified to carry out such training, focusing the firefighting action in the spaces used to transport cars, and in particular on the extinguishing of fires of electrical installations and the refrigeration units of the transported vehicles, as well as how to operate and shut-off ventilation in order to prevent smoke penetration into passengers spaces, including: turning off ventilators, remote closing of fire damper, manual closing of inlets and outlets of passenger rooms ventilation – shown at the ship's fire protection plan;



- 9) improve the instruction manual of the drencher system to ensure that the numbering of the different sections of the drencher system corresponds to the numbering used in the fire protection plan.

Moreover, the Commission recommends that the ship-owner consider the implementation of construction solutions in the cargo spaces used to transport vehicles, which will:

- a) eliminate the possibility of unauthorized opening of the entrance doors leading to the vehicle spaces, for example: switching off the functionality of automatically opening the doors after the fire detection system is activated, or adding the functionality of re-locking the entrance doors for passengers remotely from the bridge, while at the same time ensuring the possibility of opening each of those doors and entering the spaces by, for example, entering a code or using a magnetic card,
- b) prevent any potential leakage of inflammable liquids from the pipes running under the roof onto the working refrigerating units of the transported vehicles (e.g., by using metal covers).

6.2. Classification Society

The State Marine Accident Investigation Commission recommends that the classification society, Lloyd's Register, authorised by the ship's flag state, the Bahamas, to approve the ship's safety plans, should verify that the *Stena Spirit* fire protection plans comply with the international requirements of the SOLAS Convention with respect to the fire protection of ro-ro ships and, if irregularities are identified, to approach the ship-owner with a request to amend them.

6.3. Port State Control

The State Marine Accident Investigation Commission recommends that the Port State Control conducts inspection of *Stena Spirit* ship with respect to verification of structures and fire protection appliances, for compliance with the applicable requirements of the SOLAS Convention.

In particular, the inspection should include a check of the structures of the divisions bounding the vehicle spaces as well as the passages and closure of the openings in those



divisions, bearing in mind the fact that during fire, smoke from the vehicle spaces has spread to the passenger spaces and the passenger muster stations.

During the inspection, it is recommended to check the ship's fire protection documentation, such as fire control plan, the maintenance plan of the fire protection systems and appliances, and to check the records of periodic firefighting trainings and drills.

6.4. Minister relevant for Maritime Economy matters

The State Marine Accident Investigation Commission provides for consideration by the minister relevant for maritime economy matters the presentation in the *Safety Systems and Equipment Subcommittee* of the International Maritime Organization (IMO) of the following proposals of amendments to the SOLAS Convention regarding additional solutions in the scope of fire safety of ro-ro newly constructed passenger ships:

- 1) in all ro-ro cargo spaces – all electrical wires, hydraulic system piping as well as cables from other systems having a significant impact on ship safety, run under the ceiling, should be secured with steel casing against damage as a result of fire of vehicles in these premises; instead of using casing for electric cables, such cables can be made as being fire-resistant;
- 2) in all ro-ro cargo spaces, for vehicles, separate rows should be indicated for parking (placing in order) of refrigerator vehicles and the relevant number of spaces should be ensured for access for the handling (inspection) of these vehicles while the ship is at sea; the path on one side of the indicated row of vehicles should be at least 600 mm so that it would facilitate easy access to the vehicle by fire fighters in special breathing apparatuses and protective clothing during rescue and fire extinguishing operations in emergency situations, such as vehicle fire.

7. List of photographs

Photograph No. 1. The "Stena Spirit" ro-ro passenger ferry.....	4
Photograph No. 2. Extinguishing the fire of a refrigerator truck onboard of "Stena Spirit".....	7
Photograph No. 3. Fire alarm recorded by the VDR.....	8
Photograph No. 4. Watchman next to the refrigerator truck in smoke fumes.....	9



Photograph No. 5. Deactivated fire alarm recorded by the VDR	10
Photograph No. 6. Flames recorded by the monitoring camera.....	11
Photograph No. 7. Watchman notices flames on the truck roof	11
Photograph No. 8. Another activation of the fire alarm recorded by the VDR	12
Photograph No. 9. Flames on the truck roof	12
Photograph No. 10. Watchman attempting to suppress the fire using a powder fire extinguisher	13
Photograph No. 11. Smoke on the car deck no. 5 recorded by camera No. 16.....	14
Photograph No. 12. The "Stena Spirit" after removing the refrigerator truck to the wharf and completion of the fire fighting operation	16
Photograph No. 13. Burnt vehicle roof with damaged refrigeration unit	17
Photograph No. 14. Burnt refrigeration unit on the truck trailer floor	17
Photograph No. 15. Burnt driver's cabin of the refrigerator truck	17
Photograph No. 16. Burnt tarpaulin of the truck parked next to the refrigerator truck and its cargo	18
Photograph No. 17. Ceiling of the car deck No. 3; ship systems damaged by fire.....	19
Photograph No. 18. Car deck no. 5; burnt paint spots and deformed deck plate	19
Photograph No. 19. View of the car decks of the "Stena Spirit".	20
Photograph No. 20. View recorded by all 16 internal CCTV cameras of the "Stena Spirit" on 31 August 2016 at 06:30 ship time.....	22
Photograph No. 21. Flames above the refrigerator unit on the truck roof	22
Photograph No. 22. Flames above the truck recorded by camera No. 07 immediately after activation of the fire alarm	23
Photograph No. 23. Image from camera No. 14 pointing at the stern door next to which first three trucks stood	24
Photograph No. 24. Billows of smoke recorded by camera No. 14	24
Photograph No. 25. Smoke entering the space in front of the vehicles standing next to the starboard side stern door	25
Photograph No. 26. CCTV images on the screens on the bridge (left) and in the engine control room (right)	25
Photograph No. 27. Typical truck-mounted refrigerator unit	26



Photograph No. 28. Carrier Supra 850 refrigeration unit; its respective components are marked as follows: 1 – Diesel internal combustion engine, 2 – cooling compressor, 3 – electric motor, 4 – alternator	27
Photograph No. 29. Burnt refrigeration unit and truck's cargo space	27
Photograph No. 30. Blocked belt wheel of the V-belt tensioner.....	28
Photograph No. 31. Charred portion of the V-belt.....	28
Photograph No. 32. Damaged hydraulic system pipelines.....	30
Photograph No. 33. Hydraulic pipeline cracked and deformed as a result of the fire	31
Photograph No. 34. Ceiling of the car deck no. 3 in the place of the fire	31
Photograph No. 35. Plugged electric device charger (pilot light on).....	32
Photograph No. 36. Burnt computer (laptop).....	32
Photograph No. 37. Electric cables with plugs for connection of a refrigeration unit to ship's power supply system and truck's socket for cable connection	32
Photograph No. 38. Passengers in the vehicle space on deck no. 5 during the firefighting operation, in the place where smoke was appearing	35
Photograph No. 39. Arrangement of smoke detectors on the car deck no. 3 – aft part, in the place where the smoke detector was activated - zone 110	38
Photograph No. 40. Trucks parked close next to each other on deck no. 3	38
Photograph No. 41. Fireman squeezing between the truck and a wall	38
Photograph No. 42. Automatically closed door dividing the car deck from the staircase to passenger rooms	40
Photograph No. 43. Charred door in the electric equipment room	42
Photograph No. 44. Door on the deck side (after repairs).....	42
Photograph No. 45. Hydraulic system pipelines routed under the ceiling	46
Photograph No. 46. Ship fire protection plan with a stamp of Lloyd's Register EMEA	47
Photograph No. 47. Port Fire Brigade firefighters and members of the ship's fire-fighting team	58
Photograph No. 48. Camera No. 01: view from the bridge at the entrance to the port of Gdynia	59



8. List of figures

Figure 1. Area directly affected by fire (port side view).....	5
Figure 2. Refrigerator truck position on car deck no. 3	8
Figure 3. System of V-belts of the belt gear drive transmission of the Carrier Supra 850 refrigeration unit.....	28
Figure 4. Deck no. 7: Passenger lift shaft (frames 105-109) in the reception hall is not marked as the class "A" division.....	41
Figure 5. Deck no. 3: doors to staircases and passenger lift shaft are not marked as the class "A" divisions	42
Figure 6. Deck no. 4: walls of spaces (under the cargo space ceiling) with fire dampers in vehicle space ventilation ducts are not separated with the class "A" divisions	43
Figure 7. Deck no. 6: walls of spaces with fire dampers in fan room are not separated with the class "A" divisions.....	44
Figure 8. Part of fire protection plan: "Control station 4" including the drencher system station	44
Figure 9. Deck no. 4: entrance door to the staircase from the car deck and wall with doors at frame No. 143 separating the drencher station from the staircase are not marked as the class "A" divisions	45
Figure 10. Longitudinal section of the ship "Stena Spirit": main vertical zones are not shown	49
Figure 11. Deck no. 10: no marking of main vertical zones	50
Figure 12. Deck no. 3: no marking of walls and stairways door as the "A" class division.....	50
Figure 13. Deck no. 5: no marking of walls and stairways door as the "A" class division.....	51
Figure 14. Deck no. 3: no marking of walls and doors of the companioway to the steering gear room under deck as the class "A" division.....	51
Figure 15. Deck no. 11: no marking of the walls and doors of the emergency generator room as the "A" class division.....	52
Figure 16. Deck no. 11: no marking of the walls and doors of the paint store and a fan room as the "A" class division	52
Figure 17. Deck no. 11: no marking of walls and doors of the superstructure crew and passengers rooms as well as walls of the fan room as the "A" class divisions	53



Figure 18. Deck no. 10: no marking of walls and doors of the superstructure with crew cabins as the "A" class divisions	53
Figure 19. Deck no. 10: no marking of the door as being of self-closing type in the walls and in the division which should be marked as the separation of the main vertical zones.....	54
Figure 20. Car deck no. 3: lack of designated escape routes leading along the space between rows of vehicles.....	55

9. List of abbreviations used

CCTV – Closed Circuit Television

cat. – category

EMSA – European Maritime Safety Agency

ISM – ISM code

MVZ – main vertical zone

PMS – Planned Maintenance System

SOLAS Convention – International Convention for the Safety of Life at Sea

10. Source of information

Notification about the accident

Ship documents

Materials from witness testimony

Materials and documents received from the ship's operator

Expert opinion prepared by S. Affek – SMAIC individual expert

Opinion from the conducted metallographic research conducted by the Police Central Forensics Laboratory

Opinion prepared by M. Hitzemann – DEKRA Automobil GmbH expert



11. Composition of the accident investigation team

The team conducting the investigation of the accident was comprised of:

Team leader: Marek Szymankiewicz – SMAIC Secretary

Team member: Eugeniusz Chodań – SMAIC Chairman

Team member: Krzysztof Kuropieska – SMAIC member

Team member: Sławomir Affek – SMAIC expert

Team member: Tadeusz Gontarek – SMAIC expert



Annexes

Annex 1

Passenger Ship Safety Certificate

Certificate no: **GDK 1600098**
Page 1 of 2

Passenger Ship Safety Certificate

This Certificate shall be supplemented by a Record of Equipment for Passenger Ship Safety (Form P): **7907661/04**
Issued under the provisions of the International Convention for the Safety of Life at Sea, 1974, as modified by the Protocol of 1988 relating thereto,
under the authority of the Government of the Commonwealth of The Bahamas by Lloyd's Register EMEA
For a short international voyage

Name of ship	STENA SPIRIT
Distinctive number or letters	C6ZK8
Port of registry	Nassau
Gross tonnage	39,193
Sea areas in which ship is certified to operate (regulation IV/2)	A1 + A2
IMO number	7907661
Date of build ¹	

Date of building contract	28 March 1979
Date on which keel was laid or ship was at similar stage of construction	31 August 1981
Date of delivery	02 February 1988
Date on which work for a conversion or an alteration or modification of a major character was commenced (where applicable)	-

This is to certify:

1. that the ship has been surveyed in accordance with the requirements of regulation I/7 of the Convention;
2. that the survey showed that:
 - 2.1 the ship complied with the requirements of the Convention as regards:
 - 2.1.1 the structure, main and auxiliary machinery, boilers and other pressure vessels;
 - 2.1.2 the watertight subdivision arrangements and details;
 - 2.1.3 the following subdivision load lines:

Subdivision load lines assigned and marked on the ship's side amidships (regulation II-1/18) ²	Freeboard	To apply when the spaces in which passengers are carried include the following alternative spaces
	1812 mm	No Alternative Spaces
	-	-
	-	-

- 2.2 the ship complied with the requirements of the Convention as regards structural fire protection, fire safety systems and appliances and fire control plans;
- 2.3 the life-saving appliances and the equipment of the lifeboats, liferafts and rescue boats were provided in accordance with the requirements of the Convention;
- 2.4 the ship was provided with a line-throwing appliance and radio installations used in life-saving appliances in accordance with the requirements of the Convention;
- 2.5 the ship complied with the requirements of the Convention as regards radio installations;
- 2.6 the functioning of the radio installations used in life-saving appliances complied with the requirements of the Convention;
- 2.7 the ship complied with the requirements of the Convention as regards shipborne navigational equipment, means of embarkation for pilots and nautical publications;
- 2.8 the ship was provided with lights, shapes, means of making sound signals and distress signals, in accordance with the requirements of the Convention and the International Regulations for Preventing Collisions at Sea in force;
- 2.9 in all other respects the ship complied with the relevant requirements of the Convention;
- 2.10 the ship **was not** subjected to an alternative design and arrangements in pursuance of regulation(s) II-1/55 / II-2/17 / III/38 of the Convention;
- 2.11 a Document of approval of alternative design and arrangements for **machinery and electrical installations/fire protection/life-saving appliances and arrangements is not** appended to this Certificate.

3. that an Exemption Certificate **has** been issued.

¹ All applicable dates shall be completed.² For ships constructed before 1 January 2009, the applicable subdivision notation "C.1, C.2 and C.3" should be used.

* Delete as appropriate

Lloyd's Register Group Limited, its affiliates and subsidiaries and their respective officers, employees or agents are, individually and collectively, referred to in this clause as 'Lloyd's Register'. Lloyd's Register assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.

Certificate no: **GDK 1600098**
Page 1 of 2

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under the authority of the Government of the Commonwealth of The Bahamas by Lloyd's Register EMEA
For a short international voyage

Particulars of Ship	
Name of ship	STENA SPIRIT
Distinctive number or letters	C6ZK8
Port of registry	Nassau
Gross tonnage	39,193
Sea areas in which ship is certified to operate (regulation IV/2)	A1 + A2
IMO number	7907661
Date of build ¹ :	
Date of building contract	28 March 1979
Date on which keel was laid or ship was at similar stage of construction	31 August 1981
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Date on which work for a conversion or an alteration or modification of a major character was commenced (where applicable)	-

This is to certify:

- that the ship has been surveyed in accordance with the requirements of regulation I/7 of the Convention;
- that the survey showed that:
 - the ship complied with the requirements of the Convention as regards:
 - the structure, main and auxiliary machinery, boilers and other pressure vessels;
 - the watertight subdivision arrangements and details;
 - the following subdivision load lines:

Subdivision load lines assigned and marked on the ship's side amidships (regulation II-1/18) ²	Freeboard	To apply when the spaces in which passengers are carried include the following alternative spaces
	1812 mm	No Alternative Spaces
	-	-
	-	-

- the ship complied with the requirements of the Convention as regards structural fire protection, fire safety systems and appliances and fire control plans;
 - the life-saving appliances and the equipment of the lifeboats, liferafts and rescue boats were provided in accordance with the requirements of the Convention;
 - the ship was provided with a line-throwing appliance and radio installations used in life-saving appliances in accordance with the requirements of the Convention;
 - the ship complied with the requirements of the Convention as regards radio installations;
 - the functioning of the radio installations used in life-saving appliances complied with the requirements of the Convention;
 - the ship complied with the requirements of the Convention as regards shipborne navigational equipment, means of embarkation for pilots and nautical publications;
 - the ship was provided with lights, shapes, means of making sound signals and distress signals, in accordance with the requirements of the Convention and the International Regulations for Preventing Collisions at Sea in force;
 - in all other respects the ship complied with the relevant requirements of the Convention;
 - the ship **was not** subjected to an alternative design and arrangements in pursuance of regulation(s) **II-1/55 / II-2/17 / III/38** of the Convention;
 - a Document of approval of alternative design and arrangements for **machinery and electrical installations/fire protection/life-saving appliances and arrangements is not** appended to this Certificate.
- that an Exemption Certificate **has** been issued.

¹ All applicable dates shall be completed.² For ships constructed before 1 January 2009, the applicable subdivision notation "C.1, C.2 and C.3" should be used.

* Delete as appropriate

Lloyd's Register Group Limited, its affiliates and subsidiaries and their respective officers, employees or agents are, individually and collectively, referred to in this clause as 'Lloyd's Register'. Lloyd's Register assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.



Certificate no: **GDK 1600098**
Page 2 of 2

This certificate is valid until **01 February 2017**

Completion date of the survey on which this certificate is based **29 January 2016**

Issued at **Gdansk** on **14 February 2016**

Waldemar M. Kaniszewski
Surveyor to Lloyd's Register EMEA

a member of the Lloyd's Register group.

Endorsement where the renewal survey has been completed and regulation I/14(d) applies

The ship complies with the relevant requirements of the Convention, and this certificate shall, in accordance with regulation I/14(d) of the Convention, be accepted as valid until

Signed: _____
Place of survey
Date

Endorsement to extend the validity of the certificate until reaching the port of survey or for a period of grace where regulation I/14(e) or I/14(f) applies

This certificate shall, in accordance with regulation I/14(e) / I/14(f) * of the Convention, be accepted as valid until

Signed: _____
Place of survey
Date

* Delete as appropriate

Form 1736 (2015.07)



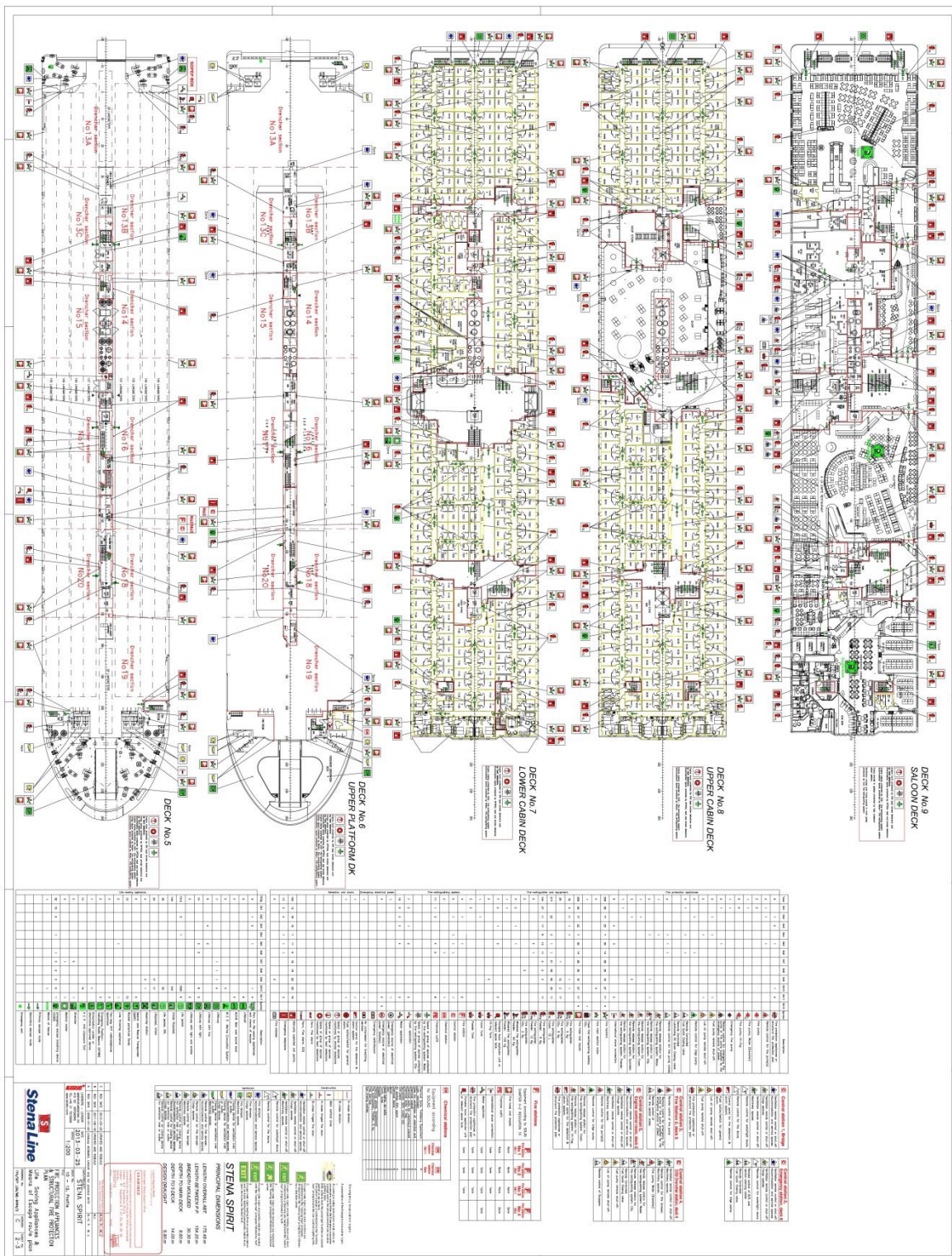
Annex 2

Fire Protection Appliances & Structural Fire Protection Plan – decks 1-4





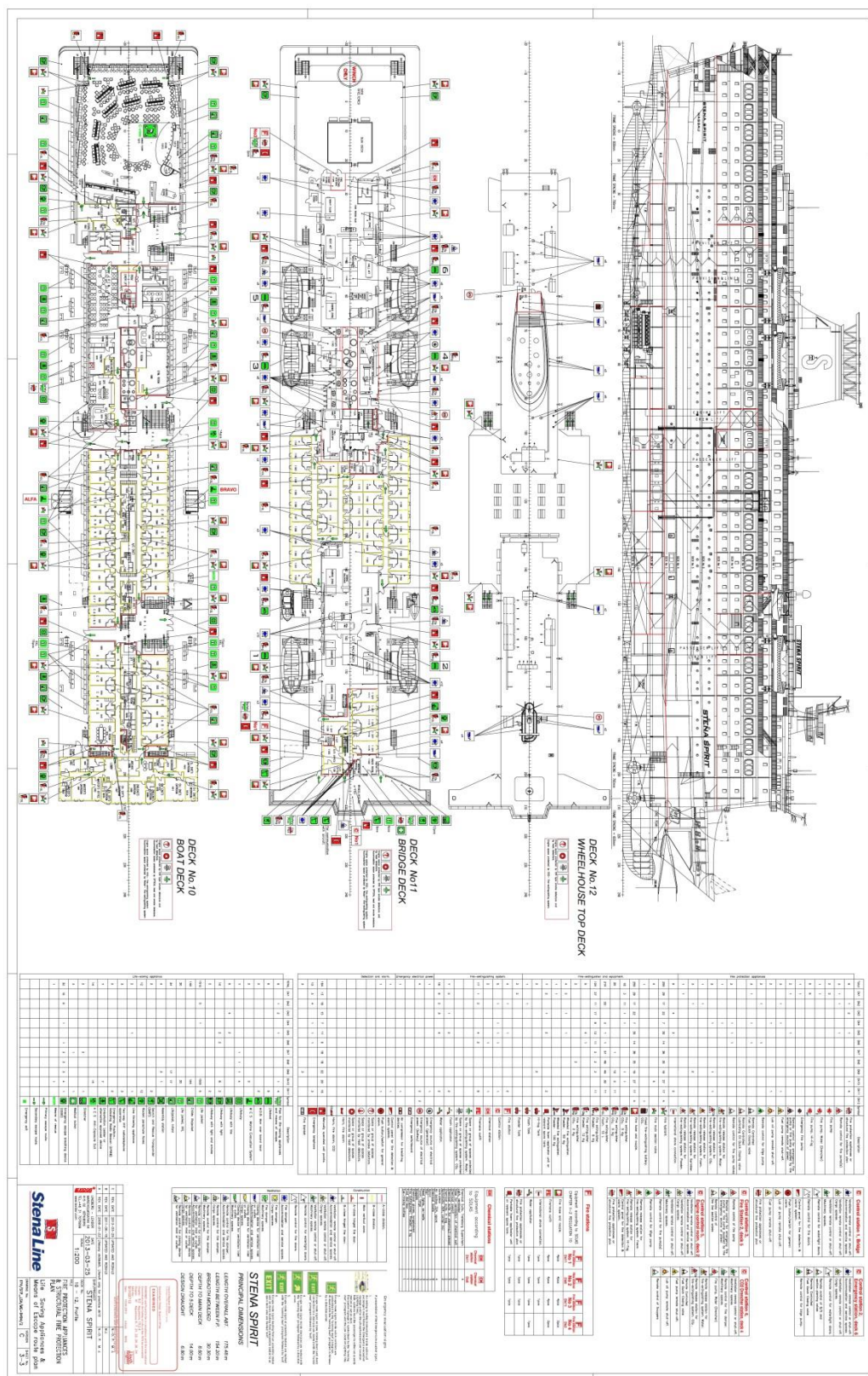
Fire Protection Appliances & Structural Fire Protection Plan – decks 5-9





Annex 4

Fire Protection Appliances & Structural Fire Protection Plan – decks 10-12





Ship Safety Procedures – Procedure SMM-0241

Fire Car Deck - General				
Version No.	Revision Date.	Document ID.	Page.	
2	2016-01-01	SMM-0241	1	

SMM chapter: 8.1

ISM reference: 8

Validity: All vessels

Scope

The guidance given below applies to fire prevention in all areas of a ship but is particularly pertinent to car deck areas where any small fire can quickly develop to be an immediate threat to adjacent cargo.

General

This section covers fire incidents on board. Instructions are posted on several places on board on the "muster list". The following procedure can be guidance for the activities to be performed.

For detail information concerning the installation, equipment and how to fight a fire see safety manual.

Decision Support System

A ship specific decision support procedure to cover this area should be established and maintained on board.

Fire Hazards

The greatest hazards associated with vehicle deck fires are:

- Cargoes of Dangerous Goods
- Reefer Units
- Alternative fuelled vehicles (e.g. LNG, battery, hydrogen, hybrids etc.)

To mitigate those hazards, procedures are established in other documents in the Safety Management Manual.

Fire Prevention

Strenuous efforts are made by the Stena Line freight department to ensure that customers abide by the regulations for the transportation of dangerous goods but regrettably there are a small minority of unscrupulous operators. Any violation of the regulations governing the transportation of dangerous goods will be actively pursued by the Company, but that is of little consolation when dealing with an incident involving undeclared dangerous goods.

Given the above the details of any units involved in an incident should be ascertained as quickly as possible so that they can be passed to shore authorities to obtain more details if required.

Fire Fighting

The use of fixed vehicle deck firefighting installations to rapidly beat back fires that appear to be getting out of control shall always be considered. A quick response will likely constrain the fire to develop. The Master should therefore never hesitate to activate the fixed vehicle deck firefighting installations.

If dangerous goods are identified as being involved in an incident the IMDG Code shall be consulted.



Ship Safety Procedures – Procedure SOM-050

Fire and Safety Patrols Arrangement (Stena Spirit)				
Version No. 1.1	Revision Date. 2014-07-28	Document ID. SOM-0050	Page. 1	

SOM chapter: 7

SMM reference:

Validity: Stena Spirit

Fire and Safety Patrols Arrangement (Stena Spirit)

Patrol Instructions

The patrol with the use of the scanning device, which is kept on bridge, takes place every day. When the ship is at sea, between 22.00 - 05.00 the round takes place at one and half hour:

Instructions for the Computer Data Procession (Documentation)

After a patrol is finished, the scanning apparatus is put in the computer attachment by Safety Officer. By means of the adequate procedure enter the data into the computer. The everyday records of fire patrol are kept in computers memory in Safety Officer Office.

The code tables are arranged on the ship in such a way, that in case of the complete round all zones are controlled.



Ship Safety Procedures – Procedure DS-0715

Fire Outside Engine Room (Stena Spirit)			
Version No. 1.1	Revision Date.	Document ID. DS-0715	Page. 1



Fire Outside Engine Room (Stena Spirit)

Actions taken in case of detection of fire within:

- car decks
- ship stores
- galley
- pantries
- accommodations
- any spaces outside the engine room

When a fire is confirmed:

- inform Master, Engine Control Room, Chief Officer about situation
- stop ventilation, electric power in particular section
- close ventilation flaps, fire dampers depends on the area affected,
- close fire screen doors for the appropriate section,
- close watertight doors, if necessary
- prepare drencher station, if necessary
- start fire pump, emergency fire pump, emergency generator,
- rise Fire alarm if the situation requires,

(follow the Muster List and Crew Emergency Plan procedures)

- depending on the situation, send relevant information using DSC (Urgency or Distress priority) in accordance with the GMDSS procedure. It is also possible to use the VHF radiotelephone (channel 16) and/or the MF transmitter of the 2182 kHz frequency (the priorities are PAN PAN or MAYDAY) in accordance with the procedure included in the Radio communication Regulations for the radiotelephone call by a station being in danger.
- inform owner,

In the event of a major fire

- inform Master, Engine Control Room, Chief Officer about situation
- sound General Alarm (follow the Station Bill and Crew Emergency Plan procedures),
- close appropriate ventilation systems, fire dampers
- start fire pumps
- start drencher pump, if necessary
- prepare lifeboats to be ready for first launch,
- Close fire doors as necessary
- close watertight doors (WTD),
- ensure illumination of the all decks,
- display appropriate lights/shapes, NUC
- check position of the ship, consider altering course and reduce speed (if it is possible) to decrease the risk of spreading the fire and to avoid smokiness of the ship's rooms,
- consider anchoring possibility
- prepare equipment for MAYDAY transmission



Ship Safety Procedures – Procedure SOM-0158

Use of Drencher Facilities on Car Deck (Stena Spirit)				
Version No. 1.1	Revision Date. 2014-07-28	Document ID. SOM-0158	Page. 1	

SOM chapter: 7

SMM reference: SMM-0019

Validity: Stena Spirit

Use of Drencher Facilities on Car Deck (Stena Spirit)

Drencher is used as freighting system on car decks. Drencher nozzles are fitted in upper part of each car deck. The system is activated by hand start of drencher pump and by opening valves for adequate section of car deck. The drencher section plan makes it easy to determine which, and how many sections should be used to freighting purposes.

Operation of Drencher System

- 1) Open bottom valve (A) (pneumatically controlled from Drencher control central)
- 2) Open valve (B) for sprinkler – manifold
- 3) Open section valve till each drencher zone
- 4) Check that draining through the car deck bilges are working
- 5) Start the sprinkler pump (from sprinkler control central)

Fire pump and deck wash pump can be also used to supply water to the system (the valve(C) of the fire main must be opened and then pump can be started).

Maintenance

- 1) The sprinkler facility is drained with valve (D)
- 2) Flushing through with fresh water:
 - valve (E) hydrophor pump
 - valve (C) fresh water pump, started from the bridge
- 3) Blowing with air – valve (F)

Every valve constituting the sprinkler system is checked in accordance with Planed Maintenance System.



Ship Safety Procedures – Procedure SMM-0187

Refrigerated Units				
Version No. 3	Revision Date. 2016-01-01	Document ID. SMM-0187	Page. 1	

SMM-chapter: 7.2

ISM-reference: 7

Validity: All vessels

Scope

This document is to ensure that transporting of refrigerated units can be done in a safe way.

General

Refrigerated lorry using its diesel generator brings about the risk of fire and emission of exhaust fumes harmful to health. Running of diesel driven refrigeration plants is only permitted on weather decks and open vehicle decks. In closed vehicle decks it is prohibited to use diesel driven plants.

Procedure

The Loading Officer should know what number of refrigerated units is expected for loading before cargo operation.

When a refrigerated vehicle arrives on board it will be directed to the designated stowage position and will be plugged into the ship's electric system by the designated crew or by the truck driver (where applicable).

Vehicles requiring refrigerating during sea voyage should be connected to the ship's electric system in accordance with the following rules:

- Cables connecting refrigerated vehicles to the ship's electric system must be led in a way minimising the risk of their being damaged by other cars. The cables may not pose a threat to the safety of passengers leaving or entering their cars on the car deck
- The Loading Officer has to be immediately advised about troubles, if any, with connecting or maintaining electric power supply to the refrigerated vehicle, so that a decision could be made in due time whether the cargo may be carried, the power supply missing, or whether it should be returned ashore
- Prior to the commencement of discharging, all refrigerated vehicles should be disconnected.

**SOLAS 74 Convention (extract)****INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974****ANNEX:****Chapter II-2 Construction - Fire Protection, Fire Detection and Fire Extinction****Regulation 4****Fire control plans**

There shall be permanently exhibited in all new and existing ships for the guidance of the ship's officers general arrangement plans showing clearly for each deck the control stations, the various fire sections enclosed by "A" Class divisions, the sections enclosed by "B" Class divisions (if any), together with particulars of the fire alarms, detecting systems, the sprinkler installation (if any), the fire extinguishing appliances, means of access to different compartments, decks, etc. and the ventilating system including particulars of the fan control positions, the position of dampers and identification numbers of the ventilating fans serving each section. Alternatively, at the discretion of the Administration, the aforementioned details may be set out in a booklet, a copy of which shall be supplied to each officer, and one copy at all times shall be available on board in an accessible position. **Plans and booklets shall be kept up to date**, any alterations being recorded thereon as soon as practicable. Description in such plans and booklets shall be in the national language. If the language is neither English nor French, a translation into one of those languages shall be included. In addition, instructions concerning the maintenance and operation of all the equipment and installations on board for the fighting and containment of fire shall be kept under one cover, readily available in an accessible position.



IMO RESOLUTION MSC.99(73)

(adopted on 5 December 2000)

**ADOPTION OF AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR
THE SAFETY OF LIFE AT SEA, 1974, AS AMENDED**

PART E - OPERATIONAL REQUIREMENTS

Regulation 15

Instructions, on-board training and drills

2.4 Fire control plans

2.4.1 General arrangement plans shall be permanently exhibited for the guidance of the ship's officers, showing clearly for each deck the control stations, the various fire sections enclosed by "A" class divisions, the sections enclosed by "B" class divisions together with particulars of the fire detection and fire alarm systems, the sprinkler installation, the fire-extinguishing appliances, means of access to different compartments, decks, etc., and the ventilating system including particulars of the fan control positions, the position of dampers and identification numbers of the ventilating fans serving each section. Alternatively, at the discretion of the Administration, the aforementioned details may be set out in a booklet, a copy of which shall be supplied to each officer, and one copy shall at all times be available on board in an accessible position. Plans and booklets shall be kept up to date; any alterations thereto shall be recorded as soon as practicable. Description in such plans and booklets shall be in the language or languages required by the Administration. If the language is neither English nor French, a translation into one of those languages shall be included.

**SOLAS'2000 Convention (extract)****INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 2000****Chapter II-2: Construction - fire protection, detection, extinction****Regulation 20***Fire control plans* and fire drills**(This regulation applies to all ships)*

1 In all ships general arrangement plans shall be permanently exhibited for the guidance of the ship's officers, showing clearly for each deck the control stations, the various fire sections enclosed by "A" class divisions, the sections enclosed by "B" class divisions together with particulars of the fire detection and fire alarm systems, the sprinkler installation, the fire extinguishing appliances, means of access to different compartments, decks, etc. and the ventilating system including particulars of the fan control positions, the position of dampers and identification numbers of the ventilating fans serving each section. Alternatively, at the discretion of the Administration, the aforementioned details may be set out in a booklet, a copy of which shall be supplied to each officer, and one copy shall at all times be available on board in an accessible position. **Plans and booklets shall be kept up to date**, any alterations being recorded thereon as soon as practicable. Description in such plans and booklets shall be in the official language of the flag State. If the language is neither English nor French, a translation into one of those languages shall be included. In addition, instructions concerning the maintenance and operation of all the equipment and installations on board for the fighting and containment of fire shall be kept under one cover, readily available in an accessible position.

2 In all ships a duplicate set of fire control plans or a booklet containing such plans shall be permanently stored in a prominently marked weathertight enclosure outside the deckhouse for the assistance of shoreside firefighting personnel.*