Danish Maritime Accident Investigation Board

# MARINE ACCIDENT REPORT
# May 2015


## SEA GALE
## Fire on 20 May 2014

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**Front page: SEA GALE Source: DMAIB**

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

## The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth that carries out investigations as an impartial unit which is, organizationally and legally, independent of other parties. The board investigates maritime accidents and occupational accidents on Danish and Greenlandic merchant and fishing ships as well as accidents on foreign merchant ships in Danish and Greenlandic waters.

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

## The investigations

The investigations are carried out separate from the criminal investigation without having used legal evidence procedures and with no other basic aim than learning about accidents with the purpose of preventing future accidents. Consequently, any use of this report for other purposes may lead to erroneous or misleading interpretations.

# Contents

# 1. INTRODUCTION

On the morning of 20 May 2014, the Danish crew/supply vessel SEA GALE had an engine room fire while engaged in the transfer of wind turbine technicians in the German Bight, the North Sea. All 12 passengers were evacuated, and the fire was extinguished with assistance from other ships in the vicinity. Neither the crew and passengers on board, nor assisting personnel were injured during the accident.

In this report, the DMAIB focuses on the special features of high-speed and carbon composite craft and the challenges of emergency management on board.

# 2. FACTUAL INFORMATION

## 2.1 Photo of the ship


*Figure 1: SEA GALE*
*Source: DMAIB*

## 2.2 Ship particulars

| | |
|---|---|
| Name of vessel: | SEA GALE |
| Type of vessel: | Crew/Supply vessel (HSC Category A) |
| Nationality/flag: | Denmark |
| Port of registry: | Fredericia |
| IMO number: | 9672935 |
| Call sign: | OUWY2 |
| DOC company: | A2SEA A/S |

| | |
|---|---|
| IMO company no. (DOC): | 5082412 |
| Year built: | 2013 |
| Shipyard/yard number: | Danish Yachts A/S/120 |
| Classification society: | DnV GL |
| Length overall: | 24.65 m |
| Breadth overall: | 10.83 m |
| Gross tonnage: | 244 |
| Deadweight: | 65 t |
| Draught max.: | 2.490 m |
| Engine rating: | 1,800 kW |
| Service speed: | 22.0 knots |
| Hull material: | Carbon fibre sandwich |
| Hull design: | Multihull SWATH (Small Waterplane Area Twin Hull) |

## 2.3 Voyage particulars

| | |
|---|---|
| Port of departure: | Helgoland, Germany |
| Port of call: | Meerwind Süd/Ost Wind Farm, North Sea |
| Type of voyage: | Coastal |
| Cargo information: | Passengers |
| Manning: | 3 |
| Pilot on board: | No |
| Number of passengers: | 12 |

## 2.4 Weather data

| | |
|---|---|
| Wind – direction and speed: | SW – 7 m/s |
| Wave height: | 0.5 m |
| Visibility: | Good |
| Light/dark: | Daylight |
| Current: | Unknown |

## 2.5 Marine casualty or incident information

| | |
|---|---|
| Type of marine casualty/incident: | Fire |
| IMO classification: | Serious |
| Date, time: | 20 May 2014 at 08.06 LMT |
| Location: | Meerwind Süd/Ost Wind Farm, North Sea |
| Position: | 54°22.3’ N – 007°39.6’ E |
| Ship’s operation, voyage segment: | Manoeuvring/Disembarking |
| Place on board: | Engine casing/engine room |
| Human factor data: | Yes |
| Consequences: | Structural and equipment damage to ship, evacuation of passengers. |

## 2.6 Shore authority involvement and emergency response

| | |
|---|---|
| Involved parties: | MRCC Bremen, assisting vessels: NJORD ALPHA, BAYARDS 3, MELLUM, SC AMETHYST, MECKLENNURG-VORPOMMERN, GESA, KAREN M |
| Resources used: | Fire-fighting teams, firefighting equipment and |

| | |
|---|---|
| | pump capacity, towing assistance. |
| Speed of response: | Within a few minutes |
| Actions taken: | Firefighting and cooling assistance rendered. Evacuation of passengers. Towage to port. |
| Results achieved: | All passengers safely evacuated. Fire extinguished. Ship towed to port. No injuries. |

## 2.7 The ship's crew

| | |
|---|---|
| Master: | STCW II/2 Certificate as master unlimited.<br>Had been at sea for 40 years. Employed with the company for two months with five weeks serving on SEA GALE. Substantial passenger ship experience. |
| Chief officer: | STCW II/2 Certificate as chief mate,<br>max. 3000 GT<br>Had been at sea for 20 years. Employed with the company for four months, all of them serving on SEA GALE. |
| Deckhand/motorman: | STCW II/3 Certificate as second hand/able seaman.<br>Had been at sea for 11 years. Employed with the company for three months with approx. one month serving on SEA GALE. |

## 2.8 Scene of the accident

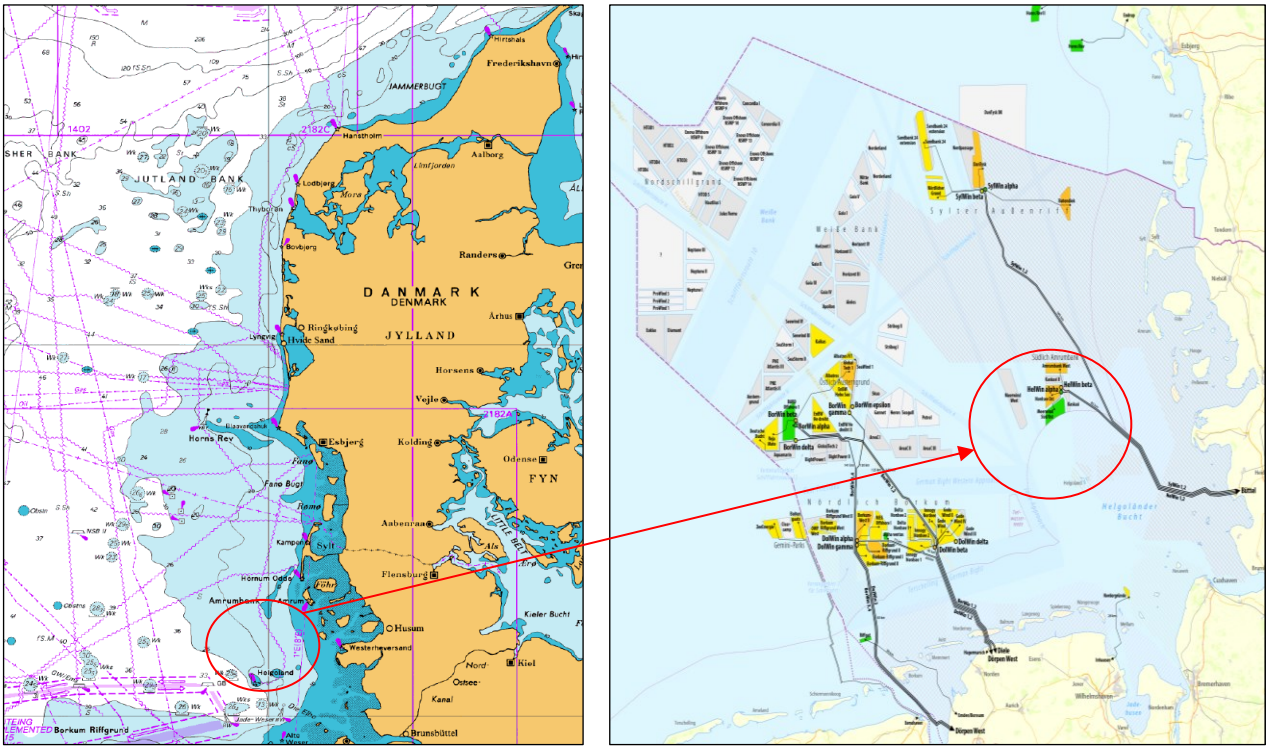


*Figure 2: Scene of the accident. German Bight, North Sea. Meerwind Offshore Wind Farm Süd und Ost*
*Source: A2SEA/WindMW GmbH / Source: © Crown Copyright and/or database rights. Reproduced by permission of the controller of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk).*

# 3. NARRATIVE

## 3.1 Background

The Danish crew/supply vessel[1] SEA GALE was owned by FOB Swath AS, Norway, and operated by A2SEA A/S in Denmark. SEA GALE was classified as a HSC[2] category A passenger vessel with a capacity of 24 passengers and a crew of three to four, depending on service area. At the time of the accident, the ship was contracted by Siemens to service the Meerwind Offshore Süd/ Ost Wind Farm in the German Bight, in the North Sea (figure 3).

The Meerwind Offshore Wind Farm was located northwest of the island of Helgoland in the German Bight, the North Sea, and was planned to consist of 80 wind turbines. The coordination of ship traffic and safety in the area was managed by an Operations Control Centre (OCC), operated by the company OutSmart and located in Emden, Germany. All ships were to report to the OCC upon departure and when transferring persons to and from the wind turbines. Accidents, incidents and emergencies were also reported to the OCC.

SEA GALE's main task was daily trips from Helgoland to the individual wind turbines, transferring technicians to, from, and between the turbines in the area. The normal work routine was to depart Helgoland at 0700, delivering the technicians to their assigned locations according to a schedule provided by the contractor. Typically, the group of technicians consisted of 12-15 persons in teams of three. After having finished the round, the ship would stand by for transfers between the turbines. At the end of the working day, around 1700, SEA GALE would start boarding the technicians and transport them back to Helgoland. A normal working day ended around 1900, when SEA GALE returned to port at Helgoland.

The routine for transferring technicians to the turbines was to approach the turbine foundation by the bow of the ship. The navigation officer would then push the ship onto the foundation, using the necessary engine power, while the deckhand manned the gate at the bow and assisted the technicians with attaching their fall arrest gear and safely disembarking the ship. Typically, the ship would call at 15 to 20 turbines per day.

In a restricted area of operation, such as a wind farm, SEA GALE operated with a crew of three, consisting of a master, a chief officer and a motorman who also served as a deckhand. The master and chief officer usually divided the duties of navigating the vessel and other tasks between them as they saw fit.

Figure 3 below shows excerpts from the general arrangement of SEA GALE. The ship was a SWATH[3] type passenger vessel. The hull was constructed of carbon composite with GRP[4] bulkheads. The engine arrangement consisted of two identical engine rooms, one in each of the twin hulls, containing a diesel generator set on the upper level, and one main engine on the lower level, each driving a propeller. In addition, the ship was equipped with bow and stern thrusters.

[1] Often referred to as a CTV; Crew Transfer Vessel.
[2] HSC: High-Speed Craft, as defined by the International Code of Safety for High-Speed Craft (HSC Code).
[3] SWATH: Small Waterplane Area Twin Hull, a catamaran hull design which provides good stability in rough seas.
[4] GRP: Glass fibre Reinforced Plastics.

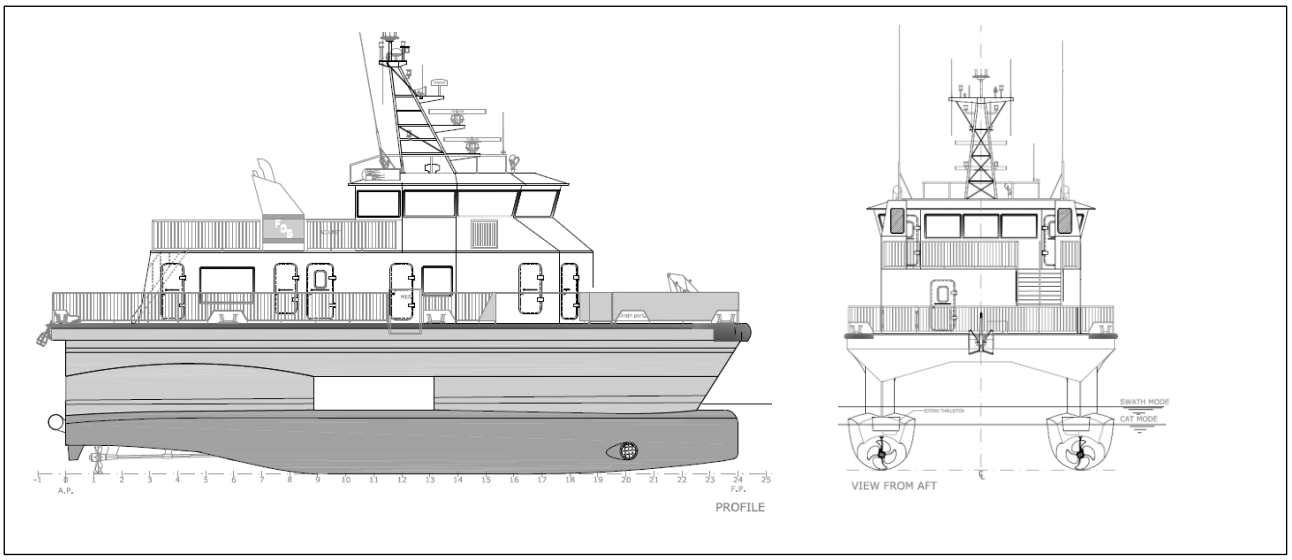


*Figure 3: Excerpts from the general arrangement of SEA GALE*
*Source: A2SEA/ DMAIB*

## 3.2 Sequence of events

*The accidental events described in the following section all unfolded within a short time frame. It should be noted that some of the events took place simultaneously in different locations on board.*

On 20 May 2014 at 0658, SEA GALE departed Helgoland bound for the Meerwind wind farm on a normal crew transfer round with 12 technicians as passengers. The chief officer was in the wheelhouse navigating the ship, while the master was below in his cabin.

The first stop of the day was the turbine *T30* (figure 4), where one team of three disembarked at 0750. The ship then proceeded to *T17,* ready to deliver the next team at 0806.

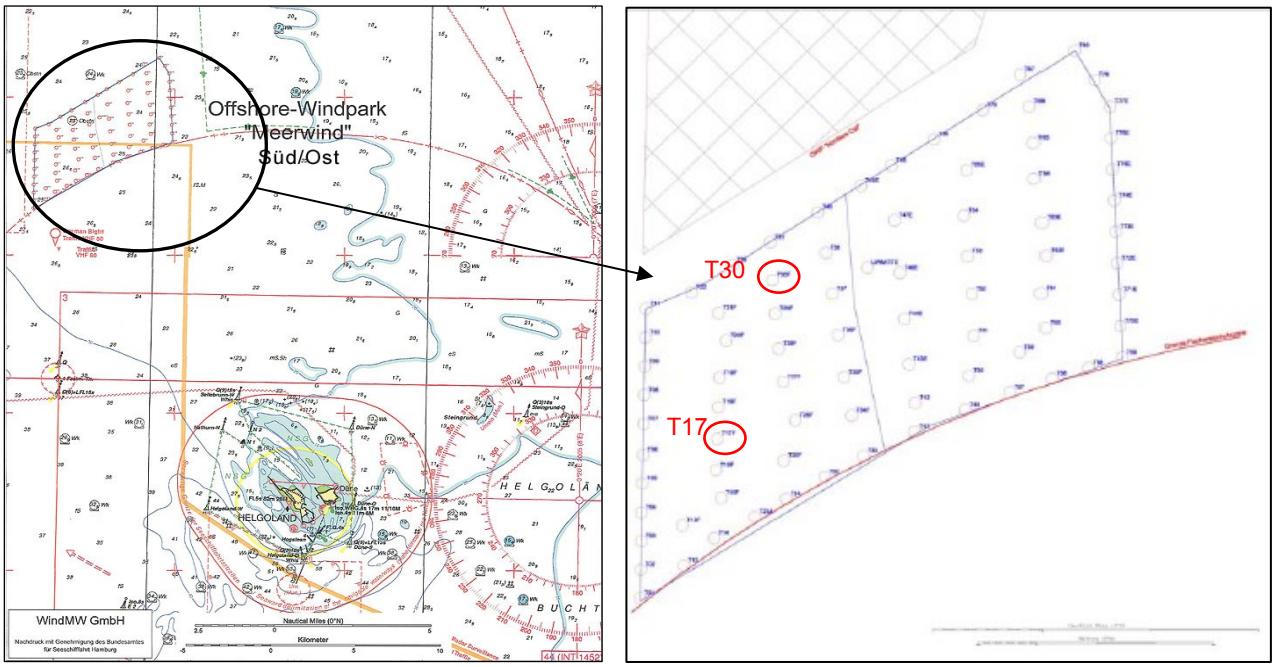


*Figure 4: Meerwind Süd/Ost field. Turbines T30 and T17 indicated in red.*
*Source: A2SEA/ DMAIB*

Just as the team of technicians were ready to leave the ship, the fire alarm sounded. The alarm setup on SEA GALE was such that the fire alarm sounded in all areas at once, including in the passenger lounge. The fire alarm panel showed that the alarm came from the starboard generator casing. From experience the chief officer initially suspected that the alarm may have been caused by the engine room overheating because the fans were running at reduced speed, which they usually did during port stays. He checked to ensure that the fans were running at the intended 80% capacity which they were not. He then adjusted the fans to 80%.

The chief officer silenced the alarm and hand-signalled to the deckhand that the transfer of passengers should be aborted. He then reversed the ship away from the turbine, and checked the CCTV[5] monitors that covered all areas of the ship. He could see no smoke or fire anywhere.

Alerted by the alarm, the master arrived on the bridge where he relieved the chief officer, who could then attend to his duties managing the firefighting.

Meanwhile, the deckhand went to the passenger lounge and asked if anyone was smoking, which might have set of the fire alarm. As this was not the case, he joined the chief officer at the door to the casing. After having established that it was not warm to touch the door, they opened it and the chief officer entered into the casing and onto the upper grating (figure 5). From there, he inspected the casing and exhaust pipes below using a flashlight. Initially, he could not see any significant amount of smoke or any open flames, but after a few minutes he saw flames reflecting from the stainless steel exhaust pipes towards the starboard engine. The chief officer reported by radio to the bridge that there was a fire and that evacuation procedures should be initiated immediately. He then closed the door to the casing. No firefighter's outfits were available so the crew did not consider it safe to enter very far into the engine rooms to assess or fight the fire as they did not know the extent of fire, or the risk of toxic smoke and fumes.

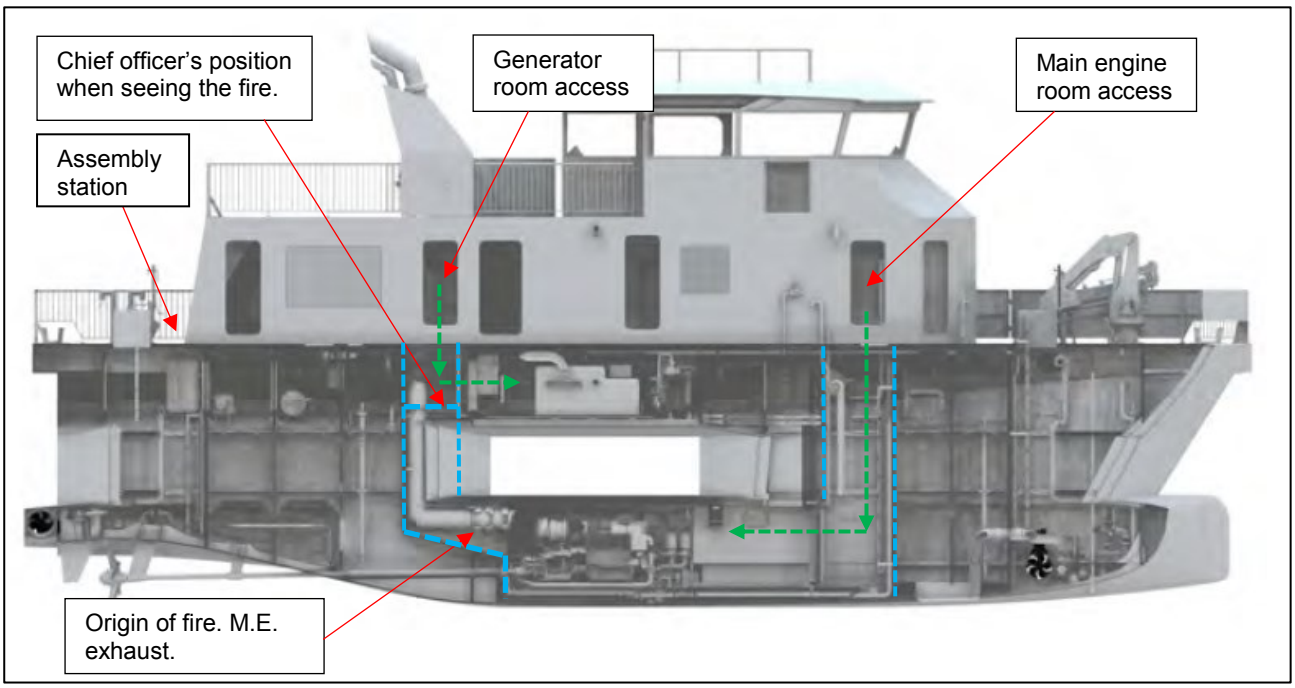


*Figure 5: Cutaway photo of a SEA GALE class ship*
*Source: Danish Yachts / DMAIB*

The master went to the passenger lounge to inform the passengers that they should muster for evacuation and found that they had already mustered at the assembly station on the aft deck. He briefed them on the situation and returned to the bridge.

[5] Closed-circuit television, i.e. video surveillance.

The chief officer activated the button for shutting the fire dampers and then returned to the bridge, where he activated the water mist fire-extinguishing system, opening the valves for all engine rooms at 0819.

At 0820, the chief officer pushed the emergency stop buttons for the main engines. After a few minutes, he noticed that the starboard main engine was still running. The master then stopped the engine by means of the normal stop button. The chief officer then activated all emergency stop buttons, and by doing so, unintentionally also stopped the generators which caused a black-out that surprised the crew (figure 6). The power interruption stopped the water mist system after it had been activated for roughly one minute. The black-out caused an abundance of audible and visual alarms on the bridge, indicating multiple system failures. Because the noise from the alarms stressed the crew, the master silenced as many as he could by acknowledging them on the alarm panel.

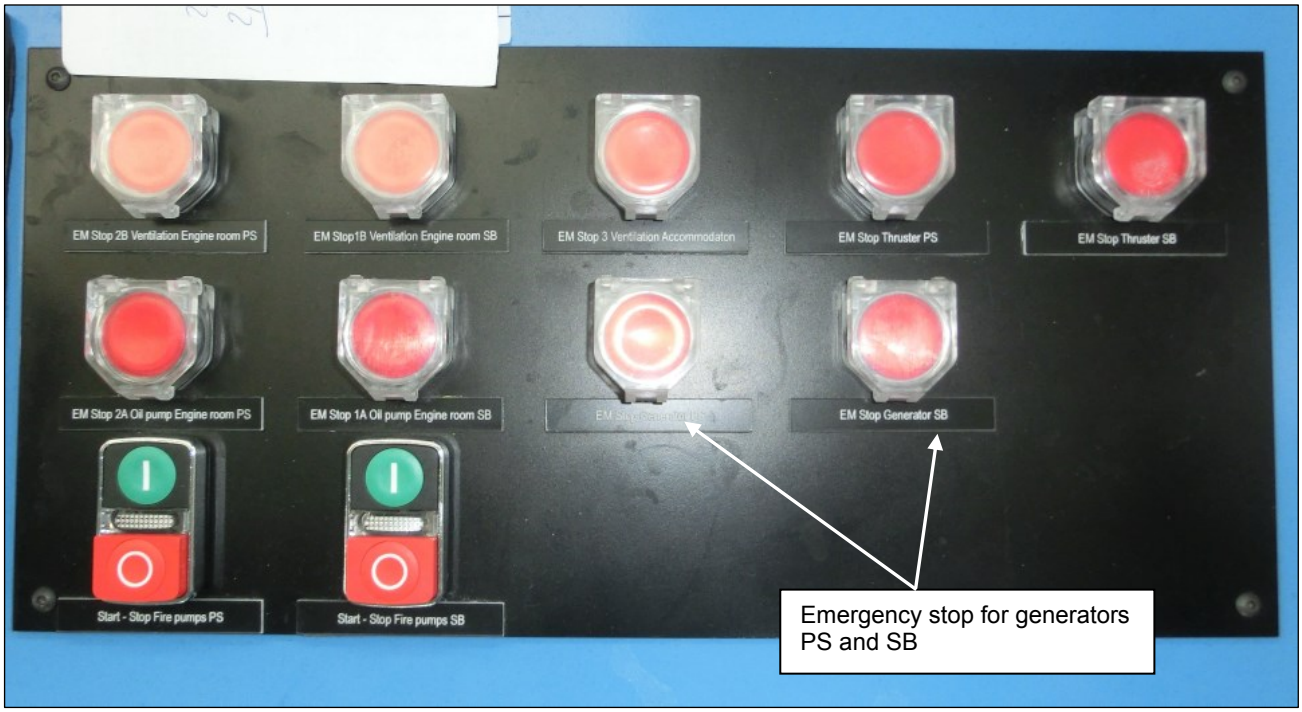


*Figure 6: Bridge panel for emergency stop of main engines, generators, thrusters, ventilation etc.*
*Source: DMAIB*

Meanwhile, the master was communicating with other ships in the area and with the OCC, requesting assistance.

Contact was established with the crew vessels BAYARD 3, NJORD ALPHA and SC AMETHYST which all approached SEA GALE and stood by for assistance. At 0822, MRCC[6] Bremen was informed of the situation.

At 0820, an attempt was made to evacuate the remaining nine passengers to BAYARD 3 that had approached from the stern; however, as the difference in freeboard was too large, the attempt was abandoned. Instead, all passengers were successfully evacuated, at 0823, to NJORD ALPHA which had approached SEA GALE's bow.

At 0825, smoke was pouring out of the starboard funnel and the master of SEA GALE requested that a professional fire-fighting team should be deployed to assist, possibly by helicopter.

[6] MRCC: Maritime Rescue Coordination Centre.

SC AMETHYST supplied a fire hose and pump capacity, enabling the chief officer and deckhand to start cooling the outside engine casing at approximately 0837, and shortly after to spray water into the exhaust outlet. Simultaneously, the vessels KAREN M, NJORD ALPHA and GESA assisted with cooling the starboard side.

The German navy vessel MECKLENBURG-VORPOMMERN arrived at the scene at 0853 and, shortly after, deployed two teams of smoke divers to SEA GALE, boarding via SC AMETHYST. The master briefed the teams of the situation and the layout of the ship. Efforts were then made to extinguish the fire by spraying water into the casing via the door, which caused black smoke to evolve. The master proceeded to break down the air inlets to the funnel with a fire axe, thus enabling him to release a powder extinguisher into the casing. The firefighting teams then entered the room while continuing to spray water. These combined efforts seemed to contain the fire.

Meanwhile, a third smoke diver team arrived from the coast guard vessel MELLUM, deployed by Cuxhaven Havariekommando[7]. They inspected the scene and proceeded to fill the casing with foam.

At 1100, the fire was reported to be under control. The MELLUM had made fast alongside SEA GALE half an hour earlier, and the firefighting teams continued the firefighting efforts and keeping watch on the situation (figure 7).


*Figure 7: German Coast Guard vessel MELLUM alongside SEA GALE. Aft SC AMETHYST.*
*Source: Havariekommando*

At 1300, the firefighters from MELLUM declared the fire extinguished and, at 1741, the Cuxhaven Havariekommando declared the incident closed. No persons were injured.

In parallel with the ongoing firefighting efforts, the company and the master had arranged for towing of SEA GALE to Hvide Sande, Denmark, for assessment of damage and subsequent repairs.

[7] Central Command for Maritime Emergencies, a joint institution of the German federal Government and coastal states.

## 3.3 Background on SEA GALE and the HSC Code

*SEA GALE was a carbon composite, high-speed category A passenger ship. The following sections will elaborate on some of the significant differences between the safety approach to this type of ship compared to traditional passenger ships.*

### *3.3.1 The High-Speed Craft Code*

The International Code of Safety for High-Speed Craft, adopted by IMO (The International Maritime Organization) in 1994 and amended in 2002, was developed to accommodate the design and operation of vessels constructed of other materials than steel, and with a speed/displacement ratio above a fixed limit.

High-speed passenger craft are different from conventional passenger ships as:

> *"The safety philosophy of the regulations for high-speed craft (HSC) is based on the management and reduction of risk as well as the traditional philosophy of passive protection in the event of an accident. Management of risk through accommodation arrangements, active safety systems, restricted operation, quality management and human factor engineering should be considered in evaluating safety equivalent to current conventions. The application of mathematical analysis to assess risk and determine the validity of safety measures is encouraged. The regulations take into account that a high-speed craft is of a light displacement compared with a conventional ship. This displacement aspect is the essential parameter to obtain fast and competitive sea transportation and consequently the regulations allow for use of non-conventional shipbuilding materials, provided that a safety standard at least equivalent to conventional ships is achieved. To clearly distinguish such craft, criteria based on speed and volumetric Froude number have been used to delineate those craft to which these regulations apply from other, more conventional, craft."*[8]

One of the concepts introduced by the code is the concept of an "assisted craft". This forms the basis for a "category A passenger craft", which permits a reduction in active and passive protection where rescue assistance is readily available and the total number of passengers is limited. Examples of active and passive protection are, active: Emergency bilge pumps, fixed firefighting systems, evacuation systems, passive: Intact stability, fire insulated bulkheads, use of non-flammable materials.

The HSC Code defines a "category A craft" as any high speed passenger craft:

- *operating on a route where it has been demonstrated to the satisfaction of the flag and port States that there is a high probability that in the event of an evacuation at any point of the route, all passengers and crew can be rescued safely within the least of:*
    - *the time to prevent persons in survival craft from exposure causing hypothermia in the worst intended conditions,*
    - *the time appropriate with respect to environmental conditions and geographical features of the route, or*
    - *4 h; and*
- *carrying not more than 450 passengers.*(HSC Code 2000 edition, ch. 1, sect. 1.4.12)

[8] H. Hoppe (2005). *International regulations for high-speed craft – an overview*. International Conference on Fast Sea Transportation FAST'2005, June 2005, St. Petersburg, Russia.

Thus the underlying principle behind the HSC Code is based on operational limitations, the management and reduction of risk, and the reliance on outside help. That is what distinguishes high-speed craft from conventional ships. This is in contrast to the approach that ships and their crews should, to some extent, be self-assisted, and abandoning the ship is a last resort, only to be applied if all other efforts to rescue crew, passengers and ship fail.

### *3.3.2 Carbon fibre composite*

The use of carbon composites in commercial shipbuilding is relatively new. The major advantage of using composites is a significant reduction in structural weight (up to 50-70% compared to steel). This weight reduction can be utilised for increasing the ship's speed, reducing fuel consumption, increasing the deadweight, improving stability, or a combination of these.

Carbon fibre is combustible, which is in contrast to the traditional rules of shipbuilding which state that ships shall be built of non-combustible materials, i.e. steel. Carbon composites are composed of carbon fibres in combination with a thermoset resin, typically vinyl-ester or epoxy. It can be used as single skin laminate or together with a core material in a sandwich construction. The use of these resins raises the concern of the material developing toxic fumes and smoke in case of fire.

### *3.3.3 Safe manning, service area and restrictions*

SEA GALE's class notation included a service restriction R1, which was defined as follows:

"*Short ocean service restriction applies to craft on short international voyages where the craft is assumed to be outside the range of rescue assistance from shore, other than from helicopter. The craft is assumed to be outside the possibility to seek shelter if the weather forces are above sea state 6"*.

The Danish Maritime Authority (DMA) had issued a *Permit for carriage of passengers*, which, along with a maximum of 24 passengers, restricted the vessel to voyages between North European harbours and wind farms in North European waters within 150 nautical miles of the nearest coastline.

The Minimum Safe Manning Document, also issued by the DMA, permitted the ship to operate 14 hours a day with passengers and a crew of three, in trade south of 62°N, north of 48°N and east of 007°W.

### *3.3.4 Firefighting and safety systems*

SEA GALE was equipped with smoke and heat detectors in all rooms and relevant compartments. The ship's firefighting systems consisted of fixed water mist/sprinkler systems covering the accommodation and engine rooms. These were operated from the bridge and required opening the relevant valves located in compartments on the aft part of the bridge, and then activating the pumps from a panel on the bridge console. The water mist system, as well as the three fire hydrants located on the open deck, was powered by the auxiliary generators, with no back-up, which meant that when the generators were stopped, the water mist system was inoperable. A restart of the generators could only be done after a manual reset in the engine room. In addition to the fixed systems, the ship was equipped with a number of portable $CO_2$ and powder extinguishers. As it is not a requirement for ships of HSC category A to carry firefighter's outfits with breathing apparatuses, SEA GALE did not have them on board.

The ship's main means of evacuation was a MES (Marine Evacuation System) in each side located on the upper deck. These were, however, not in use on the day of the accident, as the passengers were evacuated directly to other vessels from the main deck.

## 3.4 Damage and fire investigation

The fire originated in a carbon composite panel and insulation above the main engine exhaust pipe, in the transition area between the aft engine room bulkhead and the casing. The panel was most likely overheated by radiating heat from the exhaust pipe. It is likely that insufficient ventilation of the engine room caused excessive exhaust gas temperatures which led to overheating of the exhaust pipe.

A few weeks prior to the incident, the ship had been docked for maintenance, including an overhaul of the starboard main engine. As a part of the overhaul, insulation was removed and later replaced. From the owner's investigations, it seems likely that the insulation in the transition area between the engine room and the casing, had not been replaced properly, thus leaving an area exposed to excessive radiant heating from the exhaust.

Assessment of damage revealed that insulation material, electrical cables, composite panels and GRP bulkheads in the main engine room area and casing were damaged by the fire. Additionally, there was some damage caused by smoke and water from the firefighting (figure 8).


*Figure 8: Damaged main engine exhaust and surrounding bulkheads.*
*Source: A2SEA*

# 4. ANALYSIS & CONCLUSIONS

The accident happened when a fire occurred in the transition area between the starboard main engine room and the adjacent casing. The immediate, technical cause of the fire was likely a combination of insufficient insulation and possibly elevated exhaust gas temperatures from the propulsion engine due to insufficient ventilation. All passengers were evacuated to assisting vessels, and the fire was subsequently also extinguished with outside assistance.

The thinking underpinning the HSC Code is that ships are not self-assisted and thus depend on external assistance. This was also the case for SEA GALE, where the positive outcome of the events can be ascribed to the availability of assistance from other ships that supplied evacuation capacity, firefighters, equipment and pump capacity.

The crew faced a number of challenges:

- They did not have the equipment needed to effectively assess the extent and intensity of the fire in the casing,
- and the layout of the controls for the firefighting and engine systems caused an unintended blackout.
- The large amount of audible and visual alarms impaired the crewmembers' handling of the emergency situation.

According to the HSC Code, it is not a requirement for ships of category A to carry firefighter's outfits with breathing apparatuses. However, in this particular situation without having repiratory protective equipment, the crew felt hindered in their efforts to move freely and safely around the ship to assess and possibly extinguish the fire before it developed.

The uncertainty about the risk of a fire in a carbon composite structure introduced further stress factors in the decision making process, thus adding to the complexity of the situation: The crew did not know to which extent the smoke and fumes from the fire were toxic, there was uncertainty about the structural strength of the ship or how fast the fire might spread.

The HSC Code requirements imply that evacuation is the immediate response to emergency scenarios. In this context, it should be noted that there are also inherent risks in evacuating a ship where passengers are to be transferred to life rafts in open sea. This risk might make ship crews reluctant to immediately decide on evacuation before the seriousness of the situation is established. It is problematic to make a decision about evacuation based on uncertain circumstances, i.e. it is unknown to the crew whether a situation is serious enough to abandon the ship. The extremes are usually easy to establish, e.g. a small smouldering fire in a garbage bin does usually not lead to evacuation, whereas a visible serious engine room explosion usually does. All the situations in between may be difficult for ship crews to assess. Therefore, it is up to the crewmembers to assess when a situation is serious enough to abandon the ship.

While the crew did activate the water mist system, it only ran for approximately one minute because, in the process of shutting down the main engines, the power supply for the water mist was unintentionally cut off. The layout and operation of the systems was such that in an emergency they were prone to mistakes. In order to restart the engines after a stop, they must be reset, which could only be achieved by entering the emergency generator rooms. This would not have been an option under circumstances where the extent of a fire was not known. There was no back-up system for the water mist firefighting system.

The combination of the above factors left the crew of SEA GALE with only one option: To rely entirely on external assistance to extinguish the fire.

## 5. PREVENTIVE MEASURES TAKEN

The company A2SEA, the owner of SEA GALE, has supplied DMAIB with the following summary of preventive measures taken after the accident:

*Following technical investegations, A2SEA have initiated several preventive measures including a design review of the insulation in the area of the manifolds, exhaust pipes and funnel. The changes were implemented on SEA GALE during the reconstruction. All other A2SEA operated vessels were inspected for signs of similar weaknesses.*

*Futher measures as following have been initiated and implemented:*

- *The evaluation of the layout of the emergency buttons made A2SEA remark the emergency stops on the bridge to better distinguish betweem them and to which redundant engine they belong. Same with the quick closing valves which have been marked more thoroughly with green and red markings.*
- *Checklist for main engine start up (SMS 7-0700A) have been amended where increasing of airflow prior to start up to 80 % have been added. Duty engineer must report to Master when this is completed. A2SEA is currently working on a automatic control system where ventilation to the engine rooms is automatically initiated and closed.*
- *Procedure for supervision/approval of works going on at ship yards have been thoroughly scrutinized and also amended where we do a more closely supervision now and furthermore prepare bridging documents with the yard.*
- *More focus on training in redundancy equipment and technical layout of the vessel in order to ensure a better familiarization with the emergency equipment on board.*