



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

## Investigation Report 124/14

### Marine Casualty

# **Exploding shrimp boiler on board the fishing vessel KLAUS GROTH on 19 May 2014 south-west of Amrum**

18 May 2015

The investigation was conducted in conformity with the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Act - SUG) of 16 June 2002, amended most recently by Article 1 of 22 November 2011, BGBl. (Federal Law Gazette) I p. 2279.

According to said Law, the sole objective of this investigation is to prevent future accidents and malfunctions. 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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## 1 Summary

At about 2330<sup>1</sup> on 19 May 2014, the German-flagged fishing vessel KLAUS GROTH was located south-west of Amrum, where she was hauling in her shrimp trawl for the first time during this voyage. The shrimps were sorted immediately and placed into the shrimp boiler, which is situated on the fore section. At this point, the skipper was in the wheelhouse and the two fishing hands were working at the boiler. The boiler's hearth suddenly exploded and a darting flame injured the two fishermen. The work clothing worn by the younger of the two caught fire in the process. He ran towards the aft section and tore the clothes from his body. The older fishermen, later joined by the skipper when he had recognised the situation and descended from the wheelhouse, helped him in the process.

The injuries became apparent after the fire was extinguished and the skipper informed the German Maritime Search and Rescue Service (DGzRS) at once.

The rescue cruiser VORMANN LEISS collected the two casualties and took them to Dagebüll, from where they were taken to a hospital in Flensburg.

Assisted by the waterway police, the skipper sailed the KLAUS GROTH back to Büsum.

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<sup>1</sup> Unless stated otherwise, all times shown in this report are local = UTC + 2 (CEST).

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## 2 FACTUAL INFORMATION

### 2.1 Photo



© BSU

Figure 1: Photo of ship

### 2.2 Ship particulars

Name of ship:	KLAUS GROTH
Type of ship:	Fishing vessel
Nationality/Flag:	German
Port of registry:	Büsum
IMO number:	N/A
Call sign:	DIVC
Owner:	Single-ship company
Year built:	1959
Shipyard/Yard number:	HIJLKMA & ZONEN/2-69
Classification society:	GL
Length overall:	24.50 m
Breadth overall:	6.03 m
Gross tonnage:	81
Minimum safe manning:	2
Draught (max.):	2.69 m
Engine rating:	221 kW
Main engine:	MTU
(Service) Speed:	8 kts
Hull material:	Steel

### 2.3 Voyage particulars

Port of departure:	Büsum
Port of call:	Büsum
Type of voyage:	Merchant shipping
	Fishing
Cargo information:	Shrimp
Draught at time of accident:	F/M/A: 2.70 m
Manning:	3
Pilot on board:	No

### 2.4 Marine casualty or incident information

Type of marine casualty or incident:	Marine casualty, explosion
Date, time:	19/05/2014, 2330
Location:	South-west of Amrum
Ship operation and voyage segment:	Open sea
Place on board:	Fore section
Consequences (for people, ship, cargo, environment, other):	Two people suffered second and third degree burns; no damage to the ship or environment

Excerpt from ECDIS DE421010 and DE421020, BSH

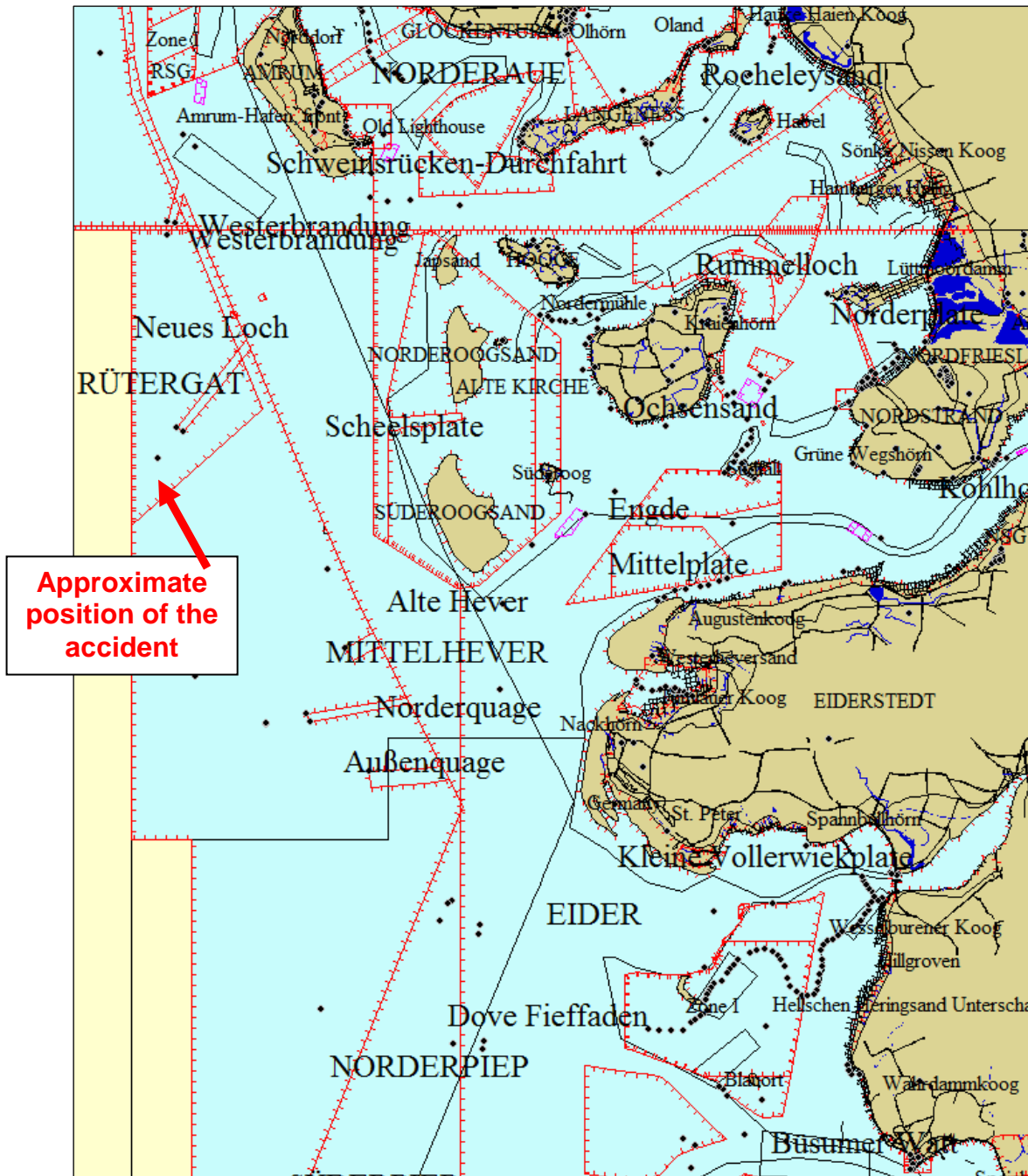


Figure 2: Nautical chart showing the scene of the accident

## 2.5 Shore authority involvement and emergency response

Agencies involved:	DGzRS
Resources used:	Rescue cruiser VORMANN LEISS
Actions taken:	Hospitalised
Results achieved:	Recovered



### 3 Course of the accident and investigation

#### 3.1 Course of the accident

At about 2330 on 19 May 2014, the German-flagged fishing vessel KLAUS GROTH was located south-west of Amrum, where she was hauling in her shrimp trawl for the first time during this voyage. The shrimps were sorted immediately and placed into the shrimp boiler, which is situated on the fore section. At this point, the skipper was in the wheelhouse and the two fishing hands were working at the boiler. The boiler's hearth suddenly exploded and a darting flame injured the two fishermen. The work clothing worn by the younger of the two caught fire in the process. He ran towards the aft section and tore the clothes from his body. The older fishermen, later joined by the skipper when he had recognised the situation and descended from the wheelhouse, helped him in the process.

The photograph of the vessel's electronic nautical chart in Figure 3 shows the course of her voyage. Proceeding from the west (see point 1), a sharp kink is clearly visible when the skipper left his wheelhouse to assist (point 2). When the fire was extinguished, the skipper called the rescue cruiser VORMANN LEISS and requested assistance at 2340. She informed MRCC at 2345 and sailed for Amrum to pick up a doctor and paramedic there. The VORMANN LEISS left Amrum at about 0010 and reached the fishing vessel at about 0100. In the meantime, the KLAUS GROTH had sailed towards the rescuers (point 3).

The VORMANN LEISS collected the two casualties at about 0110 (point 4) and took them to Dagebüll, from where they were taken to a hospital in Flensburg at about 0235.

Assisted by the waterway police, the skipper sailed the KLAUS GROTH back to Büsum (point 5).

Favourable circumstances for the rescue of the casualties were the calm weather and the low swell.

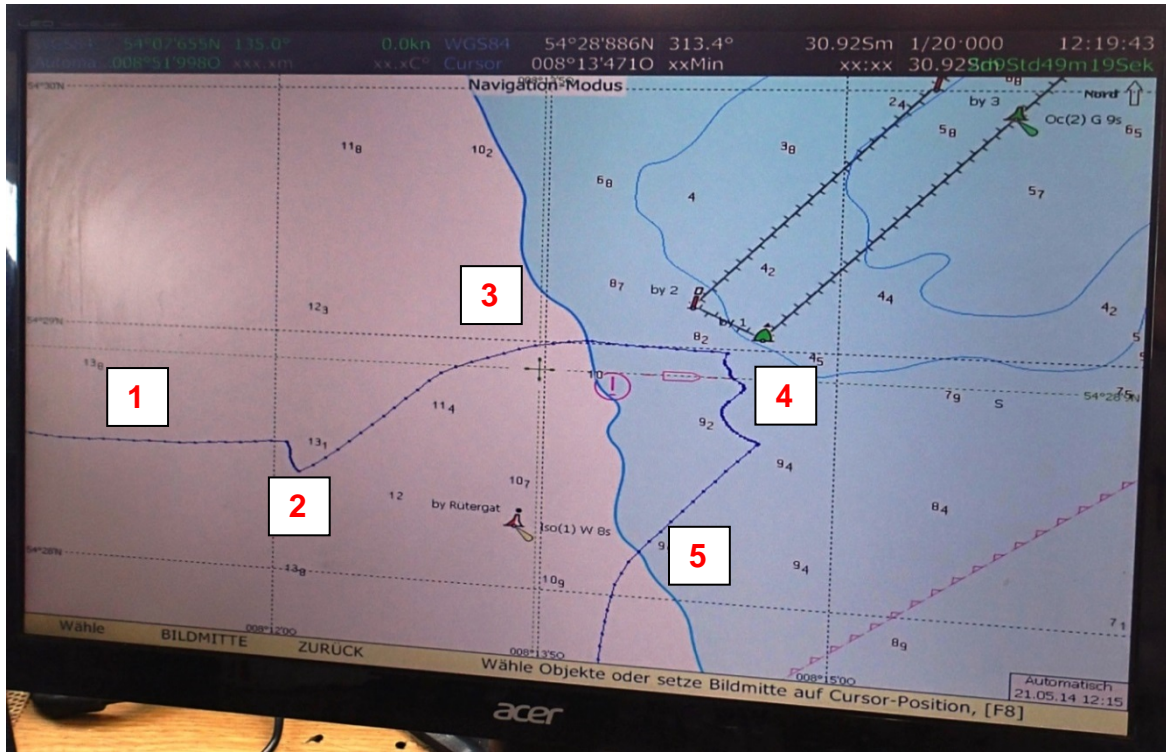


Figure 3: Course of the voyage

### 3.2 Accident damage

There was no harm to the environment. The vessel merely sustained smoke damage. The two fishermen suffered second and third degree burns on the upper body and face. According to the skipper, large parts of the clothing worn by the two deckhands were on fire. A comprehensive survey of the damage, in particular, the affected area surrounding the shrimp boiler on the vessel's fore section beneath the forecabin, was carried out locally at Büsum on 21 May 2014.

Some 34 hours had passed since the accident event when the BSU and an appointed expert did the survey. The skipper did extensive clean-up work during this period, meaning possible evidence on the outbreak of the fire was destroyed. In particular, soot and burn marks caused by the fire event were destroyed and thus possible evidence on the course and outbreak of the fire. Consequently, it was impossible to obtain a precise image of the original condition immediately after the accident event during the survey. One must assume that the status found was affected significantly by the action taken beforehand.

## 4 Analysis

The BSU commissioned fire expert Dipl.-Ing. Lars Tober with the production of an opinion to determine the cause of the explosion. This opinion was considered in the BSU's report.

### 4.1 Shrimp boiler

The following aims to provide a detailed description of the shrimp boiler's technology. The objective is to refer to certain characteristic phenomena to describe the possible processes involved in the outbreak and spread of the fire. Of particular note here are the workflows and routines when operating the shrimp boiler, as well as the technical equipment.

Although the shrimp boiler is not a standard unit, the skipper claims that it is still used in this form on many shrimp boats.

According to statements given, the routine when 'heating-up' the shrimp boiler is as follows:

1. open the main supply to the diesel tank;
2. ignite the cup burner using wick and petrol;
3. close the diesel supply;
4. monitor the flame's development/ignition;
5. switch on the blower;
6. set main diesel supply to running.



Figure 4: Diesel tank beneath the forecastle



Figure 5: Main ball valve with upstream throttle needle valve

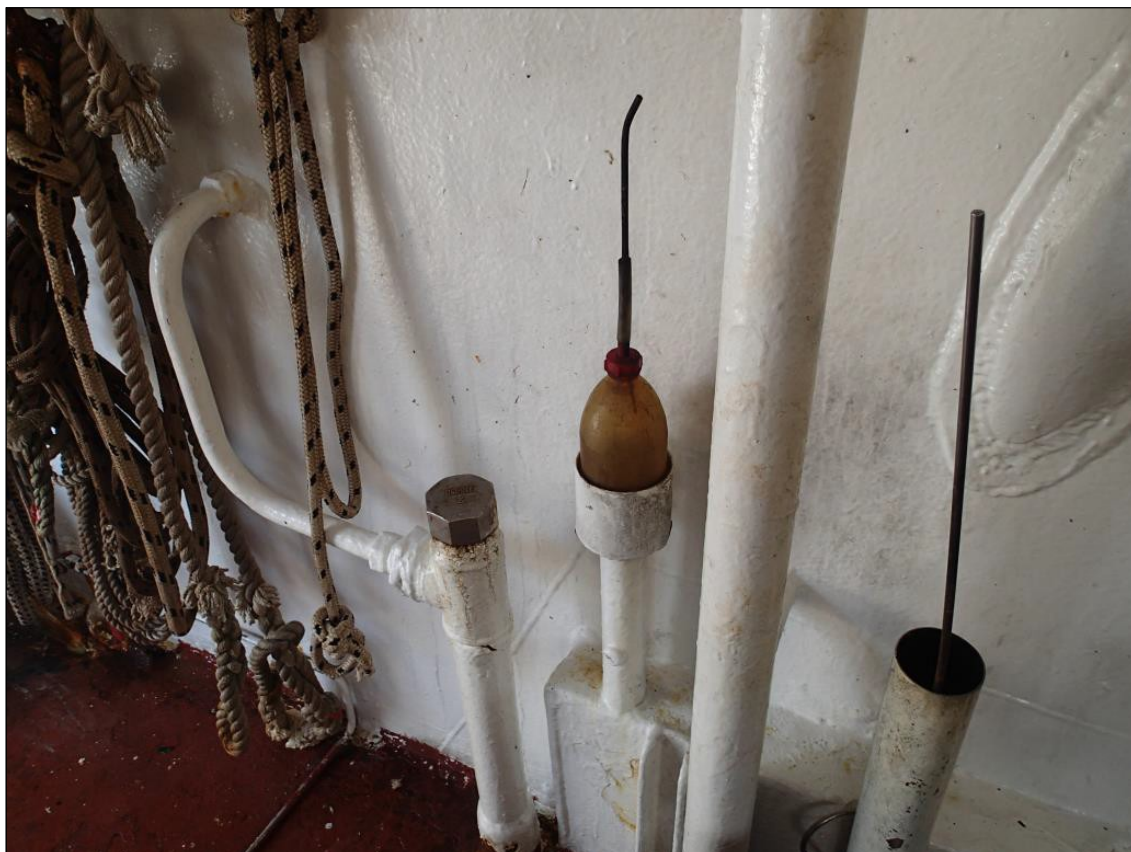


Figure 6: Petrol bottle and wick

The shrimp boiler is heated by means of a statically operated cup burner of the simplest design. The system is supplied via a tank in the immediate vicinity beneath the forecastle. The diesel fuel travels through a pipe joint to the cup burner by means of static pressure in the storage tank. The flow is regulated using only a needle valve, the setting of which was not changed according to the skipper.

When it is determined by means of sight that the flame is stable, a support blower is switched on manually, which ensures the required air supply exists via apertures in the cup burner.

There is no regulation of fuel quantity. It appears that the throttle valve, which is fixed based on experience, is set so that a certain level of fuel remains in the cup burner. Consumed diesel is re-filled via the tank. If the flame extinguishes and this goes undetected, then the cup burner would inevitably overflow.

The exhaust/waste gas is evacuated through the forecastle via a flue pipe.

The shrimp boiler system is equipped with an emergency shutdown; however, this only affects the system's conveyor belts. Here, there is no regulation or monitoring and emergency shutdown of the burner's circuit.

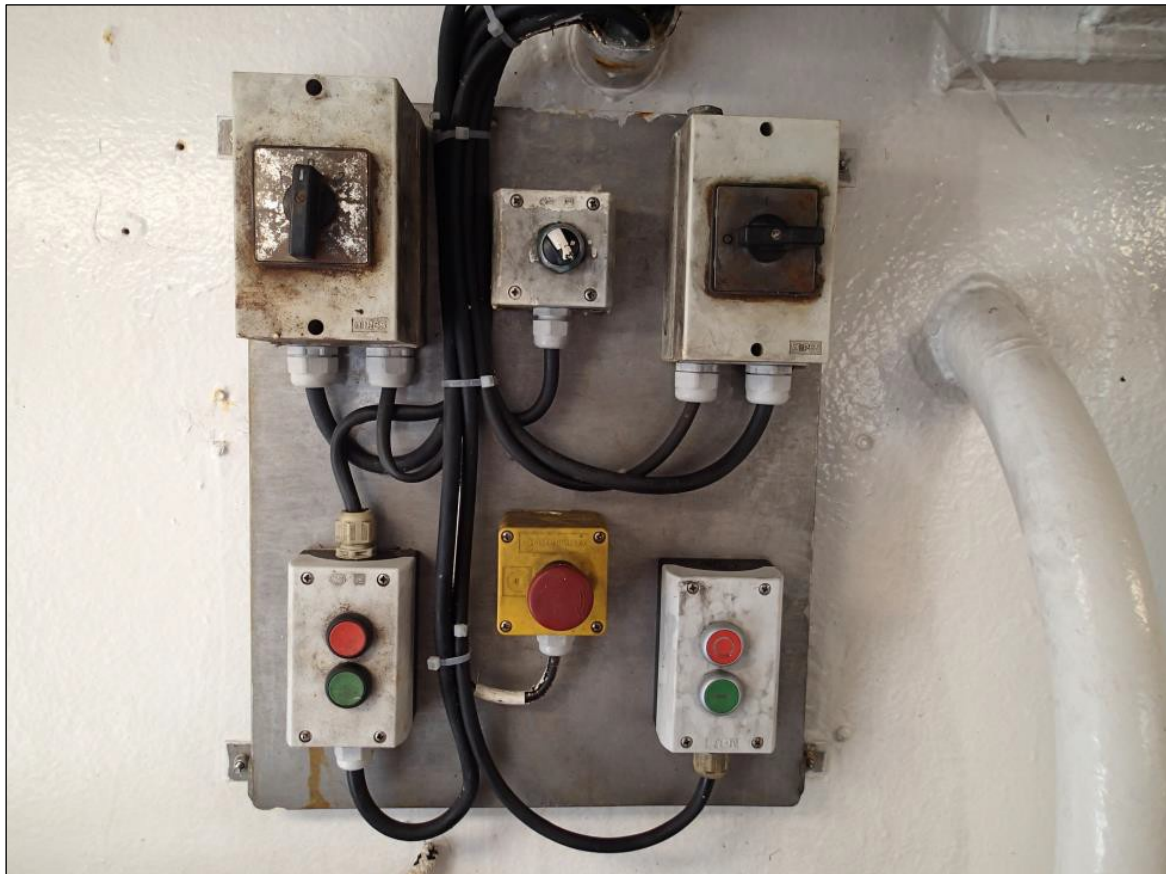


Figure 7: Switch and emergency stop for the shrimp boiler system



Figure 8: Fuel line to the boiler



Figure 9: Fuel connection over the blower pipe



Figure 10: Cup burner below the tank



Figure 11: Insulated interior of the combustion chamber



Figure 12: Waste gas/exhaust ventilation duct



Figure 13: Exhaust pipe over the forecastle





Figure 14: Ignition aperture with metal cover



Figure 15: Fully open ignition aperture



Figure 16: Blower below deck

#### 4.2 Cause of the fire

Based on the equipment used and routine applied for the shrimp boiler, the most probable cause is set out below.

According to the skipper, the shrimp boiler had been in operation a number of times in the preceding days for several hours.

After the shrimp basket was tilted, it would be feasible that the deckhands noticed that the burner was no longer working. It is not possible to verify how long the flame was extinguished. Due to the permanent flow, it is possible that the diesel overflowed into the air apertures and then atomised. The result would be a highly flammable and possibly explosive atmosphere (6-12% by volume) in the combustion chamber.

Local testing by the expert revealed that the chimney effect is sufficient to evacuate the gases via the exhaust pipe when the blower is running and the fire damper is closed. When the fire damper is opened, the chimney effect drops and there is a marked discharge through this aperture.

It is highly probable that subsequent re-ignition or approaching with a burning wick or other source of ignition (e.g. burning cigarette) would cause the escaping gas cloud to ignite. The effect would be similar if the fuel (diesel) was not processed mechanically, but evaporated due to the build-up of heat in the insulated combustion chamber.

It is also conceivable that petrol was added to the overheated combustion chamber for re-ignition, which would lead to the gas igniting and/or the development of darting flames due to the sudden evaporation on hot surfaces.

A detonation in the combustion chamber with ensuing pressure build-up is conceivable as another sequence of events. That the water tank was raised briefly as a result of that would be theoretically possible. The pressure release through this narrow coaming area would be accompanied by a rapid emission of flames. This would explain the pattern of burns on standing operating personnel. Also indicative of this scenario would be the shrimp boiler's buckled lid. The opened lid striking the deck structure could explain this deformation.



Figure 17: Deck structure struck by lid

A twisting of the shrimp basket in the tank, causing the tank to raise when tilting, is rather unlikely but cannot be discounted. It is also possible that this would have affected the mixture formation in the combustion chamber and caused a detonation with flame emission.



Figure 18: Buckled boiler lid



Figure 19: Tilted shrimp basket

The Ship Safety Division (BG Verkehr) commented on the draft of this investigation report as follows:

*"The Ship Safety Division conducts the technical inspection of the fishing vessel KLAUS GROTH in accordance with the German guideline for fishing vessels of 16 February 2009 (p. 155 of issue 5-2009 of the Gazette of the Federal Ministry of Transport, Building and Urban Affairs). This is verified by a valid safety certificate for fishing vessels of less than 24 m in length.*

*It is not necessary to issue a fishing labour certificate under Germany's Maritime Labour Act (Seearbeitsgesetz – SeeArbG) because the fishing vessel does not satisfy the conditions of Article 133(1) therein. Here, the Ship Safety Division may only conduct an inspection under Germany's Maritime Labour Act on an ad hoc basis.*

*The guideline for fishing vessels deals with a vessel's seaworthiness in terms of her technical characteristics and her equipment relating to the life-saving appliances, radio, and navigation. Regular inspection of the work equipment on board, which also includes cooking appliances, does not fall within the responsibility of the Ship Safety Division. Instead, Germany's Ordinance on Industrial Safety and Health (Betriebssicherheitsverordnung – BetrSichV) states that this is a basic obligation of the system operator.*

*[...]*

*On board, the shrimp boiler is an item of work equipment within the meaning of Germany's Ordinance on Industrial Safety and Health. As employer, the owner of the vessel is responsible for operation and running. The owner is required to assess this work equipment during a hazard assessment and to establish appropriate steps for safe operation on board. This may include technical steps, organisational steps, and individual steps.*

*The owner of the vessel is also required to observe the requirements of other competent bodies, such as the German Accident Prevention Regulations for Shipping Enterprises (Unfallverhütungsvorschriften für Unternehmen der Seefahrt – UVV See) of BG Verkehr<sup>2</sup> [sic]. Inter alia, Article 180 'Operation of ovens and stoves for liquid and solid fuel' of UVV See (as of 1 January 2011) stipulates that cup burners must be cleaned regularly. Moreover, apertures for ventilation may not be closed for operation.*

*If the combustion chamber was pre-vented for at least 2-3 minutes using a blower [...] before the fuel supply was opened, then the explosion could have been avoided. This would have been sufficient to ensure that any explosive gaseous mixture was no longer present in the combustion chamber. This instruction should always have been observed before ignition and noted in the operating instructions that must be handed out."*

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<sup>2</sup> The BSU understands that the Ship Safety Division is part of BG Verkehr.

## 5 Conclusions

The fire that broke out on the FV KLAUS GROTH must have developed after an extremely flammable atmosphere formed inside the shrimp boiler. It is no longer possible to determine the extent to which the involvement of ignition fuel affected its course. In analysing the events and consideration of the many similar shrimp boilers on fishing vessels, the following summarising facts can be listed, from which recommendations can be derived:

It seems that this incident was caused by the apparent lack of installation/maintenance/operating instructions and sufficient safety technology (for monitoring the burner functions, in particular).

The operation of cup burners without flame controllers and open fuel surfaces is not in line with current standards, on ships and boats, in particular. The absence of metering equipment, controlled injection technology, and emergency stop systems for shutting down the fuel supply, in particular, borders on gross negligence.

As an initial measure, the skipper and owner opted to have an automated quick closing valve installed in the fuel line.

In the course of the winter of 2014/2015, the previous shrimp boiler was replaced by a fully automated system for sorting and boiling shrimps. The main advantage here is that crew members no longer have to work at an open fire. It would be desirable if this could become a standard feature on German fishing vessels.

## **6 Safety recommendations**

The following safety recommendation does not constitute a presumption of blame or liability.

### **6.1 Ship Safety Division (BG Verkehr)**

The Federal Bureau of Maritime Casualty Investigation recommends that the Ship Safety Division (BG Verkehr) conduct intensified inspections for potential fire loads and flaws in the installation of burner technology and technical supply systems (especially external diesel and gas systems) on older fishing vessels, in particular.

## 7 SOURCES

- Written statements
  - Ship's command
  - Owner
- Expert opinion of Dipl.-Ing. L. Tober
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- Opinion of the Ship Safety Division (BG Verkehr)