



**Federal Bureau for the Investigation
of Maritime Accidents**

Vooruitgangstraat 56
B - 1210 Brussels
Belgium

2021/001361

Report on the investigation into
the accident on board the mv
KNOKKE on Tuesday February
23rd 2021
whereby a crewmember was
severely burnt



Federal Bureau for the Investigation of Maritime Accidents

Extract from the European Directive 2009/18/EC

(26) Since the aim of the technical safety investigation is the prevention of marine casualties and incidents, the conclusions and the safety recommendations should under no circumstances determine liability or apportion blame.

In view of the COVID-19 pandemic in 2020, and local rules and regulations to prevent the further spread of the virus, the investigators of the Federal Bureau for the Investigation of Maritime Accidents adhered to all legislation in vigour, which might have hampered certain investigative acts. Nevertheless, no efforts were spared to conduct the investigation, into the cause of the marine accident mentioned in this report, to the largest possible extent and conclusions were only drawn after very large consideration

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1. Marine Casualty Information

1.1 Classification of Accident

According to Resolution A.849(20) of the IMO Assembly of 27 November 1997, Code for the investigation of Marine Casualties and Incidents, a marine casualty means an event that has resulted in, amongst others, the death of, or serious injury to, a person that is caused by, or in connection with, the operations of a ship.

According to this definition, the accident was classified as

Marine Casualty

1.2 Accident Details

Report number: 2021/001361

Incident name: Severely burnt crewmember on board the mv KNOKKE

Incident time and date: At 18:00 hours on Tuesday, February 23, 2021

Incident location: Remontowa Shipyard in Gdansk, Poland

Investigated by: Federal Bureau for the Investigation of Maritime Accidents, Belgium
State Marine Accident Investigation Commission, Poland

Incident type: Marine Casualty

Incident category: Injured Crewmember

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5. Synopsis

The motor vessel mv KNOKKE was scheduled for drydock, in Gdansk, Poland, during the month of February 2021.

The servicing of the auxiliary boiler, placed in the engine room, was included in the works to be performed while the vessel was in drydock, since the vessel's classification society, was to perform some inspection and testing of the auxiliary boiler.

The morning of 23 February 2021, the mv KNOKKE was docked at Remontowa Shipyard in Gdansk, Poland, when on February 23rd 2021, at 08:00 hours it was agreed during a meeting with the vessel's engine room staff and shipyard technical staff to prepare the auxiliary boiler for survey and service the day after.

After the meeting, an engineer was assigned the task of shutting down the auxiliary boiler, to bring down the pressure inside the boiler to 1 bar and to subsequently open the boiler's vent valves to prevent a vacuum in the boiler and apply a lockout-tagout or LOTO¹.

Immediately thereafter, the appointed engineer proceeded to the engine control room and stopped the boiler's circulating pumps. After a period of time, estimated to be one hour, the appointed engineer opened a vent valve to keep depressurizing the boiler. The pressure inside the auxiliary boiler at that time was 2.5 Bar. The rest of the day the appointed engineer was preoccupied with other chores such as pumping sludge overboard since he was the duty engineer for the day.

Later that day, around 17:00 hours, a daily meeting was held, however the appointed engineer did not attend the meeting, and started draining the auxiliary boiler instead.

The appointed engineer opened the 2 blowdown valves and the 2 overboard valves. At 17:27 hours the feed water pumps were started in order to drain the auxiliary boiler and were stopped again at 17:46 hours later that day.

It was subsequently noted via the water level indicator that the water level no longer decreased and that the pressure inside the auxiliary boiler settled at 1 bar.

The assigned engineer started removing the hand hole cover, which consisted of two parts, the upper and the lower part.

At 18:05, when removing the lower part of the hand hole cover of the auxiliary boiler, the appointed engineer was sprayed over his legs and lower forearms with hot water at 70° C when a mix of steam and water escaped under pressure from the auxiliary boiler. Consequentially the fire alarm in the engine room was triggered. The appointed engineer consequently started shouting and undressed to

¹ Lock out, tag out or lockout-tagout or LOTO is a safety procedure used to ensure that dangerous equipment is properly shut off and not able to be started up again prior to the completion of maintenance or repair work. It requires that hazardous energy sources be "isolated and rendered inoperative" before work is started on the equipment in question. The isolated power sources are then locked and a tag is placed on the lock identifying the worker and reason the LOTO is placed on it. The assigned worker then holds the key for the lock, ensuring that only they can remove the lock and start the equipment. This prevents accidental startup of equipment while it is in a hazardous state or while a worker is in direct contact with it.

his underwear. He ran to a sink under the engine room stairs, where he started throwing cold water on his burnt body parts. Two more engineers arrived at the scene soon thereafter and advised the burnt engineer to proceed quickly to the vessel's sickbay and subsequently go sit in the bath tub and run cold water on his body. The engineers who came to the call noted the forming of blisters on the burnt engineer's arms and legs and preferred not to touch him in order to prevent infections. Moments later a deck officer arrived at the sick bay and assisted the engineer with the taking of the bath and administered ibuprofen for pain relief . A shipyard watchman hailed for the shipyard's medical intervention team.

Soon thereafter the medical intervention team from the shipyard arrived in the sick bay. They called for an ambulance and subsequently removed the injured engineer's T-shirt and socks. After the ambulance had arrived, at 18:25, the victim himself walked to the ambulance and was subsequently transported to the a hospital in Gdansk. At the hospital the victim was administered painkillers. It was subsequently decided to airlift the victim to a specialised trauma centre in Southern Poland.

Once arrived at the specialised trauma centre, and after assessment, it was decided to put to victim in a coma and to airlift the victim to Belgium, where he was to be hospitalized in a specialized centre for burns in a wing of a major hospital. After his convalescence, the victim was discharged from the hospital and further recovered at home.

6. Factual Information

6.1 Particulars of mv KNOKKE



Figure 1 - mv KNOKKE

Ship's Name	Mv KNOKKE
IMO Number	9687497
Call Sign	ONIL
Flag	Belgian
Ship type	LPG Tanker
Gross Tonnage	26.261
Deadweight	29.478 Mt
Date keel laid	01/04/2015
Company Name	Exmar Shipmanagement
Maximum engine power	8.560 KW
Length over all	181.70 m
Length between perpendiculars	171,40 m
Breath	29,43 m
Draught	10,416 m
Hull Material	Steel

7. Incident Classification

Incident type: Marine Casualty – Serious Injury

Incident category: Injured Crewmember

8. Detailed Incident Description

On February 23rd 2021, at 08:00, during a morning meeting with the engineering staff of the mv KNOKKE and technical staff from the Remontowa Shipyard in Gdansk it was agreed to work the day after on the auxiliary boiler, as seen in Figure 2 on page 10, for survey and service.



Figure 2 - auxiliary boiler

Subsequent to the said meeting, an engineer was appointed to prepare the auxiliary boiler.

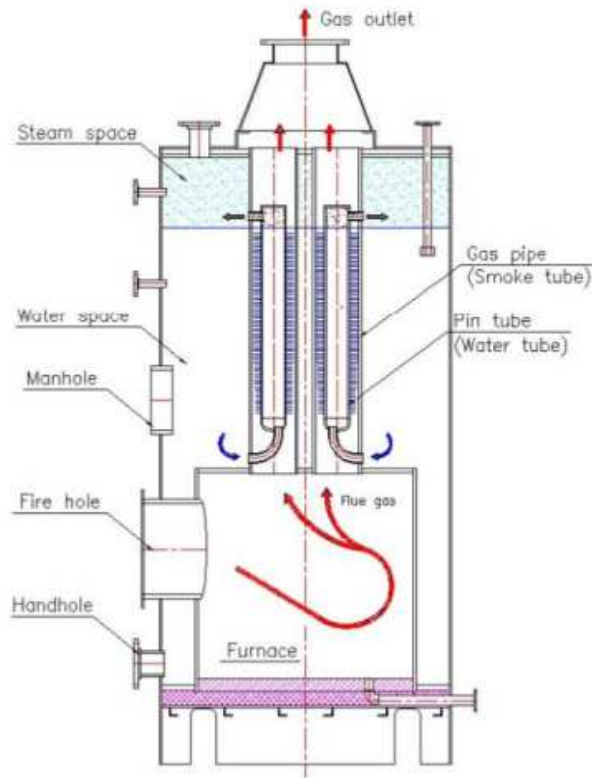


Figure 3 - schematic drawing of auxiliary boiler

The auxiliary boiler was to be shut down, the pressure inside the boiler brought down to 1 bar, which occurred on February 2021 at 12:22 hours according to the auxiliary boiler pressure, level and temperature monitoring as seen on Figure 4 on page 11 .

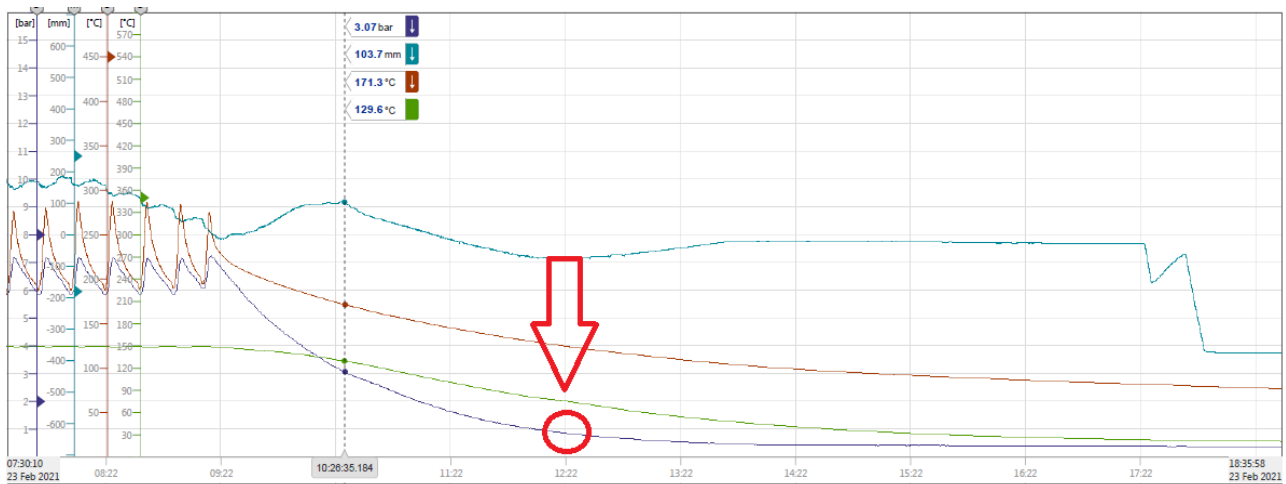


Figure 4 - evolution of auxiliary boiler pressure from the remote monitoring device

Subsequently the boiler's vent were to be opened, the hand hole was to be opened and a LOTO was to be applied of which an example is shown in Figure 5 on page 12.



Figure 5 - example of a LOTO

The appointed engineer stopped the boiler's circulating pumps. After a period of time, estimated to be one hour, the appointed engineer opened a vent valve to keep depressurizing the boiler. The pressure inside the auxiliary boiler at that time was 2.5 Bar. The rest of the day the appointed engineer was preoccupied with other chores since he was the duty engineer for the day.

Later that day, around 17:00 hours, a daily meeting was held, however the engineer assigned the task of depressurising the auxiliary boiler did not attend the meeting, and started draining the auxiliary boiler instead.

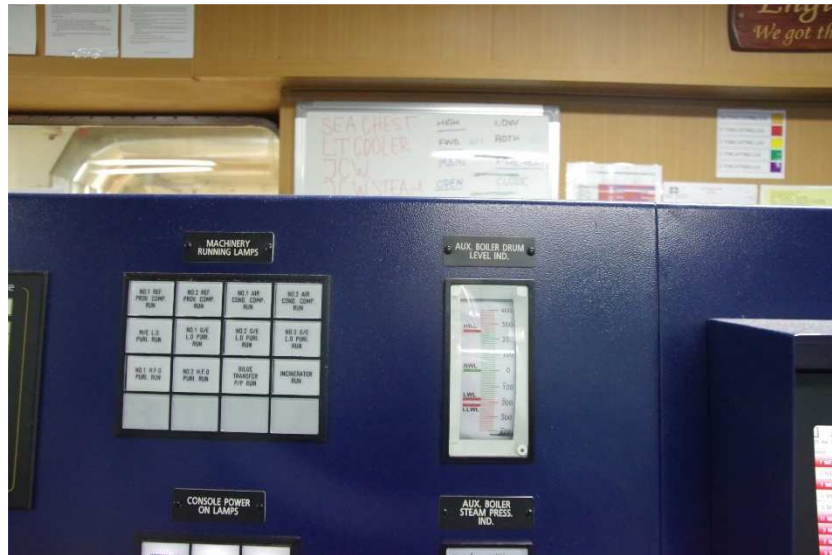


Figure 6 - auxiliary boiler remote water level indicator

The engineer assigned the task of depressurising the auxiliary boiler opened the 2 blowdown valves and the 2 overboard valves. At 17:27 hours the feed water pumps were started in order to drain the auxiliary boiler and were stopped again at 17:46 hours later that day.

It was subsequently noted via the water level indicators as in Figure 6 on page 13 and Figure 7 on page 14 that the water level no longer decreased and that the pressure inside the auxiliary boiler settled at 1 bar.



Figure 7 - glass water level indicating gauges

The appointed engineer started removing the handhole cover, which consisted of two parts, the upper and the lower part.



Figure 8 - handhole cover on auxiliary boiler

At 18:05, when removing the lower part of the handhole cover of the auxiliary boiler, the appointed engineer was sprayed over his legs and lower forearms with boiling hot water when a mix of steam and water escaped under pressure from the auxiliary boiler. The appointed engineer consequently started shouting and ran to the vessel's sickbay, where he jumped into a cold shower. Moments later the 2nd officer arrived at the sick bay and assisted the engineer. Soon thereafter the medical intervention team from the shipyard arrived in the sick bay. They called for an ambulance and subsequently removed the injured engineer's T-shirt and socks. After the ambulance had arrived, the victim himself walked to the ambulance and was subsequently transported to the a hospital in Gdansk. At the hospital the victim was administered painkillers. It was subsequently decided to airlift the victim to a specialised trauma centre in Southern Poland.

Once arrived at the specialised trauma centre, and after assessment, it was decided to put to victim in a coma and to airlift the victim to Belgium, where he was to be hospitalized in a specialized centre for burns in a wing of a major hospital. After his convalescence, the victim was discharged from the hospital and further recovered at home

9. Incident Timeline

Name	Actor	Date and Time
Preparatory meeting	Crew and Shipyard Personnel	23/02/2021 8:00
Stop boiler and bring down pressure to 1 bar	Crew	23/02/2021 9:00
Open ventilation valve	Appointed engineer	23/02/2021 10:00
Meeting	Crew	23/02/2021 17:00
Draining auxiliary boiler	Appointed engineer	23/02/2021 17:00
Start water feeding pumps	Appointed engineer	23/02/2021 17:27
Stop water feeding pumps	Appointed engineer	23/02/2021 17:47
Jump into cold shower in sick bay	Appointed engineer	23/02/2021 18:06
Assist injured engineer	Deck officer	23/02/2021 18:06
Assist injured engineer	Shipyard's medical intervention team	23/02/2021 18:06
Call for ambulance	Shipyard's medical intervention team	23/02/2021 18:07
Proceed to hospital	Hospital medical team	23/02/2021 18:25
Put victim in a coma	Hospital medical team	23/02/2021 20:00
Airlift engineer to Belgium	Hospital medical team	23/02/2021 21:00

Figure 9 - incident timeline

10. Incident Tree Overview

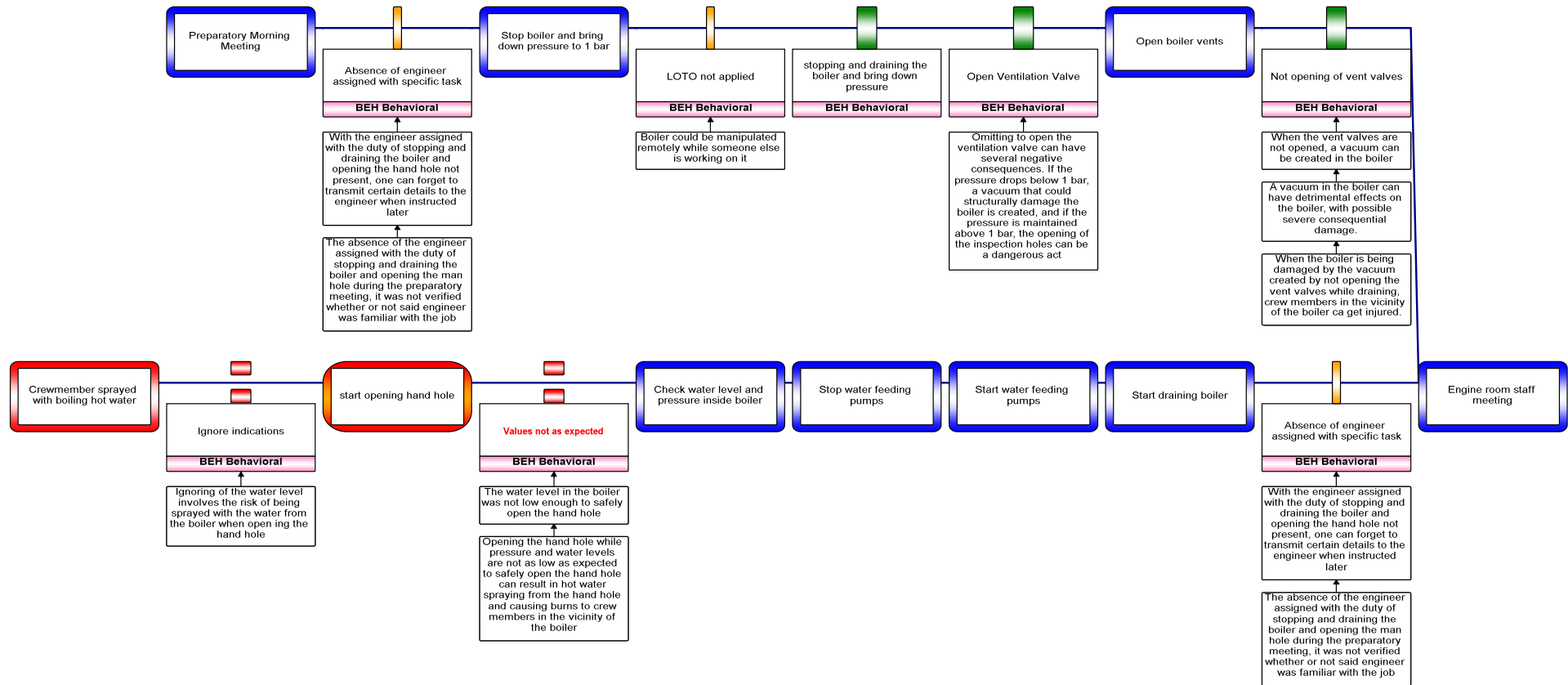
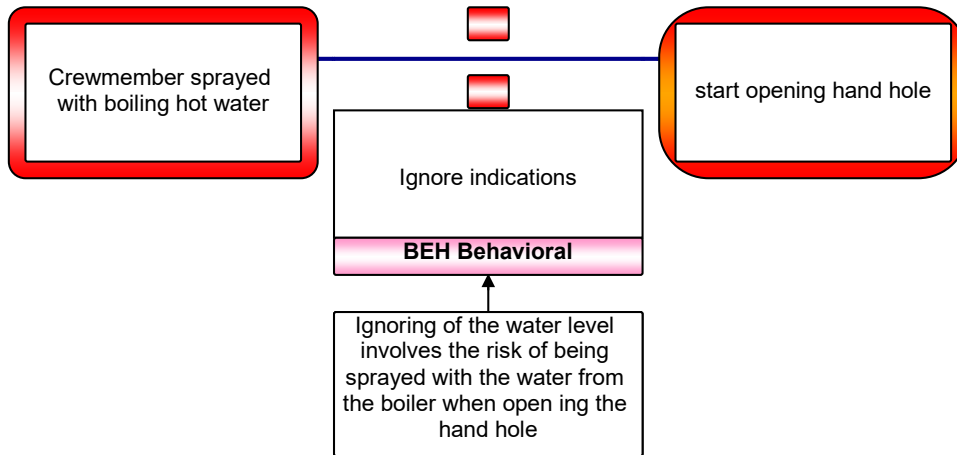


Figure 10 - barrier fail diagram

11. Incident Tree Cut-up

From: Consequence Crewmember sprayed with boiling hot water

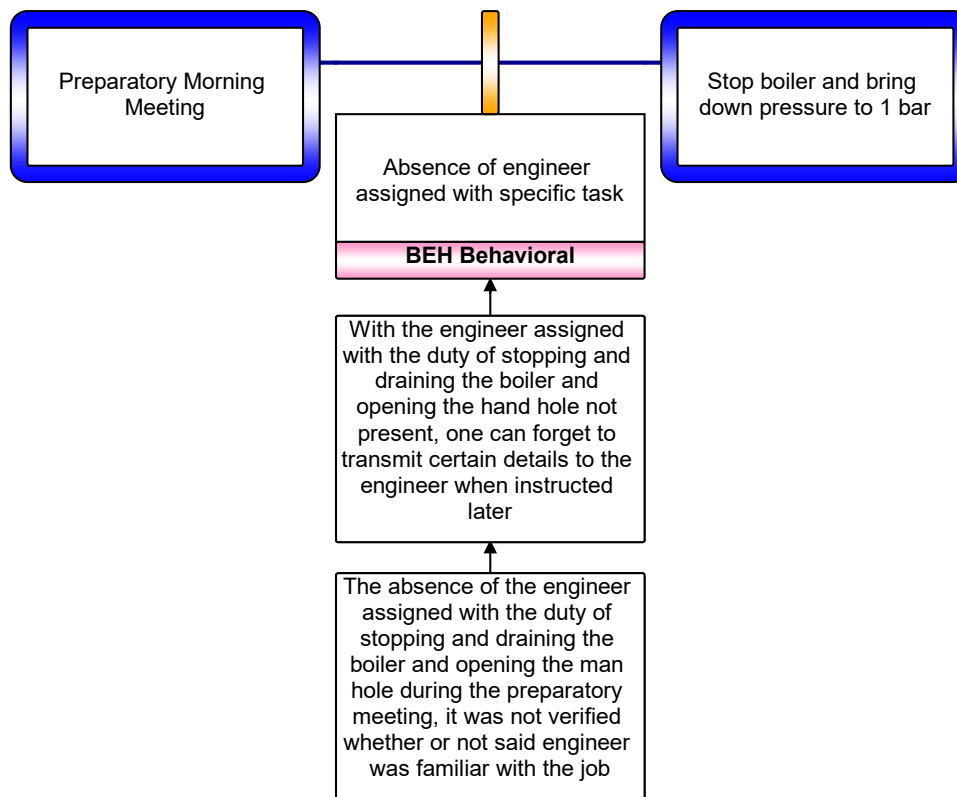
To: Top event start opening hand hole



Incident Barrier	Performance	Barrier Challenge / Causes	Remarks concerning performance
start opening hand hole			
Ignore indications	Failed		
	BFA Primary Causes		Ignoring of the water level involves the risk of being sprayed with the water from the boiler when opening the hand hole

From: **Event Preparatory Morning Meeting**

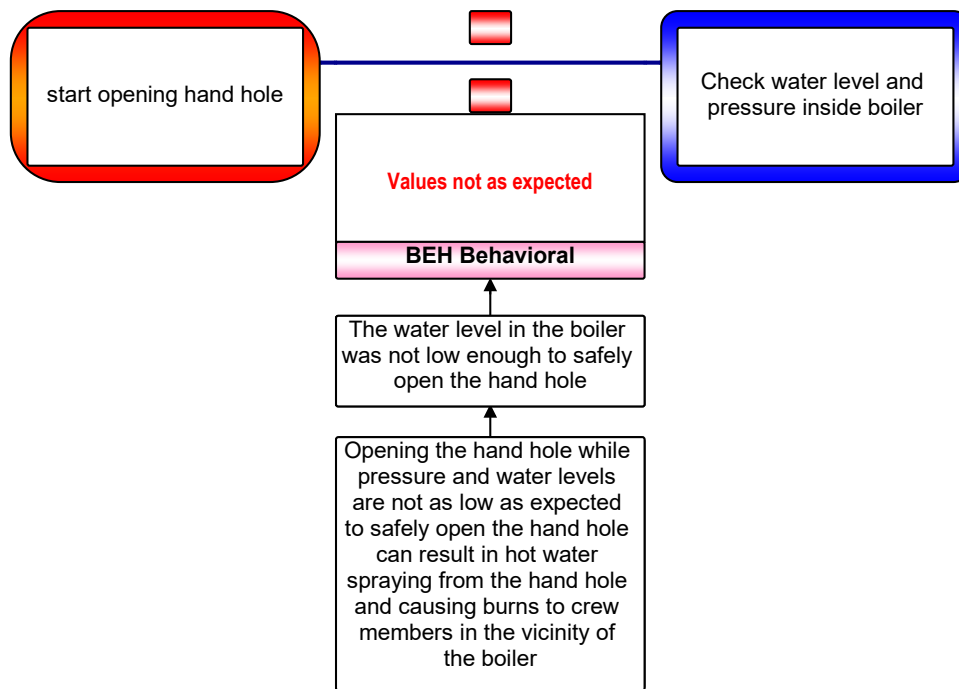
To: **Event Stop boiler and bring down pressure to 1 bar**



Incident Barrier	Performance	Barrier Challenge / Causes	Remarks concerning performance
Stop boiler and bring down pressure to 1 bar			
Absence of engineer assigned with specific task	Unreliable	The ship's engine room staff should check whether or not an engine room crew member is familiar with the tasks assigned	No checks and balances The engineer assigned with the task was absent and it was not checked whether or not he was familiar with the task
	BFA Primary Causes		With the engineer assigned with the duty of stopping and draining the boiler and opening the hand hole not present, one can forget to transmit certain details to the engineer when instructed later
	BFA Secondary Causes		The absence of the engineer assigned with the duty of stopping and draining the boiler and opening the man hole during the preparatory meeting, it was not verified whether or not said engineer was familiar with the job

From: Top event start opening hand hole

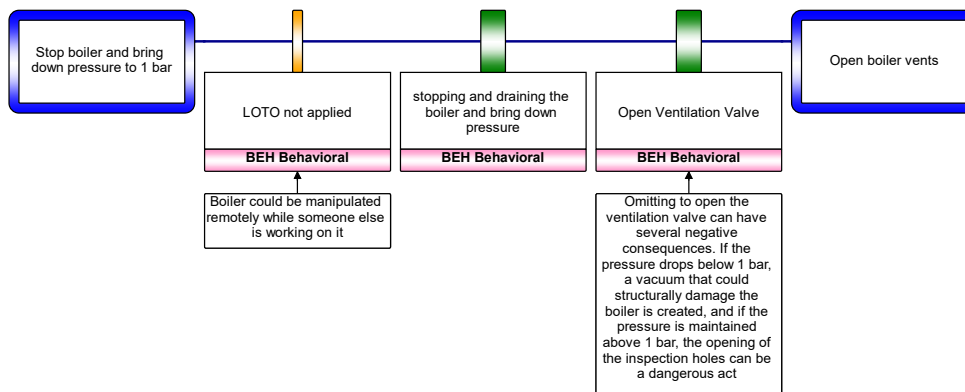
To: Event Check water level and pressure inside boiler



Incident Barrier	Performance	Barrier Challenge / Causes	Remarks concerning performance
Check water level and pressure inside boiler			
Values not as expected	Failed		Despite values that do not allow opening the hand hole the hand hole was opened anyway
	BFA Primary Causes		The water level in the boiler was not low enough to safely open the hand hole
	BFA Secondary Causes		Opening the hand hole while pressure and water levels are not as low as expected to safely open the hand hole can result in hot water spraying from the hand hole and causing burns to crew members in the vicinity of the boiler

From: Event Stop boiler and bring down pressure to 1 bar

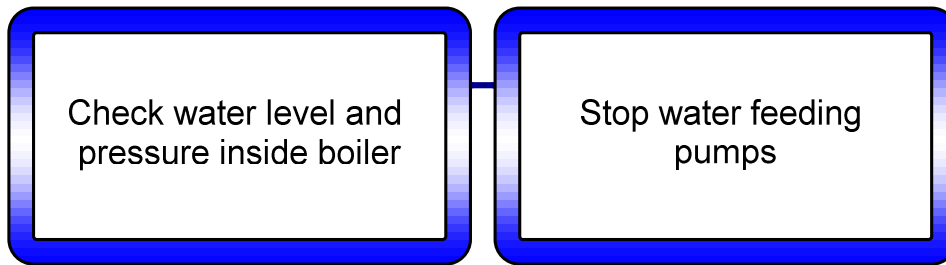
To: Event Open boiler vents



Incident Barrier	Performance	Barrier Challenge / Causes	Remarks concerning performance
Open boiler vents			
LOTO not applied	Unreliable		Boiler could be manipulated remotely without the engineer assigned with the task of draining the boiler and opening the hand holes knowing that the boiler is manipulated
	BFA Primary Causes		Boiler could be manipulated remotely while someone else is working on it
Open boiler vents			
stopping and draining the boiler and bring down pressure	Effective		
Open boiler vents			
Open Ventilation Valve	Effective		
	BFA Primary Causes		Omitting to open the ventilation valve can have several negative consequences. If the pressure drops below 1 bar, a vacuum that could structurally damage the boiler is created, and if the pressure is maintained above 1 bar, the opening of the inspection holes can be a dangerous act

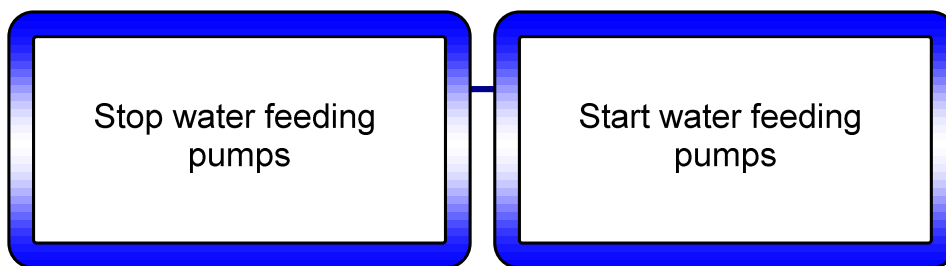
From: Event Check water level and pressure inside boiler

To: **Event Stop water feeding pumps**



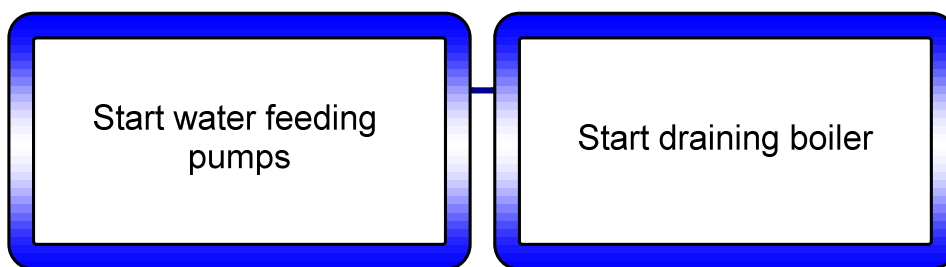
From: **Event Stop water feeding pumps**

To: **Event Start water feeding pumps**



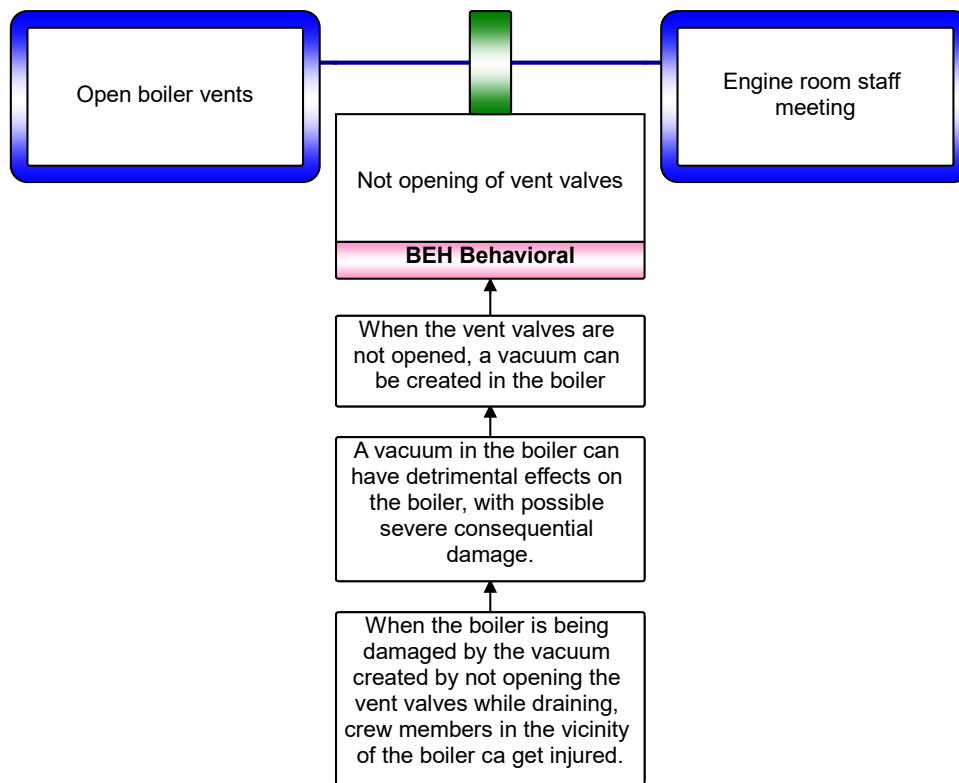
From: **Event Start water feeding pumps**

To: **Event Start draining boiler**



From: **Event Open boiler vents**

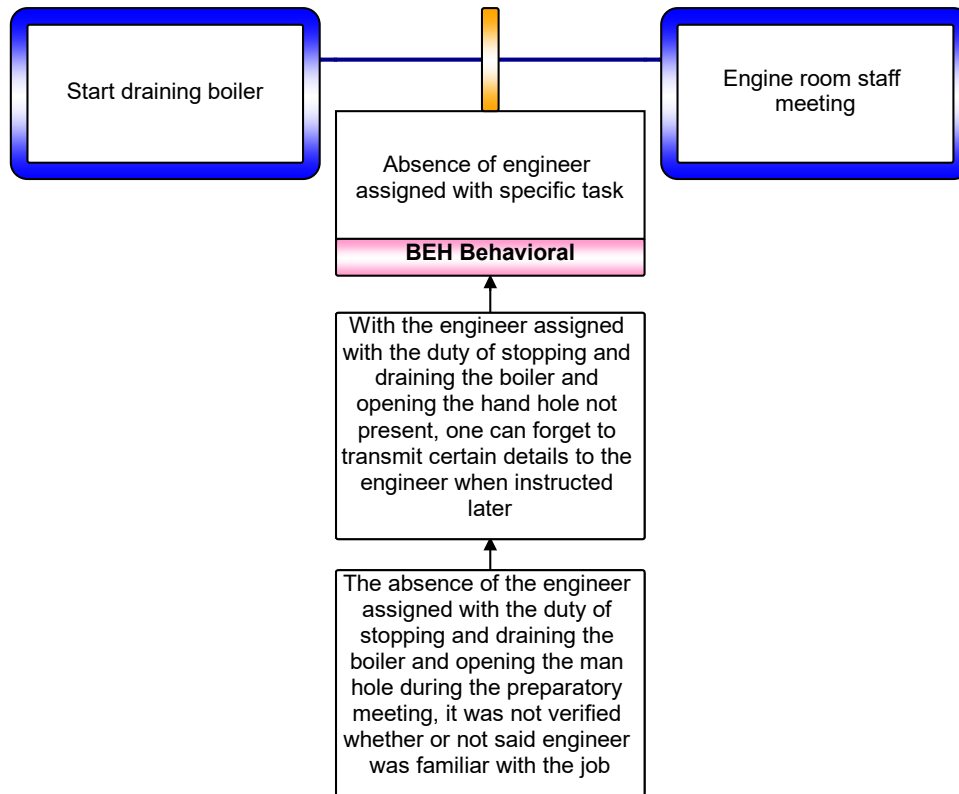
To: **Event Engine room staff meeting**



Incident Barrier	Performance	Barrier Challenge / Causes	Remarks concerning performance
Engine room staff meeting			
Not opening of vent valves	Effective		
	BFA Primary Causes		When the vent valves are not opened, a vacuum can be created in the boiler
	BFA Secondary Causes		A vacuum in the boiler can have detrimental effects on the boiler, with possible severe consequential damage.
	BFA Tertiary Causes		When the boiler is being damaged by the vacuum created by not opening the vent valves while draining, crew members in the vicinity of the boiler can get injured.

From: **Event Start draining boiler**

To: **Event Engine room staff meeting**



Incident Barrier	Performance	Barrier Challenge / Causes	Remarks concerning performance
Engine room staff meeting			
Absence of engineer assigned with specific task	Unreliable		
	BFA Primary Causes		With the engineer assigned with the duty of stopping and draining the boiler and opening the hand hole not present, one can forget to transmit certain details to the engineer when instructed later
	BFA Secondary Causes		The absence of the engineer assigned with the duty of stopping and draining the boiler and opening the man hole during the preparatory meeting, it was not verified whether or not said engineer was familiar with the job

12. Cause of the accident

The burning with boiling hot water from the boiler of the engineer assigned with the draining of the boiler and the opening of the hand hole happened because the engineer assigned with the duty was not involved in the preparatory meetings with respect to the draining of the boiler where it was not checked whether or not the assigned engineer was familiar with the assigned duty, resulting in a manipulation of the boiler which lead to the burning of the assigned engineer.

13. Safety Issues

1. Not properly checking the water level inside the boiler may cause being sprayed and consequentially being burned when opening the man and or handholes of the boiler.
2. It was not verified whether or not the engineer assigned with the task of opening the hand and manholes was familiar with the task.
3. Despite the values on the remote monitoring system were indicating that it was not safe to open the boiler, the hand and manholes were being opened anyway.
4. The boiler could be manipulated remotely without some in the vicinity of the boiler observing the manipulation.
5. The person assigned with the task of opening the man and handholes of the boiler was not present during the meetings where the task was being discussed.

14. Actions taken

By the vessel's operator:

1. A reminder was sent, to all vessels in the operator's fleet, concerning the importance of tool box meetings on the work floor and the importance of supervision of juniors
2. Ensure that the manual of the boiler clearly states that there is a cool-down period for the boiler after it has been switched off and before the hand and or manholes or being opened

15. Investigation Team

The following accident investigation bodies were part of the investigation team:

Federal Bureau for the investigation of Maritime Accidents	Belgium
State Marine Accident Investigation Commission	Poland

16. Incident Analysis Methodology

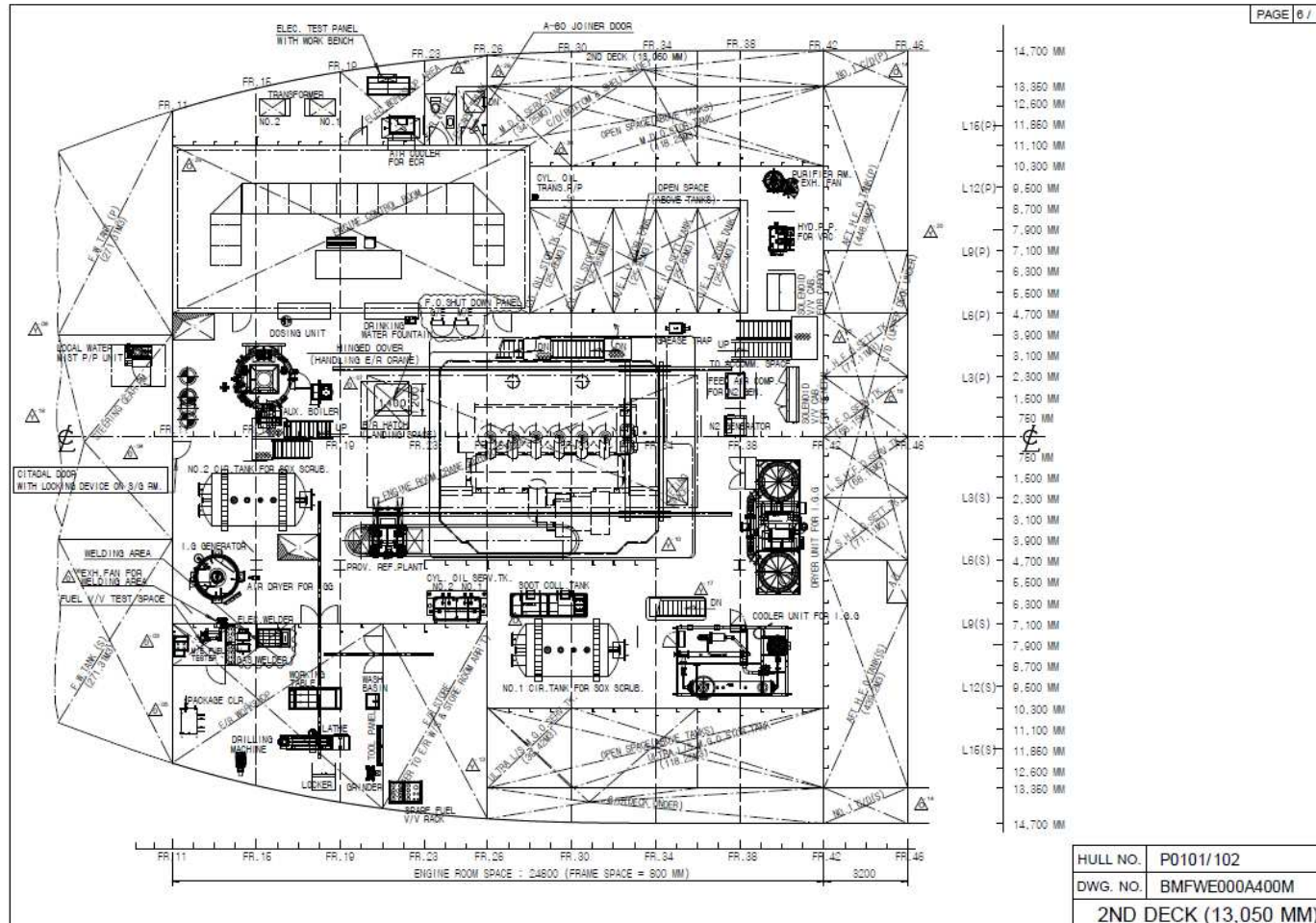
The method used to analyse the accident on board the mv KNOCKE on February 23rd 2021 is the Barrier Failure Analysis method or in short BFA. The Barrier Failure Analysis method is a pragmatic, un-opinionated, general-purpose incident analysis method.

The Barrier Failure Analysis method is a way to structure incidents and to categorize certain parts of an incident taxonomy. The structure consists of events, barriers and causation paths. Events are used to describe a casual sequence of events that we want to prevent from cascading. This means that each event causes the occurrence of a next event. There can also be a parallel events that combined cause the next event to happen.

The barriers in a Barrier Fail Analyses are designed to stop a chain of events.

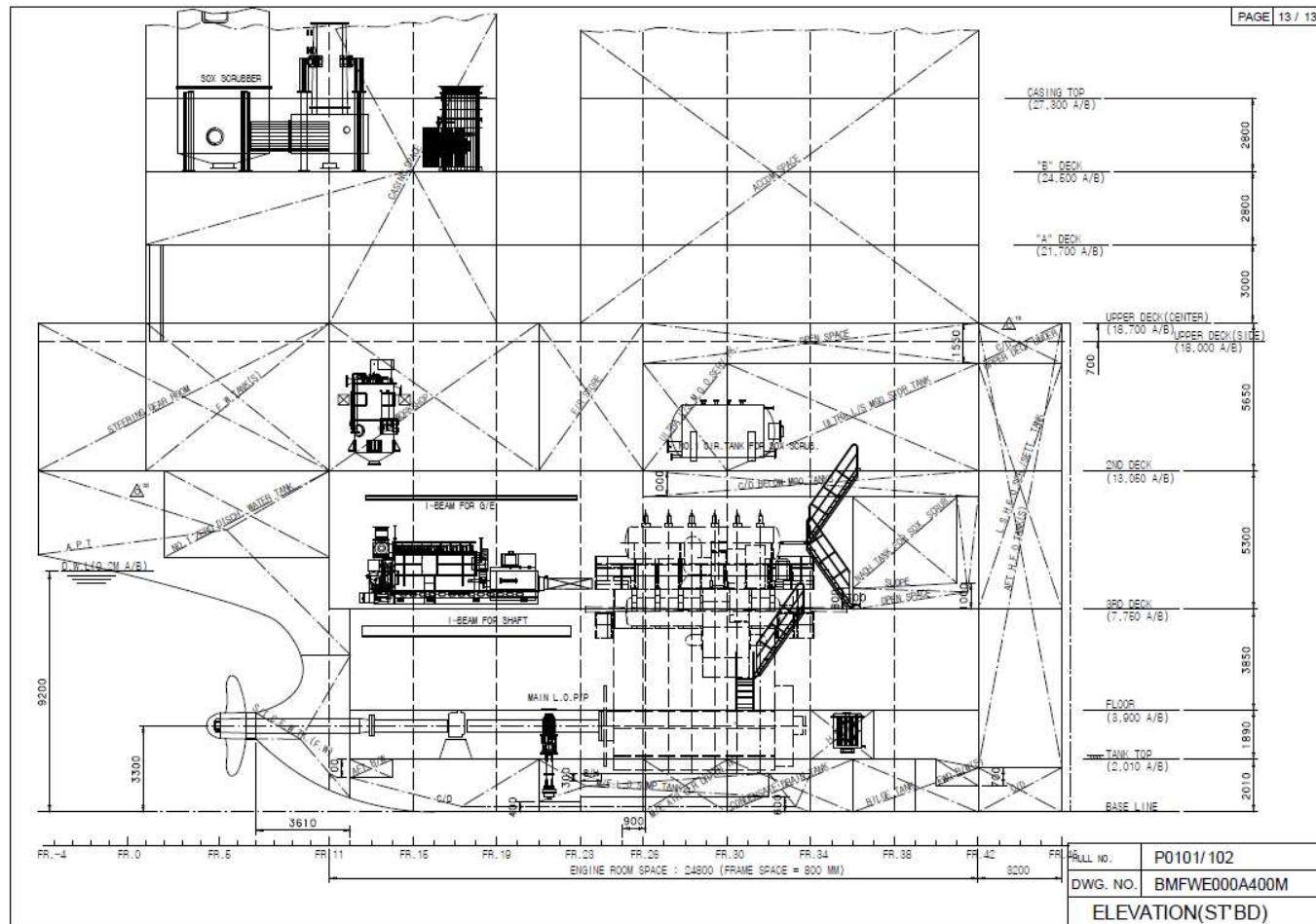
17. Annexes

17.1 Drawing of second deck



Annex 1 - Drawing of second deck

17.2 Elevation drawing of the starboard side of the engine room



Annex 2 - Elevation drawing of the starboard side of the engine room



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**Vooruitgangstraat 56
B - 1210 Brussels
Belgium**