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

Investigation Report No. 261/20

Less serious marine casualty

Fire in the engine room on board the ferry BERLIN in the access to the port of Rostock on 13 August 2020

30 November 2022

This investigation was conducted in conformity with the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law – SUG). According to said Law, the sole objective of this investigation is to prevent future accidents. This investigation does not serve to ascertain fault, liability or claims (Article 9(2) SUG).

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

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

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List of Abbreviations

2D / 3D	Two-dimensional/three-dimensional
AFF	Advanced Fire Fighting
CPP	Controllable pitch propeller
CE	Chief Engineer
d	Draught (d_m = midships draught)
DG	Diesel generator
DMA	Danish Maritime Authority
ECR	Engine Control Room
EEBD	Emergency escape breathing device
ELSA	Emergency Life-Saving Apparatus
ER	Engine Room
ESS	Energy storing system
EU	European Union
GSSO	Gesellschaft für Sicherheitstechnik/Schiffssicherheit Ostsee mbH (“Baltic Association for Safety Technololgy/Ship Safety“)
IACS	International Association of Classification Societies
IMAC	Integrated Machine Alarm Centre
kn	Knots
l/ltr.	Litres
l/min.	Litres per minute
LP System	Low Pressure System
m	Meters
ME	Main engine
MSC	Maritime Situation Centre or Maritime Safety Committee
Paris MOU	Paris Memorandum of understanding
PSC	Port State Control
sec.	Seconds
SM	Ships mechanic
SOLAS	International Convention for the Safety of Life at Sea, 1974 (SOLAS)
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
tn	Tons
TO	Technical Officer
UTC	Universal Time Coordinated (formerly Greenwich Mean Time GMT)
VHF	Very High Frequency, a range of radio frequencies from 30 MHz to 300 MHz used for marine communications.
VTS	Vessel Traffic Services
WSP	Waterways Police (German: Wasserschutzpolizei)

1 SUMMARY

On 13 August 2020, the German flagged ferry BERLIN was en route to the port of Rostock as usual. At about 0245[1], when she was in the approach fairway about 2.6 nm from the sea channel, a fire broke out in the main engine room. The cause was determined to be material fatigue of a pressure gauge pipe that could not have been foreseen. It had broken, releasing a jet of gear oil onto insufficiently insulated engine parts, where it predictably ignited.

As the fire was initially very limited, three crewmembers spontaneously started manual firefighting. A few minutes later, the ship's command sounded the general alarm, and all necessary measures were initiated.

As early as 15:14, the fire could be reported as extinguished.

To be on the safe side, the hybrid ferry continued her journey to the berth in Rostock harbour using only her diesel-electric drive. There, all passengers were able to leave the ship unharmed. There was a manageable amount of damage in the fire area, and the three firefighting crewmembers complained of a throat irritation, which was treated by a medical response team.

This investigation revealed that there is no mandatory monitoring obligation for the "hot spot" regulations that have been in place for years.

The shipping company promptly and comprehensively corrected the shortcomings in firefighting and technical deficiencies that this report revealed.

[1] Unless otherwise stated, all times shown in this report are local: CEST (UTC + 2 hours).

2 FACTUAL INFORMATION

2.1 Ship's photo

Figure 1: Ship's photo BERLIN[2]

2.2 Ship's particulars:

Name of ship	BERLIN
Type of ship:	Passenger/RoRo Ferry
Flag	Germany
Port of registry:	Rostock
IMO-Number	9587855
Call sign:	DKDF2
Shipping company:	Scandlines Deutschland GmbH
Year built:	2016
Ship yard:	P+S Werften GmbH Stralsund
Classification society:	Lloyd's Register
Length overall:	169.50 m
Breadth overall:	25.40 m
Draught (max)	6.00
Gross Tonnage:	22.319
Deadweight:	4.835 t
Engine rating:	3x Caterpillar 9M32C (each with 4.500 kW) as propulsion engine 1x MAN diesel engine (4.500 kW) as generator 1x MAN port diesel generator (1.540 kW)

[2] Source: Shipping company.

Propulsion:	1 controllable pitch propeller (13.500 kW) (direct propulsion: 3 main engines (aforementioned Caterpillars) via a reduction gear); 2 diesel engines (power generation for diesel-electric auxiliary drive): 2 Azipull thrusters (3,500 kW each)
Speed:	24 kn
Hull material:	Steel AH36
Ship's hull construction:	Double bottom
Minimum safe manning:	14 + 10 x service personnel
Passengers:	Max. 1,300
Cargo:	Max. 460 vehicles

2.3 Voyage particulars:

Port of departure:	Gedser
Port of call:	Rostock
Type of voyage:	Merchant shipping
Cargo information:	114 vehicles
Crew:	35
Draught at the time of the accident:	d_m= 5,40 m
Pilot on board:	No
Number of passengers:	280

2.4 Marine Casualty Information

Type of marine casualty:	Less serious marine casualty Fire in the main engine room
Date/Time	13 August 2020 1446 hrs
Location:	Sea channel Rostock
Breadth/Lenght:	φ 54°14,2‘N λ 012°03,7‘E
Voyage segment:	Pilotage waters / Arrival
Place on board:	Main engine room
Human factor:	No
Consequences:	Minor damages: partially burned insulations of the exhaust duct of main engine 2 Ppollution due to the leakage of gear oil

Section of Navigational Chart INT 1672, BSH

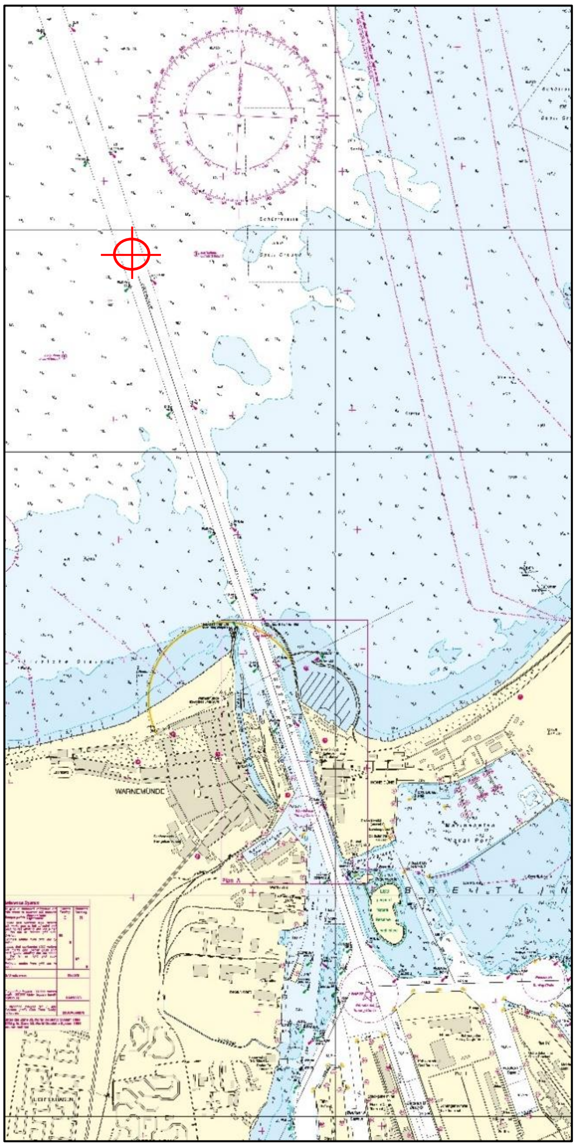

Figure 2: Navigational chart with scene of the accident

2.5 Shore authority involvement and emergency response

Agencies involved:	Vessel Traffic Services (VTS) Warnemünde, Waterways Police (WSP) Rostock, Rostock Harbour Master's Office, German Ship Safety Division (BG Verkehr[3] for short), Maritime Situation Centre (MSC) Cuxhaven
Resources used:	Shipboard fire extinguishing systems
Actions taken:	Fire extinguishing using ship’s own facilities

[3] „Berufsgenossenschaft Verkehrswirtschaft, Post-Logistik und Telekommunikation“ (“BG Verkehr” for short): German institution for statutory accident insurance and prevention in the area of transportation, postal logistics and telecommunications. Advises and supports its affiliated companies and their employees in the prevention of occupational and commuting accidents, work-related health hazards and occupational diseases. Its Ship Safety Division is often used synonymously in this report.

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

On 13 August 2020, the German flagged ferry BERLIN was en route to the port of Rostock as usual. At about 0245, when she was in the approach fairway about 2.6 nm off the sea channel, alarms sounded in the engine control room (ECR) and in the workshop. The IMAC[4] Alarm „gear oil sump level low"[5] sounded first.

Ship mechanic 1 (SM 1)[6] acknowledged the alarm in the workshop and proceeded to the source of the alarm at main engines (ME) 1 and 2 (the two main engines that drive the controllable pitch propeller together with ME 3, via a common reduction gearbox). There he detected a leakage from a double nipple[7] on top of the gearbox (from the pressure gauge connection).

Ship mechanic 2 (SM 2) meanwhile reached the scene via Deck 1. He saw flames and smoke in the area of ME 2 turbocharger.

Figure 3: View of the fire from Deck 1[8]

At 14:46, the smoke detector in the main engine room went off. However, the object protection system did not trigger automatically, as this only happens when two detectors detect an alarm.

[4] IMAC: Integrated Machine Alarm Centre (integrated engine alarm centre).
[5] Loss of gear oil.
[6] Two ship mechanics and technical officer make up the engine room watch, which is manned around the clock in shifts.
[7] Double nipple: also called „straight screw-in fitting" or "threaded steel pipe fitting". Refers to a short piece of pipe with two identical ends (threads) for the connection of two pipes.
[8] Source: Shipping company.

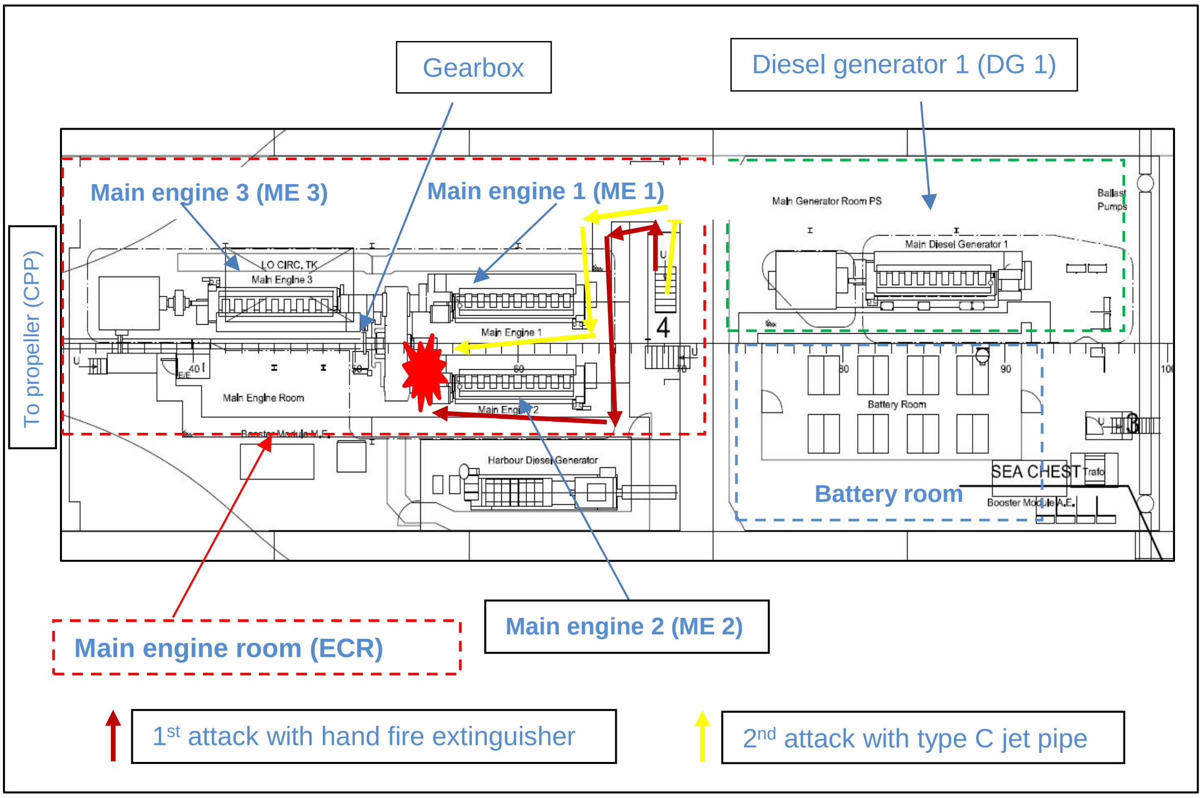

Figure 4: Floor plan of engine room with fire area on Deck 0

SM 1 informed the bridge about the situation in the main engine room.

From there, the Master was called, who arrived on the bridge at 1449.

At 1450, SM 2 stopped main engine 2 locally. The technical officer (TO) in the engine control room stopped ME 1, ME 2, and ME 3, as well as the electric gear oil pump. From the bridge, the gearbox was disengaged with an emergency stop.

The engine room watch crew (TO, SM 1 and SM 2) now began manual firefighting using hand fire extinguishers (see Figure 4).

At 1451 the general alarm was sounded from the bridge, and mustering of the crew and passengers began. At the same time, the bridge triggered the quick-closing valves of the fuel supply for ME 1, 2 and 3.

At 1453, an announcement was made to inform the passengers. A distress call was sent to Warnemünde Vessel Traffic Services via VHF, in which the intention to leave the sea channel in a westerly direction was declared. This was carried out immediately. Furthermore, they stated that the fire was being fought and that no assistance was required. The ship would continue to be fully manoeuvrable with its electric drive.

Meanwhile, the ER crew laid out fire hoses in the main engine room. SM 1 then fought the fire on Deck 1 between ME 1 and ME 2, SM 2 on Deck 2 with a foam extinguisher in the turbocharger area. The technical officer cooled the machinery space casing from Deck 1 until this was taken over by SM 1 (see Figure 4).

At 1454, the watertight bulkheads were closed; the ventilation in the ER remained active. The Chief Engineer (CE) manually triggered the object protection system[9] at main engines 1 and 2.

He then applied the propeller shaft brake, preventing further leakage of gear oil caused by continued rotation of the shaft side of the gearbox. At the same time, the engine room crew used jet pipes to cool the surrounding area.

At 1456, the crew began distributing life jackets to the passengers at the muster stations. The firefighting squad and the hose squad, each consisting of three people, began gearing up.

The hose squad prepared fire hoses. At this time, the Chief Engineer started the object protection system above ME 3.

Figure 5: Object protection system triggered above ME 3[10]

[9] Fixed water-based firefighting (deluge) system for a particular object or item of machinery.
[10] Source: Shipping company.

At 1504, the fire squad started local firefighting. They dispersed the extinguishing agent F-500[11] using a hose and a Venturi jet pipe[12], and low-expansion foam using a second hose (see Figure 6). Due to the active ventilation and outflow of the gases via the exhaust duct, visibility remained good.

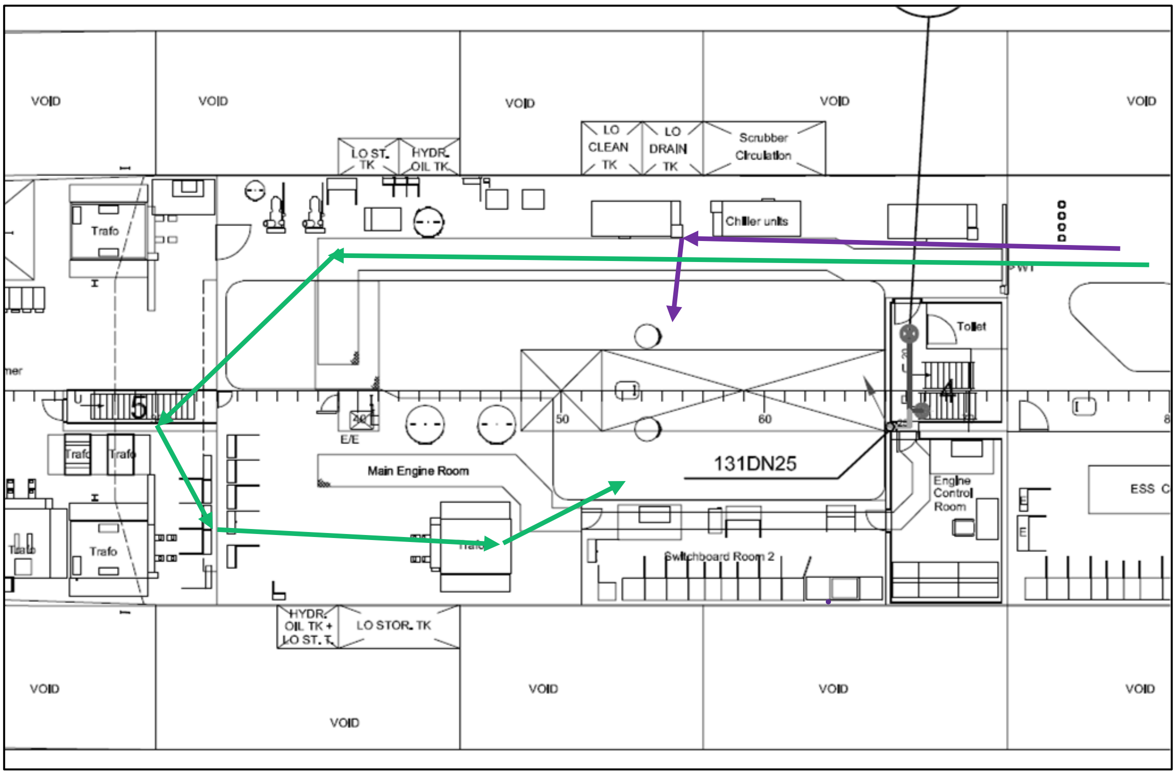

Figure 6: Floor plan of the engine room with the fire area on Deck 2

3. Firefighting attack with low-expansion foam prepared, but not carried out

4. Firefighting attack with F-500 Venturi jet pipe

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[11] F-500 (Encapsulating Agent)
This agent is mixed into the extinguishing water (even seawater) at very low rates of 0.5-1 % and acts directly on the fire source and fuel. With the correct and adapted tactics, up to 100 % of the extinguishing agent are and remain effective. The extinguishing effect is many times higher than with pure water and all conventional extinguishing agents, especially foam. Extinguishing effect: Cooling (evaporation of water at 70 °C) and permanent encapsulation of the fuel in micelles.

[12] Hollow jet pipe that can be shut off, with fixed flow rate for discharge of extinguishing water, as full or variable angle spray jet, with simultaneous automatic suction of extinguishing agent F-500 at rates of 0 %, 0.5 %, 1 % and 3 %.

At 1506, the Chief Engineer started the main engine room protection system[13]. By 1512, the fire was found to have been extinguished. This was reported to VTS at 1514.

The ship's command decided to sail into port using only the diesel-electric propulsion and berth as intended. At 1624, the BERLIN was moored at berth 54, and all passengers had disembarked by 1630.

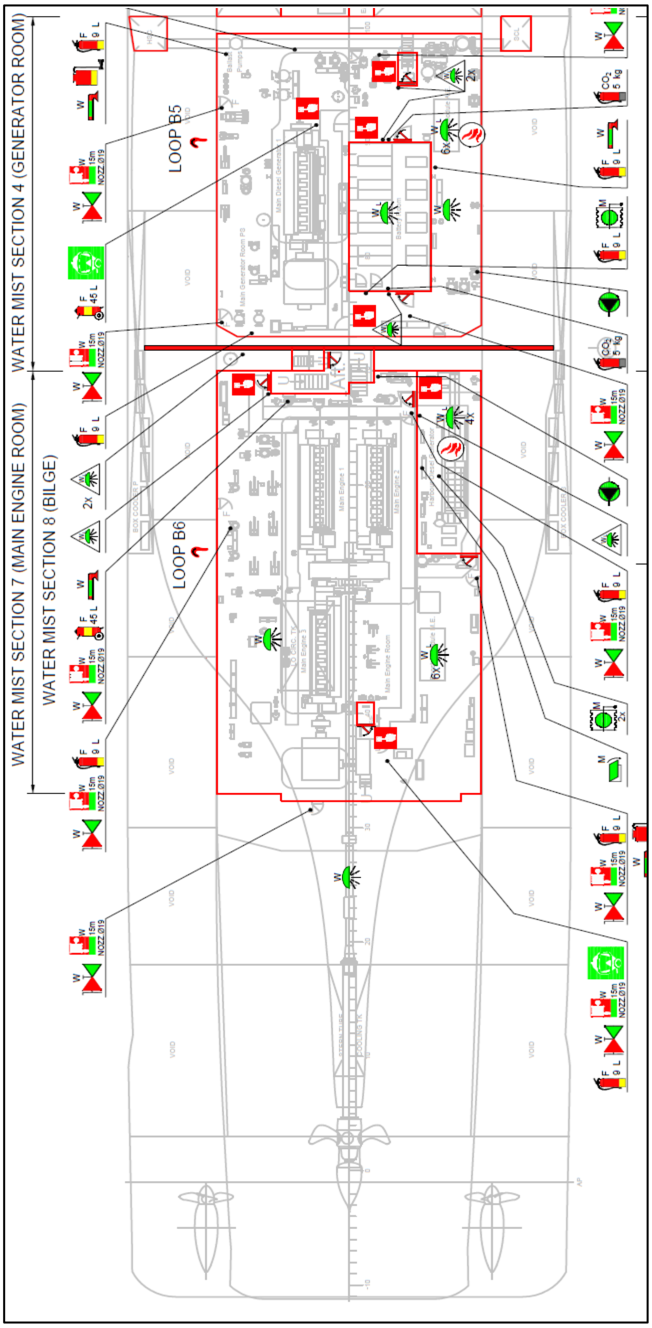


Figure 7: Fire plan

[13] Fixed firefighting system for an entire specific room, in this case also a deluge system.

3.2 Investigation

At 1453 on 13 August 2020, the ferry BERLIN reported to VTS Warnemünde that she intended to leave the sea channel at buoy 11 in a westerly direction due to problems in the engine room. At 1456, they reported a fire in the main engine room, which was under control and being fought. The ship was fully manoeuvrable and did not require assistance.

After notifying VTS at 1514 that the fire had been extinguished, a follow-up inspection was carried out. At 1530, the BERLIN's command declared the vessel fully operational and manoeuvrable, and fully able to enter port using only her electric propulsion. VTS granted permission to do so. After it had moored at berth 54, a detention order was imposed upon the vessel.

At 1828, the waterways police Rostock contacted the BSU on-call service and informed them of the accident. The expert Lars Tober was then called and asked to start an investigation on board on behalf of the BSU immediately. Experience has shown that going on board and recording the condition as soon as possible after a fire has been extinguished is critical for a fire investigation.

At 2030, the experts Lars and Oliver Tober arrived at the vessel and started surveying the fire area on behalf of the BSU. Their input is included in this report.

In order to be able to resume scheduled liner service as soon as possible, the crew had already begun dismantling some of the insulation materials and were cleaning the main engine.

It was therefore only partially possible to gain an impression of the original condition directly after the incident during this initial inspection. The observed conditions must be assumed to have been influenced in part by the measures carried out up to that point.

3.2.1 The ship and the route

According to their homepage, Scandlines have the largest fleet of hybrid ferries in the world. The ferries shuttle between Germany and Denmark, calling at the ports of Puttgarden, Rødby, Rostock and Gedser. The newest ferries, the BERLIN and the COPENHAGEN, have been operating on the Rostock-Gedser route since 2016. Both ferries were built as hybrid ferries to reduce CO_2 emissions. The hull was specifically designed for the relatively shallow route, reducing fuel consumption even further. In 2020, the COPENHAGEN was additionally fitted with a rotor sail to make it even more environmentally friendly.[14]

The BERLIN is equipped with a combined propulsion system. In addition to her three main engines that drive a controllable pitch propeller via a common gearbox, she also has two diesel generators that provide power for two Azipull thrusters. An energy storage system (ESS) of accumulators acts as buffer and assistance. When the accumulators are fully charged, the Azipull thrusters can be used as the sole propulsion system for about ten minutes at full load, or for about 20 minutes at half load.

[14] Source: https://www.scandlines.de/uber-uns/unsere-fahren-und-hafen/ (25 January 2022).

Typically, both types of propulsion are used at sea in order to achieve the service speed of 12.2 kn. In port, 6.5 kn are sufficient. Manoeuvres are carried out using only the diesel-electric system.

3.2.2 Damage survey

Both experts Tober and a BSU investigator continued their work on board the next morning. They spoke to all parties involved, collected documents and recorded technical evidence.

The damage presented itself as follows:

There was little to no fire damage to equipment, systems and built-in components in the main engine room. The damage was limited to partially burned insulation of the ME 2 exhaust duct. In the direct vicinity, there was a leak from the gearbox (pressure gauge pipe situated centrally on the gearbox between ME 1 and ME 2).

Adjacent areas, especially the exhaust duct, were extensively covered in oil due to a massive leak of hydraulic oil from the main gearbox. Before restarting the main engines, the oily insulation mats had to be completely replaced and the main engine room thoroughly cleaned. No persons were harmed as a result of the fire. Apparently, the firefighting measures and/or the boundary conditions of the event meant that the fire could be extinguished swiftly. It was possible to prevent the fire from spreading to neighbouring areas.

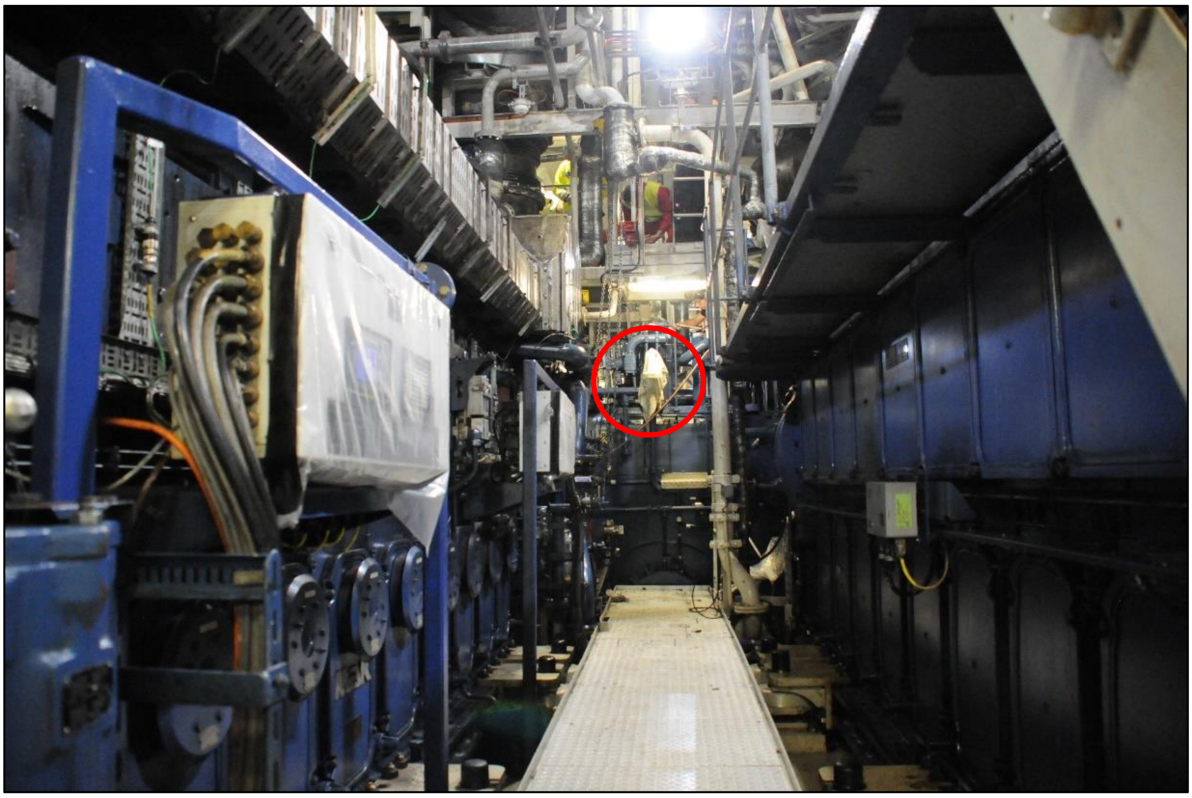


Figure 8: Leakage at the gearbox between ME 2 and ME 1

A broken double nipple was found to be the cause of the leakage. It is installed on the pipe of a gear oil transmission pipe and obviously broke due to material fatigue. Figures 9 to 16 illustrate this.

The expelled gear oil hit hot surfaces and caught fire.

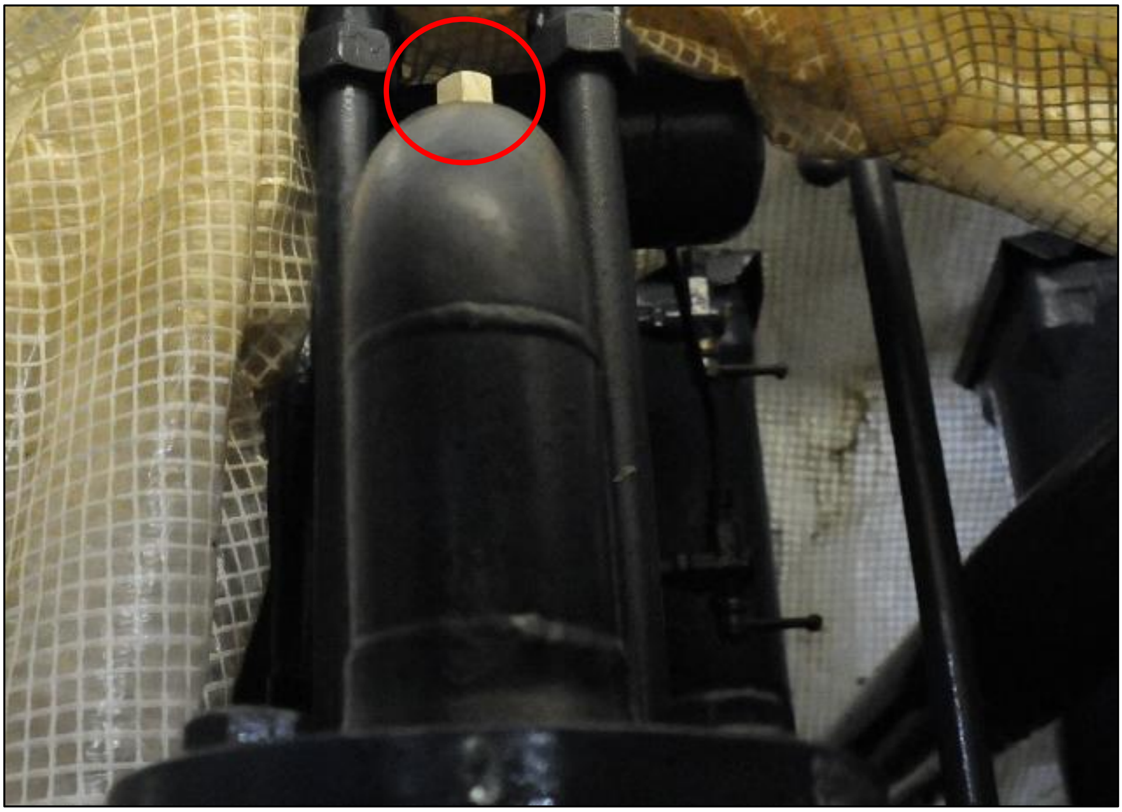


Figure 9: Cover of broken pressure gauge pipe

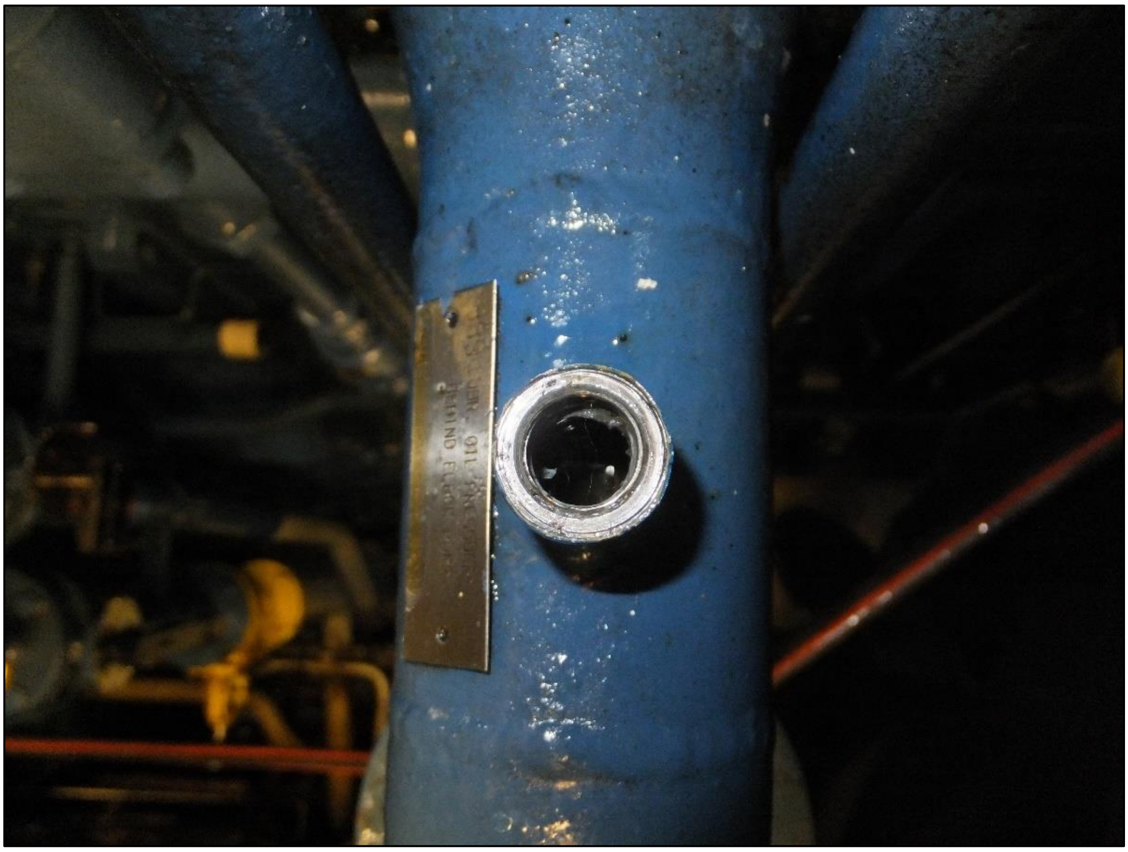


Figure 10: Open connecting piece (without double nipple)

Figure 11: Double nipple Ermeto L10 with cap nut

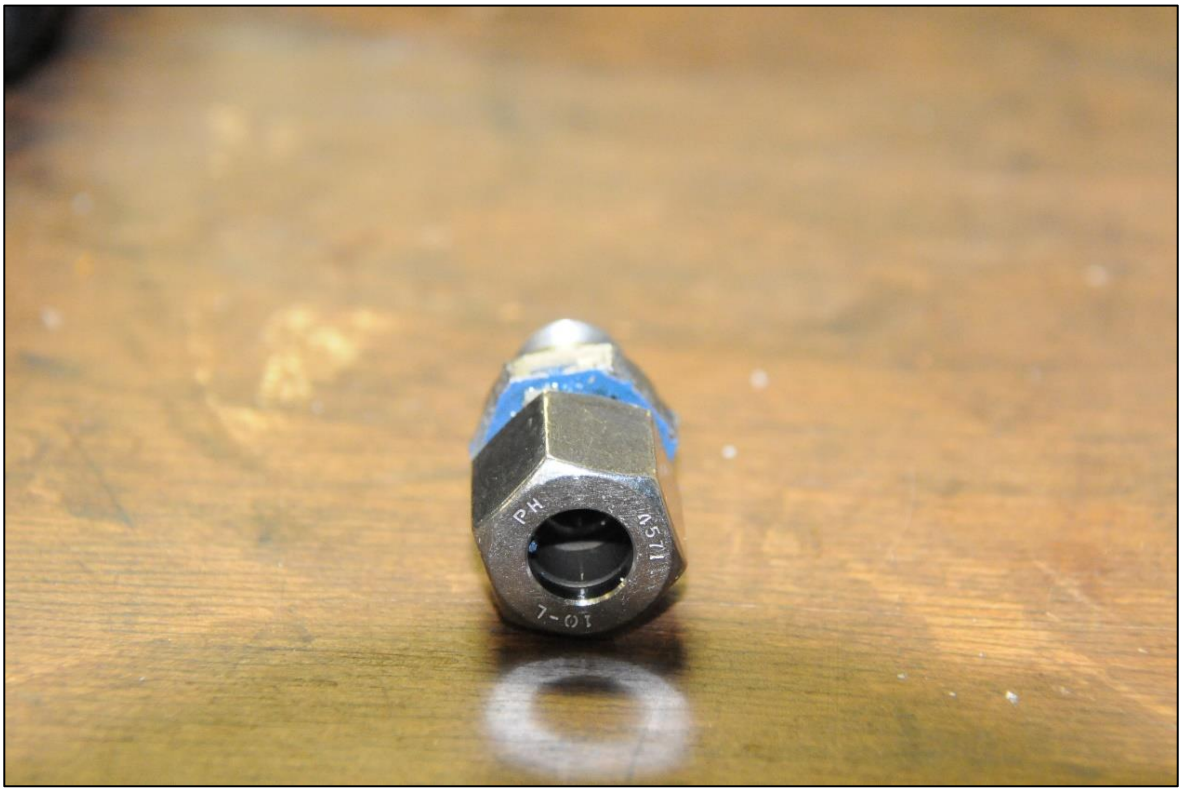


Figure 12: Detailed view from the front

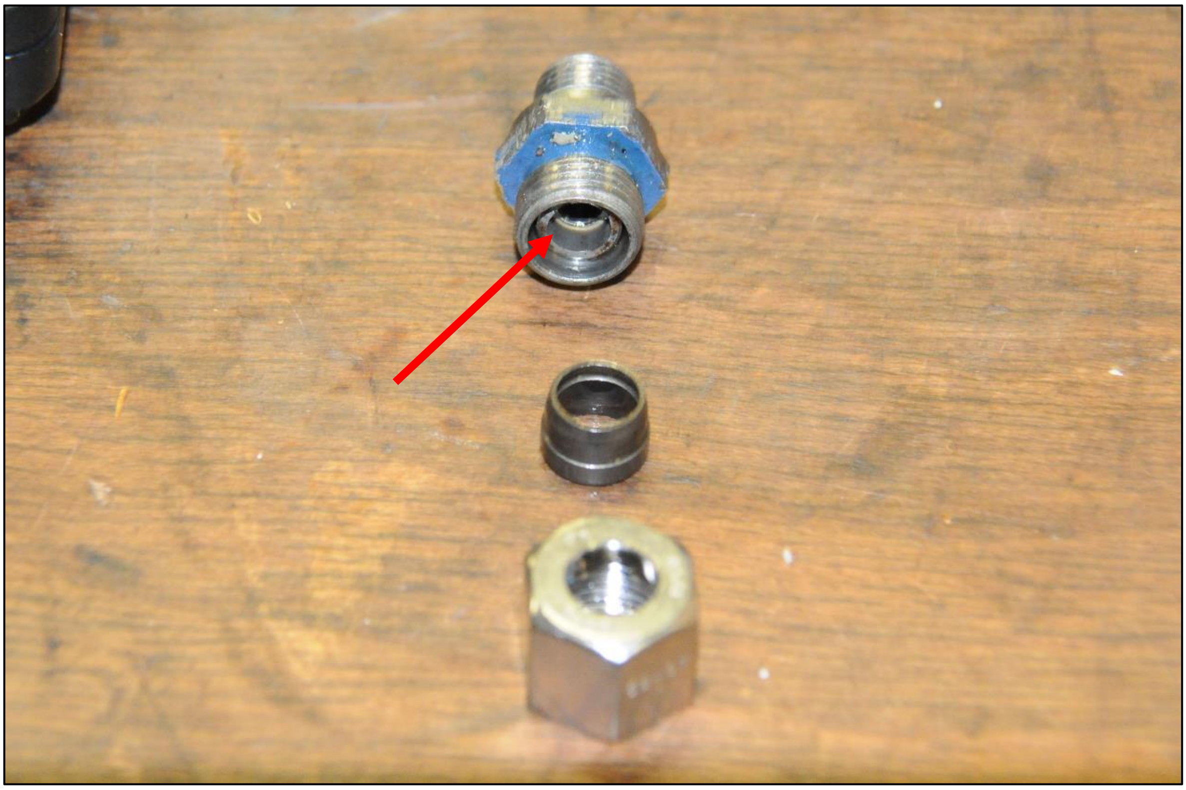


Figure 13: Cutting ring[15] and pipe fragment of double nipple on the inside

[15] Sealing element for hydraulic fittings. When screwed together, it is compressed by the cap nut, cutting lightly into the pipe wall and thus producing a tight form fit.

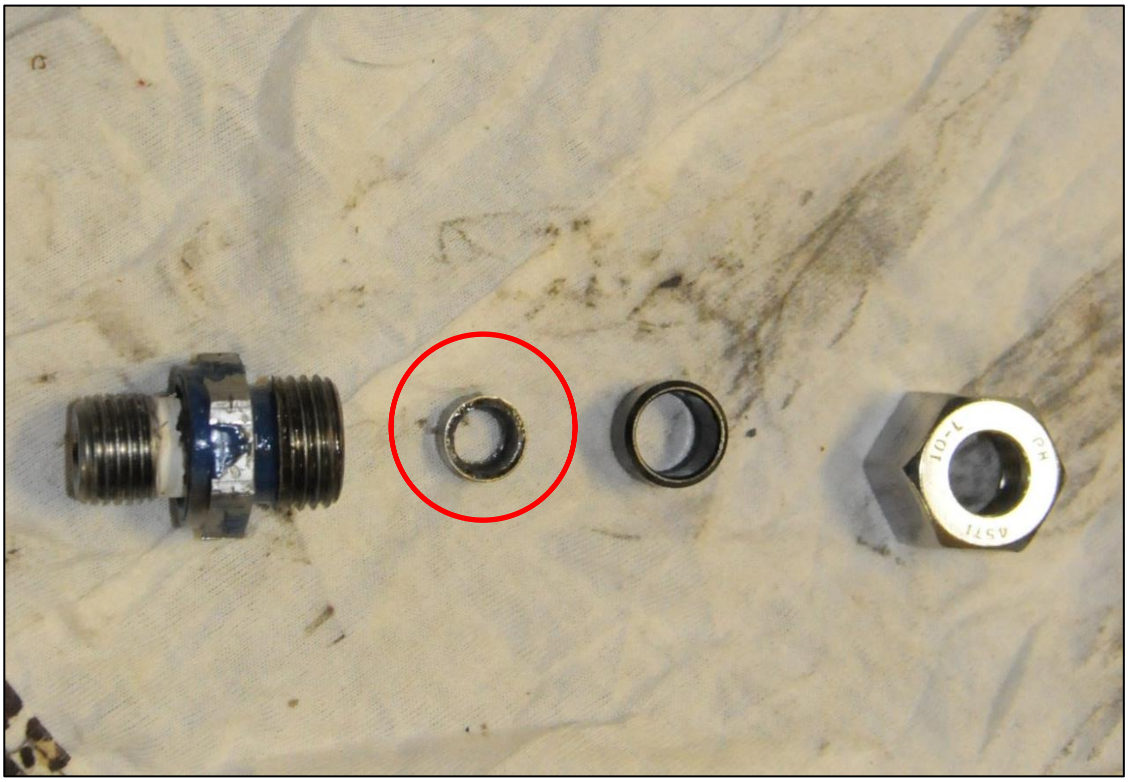


Figure 14: Fitting with broken-off piece of pipe

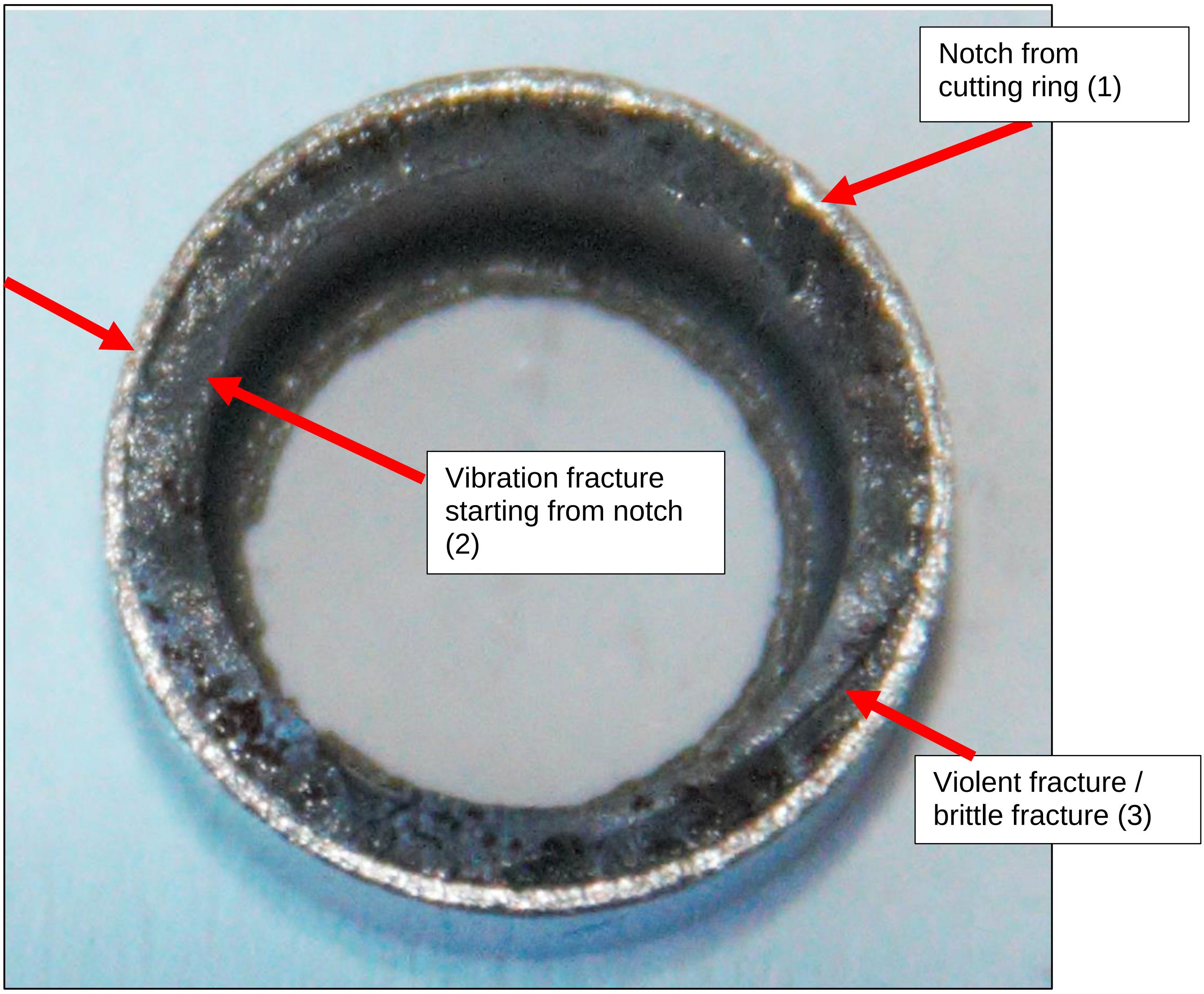


Figure 15: Pipe segment, notch from cutting ring outside and inner fracture surface

Figure 15 shows the fracture surface of the pipe inside the cutting ring connection (2). Component vibration promoted the propagation of the vibration fracture out from the notch edge (1). At some point, due to pressure and vibration load, the material was so weak that the remaining material broke abruptly (3).

Figure 16 shows an example of the construction of the pressure gauge on board the COPENHAGEN. Identical in design to the pressure gauge on the BERLIN, it stands completely free and vertically on the gear oil pipe.[16]

[16]. The pressure gauge is not connected to the horizontal pipes visible in the photo.

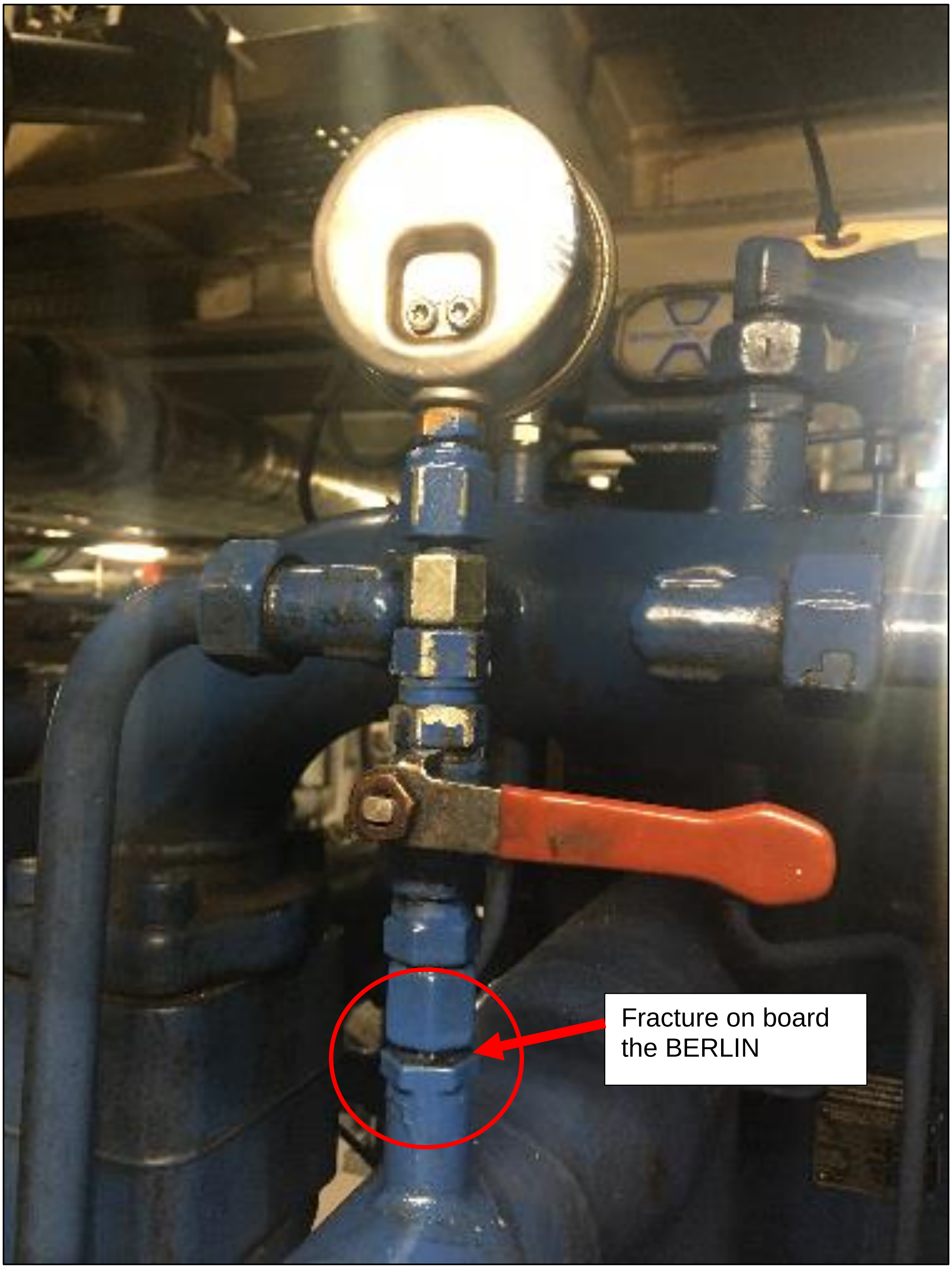


Figure 16: Pressure gauge assembly on board the COPENHAGEN [17]

[17] Source: L. Tober – as an example of what the pressure gauge connection on the BERLIN looked like before it broke.

Within the scope of the investigation report, the following questions are to be answered:

1. Based on the survey report of 13 August 2020, the last thermographic protocols are to be used to check whether the relevant regulations for hot surfaces[18] with temperatures exceeding 220°C were fully enforced, and whether deficiencies had any impact on the accident event.

2. Furthermore, the extinguishing measures carried out by the crew are to be examined with regard to their efficiency, self-protection, and tactics.

3. Finally, it is to be clarified whether the broken pressure gauge pipe is fundamentally necessary in this case, and/or whether this pressure gauge might not be installed in a different position.

The starting point for assessing a possible "hot surface situation" at the time when the fire broke out is the protocol of the thermographic inspection dated October 15 2019, which was made available to the BSU by the shipping company Scandlines.

By way of illustration, excerpts from the thermography report showing the affected areas are compared with photographs of the fire damage in the same areas.

The last thermographic inspection was carried out ten months prior to the fire event.

There are neither class regulations nor German Ship Safety Division specifications for carrying out such an inspection. This issue will be addressed separately. The inspections are therefore voluntary in-company checks arranged by Scandlines.

The pictures show a number of small hot spots in the area in which the fire broke out. It is no longer possible to determine to what extent these were still in place at the time of the fire.

However, these hot spots are exemplary of the situation with this type of engine, especially in the affected area, which is extremely difficult to insulate. The construction of a medium-speed four-stroke diesel engine is so compact and delicate that insulating it is generally difficult.

[18]So-called “hot spots” = locally limited areas with temperatures significantly higher than those of their surroundings. SOLAS Chapter II-2, Part B, Regulation 4.2.2.6 Protection of high-temperature surfaces.

3.2.3 Thermographic images from the pre-fire inspection report vs. the post-fire survey

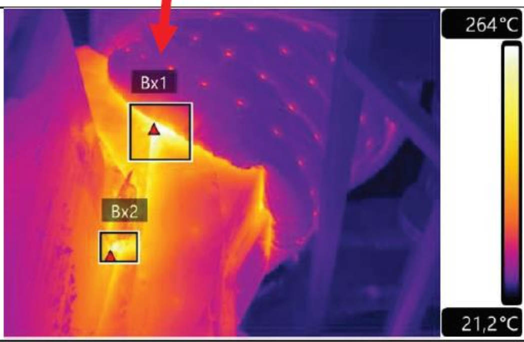
Based on the survey report dated 13 August 2020, the last thermographic protocols were used to check whether the relevant regulations related to hot surfaces with temperatures exceeding 220°C were fully enforced, and whether deficiencies had an influence on the accident event. A thermographic inspection is always carried out by a commissioned specialist company when the engine is warm and under a load of at least 60%.

Customer: M/F Berlin **Inspection date:** 15. oktober 2019

Position: ME No. 2
Area: Insulation around the flange between T/C and exhaust pipe

Remarks:

Temperatures above 220 degrees Celsius.



FLIR0390

Objektemissitivitet	0,95
Punkter	-
Bx1 Maksimum	295,3 °C
Bx2 Maksimum	297,5 °C

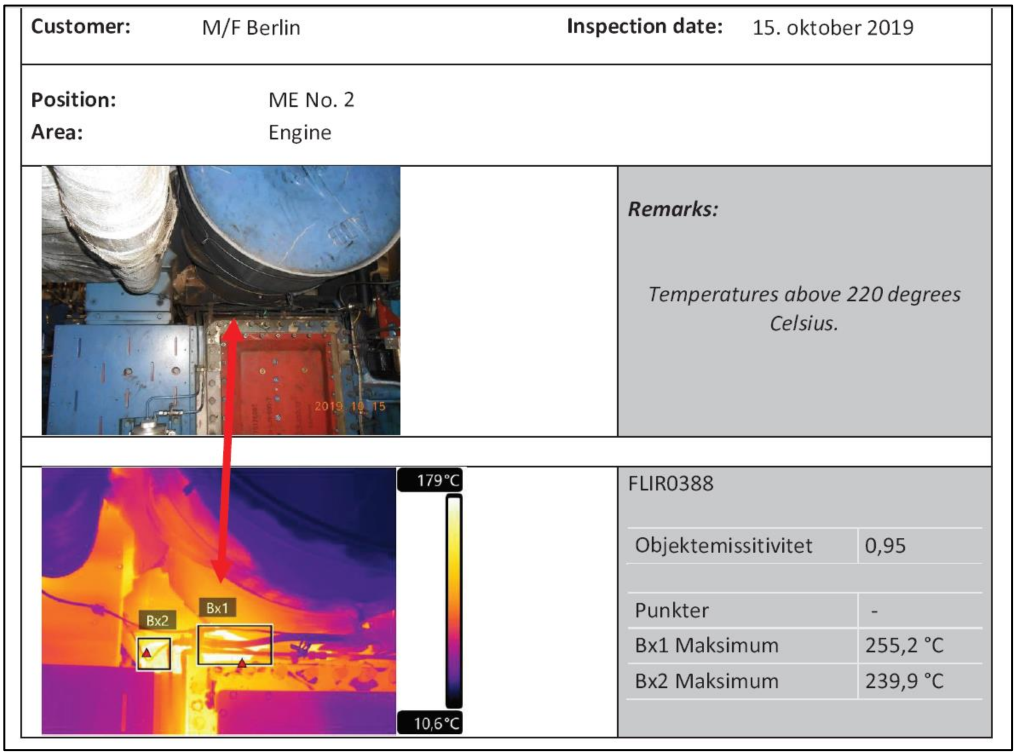
Figure 17: Exhaust duct in the turbocharger area (inside)[19]

The points of maximum temperature Bx1 with 295.3°C and Bx2 with 297.5°C found in Figure 17 are clearly reflected in the post-fire damage pattern in Figure 18.

[19]Source: Shipping company.

Figure 18: Burn marks on insulation mats of exhaust pipe

The same applies to the area below the turbocharger, see Figures 19 and 20.



Customer: M/F Berlin **Inspection date:** 15. oktober 2019

Position: ME No. 2
Area: Engine

Remarks:

Temperatures above 220 degrees Celsius.

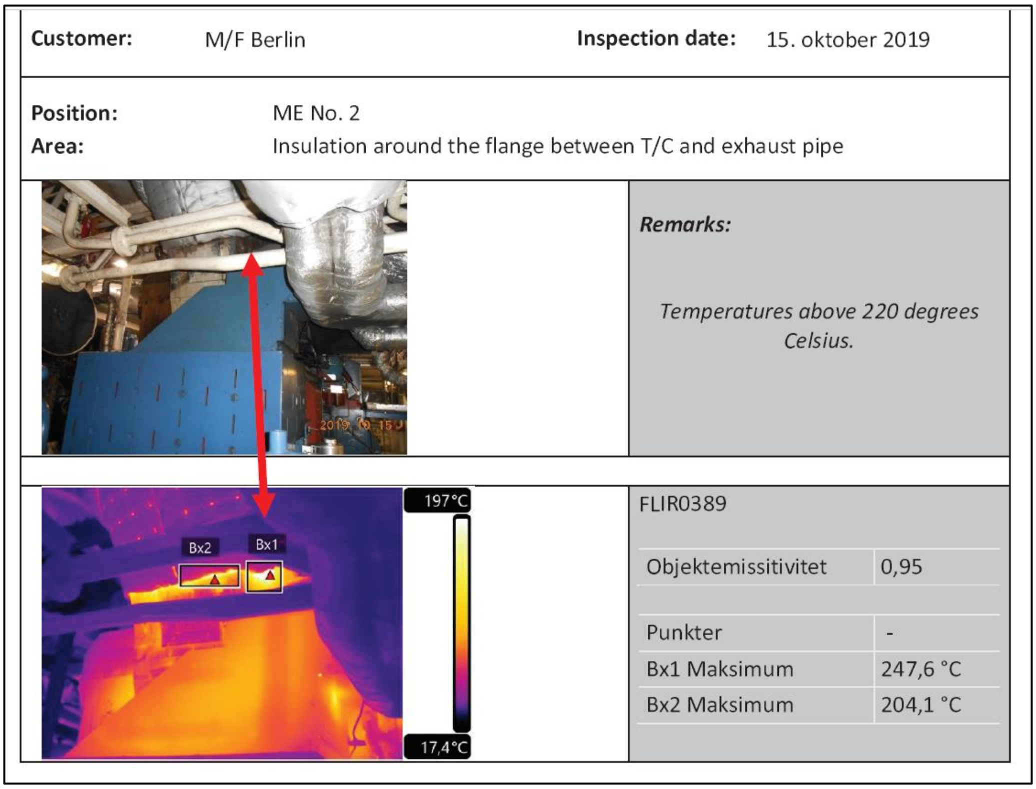
FLIR0388

Objektemissitivitet	0,95
Punkter	-
Bx1 Maksimum	255,2 °C
Bx2 Maksimum	239,9 °C

Figure 19: Area below turbocharger (air side)[20]

Figure 20: Fire damage to turbocharger insulation (air side)

[20] Source: Shipping company



Customer:	M/F Berlin	**Inspection date:**	15. oktober 2019
Position:	ME No. 2		
Area:	Insulation around the flange between T/C and exhaust pipe		

Remarks:

Temperatures above 220 degrees Celsius.

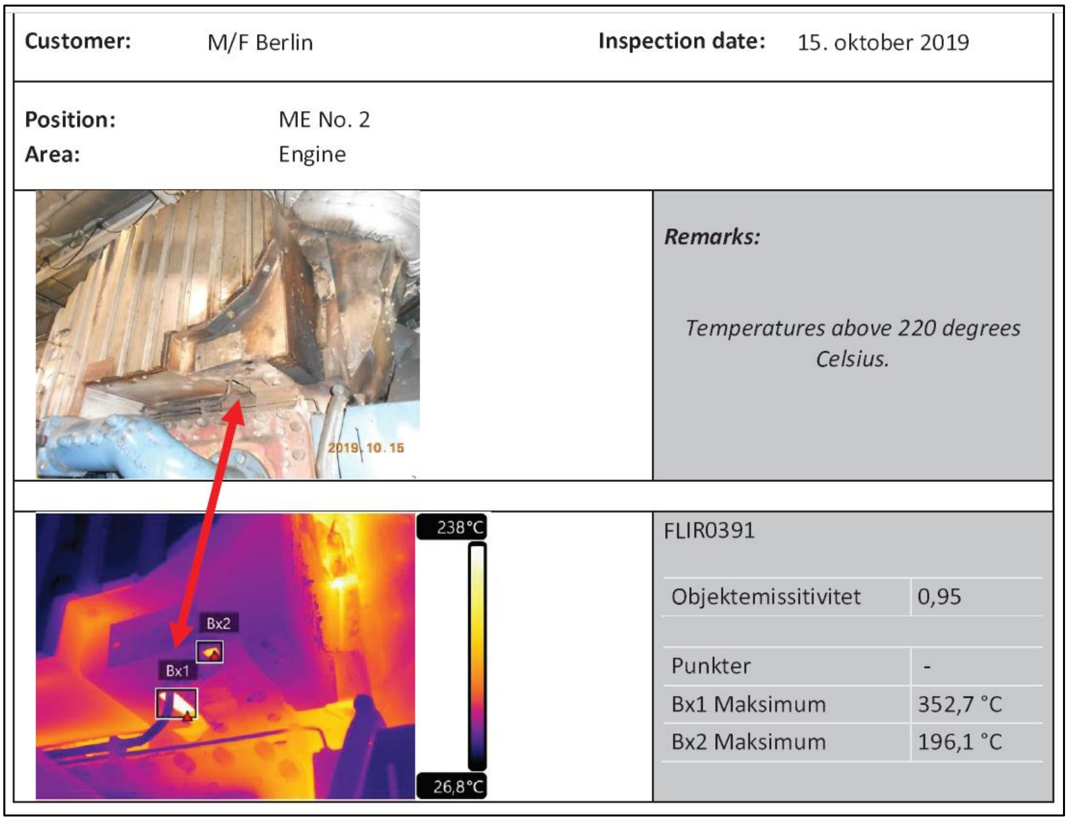
FLIR0389

Objektemissitivitet	0,95
Punkter	-
Bx1 Maksimum	247,6 °C
Bx2 Maksimum	204,1 °C

Figure 21: Area of turbocharger exhaust duct [21]

Figure 22: Fire damage to exhaust side insulation in area of turbocharger

[21] Source: Shipping company



Customer: M/F Berlin **Inspection date:** 15. oktober 2019

Position: ME No. 2
Area: Engine

2019. 10. 15

Remarks:

Temperatures above 220 degrees Celsius.

Bx2
Bx1
238°C
26,8°C

FLIR0391

Objektemissitivitet	0,95
Punkter	-
Bx1 Maksimum	352,7 °C
Bx2 Maksimum	196,1 °C

Figure 23: Area below turbocharger (exhaust side)[22]

Figure 24: Burn marks on outside of turbocharger (exhaust side)

[22] Source: Shipping company

The measurement results of the thermographic inspection show a number of hot spots with temperatures exceeding 220°C.

It is therefore not surprising that it was precisely these spots that showed particularly severe fire damage. It is highly probable that the escaping oil ignited immediately here.

3.2.4 Defence measures and crew equipment

Regular trainings are carried out for the BERLIN crew in accordance with the requirements of "Resolution 2 Manila Amendments to the Seafarers' Training, Certification and Watchkeeping Code (STCW Code)". The mandatory minimum requirements for training in modern firefighting are found in Section A-VI/3 (see appendices). However, these regulations only refer to those seafarers assigned to direct firefighting operations.

Paragraph 5 specifies that the prescribed standard of competency in accordance with Table A-VI/3 must be verified every five years.[23]. These courses are called "Advanced Fire Fighting (AFF) Refresher" and are offered and conducted by certified training bodies worldwide.

On board the BERLIN, the following technical firefighting measures were implemented in the main engine room:

- Emergency stop for all engines in the engine room
- Gearbox stop by disengaging (for stopping the electric pumps)
- Propeller shaft stop with a brake (for stopping the gearbox and the attached lubricating oil pumps)
- Ventilation stayed active

The following measures for active firefighting were carried out by the crew:

- Use of hand fire extinguisher (foam)
- Use of Venturi jet pipe (EA F-500)
- Use of C-type jet pipe (water fire extinguisher)
- Use of low-expansion foam pipe
- Use of object protection system
- Use of room protection system (low-pressure water spray system)

[23] See appendix for relevant excerpt.

The equipment according to the DMA (Danish Maritime Authority) and the classification society Lloyds Register for a newbuilding was adopted by the German Ship Safety Division in the course of the EU reflagging. Accordingly, the following equipment was on board:

Jet pipes
- Standard jet pipes of the simplest design with option of water curtain (see Figure 25)

Low-expansion foam pipes with integrated inductor
- Effectively not usable under real-life conditions, since the foam agent container (approx. 20 kg) must be carried along all the time. Also, the suction hose with its length of approx. 1.2 m allows hardly any free movement and thus no effective firefighting effort. (see Figure 26 and Figure 27)

Hand-held fire extinguisher (foam 9 ltr.)
- Throwing range approx. 1.5 m, application time approx. 45 sec. Effective response not possible either, considering the size of this fire.

Object protection system
- Low-pressure system of the simplest design, spray cone formation via baffle hooks[24]
- System design: Ceiling system with six nozzles above the cylinder heads (ME 1 & 2), no extended object protection system for e.g. the pump area or the turbocharger area. (see Figures 28 and 29)
- Problem: Dependency on two detectors, in this case flame detector and combined smoke/heat detector (so-called "combination detector").
  Because the turbocharger covered the flames, the combination detector responded but the flame detector did not, so that the system did not trigger automatically. Additionally, the hot flue gases were expelled via the exhaust duct, so that the combination detector signal was not constant either.

Room protection system (especially exhaust ducts)
- Low-pressure system of the simplest design, nozzle head with four solid, X-shaped individual nozzles
  (X Flow 4x NHP2, 9.5 bar)

- The system for the aft and forward exhaust duct is directly connected to the system (section) of the adjacent main engine room. This means that the room protection system for the exhaust duct cannot be triggered separately. A separate object protection system for the exhaust ducts does not exist (see Figures 30 and 31).

[24] Baffle hook = Device on a deluge nozzle that deflects a jet of water in such a way that a spray cone is formed.

Figure 25: Standard jet pipe / hydrant system

Figure 26: Mobile foam technology

Figure 27: Mobile low-expansion foam pipe with integrated inductor

Figure 28: Object protection system

Figure 29: Object protection assembly above engine

Figure 30: Room protection system

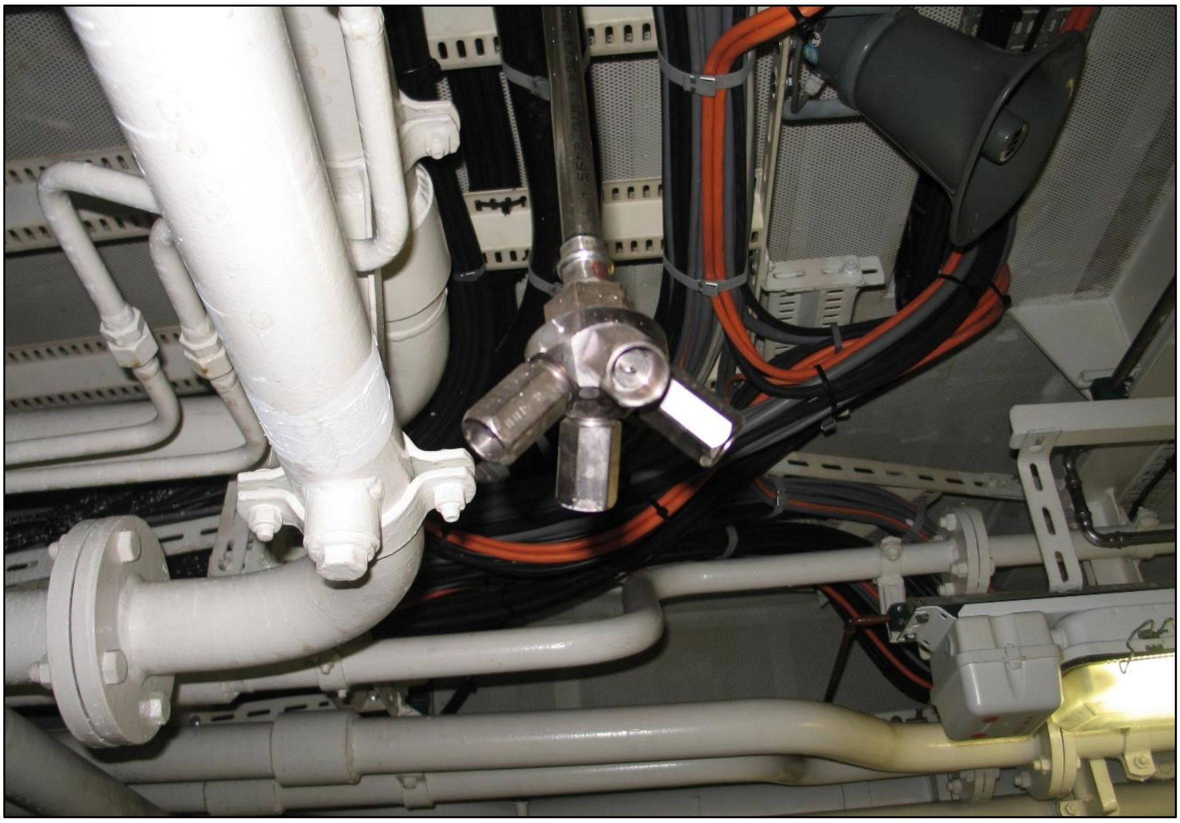


Figure 31: Room protection nozzle – X-flow

4 ACTIONS TAKEN

After main engine 2 was newly insulated by a specialist company, a follow-up thermographic inspection exhibited even more hot spots, some with an even higher temperature, than during the inspection carried out in 2019 (before the fire).[25]

By 24 November 2020, the identified hot spots had been insulated once again, this time by the crew, or covered up using so-called "shield mats"[26].

The „description of repair“ provided by the shipping company describes the measures taken and the state after 24 November 2020. The insulating and shield measures were recorded in the management system.

The crew, and in particular the ship’s command in cooperation with the GSSO[27] experts, identified various weaknesses in both the mobile and the stationary defence technology in an evaluation of the firefighting actions. Scandlines Germany compensated for these deficiencies by adding equipment and even system extensions and optimisations. The technical and tactical changes are described below.

In the course of the evaluation of these events, special training courses were developed with the GSSO, and the scenario of this fire was reconstructed with various possible outcomes. These were evaluated in theory and trained in real life. To date, all Scandlines Germany crews have completed these training courses.

On the technical side, equipment weaknesses were identified, evaluated and rectified. Additional mobile extinguishing technology was purchased, such as foam trolleys and fog nozzles with wetting agent / foam / capsule agent admixture (see Figures 32 and 33). It is possible to apply a heavy foam of comparable quality to the more bulky low-expansion foam with these fog nozzles, if required. By controlling the flow rate directly at the nozzle, the firefighter can determine when to add foam concentrate or F-500 EA.

[25] According to the thermographic protocol, this was carried out by a Danish company on behalf of the shipping company.
[26] A "splash guard", as it were, against oil spray. Also possible with sheet metal.. See also Figure 40.
[27] GSSO: Gesellschaft für Sicherheitstechnik/Schiffssicherheit Ostsee mbH (“Baltic Association for Safety Technololgy/Ship Safety“), owned by fire experts Lars and Oliver Tober.

Figure 32: Foam trolley (in risk area)

Figure 33: Low-expansion foam pipe (trolley) for incipient firefighting

Figure 34: Venturi turbo jet pipe with 2 ltrs. of F-500 EA, for flexible initial attack in all engine-room areas, positioned in the Engine Fire Locker (firefighting equipment room)

Example of the optimisation of the firefighting equipment in the entire engine-room area on board the BERLIN:

Figure 35: Equipment prior to fire

Figure 36: Equipment after fire

When using a Z2 proportioner, the proportioning process only begins at a flow rate of approx. 200 l/min. While proceeding to the fire, the jet pipe is reduced as needed below that level. At a flow rate below 200 l/min, the jet pipe provides self-protection and a high cooling effect for the attack path. On site, the pipe is set to maximum flow and starts producing low-expansion foam (primarily for 2D fires), or puts out a highly effective F-500/water mixture (particularly for 3D fires).[28]

After the flames have been quenched[29], the jet pipe can be reduced and the affected areas cooled in order to prevent re-ignition.

This approach is also helpful from the firefighting attack perspective, since low-expansion foam is only applied directly to the source of the fire, leaving the attack and retreat routes clear.

[28] Solid fires are usually referred to as two-dimensional (2D) fires. Spray fires or fires rising on vertical surfaces are called 3D fires.

[29] “Quenched” means that there are no longer open flames, but there may still be glowing-hot elements. Consequently, even though the flames have been quenched, cooling with water must continue until the fire has been fully extinguished.

This highly efficient firefighting tactic is not possible when using conventional low-expansion foam pipes. Also, self-protection from thermal lift and heat radiation is not possible when using a low-expansion foam tube.[30]

Object protection was optimised in the area of the built-in extinguishing system.

To this end, the position of several object protection nozzles were changed, functionally extending the system. Two additional object protection nozzles were installed behind the turbocharger. Thus, these sensitive areas are now completely covered by four object protection nozzles (see Figures 37 and 38).

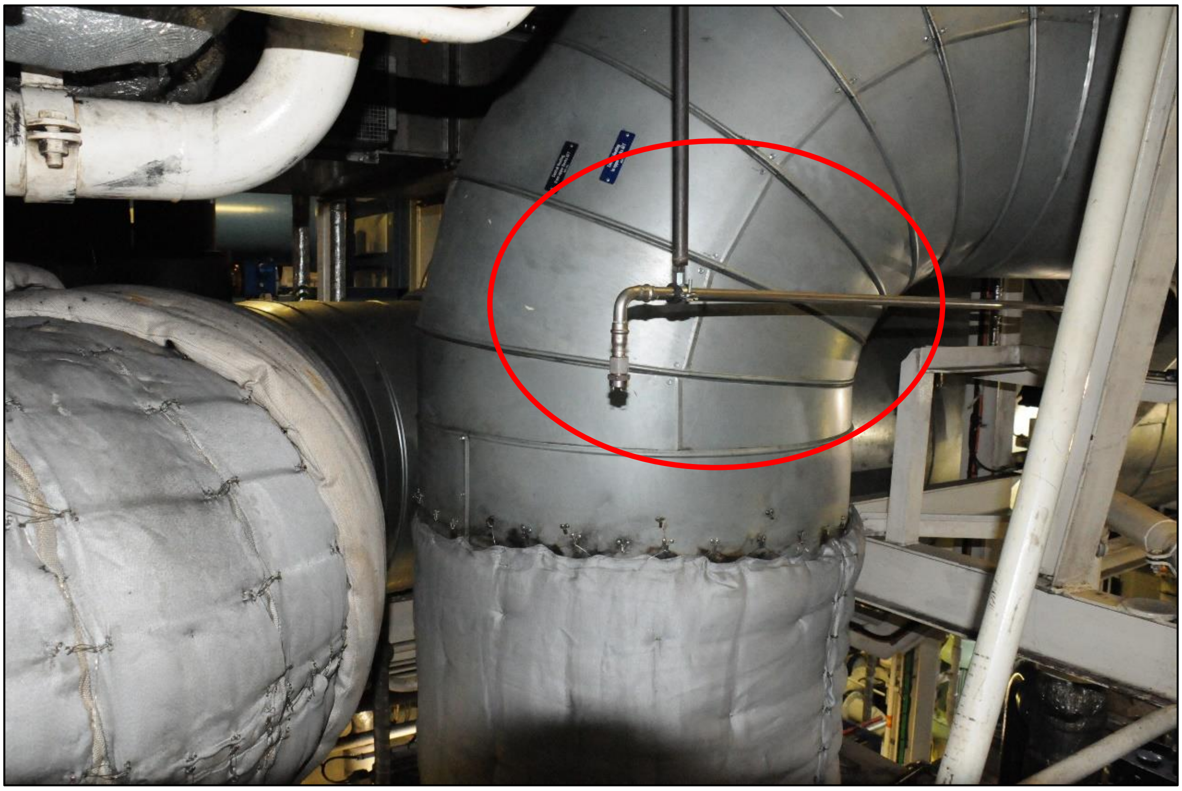


Figure 37: Expansion of object protection behind turbocharger

[30] „thermal lift“ = heat-induced air movement (mostly upward);
“heat radiation”, also "thermal radiation" = pure heat.

Figure 38: Object protection turbocharger area

An expansion of the fire detection technology by adding sensors to ensure the release of the object protection system is planned.

Moreover, a recent thermographic inspection was carried out in the engine rooms of all Scandlines Germany vessels. Detected hot spots were immediately shielded and re-insulated (see Figures 39 to 42)

Periodic thermographic checks have been incorporated into the maintenance management system. An inspection is now carried out every other year and/or after conversions or repair works. All detected hot spots are immediately shielded or insulated. If complete insulation is not possible or no fuel injection pipes are located in the vicinity, these areas are defined as risk areas and additional mobile extinguishing technology is stationed nearby.

Figure 39: Additional insulating measures

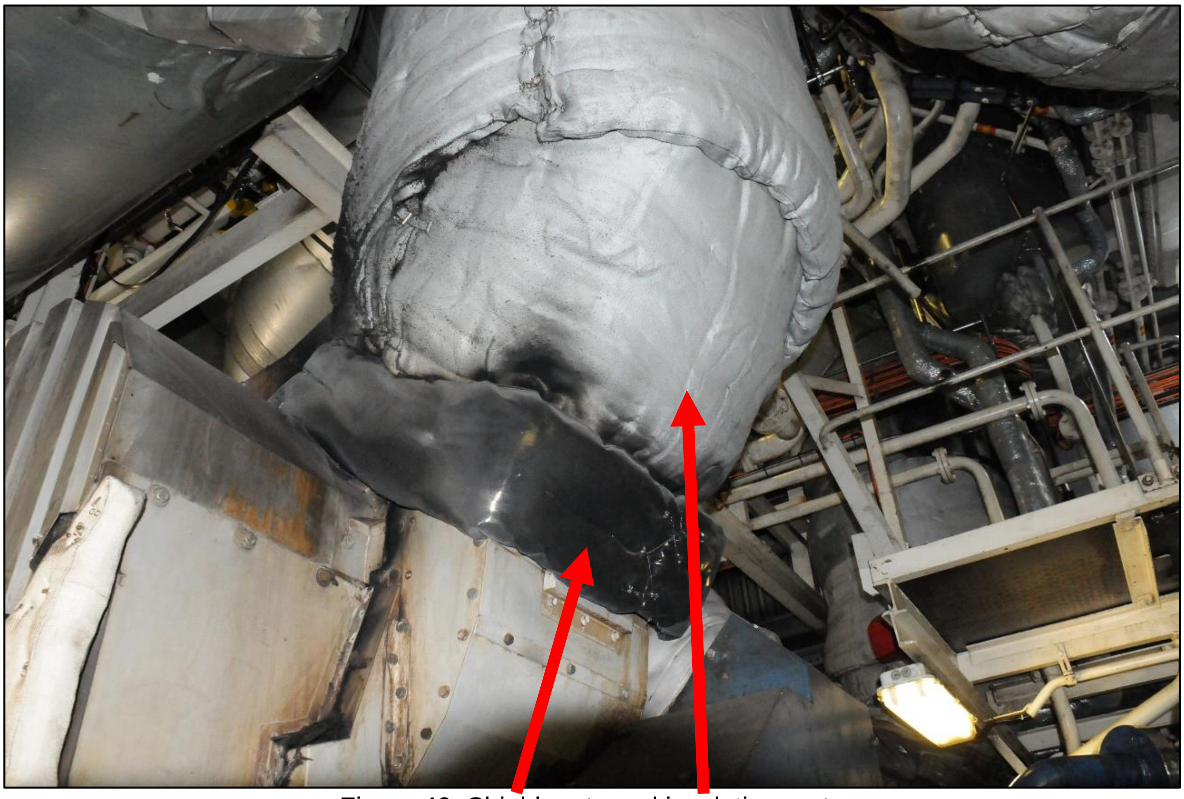


Figure 40: Shield mats and insulating mats

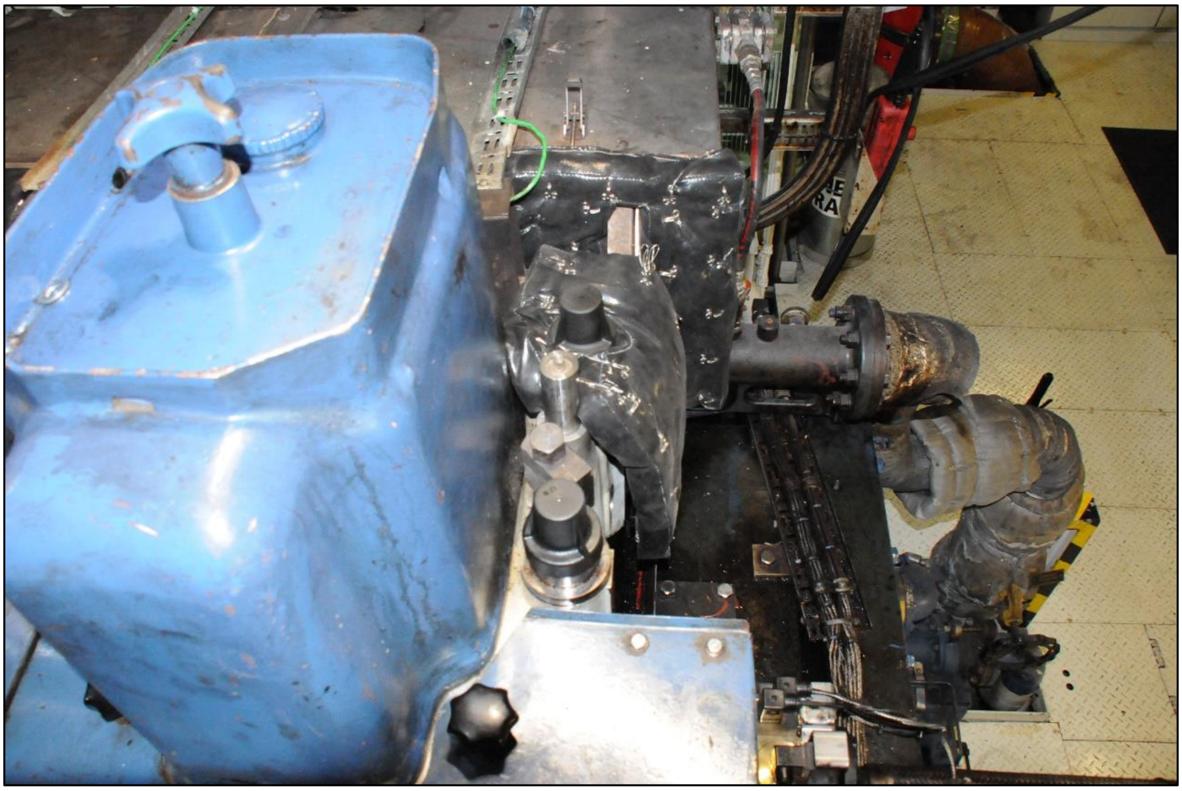


Figure 41: Shield mats at cylinder station

Figure 42: Insulation between cylinder station and exhaust pipe

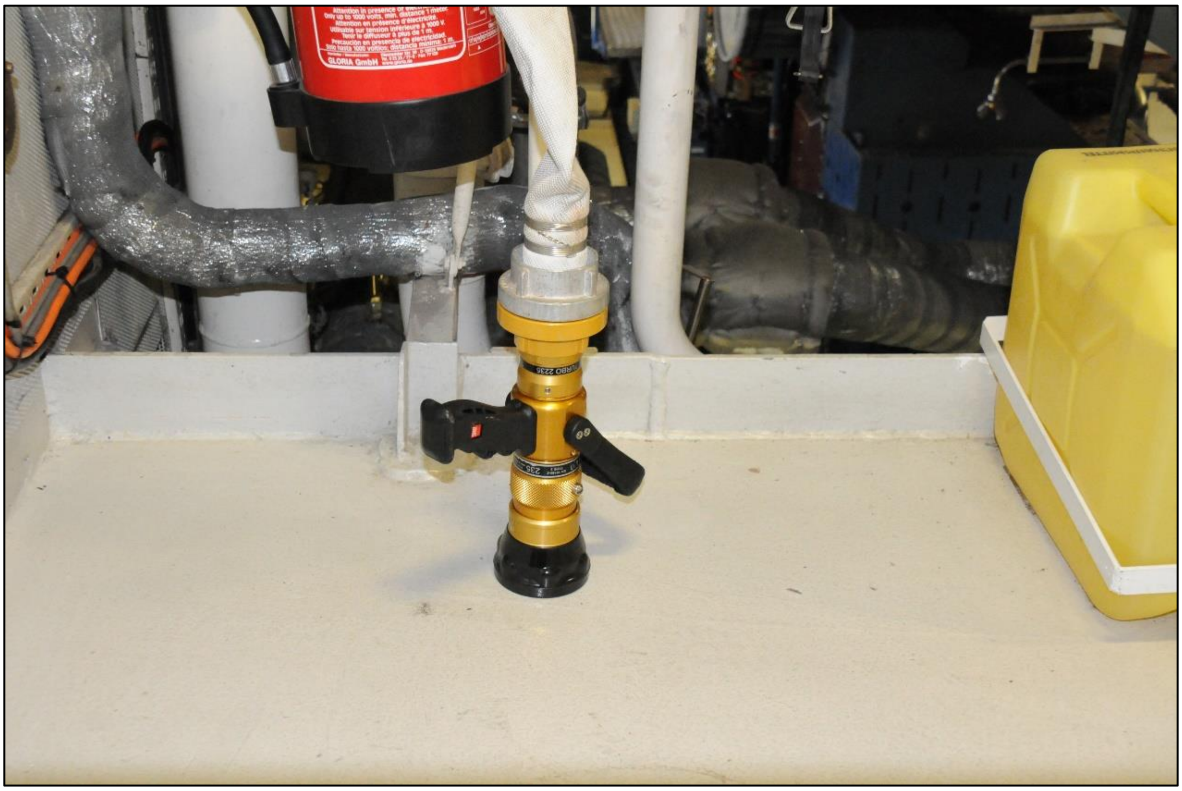


Figure 43: Turbo jet pipe for 60 / 130 / 235 l/min

Figure 44: Hydrant station (risk area) with permanently installed admixture/inductor and turbo jet pipe

Figure 45: Possibility to add foam/wetting agent or F-500 EA

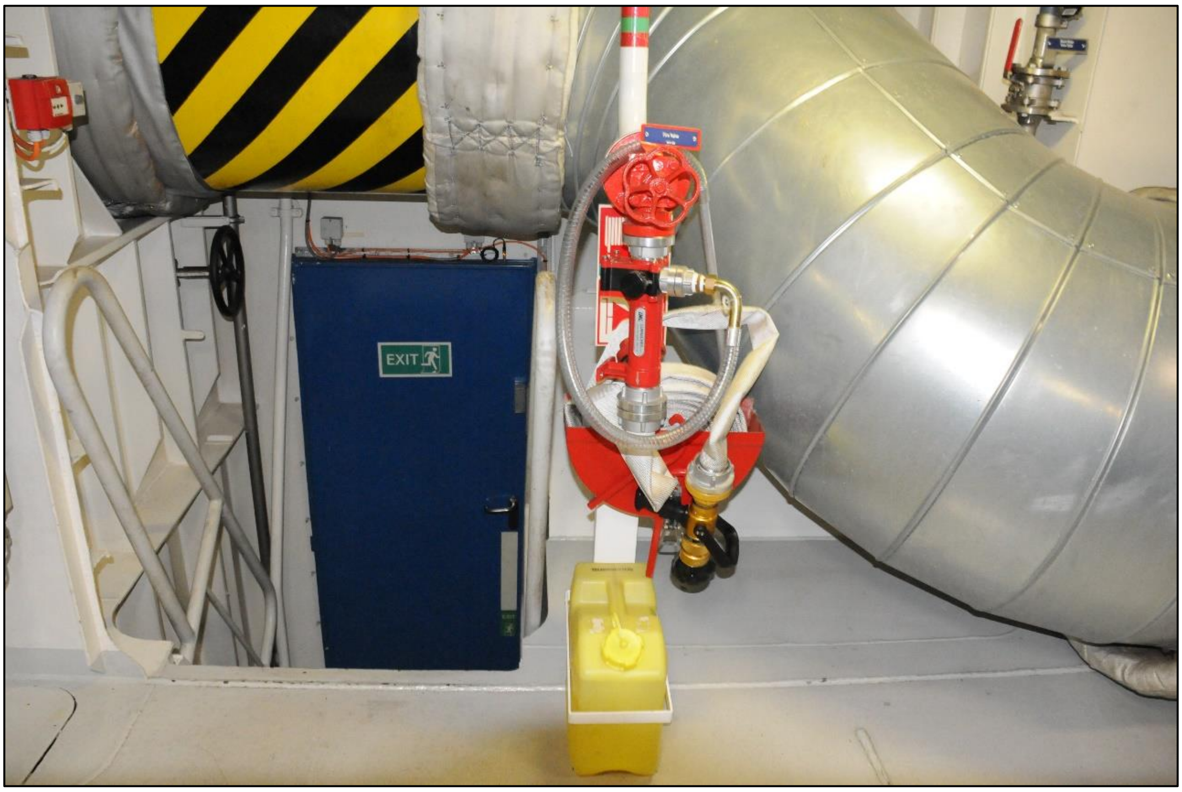


Figure 46: Hydrant station with foam/wetting agent

In the course of the repairs, the broken pressure gauge was replaced by a pressure sensor (see Figure 47)

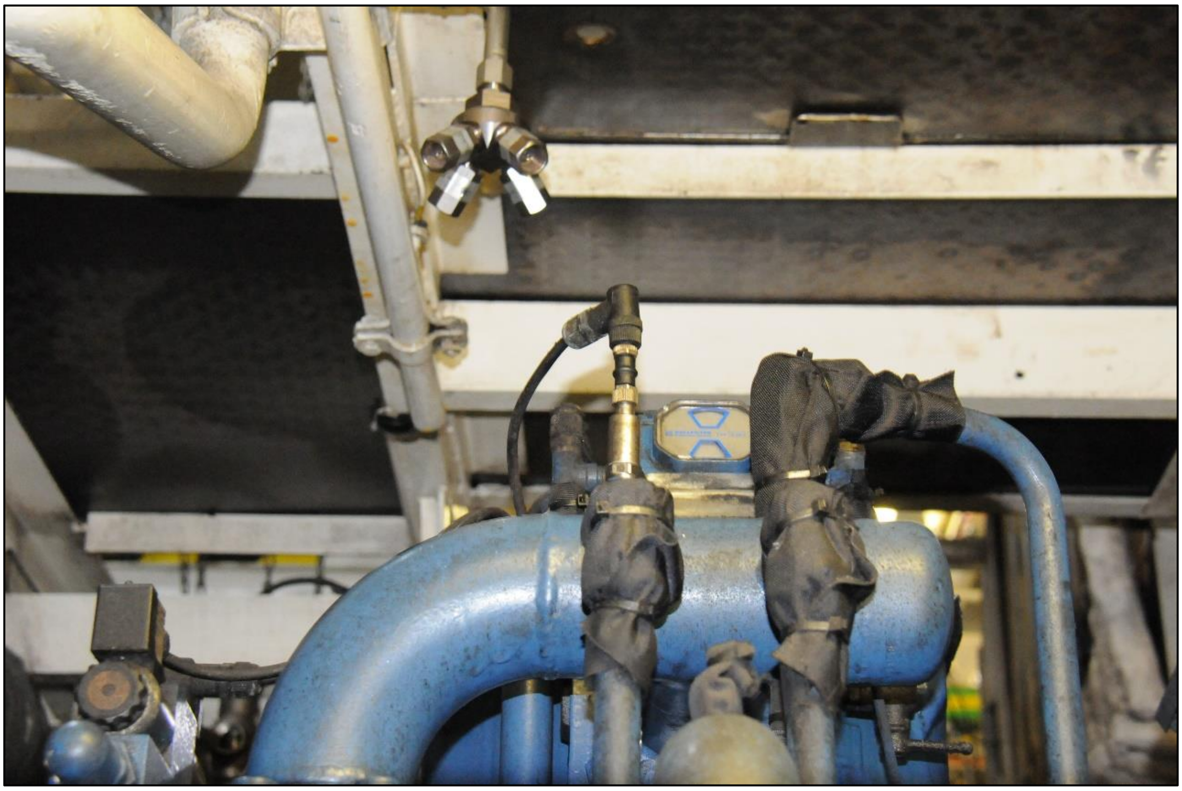


Figure 47: Pressure sensor replaced pressure gauge on top of gearbox

In addition to conventional EEBDs[31], additional Emergency Life-Saving Apparatuses (ELSA)[32] were provided for the safe retreat of the engine room staff after incipient firefighting (see Figures 48 and 49).

[31] EEBD: "Emergency Escape Breathing Device". These devices provide oxygen **through a mouthpiece**.

[32] ELSA is an emergency life-support device used in an emergency situation in order to escape from an enclosed space or building after a fire, chemical accident, or explosion. An ELSA is needed when breathing air is insufficient or heavily contaminated. It includes **a complete breathing mask**.

Figure 48: Conventional escape breathing device on board

Figure 49: ELSA for protection of retreating ER staff after incipient firefighting

5 ANALYSIS

The cause for the fire was a broken pressure gauge pipe on top of the gearbox, which was no longer operational due to the resulting heavy oil leakage. Therefore, the ship had to continue her voyage without conventional mechanical propulsion. The use of DG 1 and ESS was safe and uncritical, since they are situated in a different engine room and were not impaired. Also, this is standard procedure during the vessel's port calls in any case.

This special propulsion technology enabled the ship's command to berth at the pier independently and with full manoeuvrability after extinguishing the fire.

5.1 Technology

Due to material fatigue, the double nipple of a pressure gauge on the pipe of a gear oil pipe broke. This resulted in gear oil spraying far into the engine room and onto hot surfaces, where it ignited. At the same time, this caused the oil pressure in the system to drop.

Following the resulting alarm "oil level gearbox low ", a ship mechanic proceeded to the scene immediately from Deck 2 and detected a heavy oil leak there. At about the same time, another ship mechanic reached the area from Deck 1 and saw fire and smoke in the vicinity of the turbocharger of ME 2. He immediately activated the emergency stop for ME 2. At the same time, a smoke detector in this area detected a fire in ER 2. The ship mechanic informed the bridge that a fire had broken out.

5.2 Extinguishing measures

Up to that point, all measures and procedures were faultless and complied with the normal routine of an engine room watch. The further measures and actions were successful, did not comply with established procedures, however, and were self-endangering.

Due to the still very good visibility conditions in the ER, the fire was sporadically fought with hand fire extinguishers (foam). Although it became obvious very quickly that either the effectiveness of the extinguishing agent or the accessibility of the fire scene (with approx. 1.5 m throwing range) was insufficient, this procedure was repeated by the ship mechanics several times.

With an average flame height of 2 – 3 m in the area of the turbocharger and the exhaust pipe, this was no longer a small incipient fire, so that the operation of a hand fire extinguisher was no longer reasonable. This factor was underestimated.

By keeping the ER ventilation active, the flue gas dispersed through the exhaust duct, making the operating conditions appear very good. This obviously influenced the engine room watch to continue the firefighting without self-protection. Next, a water and a foam line[33] were set up and put to use. No teams were formed. The firefighting measures were limited to a number of individual actions without central supervision.

[33] While a water line consists only of interconnected water hoses and a jet pipe, a foam line also includes a proportioner and a low-expansion foam pipe.

Despite the increasing containment success, this approach should be avoided, if possible, from a self-protection point of view. Only slight deviations from and changes to the scenario, which might not have been controllable by the engine room crew, could have put the persons in the vicinity of the fire in sudden danger.

A further tactical error was that the water-based object protection system was not activated manually immediately, at least above ME 2 and ME 1. Due to the dependency on two detectors and the flue gas flow conditions, the automatic activation was not functional. This was only carried out manually, about ten minutes later from the ECR by the Chief Engineer.

Following this, the object protection system for ER 3 was activated manually. After about 18 – 19 minutes, all preparations and equipment were completed and the fire squad started direct firefighting with full protection and a Venturi jet pipe, F-500, and a second hose line with a low-expansion foam pipe.

Approximately at the same time, the water-based room protection system for die ER was activated manually.

The visibility and temperature conditions were so good during the fire attack, right up until the fire was extinguished, that the fire squad was neither impaired nor endangered at any point. This was especially true of the unprotected engine room watch, who operated in the affected ER throughout the entire period. However, this situation could have changed rapidly through only small changes in the scenario.

Fires in engine rooms can never be completely avoided. There will always be circumstances that can lead to the outbreak of a fire. It should be noted that, in this case, it was only thanks to exceptionally favourable circumstances that there were neither personal injuries nor far greater fire damage.

The safety training of the ship’s crew is based on an annual drill plan. The drills take place weekly for the ship’s crew. In addition, on another day of the same week, theoretical topics related to the fire protection equipment on board are taught. Therefore, because crews change over weekly, each crew receives two practical and two theoretical training sessions per month.

Licensed officers attend regular Advanced Fire Fighting (AFF) refresher courses.[34] This case shows that it may also be reasonable to implement these courses for crewmembers at ratings level who are assigned firefighting duties, depending on the type of ship. As a part of the AFF Refresher training courses, separate specialist courses should be established especially for passenger ferries (Ro/Pax)[35] and passenger ships. This way, all equipment particular to the ships can be included, taking into account the increasing risks related to growing passenger numbers.

[34] Based on ISM Code Reg. 8 and Res.A.1072(28) 3.2.3. and STCW 2010 Ch. A-VI/3 para. 5 + 6.
[35] RoPax = Hybrid term derived from "Roll On/Roll Off", for ships carrying rolling cargo such as cars, and "Pax", for "passengers". RoPax ships are therefore usually car ferries.

Object protection systems should be extended in a reasonable way in order to avoid partial covering of spray cones or blind sections that sprays do not reach, thereby preventing unprotected areas on the engines or other vulnerable objects. The basis for this should be risk analyses that identify special hazard areas such as injection pump areas, turbochargers, as well as lubricating and fuel oil systems.

5.3 Legal framework

There are various regulations for insulating/protecting/securing hot surfaces in engine rooms. The following is an exemplary, non-exhaustive list:

SOLAS II-2/4.2.2.6.1 Surfaces with a temperature in excess of 220°C, which can be impinged with fuel in the event of damage to the fuel system, shall be suitably insulated.

SOLAS Ch. II-2 Construction, fire protection, fire detection and fire extinction, Part C Suppression of fire, Regulation 10 Fire fighting

5.6.3.1 Definition of the areas to be protected by local application systems (internal combustion machinery)

- Hot surfaces such as exhaust pipes without insulation or with insulation likely to be removed frequently for maintenance and high-pressure fuel oil systems installed nearby the hot surfaces should be protected.
- The term “insulation likely to be removed frequently” means insulation fitted in accordance with the requirements of regulation 4.2.2.6.1, but which might not be secured firmly because it may be removed frequently for periodic maintenance, such as pipes between cylinders and the exhaust manifold.
- For typical diesel engines, the area on top of the engine, fuel oil injection pumps and turbo chargers should be protected. Where the fuel oil injection pumps are located in a sheltered position such as under the steel platform, the pump need not be protected by the system.

MSC/Circ.601, ANNEX 1 IACS F35, Fire protection of machinery spaces Rev. 2 1991

2.4 Hot surfaces

All surfaces of machinery with high temperatures above 220 degrees C e.g. steam, thermal oil and exhaust gas lines, silencers, exhaust gas boilers, turbo blowers, etc., shall be effectively insulated with non-combustible material to prevent the ignition of combustible materials coming into contact with them. Where the insulation used for this purpose is oil absorbent or may permit the penetration of oil, the insulation shall be encased in steel sheathing or equivalent material.

MSC/Circ.851, Guidelines on engine room oil fuel systems

5 Maintenance and inspection procedures

5.1 The ship Safety Management System should contain procedures to identify vibration, fatigue, defects, poor components and poor fitting of the fuel system and ensure that proper attention to protecting hot surfaces is maintained. Check lists should be prepared to ensure that all procedures are followed at major overhauls and that all components, supports, restraints etc., are refitted on completion of such work. The installed system should be routinely inspected for:

- verifying the adequacy of its supports and the condition of its fittings;
- evidence of fatigue stresses to welded or brazed pipes and connections;
- assessing the level of vibration present; and
- the checking of the lagging or shielding of hot surfaces.

MSC.1/Circ.1321, Guidelines for measures to prevent fires in engine rooms and cargo pump rooms, Annex Part 2 Installation Practice, Chapter 2 Piping System

5 Insulation materials

5.1 Design

5.1.1 Insulation of high temperature surfaces should be primarily provided to reduce the risk of fire by reducing the temperature of surfaces below 220°C.

5.1.2 Insulation of hot surfaces, in addition to high temperature surfaces should be considered to reduce the potential risk of fire.

5.1.3 The insulation should be non-combustible and so supported that it will not crack or deteriorate when subject to vibration.

5.2 Installation

Manufacturers' instructions should be followed, if available. Permanent insulation should be used to the greatest extent possible. Insulation should be provided with readily removable sections to allow access for normal maintenance. The surface of any oil-absorbent and oil-permeable insulation should be covered by a material which is impervious to oil or oil vapours.

5.3 Inspection and maintenance

A regular check of equipment should be made to confirm that the insulation is in place. When maintenance or repair of equipment has been carried out, checks should be made to ensure that the insulation covering the high temperature or hot surfaces has been properly reinstalled or replaced; surface temperature should be measured if considered necessary.

MSC/Circ.647, Guidelines to minimize leakages from flammable liquid systems

Appendix 3 Spray shields

2 Application

Spray shields are intended for use around flanged joints, flanged bonnets and any other flanged connection in oil pressure systems which are located above the floor plates and which have no insulation in way of the joints. The purpose of spray shields is to prevent the impingement of leaked or sprayed flammable liquid onto a hot surface or other source of ignition. (Refer to appendix 7, guidance for insulation of hot surfaces.)

Appendix 7 Insulation

4 Inspection and maintenance

A regular check of equipment should be made to confirm that the insulation is in place. When maintenance or repair to equipment has been carried out, checks should be made to ensure that the insulation covering the heated surfaces has been properly replaced.

It should be noted that there are no regulations that require the monitoring of the above requirements by a classification society or port state control.

Upon request, the classification society LR stated:

„Lloyd's Register follows the relevant IMO recommendations, essentially MSC/Circular 647. This document provides ship owners with relevant references for inspections, maintenance, and repairs. Lloyd's Register does not have requirements beyond that.

There are neither specific requirements for temperature measurements and/or thermography, nor for periodic verification of surface temperatures.

Lloyd's Register surveyors would require ship operators to monitor hot surfaces if they found that the distances between potential hazard points were too small."[36]

The German Ship Safety Division stated:

"The German flag and our Port State Control have not yet issued any specifications or regulations for the periodic verification of surface temperatures by means of an internal or external thermographic inspection."

„MSC Circular 647 dates back to 1994, when an increased number of fires worldwide were caused by fuel leaks from high-pressure pipes and flange connections of diesel engines. The IMO's MSC developed MSC Circular No. 647 for this purpose, which is non-binding, however, and only has a recommendatory character. Since then, the SOLAS regulations concerning fire safety (reorganisation of SOLAS II-2) have been revised extensively and adapted to the latest standards. Under SOLAS, it has since been made mandatory for high-pressure injection pipes on diesel engines to be double-walled, and for all pipes and systems containing heated flammable liquids to be insulated. Such insulation can be monitored, for example, by monitoring the surface

[36] Source: Statement by Lloyd's Register – Marine & Offshore, 11.04.22.

temperatures using an infrared thermometer. There are, however, no further requirements for this under SOLAS.

Furthermore, there are no requirements for "thermographic inspections" within the PSC specifications under the Paris MOU either, nor does it check for existing documentation of such measurements."[37]

This means that specifications for the insulating of hot surfaces in the engine room exist, but their implementation is not monitored by anybody.

In addition, since the entry into force of the completely revised rules of the "new"[38] Chapter II-2, this Rule 15, to which the guidelines in MSC/Circ.647 refer, does no longer exist. The Circular itself is not repealed, however, there is already a successor since 2009 with the MSC.1/Circ.1321.

[37] Source: Statement German Ship Safety Division, 11.04.22.
[38] In the sense of: "currently valid chapter".

6 CONCLUSIONS

6.1 On the extinguishing measures

The Scandlines crews have above-average training levels in practical firefighting and also tactics. This is achieved through regular safety drills on board and large-scale exercises with ship firefighting units of the professional fire department, as well as through regular participation in so-called "Live Fire Trainings". These „Live Fire Trainings" were developed years ago for cruise vessels and ferries and go far beyond the required training according to STCW. All kinds of scenarios are trained under realistic conditions, such as engine room fires, cabin fires, or fires in vehicle decks.

This training enables crews to act independently and efficiently. However, due to the extraordinarily favourable circumstances in this case, the engine room watch was not aware of possible negative outcomes

In addition to high-quality STCW training, Advanced Fire Fighting (AFF) refresher courses in defensive fire protection should also be introduced for crew members at ratings level, if they are members of fire protection squads, not only for licensed officers.

6.2 On the legal framework

In the course of the investigation, it became apparent that uniform standards must be developed that specify periodic and repair-dependent inspections of the "hot surface situation" in terms of fire prevention for engines and machinery.

MSC-Circular 647 from 1994 is no longer state of the art. It was never binding, since it is not a mandatory SOLAS-requirement, and any Port State Control requirements are to be coordinated through Paris MOU[39] and EMSA In addition, since the entry into force of the fully revised rules of Chapter II-2 currently in force, this Rule 15, to which the guidelines in MSC/Circ.647 refer, no longer exists. The Ship Safety Division was asked to apply circular IMO-Circ.1321.[40]

The BSU received the following response to the draft of this report by IACS:
"We kindly draw your attention to the attached IACS Procedures "IACS Guidelines on Marine Casualty Investigation Reports" which state that marine casualty investigation reports for class matters should be addressed directly to the classification society involved (i.e., the one owning the ship at the time of the incident). Similarly, for statutory matters, the report should be sent to the vessel's flag state."[41]

However, Item 3) of the IACS Guidelines on Marine Accident Investigation Reports still states, mutatis mutandis:

[39] Paris MOU: Memorandum of understanding, an agreement signed in Paris between twenty-seven countries to improve the safety of life at sea, prevent pollution from ships, and improve living and working conditions on board ships.
[40] According to the statement by the Federal Ministry for Digital Affairs and Transport (BMDV) on the draft report.
[41] Source: Statement of 01.08.22 of the International Association of Classification Societies (IACS) on the draft report (freely translated from English by the BSU).

"The 'classification society involved' should make its own assessment of the recommendations in the report and, if appropriate, prepare proposals for amendments to IACS decisions and forward them to GPG for consideration."

Accordingly, the originally intended safety recommendation to IACS was removed and reworded to address LR.

The BG Verkehr Ship Safety Office's comments on the draft of this report included:

"The MSC/Circ.647 guidelines are not part of the Annex to the Ship Safety Act (SchSG) and thus cannot be used as a binding legal basis by BG Verkehr, Dienststelle Schiffssicherheit.

Surveys for the issuance of statutory safety certificates are conducted on the basis of IMO Resolution A.1140(31) (Survey Guidelines under the Harmonized System of Survey and Certification (HSSC Guidelines), 2019). These survey guidelines include specified inspection points to be checked before issuing or confirming statutory certificates. The MSC/Circ.647 guidelines are not listed as a checkpoint in the HSSC Guidelines and thus are not part of the survey scope."[42]

Accordingly, the safety recommendation to BG Verkehr was removed and a new one to the Federal Ministry of Digital Affairs and Transport (BMDV) was developed.

6.3 On actions already taken by the shipping company

Finally, it is worth emphasising that Scandlines, as a part of their own evaluation of the incident, have taken such extensive technical and personnel measures (see chapter 4) that the BSU no longer deems it necessary to address relating safety recommendations to the shipping company or the crew.

[42] Source: Opinion on the Ship Safety Division of the BG Verkehr on the draft report.

7 SAFETY RECOMMENDATIONS

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

7.1 German Federal Ministry for Digital Affairs and Transport

The Federal Bureau of Maritime Casualty Investigation recommends that the Federal Ministry for Digital Affairs and Transport ensure the fastest possible implementation of the current MSC regulations for the prevention of fires in engine and pump rooms (MSC1.Circ.1321).

7.2 Lloyd’s Register

The Federal Bureau of Maritime Casualty Investigation recommends that the classification society Lloyds Register develop internal regulations to ensure that periodic surface temperature inspections are carried out in accordance with the current MSC-Rs by means of thermographic inspections after newbuilding and repairs, as well as for class surveys.

7.3 Lloyd‘s Register (IACS)

The Federal Bureau of Marine Accident Investigation recommends that the classification society Lloyds Register, in accordance with the IACS Guidelines on Marine Accident Investigation Reports No.3, carry out its own assessment of the safety recommendations referred to here and, if necessary, draw up proposals for amendments to IACS resolutions and forward them to the GENERAL POLICY GROUP (GPG) for consideration.

It would be desirable to ensure that all members are made aware of the periodic inspection of surface temperatures, based on the current MSC regulations, if possible by a thermographic inspection, after new construction and repair as well as for the class survey.

8 SOURCES

- All photos taken by the BSU, unless stated otherwise
- Waterways Police (WSP) Rostock investigations
- Written declarations/statements
  - Ship's command
  - Shipping company
- Witness testimonies
- Technical report by L. and O. Tober, GSSO Rostock
- Navigational charts and ship's particulars: German Federal Maritime and Hydrographic Agency

9 ANNEX

Excerpt STCW-Code:

RESOLUTION 2 THE MANILA AMENDMENTS TO THE SEAFARERS' TRAINING, CERTIFICATION AND WATCHKEEPING (STCW) CODE

(Eighth Ordinance
about changes to the facility
of the 1978 International Convention
on standards for training, the issuance of certificates
and seafarers' watchkeeping
dated June 28, 2013)

STCW Code Table A-VI/3
Specification of minimum standard of competence in advanced fire fighting

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Control fire-fighting operations aboard ships	Fire-fighting procedures at sea and in port, with particular emphasis on organization, tactics and command Use of water for fire-extinguishing, the effect on ship stability, precautions and corrective procedures Communication and coordination during fire-fighting operations Ventilation control, including smoke extraction Control of fuel and electrical systems Fire-fighting process hazards (dry distillation, chemical reactions, boiler uptake fires, etc.) Fire fighting involving dangerous goods Fire precautions and hazards associated with the storage and handling of materials (paints, etc.) Management and control of injured persons Procedures for coordination with shore-based fire fighters	Practical exercises and instruction conducted under approved and truly realistic training conditions (e.g., simulated shipboard conditions) and, whenever possible and practicable, in darkness	Actions taken to control fires are based on a full and accurate assessment of the incident, using all available sources of information The order of priority, timing and sequence of actions are appropriate to the overall requirements of the incident and to minimize damage and potential damage to the ship, injuries to personnel and impairment of the operational effectiveness of the ship Transmission of information is prompt, accurate, complete and clear Personal safety during fire control activities is safeguarded at all times
Organize and train fire parties	Preparation of contingency plans Composition and allocation of personnel to fire parties Strategies and tactics for control of fires in various parts of the ship	Practical exercises and instruction conducted under approved and truly realistic training conditions, e.g. simulated shipboard conditions	Composition and organization of fire control parties ensure the prompt and effective implementation of emergency plans and procedures

- 2 - Table A-VI/3

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Inspect and service fire-detection and fire-extinguishing systems and equipment	Fire-detection systems; fixed fire-extinguishing systems; portable and mobile fire-extinguishing equipment, including appliances, pumps and rescue, salvage, life-support, personal protective and communication equipment Requirements for statutory and classification surveys	Practical exercises, using approved equipment and systems in a realistic training environment	Operational effectiveness of all fire-detection and fire-extinguishing systems and equipment is maintained at all times in accordance with performance specifications and legislative requirements
Investigate and compile reports on incidents involving fire	Assessment of cause of incidents involving fire	Practical exercises in a realistic training environment	Causes of fire are identified and the effectiveness of countermeasures is evaluated

STCW Code Section A-VI/3 Chapter V (STCW 2010 Resolution 2) Mandatory Minimum Training in Advanced Fire Fighting

Standard of Competence

1. Seafarers designated to control fire-fighting operations shall have successfully completed advanced training in techniques for fighting fire, with particular emphasis on organization, tactics and command, and shall be required to demonstrate competence to undertake the tasks, duties and responsibilities listed in column 1 of table A-VI/3.
2. The level of knowledge and understanding of the subjects listed in column 2 of table A-VI/3 shall be sufficient for the effective control of fire-fighting operations on board ship*.
3. Training and experience to achieve the necessary level of theoretical knowledge, understanding and proficiency shall take account of the guidance given in part B of this Code.
4. Every candidate for certification shall be required to provide evidence of having achieved the required standard of competence, in accordance with the methods for demonstrating competence and the criteria for evaluating competence tabulated in columns 3 and 4 of table A-VI/3.
5. Seafarers qualified in accordance with paragraph 4 in advanced fire fighting shall be required, every five years, to provide evidence of having maintained the required standards of competence to undertake the tasks, duties and responsibilities listed in column 1 of table A-VI/3.

6. Parties may accept onboard training and experience for maintaining the required standard of competence of table A-VI/3, in the following areas:
   1. Control fire-fighting operations aboard ships;
      1. fire-fighting procedures at sea and in port, with particular emphasis on organization, tactics and command;
      2. communication and coordination during fire-fighting operations;
      3. ventilation control, including smoke extraction;
      4. control of fuel and electrical systems;
      5. fire-fighting process hazards (dry distillation, chemical reactions, boiler uptake, fires);
      6. fire precautions and hazards associated with the storage and handling of materials;
      7. management and control of injured persons; and
      8. procedures for coordination with shore-based fire fighters.