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

Investigation Report 265/13

Very Serious Marine Casualty

Foundering of the Sailing Yacht FALADO VON RHODOS on 9 August 2013 off Iceland

15 December 2014

The 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) 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.

Issued by:
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1 Summary

At about 2200[1] on 8 August 2013, a high water level was discovered in the bilges on board the FALADO VON RHODOS, which was manned by 12 people. The vessel was located to the west of Iceland at this point in time. A distress call was sent at about 2330 and a fishing vessel remained in the vicinity on standby in response to that. A rescue cruiser arrived at the vessel at about 0200. A diesel pump that was handed over could not be put into operation and the water level continued to rise, resulting in the vessel being abandoned at about 0400. The FALADO VON RHODOS foundered at about 0500 on 9 August 2013.

[1] All times shown in this report are local = UTC

2 FACTUAL INFORMATION

2.1 Photo

Figure 1: Photo of vessel

2.2 Ship particulars

Name of vessel:	FALADO VON RHODOS
Type of vessel:	Brigantine
Nationality/Flag:	German
Port of registry:	Schleswig
MMSI number:	211289060
Call sign:	DJKA
Owner:	The association Brigantine Falado von Rhodos
Year built:	1968
Shipyard/Yard number:	Mastro Petros Xalkidos, Rhodes
Classification society:	None
Length (overall):	20.35 m
Hull length:	15.79 m
Width (overall):	4.83 m
Draught:	1.86 m
Gross tonnage:	25.41
Displacement:	Approximately 30 tonnes
Engine rating:	108 KW (147 HP)
Main engine:	VETUS DTA 44
Hull material:	Wood, Greek pine hull
Hull design:	Carvel structure

2.3 Voyage particulars

Port of departure:	Rif, Bredafjord, Iceland
Port of call:	Keflavik, Iceland
Type of voyage:	International trade, charter
Manning:	12
Draught at time of accident:	Fore: 2.0 m; Aft: 2.0 m
Speed at time of accident:	7.5 kts
Pilot on board:	No
Canal helmsman:	No

2.4 Marine casualty or incident information

Type of marine casualty/incident:	Very serious marine casualty; constructive total loss
Date/Time:	09/08/2014 at about 0455
Location:	About 10 nm to the west of Garoskagi
Latitude/Longitude:	φ 64° 4.14' N λ 023°5.9' W
Ship operation and voyage segment:	Marine navigation
Place on board:	Hull
Consequences (for people, ship, cargo)	Ship foundered

Excerpt from Nautical Chart BA 2733, Iceland-South West Coast

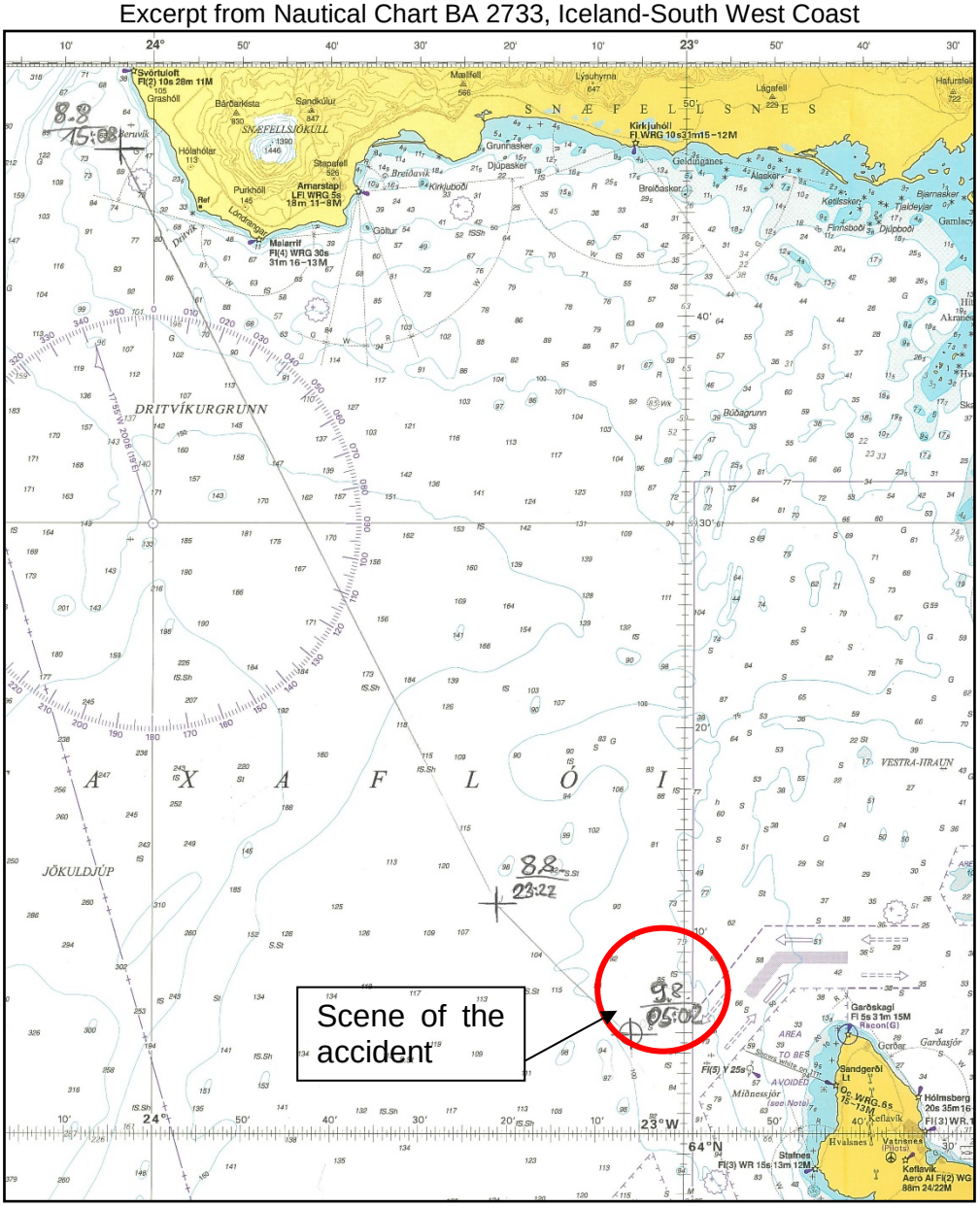


Figure 2: Nautical chart

2.5 Shore authority involvement and emergency response

Agencies involved:	Icelandic Coast Guard
Resources used:	Helicopters, watercraft, pumps
Actions taken:	Vessel drained, primary care for crew
Results achieved:	Ship could not be drained and foundered. No casualties.

3 COURSE OF THE ACCIDENT

3.1 Course of the accident

The course of the accident that follows is recounted according to the written account of the skipper and crew, as well as the mission log of the Icelandic Coast Guard.

The skipper took charge of the FALADO VON RHODOS on 3 August 2013 at the port of Keflavik in Iceland. A week-long voyage departing from and finishing at the port of Keflavik was planned.
The crew consisted of 12 people, among them seven children/adolescents aged 11 to 14. A 44-year-old skipper who holds a Sportküstenschifferschein (certificate for operators of pleasure craft in coastal waters not exceeding 12 nm from the mainland) navigated the vessel. The role of bosun was assigned to a 27-year-old who holds the Sportbootführerschein-See (certificate for operating seagoing pleasure craft sea). Another person on board also held the Sportbootführerschein-See.
A safety briefing lasting several hours was held in the port on the first day, which involved berthing and casting off exercises. A day was spent in port on 4 August 2013 because of a near gale warning (N 4, gusts of 6 Bft). The vessel cast off at about 1630 on 5 August 2013 and proceeded under sail with the assistance of engine power northward to the port of destination, Ólafsvík, in NE 3-4 Bft. The port of Ólafsvík was reached at about 1600 on the following day. The entire route was 84 nm, only 8 nm of which were covered without mechanical propulsion using just the sail.
The vessel left the port of Ólafsvík at about 1215 on 7 August 2013 and at 1230 headed for the port of Rif in SSE wind of 5 Bft with gusts of 6 Bft. The port of Rif was reached at 2105. This day's leg of 21.5 nm involved 16.5 nm under sail.
Since the weather forecast for Friday 9 August 2013 indicated strong winds of 6 Bft from the east with gusts of 8 Bft, the return voyage was started one day earlier. The FALADO VON RHODOS left the port of Rif in Iceland at about 1000 on 8 August 2013 and headed for Keflavik. She was scheduled to arrive at Keflavik at about midday on 9 August 2013.
The sail configuration used on this final voyage follows: first reef in the mainsail, inner and outer jib, fore staysail, main staysail, lower topsail. Cape Snaellsjökull was rounded at about 1500. Due to the prevailing wind direction (south-east with a force of 5 Bft), the remainder of the route was sailed with the assistance of engine power. Owing to the prevailing crossing seas with wave heights of about 2 m, the vessel started to pitch considerably and several waves washed over her fore section. The vessel took on significantly more water in the swell than in smooth sea, something the crew was familiar with. In such cases, the water was pumped out periodically using bilge pumps. At about 2200, the skipper discovered an increased water level, however. He pumped the water outboard within five to ten minutes using the bilge pump attached to the engine, which can be engaged by means of a coupling. At about 2300, the skipper once again discovered an unusually high water level just below the bottom boards. The bilge pump was reengaged but it was found that there was no power at the pump outlet. Attempts were then made to pump out the water using the three other manual pumps: hand pump on the toilet, deck pump, and portable fire pump.

It was quickly established that the water level could not be contained, however. The distress button on the radio was pressed at about 2321, alerting the Icelandic Coast Guard on VHF channel 16. It was at about this point that the main engine, as well as the portable manual fire pump failed.

The fishing trawler HRAFN SVEINBJANARSON was on a parallel course at about 0000 at the direction of the Coast Guard and tried to establish a towing connection using a deployed tender several times. A rescue helicopter that arrived at the scene at about the same time was ordered to return to the base in Keflavik because the FALADO VON RHODOS' masts and the wave height of about 1.5 m prevented it from intervening.

The rescue vessels EINAR SIGURJONSSON and GUDJON arrived at the yacht at about 0053. At this point, it was no longer possible to pump below deck using the hand pump because of the high water, which was now removed from the vessel by means of a bucket chain. The rescue services managed to get additional pumps on board at 0216. However, they were unable to draw water continuously owing to floating objects and dirt, which quickly clogged the hoses. At the same time, the seven children were evacuated to the rescue vessel EINAR SIGURJONSSON, while the remaining five crew members assisted the rescue services in the attempts to pump out the water. A tow line connection between the rescue vessel and FALADO VON RHODOS was established at about 0353 and they started to strike the sails. The two motorised pumps belonging to the rescue vessel were not up to pumping the water out of the vessel. At about 0400, the water was already about 10 cm above the chart room's bottom boards. The skipper of the FALADO VON RHODOS then informed the rescue services that he had decided to abandon the vessel. Still set, the final sail (mainsail) was struck and everybody transferred to the rescue vessel. The towing connection was cut at about 0502 and the FALADO VON RHODOS foundered shortly afterwards about 12 nm south-west of Iceland at the position 64°4.14 'N and 023°5.98 'W at a water depth of about 90 m.

4 INVESTIGATION

Neither the skipper nor the association reported the very serious marine casualty to the BSU, which learned of the incident from the press.

Written statements of the skipper, the statements of several crew members, the mission reports of the Icelandic Coast Guard, documentation of the Ship Safety Division (BG Verkehr), as well as the enquiries made with shipyards and experts were available to the BSU for the investigation.

4.1 Weather report

An official weather report was requested from the Maritime Division of Germany's National Meteorological Service (DWD) for the wind and sea conditions in the Iceland sea area for the period 8 August 2013 at 1000 to 9 August 2013 at 0500.

Summary

Weather situation

The sea area was affected by an extensive storm front (995 hPa) at 65° 'N and 028° 'W. Weakening slightly, the storm front moved to the north-east and was located just south-west of Iceland at 0600 on 9 August 2013. A weak high pressure system (1019 hPa) to the north-east of Iceland that was weakening slightly shifted to the north-east. A strong wind field from an easterly direction with corresponding swell developed between these two pressure systems.

Weather conditions

Mean wind forces of 7 to 8 Bft with gusts of up to 9 Bft from the east-south-east were already seen in the area of the accident in the early hours of 8 August 2013. The wind continued to intensify slightly until the afternoon with gusts of force 9 Bft. On the evening of 8 August and night leading up to 9 August 2013, the low pressure system approached the south-west of Iceland, causing widespread mean winds from the east of 7 to 8 Bft with gusts of up to 9 Bft in places. At the alleged time of the accident on 9 August 2013, the low pressure system was just south-west of the accident's specified position and the wind had dropped slightly with gusts of force 7 to 8 Bft from the east.

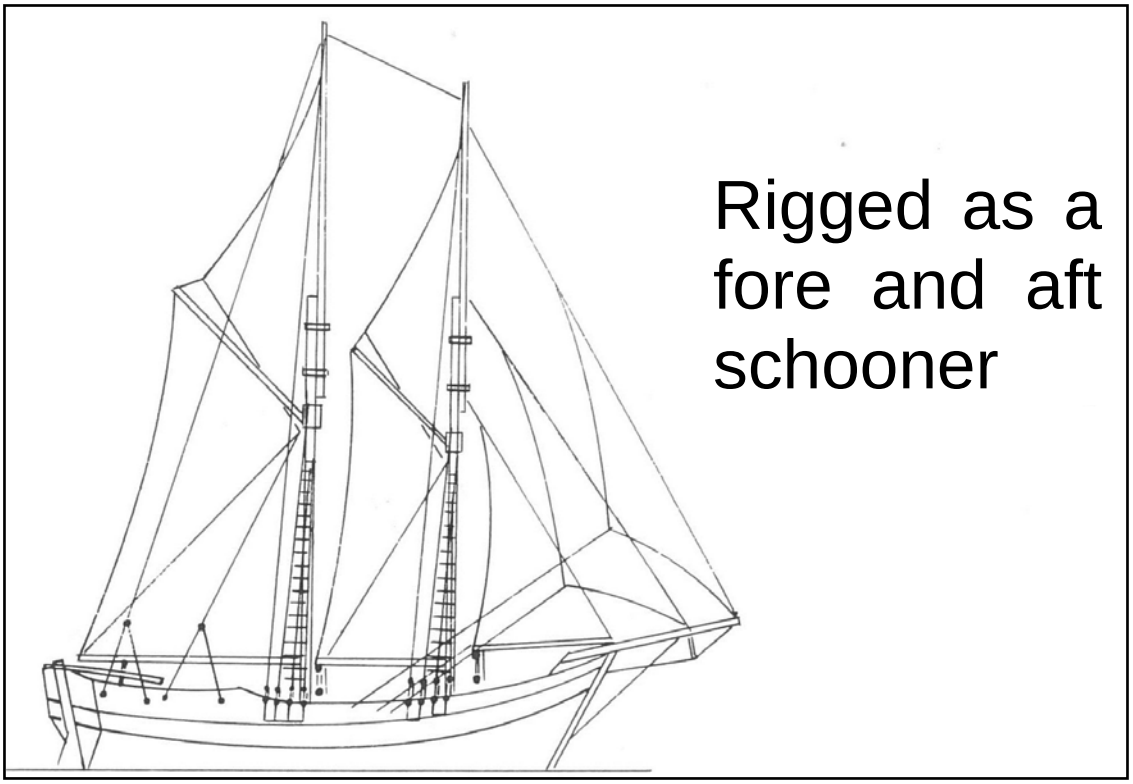
Significant wave height until the evening of 8 August 2013 reached up to 4 m from an east-south-east direction. The wave height dropped down to 3 m at times and the direction of incidence turned more to the south-east up until the alleged time the vessel foundered on 9 August 2013.

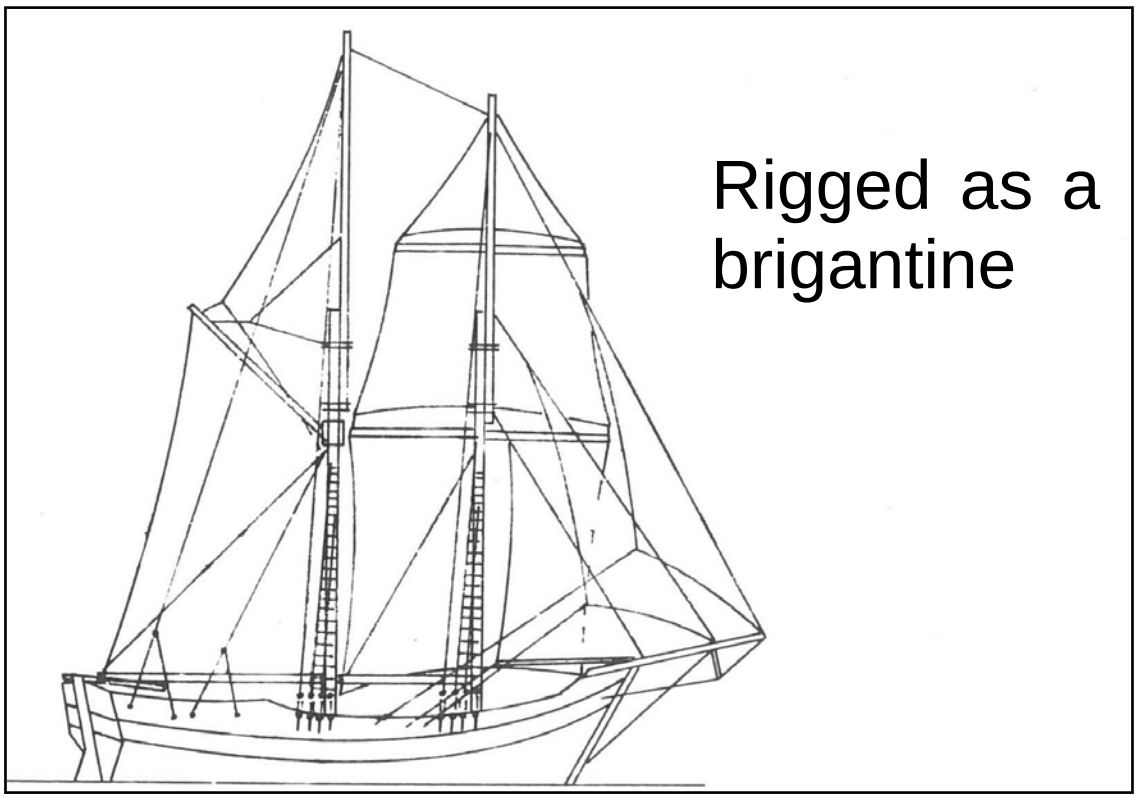
It was mainly overcast with recurrent rain or drizzle throughout the day. The air and water temperature stood at 10°C. Only in coastal areas off Iceland was it somewhat milder at 11-12°.

4.2 History of the vessel

A German boatbuilder designed the vessel in the style of the Greek coastal vessels, so-called caiques, on behalf of the first German owner in 1968 and she was built in a boatyard on Rhodes.

The owner intended to use the vessel for offshore sailing with youth groups and research the historical course of sea battles from a seafaring perspective with students.
The vessel was first provisionally rigged as a fore and aft schooner and from 1969 as a brigantine as planned.





The boom foresail was replaced by a staysail when she was rigged as a brigantine and later a yard was added.

After the owner passed away the vessel has belonged to the association 'Brigantine Falado von Rhodos' since 1972 and been sailed by different scout groups.
Greek pine was used for constructing the vessel's shell and frames. In 1974, the bottom was re-clad using iroko (kambala) planking and parts of the keel were replaced with oak.
In 1977, the FALADO VON RHODOS collided with a Danish motor coaster in the Sound and foundered. The vessel was salvaged and repaired.

The FALADO VON RHODOS has managed to cross the Atlantic five times without major damage. Her sixth Atlantic crossing in November 2012 saw her set sail for the Caribbean from where she sailed up the east coast of America and then from New York to Greenland via Halifax, Newfoundland and Labrador. She then continued to Iceland, which she reached on 5 July 2013.

4.3 Approval

The Ship Safety Division (BG Verkehr) first became aware of the FALADO VON RHODOS in the course of an inspection of the vessel by Waterway Police (WSP) Borkum on 13 July 2006. According to the operator, the vessel's operating mode was 'rein vereinsinternes Sportboot' (purely intra-association recreational craft) and approval – as a traditional vessel, for example – was not necessary. During another inspection by WSP Flensburg on 7 April 2009, a document in German and English dated 8 May 2001, the wording of which certified that the operating mode is 'Youth Training Vessel', was seized when the files carried on board were reviewed. This document was issued by the association and bore the association's stamp, as well as an official seal of the police commissioner of Berlin.

07-APR-2009 22:45 WSP FLENSBURG +49 461 4846390 S.05

Brigantine „Falado von Rhodos“ gem. e.V.

8. Mai 2001

Bescheinigung

Hiermit wird dem Segelschiff Brigantine „Falado von Rhodos“ bestätigt, dass es als

Jugendschulschiff

eingesetzt wird.

Den an Bord lebenden und fahrenden Jugendgruppen wird unter fachkundiger und pädagogischer Leitung traditionelle Seemannschaft vermittelt.
Dadurch soll im Sinne einer demokratischen Erziehung der für die Seefahrt unentbehrliche Gruppengeist gefördert, der Sinn für Verantwortung entwickelt und soziales Verhalten geübt werden.

Das Schiff wird den Jugendgruppen vom o.g. Verein, Vereinssitz in D-33102 Paderborn, Bahnhofstr. 8A, zur Verfügung gestellt.

Schiffsname	Falado von Rhodos
Schiffstyp	Brigantine
Unterscheidungssignal	DJKA
Heimathafen	Schleswig
Eingetragen im	Seeschiffsregister
Fahrtgebiet	Ostsee/Nordsee/Mittelmeer
Seefunkstelle	UKW – DJKA

02. Juni 2001

Brigantine „Falado von Rhodos“ gem. e.V. • Bahnhofstr. 8a, 33102 Paderborn • 1. Vorsitzender [redacted]
Sparkasse Paderborn • KtoNr.: 5066972 • BLZ: 472 501 01

07/04 '09 DI 21:34 [SE/EM NR 73061 ☑006

This certificate specifies the area of operation as the Baltic Sea, North Sea and Mediterranean.

The last note of 11 June 2009 in the files of the Ship Safety Division (BG Verkehr) states that commercial exploitation reportedly does not exist and a safety certificate issued by the Marine Insurance and Safety Association is reportedly not necessary.
The association is of the opinion that the FALADO VON RHODOS was used as a recreational craft, meaning approval as a traditional ship with the associated survey by an accredited expert was not required.

4.4 Vessel's condition before she foundered

The FALADO VON RHODOS was moored at the Yacht- & Bootswerft Stapelfeldt in Kappeln an der Schlei during the winter months of 2011 and 2012. During this period, association members carried out minor works with technical and mechanical support from the shipyard. The vessel was surveyed by the shipyard on behalf of the association, as there were doubts as to her seaworthiness. Inter alia, the shipyard found fault with the frame spacing reportedly being too great and the frame dimensions being too small for a vessel of this size, broken frames in the area of the chainplate, broken deckbeams in the lounge and patched deckbeams, no reasonable bracket in the area of the mast, no sufficient transverse bulkheads, only lightweight built-in bulkheads, no web or steel frame for absorbing the forces of the masts, as well as problems with the transfer of forces and thus insufficient strength in the hull. The shipyard makes the following recommendation to the association's president in a letter dated 29 February 2012:

*"The structure and its condition is appalling, especially in respect of the planned voyages. The vessel is absolutely **unseaworthy** at present. Measures proposed by us, such as bolting the cabin lining and frames, will not change this condition fundamentally."*

In March 2012, 17.3 running metres of planking were renewed forward on the starboard side in five strakes and 4.8 m on the port side in two strakes at the Modersitzki shipyard in Maasholm. This shipyard had already renewed 11 running metres of planking in two strakes and installed additional frames on the plank joints in 2008.

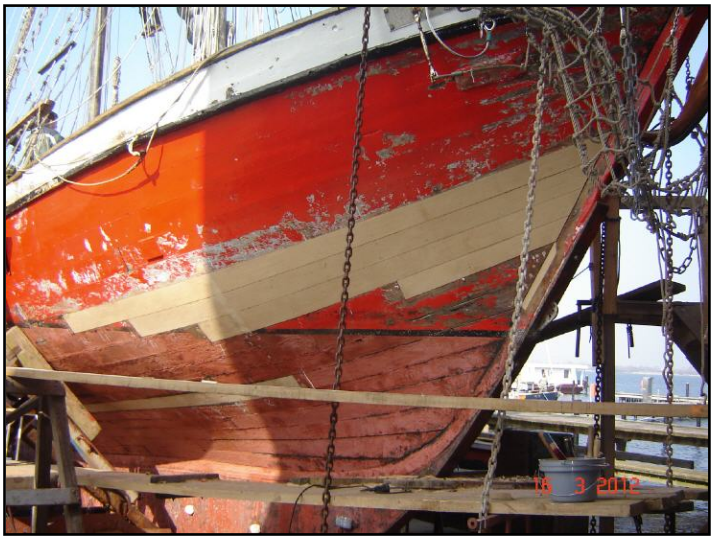


Figure 3: Renewed planking on the starboard side

Figure 4: Renewed planking on the port side

After a collision with the pier in Eckernförde, this damage was repaired at Yacht- und Bootswerft Rathje in Kiel in June 2012. A plank was plugged and a frame of about one metre in length renewed on the port side in the area of the mainmast chainplate. The existing component dimensions were maintained for all the repairs; thicker wood was not used.

Dry-dock works were carried out on the hull in the Consolidated Yachts shipyard at City Island, New York, from 27-31 May 2013. Inter alia, several joints were re-caulked without outside assistance and the starboard shroud fittings relocated. On the stem, where the bobstay (the two chains in the following figure) is attached to the stem fitting, lead sheet was pinned/bonded beneath the stem fitting to prevent any leakage there. After she was launched, a leak was discovered on the port side in the lower berth, meaning the vessel had to be hauled out of the water again. This leak was sealed from the outside and also pinned with the application of lead; no further problems occurred after that.

The last works on the bottom were carried out in Greenland at Stordalen Havn on 26 June 2013. Here, the vessel was laid up dry on sandy ground for about seven hours due to the tidal range and members of the association caulked the starboard side. Moreover, members of the association re-caulked the bow topsides later during the period 11-19 July 2013.

Figure 5: On the travel lift in the United States in May 2013

Figure 6: Stem fitting pinned with application of lead

4.5 Machinery

A SABB two cylinder diesel engine with output of 20 HP (14.7 KW) was installed in the vessel when she was first built in 1968 at the shipyard in Greece. A second engine was installed in 1974 (MTU with 85 HP/62.5 KW). In 1988, the engine had to be changed in the Canary Islands. In 1993, the fourth engine, a six cylinder MTU with 147 HP (198 KW), was installed in the vessel. This engine was given a major overhaul in 2004 and the fifth engine, a four cylinder VETUS DEUTZ with output of 140 HP (103 KW), was installed in 2011.

Figure 7: MTU with 147 HP; removal for overhaul in June 2004

4.6 Vessel's equipment

According to information given by the association, the following pumps were on board the FALADO VON RHODOS:

1.) bilge pump connected to the engine (F&P type TS 40 FM with output of 110 l/min);
2.) manual bilge pump below deck (Whale Henderson type MK5 waste pump with output of 56 l/min;
3.) permanently installed manual bilge pump on deck (Whale Gusher type 30, line 117 l/min, and
4.) portable manual fire pump on deck (Fluxinos Jolly type 300 with capacity of 110 l/min.

Photos taken in the years prior to 2010 also show a handle pump before the superstructure, which was installed when the vessel was built in Rhodes. Such handle pumps are the most effective because smaller particles in the bilge water do not affect the operation of the pump. This pump was removed because the rubber membrane was faulty and replacement parts were no longer available. In place of that, the Whale Gusher 30 pump below deck but operable from the deck indicated at 3.) was connected to the drainage system of the old handle pump. Pictured below in the photo to the left is the handle pump installed. The photo to the right was taken during the last sailing trip and shows the same place without the pump; the Whale Gusher pump (white circle, connecting point for hand lever) is installed below deck.

Figure 8: Handle pump

There was also a 230 V electrical submersible pump. Although this pump was not used, it would have been possible to operate it by means of the Fischer-Panda 230 V generator with output of 4.4 kVA available on board.

According to statements given by the skipper, he discovered an increased water level in the bilge at 2230 (at 2200 according to other crew members). Following that, he engaged the bilge pump coupled with the engine and removed the water from the bilge within five to ten minutes. Based on the pump capacity specified, the amount of water would probably have been about 550-1,100 l. He noticed an increased water level again at about 2300, engaged the pump but was unable to detect any power at the pump. Following that, the crew was woken and the three manual pumps used. After the water level below deck had risen to the extent that it was no longer possible to use the pump there, a bucket chain was formed at about 0100.

4.7 Accident reports

One marine casualty is stored for the FALADO VON RHODOS in the BSU's marine casualty database, which has existed since 2002. Manned by 13 people, the vessel ran onto a breakwater off Cuxhaven level with buoy 31 on 18 June 2012 due to a navigational misjudgement. The vessel refloated again under her own steam; damage was not reported.
Another accident reportedly happened in the port of Eckernförde in 2012, which was not reported to the BSU. Chainplates were torn out and planking and frames damaged during a berthing manoeuvre.

5 ANALYSIS

The BSU did not identify a specific cause for the foundering of the FALADO VON RHODOS because the vessel was not available for an investigation and is still located off Iceland at a depth of about 90 m. The ingress of water was probably due to errors in the vessel's construction and design or a poor state of repair on account of her age. A collision with flotsam or the wash of the sea was not reported and therefore can be ruled out.

5.1 Manning

Both the skipper and the deputy skipper had sufficient experience in operating the FALADO VON RHODOS. The skipper merely holds the Sportküstenschifferschein (certificate for operators of pleasure craft in coastal waters not exceeding 12 nm from the mainland). The maximum distance to the coast was about 25 nm during the last voyage, meaning this qualification was not sufficient for the chosen route.
A safety briefing that covered operating the vessel and handling the lifejackets took place before departure.

5.2 Approval of the vessel

The FALADO VON RHODOS was built as a research vessel based on the model of historical paragons in 1968 in Greece. After the death of the owner, the heirs bequeathed the vessel to an association pending establishment under a donation contract in 1973. The owner and operator since December 1974 is an association filed in the official register of clubs and societies of the Local Court Paderborn. The object of this association is to give any young people interested in sailing the opportunity to become familiar with traditional seamanship on the FALADO VON RHODOS. The association most recently (September 2013) consisted of 159 individual members and 67 member groups, mainly scout groups from all over Germany. The vessel does not have an approval or safety certificate.
WSP Flensburg challenged the lack of a safety certificate in 2009. In the course of the proceedings, the former Marine Insurance and Safety Association examined the need for a safety certificate and concluded that one was reportedly not necessary because the vessel is not exploited commercially.
In the opinion of the association and owner, the vessel was used as a recreational craft, which is difficult to comprehend. According to the definition in the fourth item of Article 6(1) of the Schiffssicherheitsverordnung (Germany's ordinance for the safety of seagoing ships – SchSV), recreational craft are craft built solely for the purpose of sport or recreation. That does not apply to the FALADO VON RHODOS because she was originally built for the purpose of research. According to Article 1 of the Sportboot-Führerscheinverordnung (Germany's maritime pleasure yachting navigating licences ordinance – SportbootFSV), recreational craft are watercraft used for the purpose of sport or recreation. Since sport and recreational purposes are not stated in the association's charter, this definition does not apply, either. Rather, familiarisation with traditional seamanship is the object of the charter and according to the certificate mentioned above, the vessel is used as a 'Youth Training Vessel'. With that in mind, the FALADO VON RHODOS cannot be regarded as a recreational craft.

Nevertheless, it should be noted that existing legislation does not stipulate a safety certificate, meaning mandatory, 'official' surveys of the vessel's condition were not required.
During the consultations on the BSU's draft report, the Ship Safety Division (BG Verkehr) delivered the following opinion by letter of 30 October 2014:

If a vessel is to be used to carry paying passengers, i.e. used commercially in the broadest sense, then she is subject to certification in principle. According to the case law of the Hamburg Higher Administrative Court, commercial exploitation within the meaning of maritime traffic legislation is presupposed if transport services are offered publicly against a fee to an indefinite number of people with a certain degree of regularity. The type of vessel has no effect on the applicability of the foregoing.
If a vessel and her operation satisfies the specific conditions for approval as a traditional ship (historic water craft, teaching traditional seamanship, allocated use of funds), then approval under the facilitated conditions of the Sicherheitsrichtlinie für Traditionsschiffe (Germany's safety regulations for traditional ships) may be considered. Otherwise, the safety certificates stipulated for merchant ships must be provided.
The situation is different in the case of so-called association ships, whose operator does not compete on the market but organises ship operation within the framework of the membership of a non-profit association. Apart from avoidance schemes (difficult to prove in an individual case), which only specify a form of association, this type of ship operation is not subject to any governmental regulations. This is true even if it does not concern recreational craft within the meaning of the legal definition of the fourth item of Article 6(1) SchSV 98, but reclassified former merchant vessels of less than 100 GT in size (small vessels), as commercial exploitation is a prerequisite for the certification requirement for recreational craft and small vessels.

5.3 Vessel's condition

The vessel was built in 1968 in Greece. The cost of building her was relatively low. The FALADO VON RHODOS was designed and built as a moderate long-keel vessel with 6 t of external ballast bolted below her.

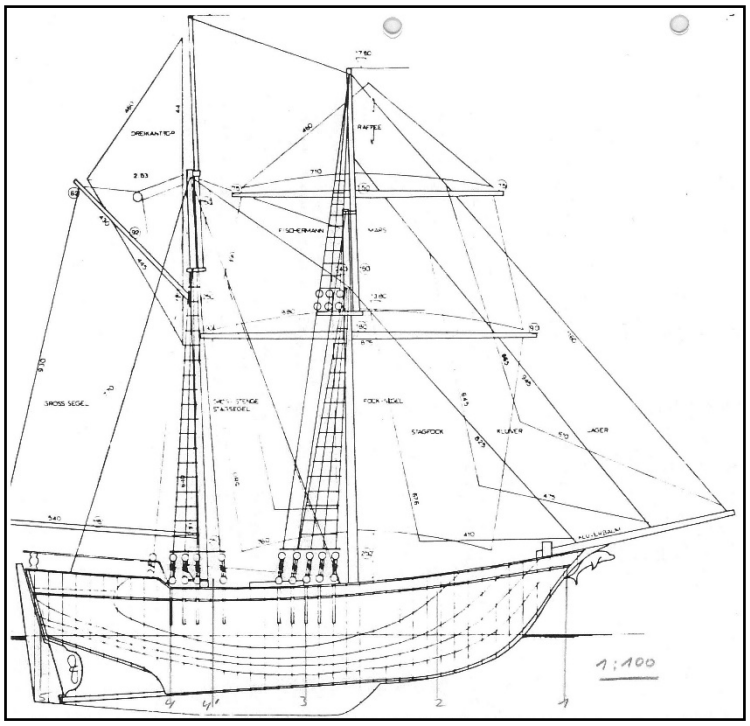


Figure 9: Sail plan and keel

According to the above drawing, the total sail area stood at 179 square metres. Two yards were used on the foremast. A third yard was attached and the sail area increased to about 200 square metres at a later date.

The BSU questioned the designer of the FALADO VON RHODOS, German boatbuilder and mechanical engineer Harro Vareschi, with regard to the vessel's design. The boatbuilder drew the lines plan and interior fittings and monitored construction of the hull locally. Designer Karl Feltz revised the lines plan in Hamburg, then enabling the vessel to be built. The dimensions of the frames, floor, shell, and the other components were dealt with by the shipyard based on past experience. Only Greek pine cut locally was used. The keel was not fitted with a rabbet to accommodate the planking side and the planking was fixed to the frames and floor with nails that were forged and galvanised locally. Solid wood was not used for the deadwood/shell chock, but rather the sides were clad with planking, so that a void of about 100 mm in width remained in the middle in which there was water. The keel was welded together using 4-mm thick steel plates that were cut from the remains of a tank from a former soap factory on Rhodes. The void of the keel was filled with steel scrap and cement. It was bolted inside to the floor from the keel sole using continuous bolts. The designer concluded that due to the design he was surprised the vessel has lasted so long.

In August 2014, the BSU questioned the master boatbuilder Uwe Baykowski about a report he prepared on 23 January 1999 on behalf of the owner. In this report, the master boatbuilder delivers an opinion on the following design and age-related vulnerabilities**:**

1.) The keel beam exhibits a marked dip from the forward connecting point of the ballast keel bolted below. Due to the absence of an internal keel, this dip will progress further and the plank joints will open or separate from the rabbet.

2.) The foremast sits only on a 1 m long mast step, spread across two floor sections directly above the ballast keel's forward connecting point. The compressive load of the mast due to the net weight, compression when pitching at sea is excessive, as well as due to the shrouds being set too taut cannot be absorbed by such a short mast step. Compressive load forces the planks in the area of the foremast apart. Significantly larger plank joints and escaped glue permit the conclusion that this process is already advanced.

3.) The frame cross section of 70/100 mm is very low and the frame spacing of 390 mm is, by contrast, very high in relation to the dimensions of the vessel. Various frames are broken or have separated from the shell. Frames in the area of the engine room were doubled and bolted together since the time of construction. The transverse bolting of all the frames is heavily corroded. Leaks have occurred in the aft section behind the engine where the planking meets the rabbet and on the plank joints. The installation of a stronger engine may have contributed to this damage.

4.) The design specified a thickness of 30 mm for the shell. The planking topsides still consists of Greek pine. The bottom was re-clad with iroko in 1974; a new oak keel also formed part of this repair. The iroko planks are generally sound and attached to the rabbet securely. Only the end of the planks on the transom are slightly soft and moisture exists beneath the peeling paint. The pine planking exhibits greater damage topsides. Several planks are separating from the rabbet, are starting to rot at the plank joints or are broken across the grain, and cross-cut edges of the planks are exposed.

5.) The foremast was relocated 1.5 m sternwards, whereupon water ingress was noted. To minimise such damage, a stainless steel bracket was fitted in the area of the mast and a steel plate over the floor in the area of the mast step. The deck beams in the new deck passage are not sufficiently braced.
The low component dimensions, the regular occurrence of leaks, as well as successful action taken to maximise the strength of the hull permit the conclusion that the torsional and longitudinal strength of the vessel is not sufficient to carry a rig of this size.
The structure and the low shell dimensions are not equal to the leverage of the rig and righting moment of the ballast keel or the hydrodynamic and hydrostatic pressures in the long run.

6.) A total of eight deck beams are cracked or broken in places. These beams have been compensated for by doubling and the fractures in the deck beams are also due to overloading.

The master boatbuilder concludes that the FALADO VON RHODOS is a lightweight but sound vessel, which was not designed for such a high rig. Therefore, she must be sailed with the utmost caution. Moreover, exposing the vessel to sustained major loads must be avoided. He recommends that the association's committee consider restricting the area of operation, the sail areas at certain wind forces, as well as operation when a certain wind force is exceeded.

Inter alia, he makes the following proposals for structural improvement of the hull's torsional and longitudinal strength:

1.) Installation of an oak internal keel with the dimensions 300/300 mm and a total length of 5.70 m. This internal keel helps to increase longitudinal strength and also as an adequately sized mast step that can absorb the compressive load of the mast.

2.) To maximise torsional strength, three steel tube web frames with a web thickness of 100 mm and strap height of 80 mm will be fitted and bolted to the shell. One web frame will be installed forward and one aft of the foremast and a third web frame forward of the mainmast. These web frames absorb a large proportion of the torsional forces and the vessel becomes stronger.

3.) The hood ends of the planking in the aft section's hull underbody should also be bolted to the frames to absorb any strong vibrations caused by the engine. The planking at the rabbet must be re-bolted and all the planking caulked professionally. A total of 25 m of planking must be replaced.

The report also includes an opinion on a planned extension of the keel. It indicates that if produced as a hollow steel body, a keel extension has positive static effects as it provides additional support for the existing ballast keel's connecting point at the keel beam.

The following drawing was enclosed with the report. It illustrates the three required measures proposed by the expert – new steel web frames, additional internal keel (300/300 mm), and the extension of the keel – for improving the torsional and longitudinal strength in different colours.

Figure 10: Keel before extension

Figure 11: Keel before extension

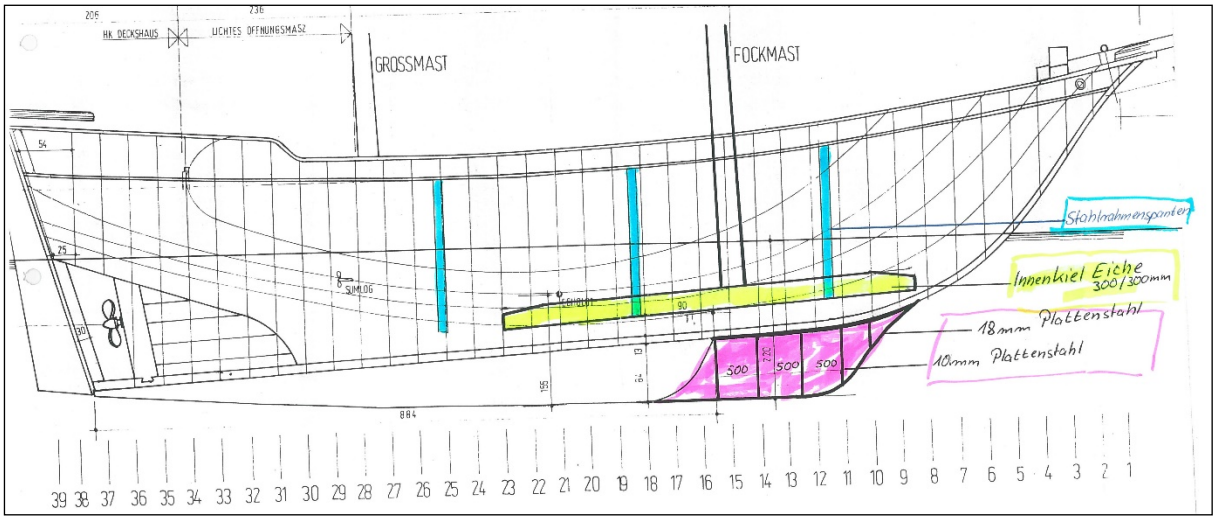


Figure 12: Drawing with the proposed construction measures

The keel extension was executed at the Rathje shipyard in Kiel in 2001/2002. Excerpts from the report were submitted to the shipyard for this. In particular, the shipyard was not aware of the proposed installation of three web frames to increase the torsional strength, however. After consultation with the association, a wooden beam of 3.7 m in length with a cross section of 220 x 180 mm was installed as the interior keel with mast step. The steel box keel with no ballast was bolted to this internal keel using keel bolts with a diameter of 20 mm.

Figure 13: Keel extension

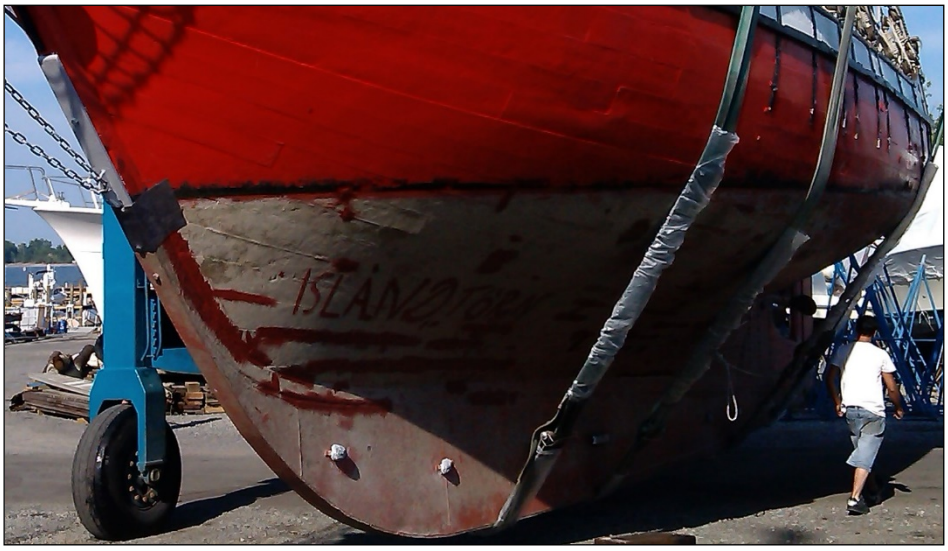


Figure 14: Keel after extension

The expert points to improper maintenance work in relation to caulking the planking in the report. It must be ensured that the caulk is not driven through to the inside when caulking, but pushed forward and aft in the direction of the planking. Photos show that the caulk protrudes from the joints at quite a number of points inside. Evidence shows that until recently the association's members carried out the caulking work unassisted. Qualified boat or shipbuilders only did it during several calls at a shipyard in Germany.

5.4 Dimensioning of the hull

For a vessel of this size, Germanischer Lloyd's Rules for Classification and Construction of Wooden Seagoing Ships, released in 1964, were drawn on for comparison. According to these rules, the following dimensions are required:

	GL requirement	Built FALADO VON RHODOS
Frame cross section	100/160 mm	70/100 mm
Frame spacing	390 mm	390 mm
Shell planking	45 mm	30 mm
Deck planking	50 mm	32 mm

Accordingly, the dimensions of the frames and planking do not conform to the classification rules.

5.5 Machinery

The FALADO VON RHODOS was originally equipped with an engine of 20 HP, which is what the seating, frames and aft section were configured for. The frames in the area of the engine room were already doubled during construction and connected by transverse bolting.

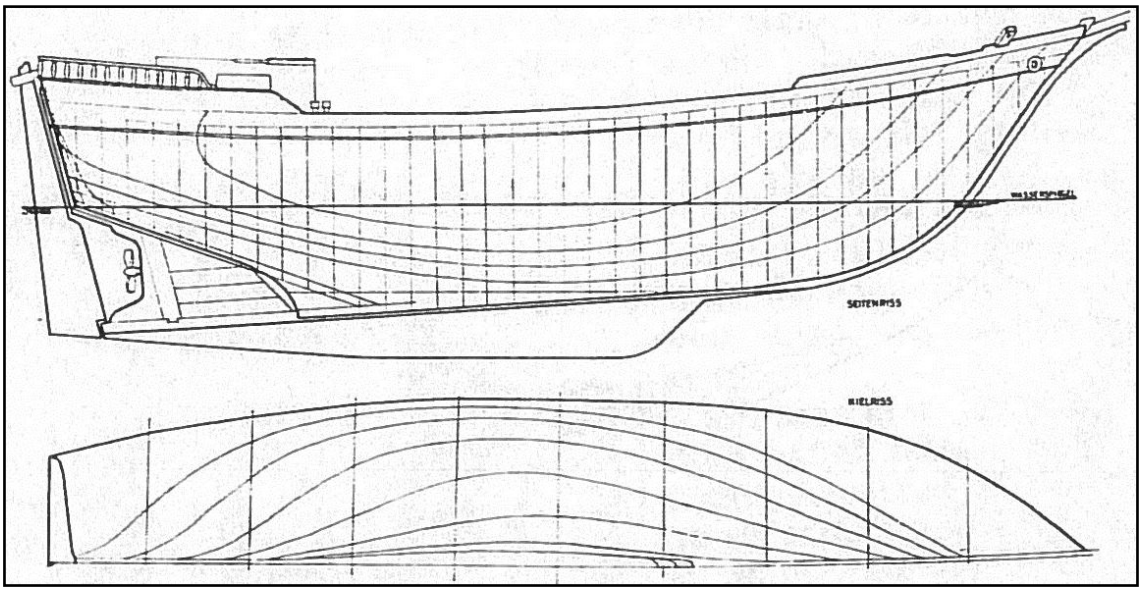


Figure 15: Lines plan with propeller

The shipyard installed a two cylinder engine with 1,800 r/min, as well as a transmission with a reduction ratio of 2:1. A two bladed, 590 mm controllable pitch propeller was installed immediately behind the deadwood in the screw aperture. Rather than using solid wood to produce this deadwood, it consisted of planks with planking on both sides, creating a void of about 100 mm in the middle.

The change in the engine's output to 85 HP, then to 147 HP, and most recently to 140 HP bears no relation to the output originally configured and installed for the vessel. Documentation on what modifications were made to integrate this output with the vessel's structure was not available to the BSU. Information given by the skipper indicates that the engine's conversion from 85 HP to 147 HP, including complete conversion of the driving chain, was planned and executed by the Ebbe shipyard in Denmark. Such an increase in output usually requires a modification to the propeller, such as an increase in diameter. Here, the propeller was relocated aftward away from the deadwood in the screw aperture. To absorb the vibrations from the larger propeller, an additional shaft bracket was bolted outside to the keel, as shown in the following photo.

Figure 16: Shaft bracket

The shaft bracket is attached (not integrally) to the aft stem and hood ends of the planking. It looks as if the entire load from the vibration of the propeller on two bolts, which were inserted into the keel, should be introduced into the vessel's structure. There is no lateral integral connection with the keel and planking. The shaft bracket's lateral bar is evidently bolted to a plank above (photo to the right). Nothing is known about the how this shaft bracket is otherwise attached to the vessel's structure. However, at a frame spacing of 390 mm it is reasonable to assume that bolting is made with two frames, which is not enough for the introduction of a load. The above left photo also suggests that the thickness of the wood on the keel at the stern tube penetration is relatively weak. It was not possible to establish whether the deadwood behind it has now been executed in solid wood.

A six cylinder engine was installed up until 2011. A four cylinder engine with 2,500 r/min replaced this the last time a new one was fitted in 2011. This engine was shorter in length to make room for a thrust bearing and a longer shaft seal. A new ZF 45-1 reversing gear (reduction ratio of 2.51:1), a P140-T Python Drive thrust bearing for a 55 mm shaft, a shaft of 60 mm in diameter and 3,500 mm in length, and a Pneumostop Profiseal for a shaft with a diameter of 60 mm were fitted when the engine was last exchanged. The BSU has no documentation on the execution of torsional vibration calculations to enable it to determine whether any significant vibration effects of the propeller and engine may have acted on the vessel's hull and structure (in particular, in the case of a four cylinder engine in conjunction with a four bladed propeller).
In May 2012, damage was discovered on the newly installed shafting after the most recent modifications to the machinery. A new PD-T thrust bearing for a 55 mm shaft was delivered and installed and the shaft seal repaired.

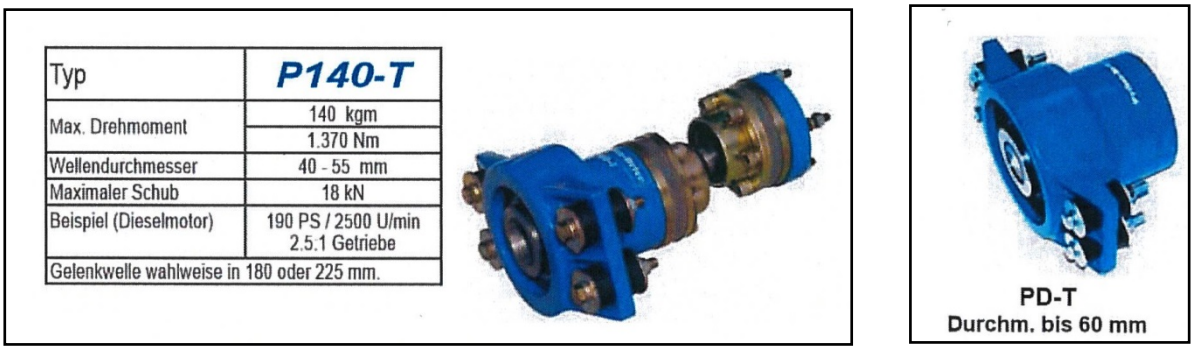


Figure 17: Thrust bearing

There were no design or manufacturing faults according to information given by the manufacturer of the thrust bearing. The damage was caused when the thrust bearing and the stern tube seal must have been exposed to water inside the vessel. It was not possible to determine precisely whether this water ingress was the result of shaft misalignment, incorrect interpretation or poor production of the design for the introduction of the compressive load into the vessel's structure, or other causes. The BSU was only informed that the FALADO VON RHODOS often had to be put on a slipway after calling at a shipyard due to water ingress in the aft section, in particular. Problems with the tightness of planking below the engine seating were experienced on several occasions, which involved planking separating from the frames and not being properly attached to the stern rabbet, floor or frames.
The supervision and advice of an accredited boat or shipbuilding expert was not sought in the last ten years during these conversions and repairs.

5.6 Rig load

Various conversions altered the rig significantly. For example, the forward mast was relocated and the sail carrying capacity increased. Sails build up power when set, which acts on the hull via the masts leeward and in the opposite direction via the stays and shrouds. The hull twists and warps in the process, and this can lead to leakage if the structural reinforcements mounted are insufficient. The FALADO VON RHODOS did not have the reinforcements, e.g. steel or wooden web frames, needed to introduce the load from the rigging into the hull and keel. Installed after water ingress were merely a stainless steel vertical bracket in the area of the foremast and a steel plate in the area of the mast step above the floor. It is apparent that these subsequent repairs did not lead to an increase in the torsional and longitudinal strength, however. The hull took on water in different sailing conditions permanently and leakage occurred repeatedly at the same points in spite of members of the association re-caulking on several occasions. Further deformation of the hull is caused by additional loads in swell and such leakage inevitably occurs due to the insufficient or then non-existing strength of the supporting structure, which can lead to the planking separating from the frames or stem rabbet in extreme cases.

Leakage at the forward stem rabbet below the bobstay mounting was clad with lead plating on the last voyage.

On the following photos, which were taken during the rescue operation, it looks as if there is a significant amount of paint peeling in the area of the chainplate attachments (white vertical stripe). This suggests that the longitudinal joints in that area have cracked due to the load of the mast, which may have led to leakage.
Indeed, a systematic search for the cause of the water ingress was carried out. However, the crew did not isolate any damage that viewed alone could be regarded as the cause of the water ingress.

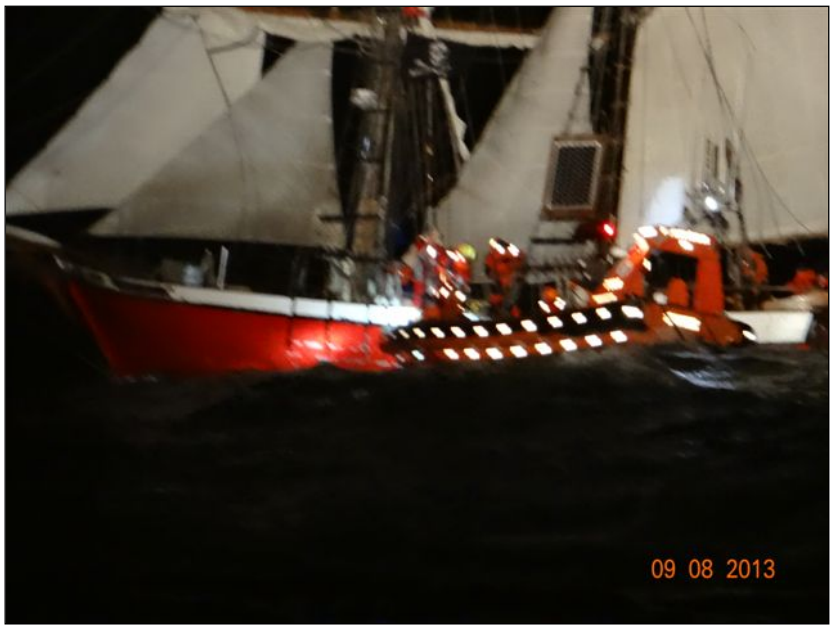


Figure 18: Final photos of the FALADO VON RHODOS

6 CONCLUSIONS

6.1 Vessel's condition

The 45-year-old brigantine FALADO VON RHODOS was not seaworthy when the very serious marine casualty occurred. The member responsible of the association's committee and the skipper knew this fact before setting sail on the Atlantic voyage, and it was carried out despite many warning voices of specialists and qualified members of the association, who were opposed to this voyage across the Atlantic. The association operated the FALADO VON RHODOS as a recreational craft and an accredited expert or a classification society did not examine her. The FALADO VON RHODOS was not built under the supervision or according to the rules of a classification society.
Maintenance of the vessel was carried out voluntarily by members of the association and professionally by various shipyards. Inspection and repair of the hull's caulking at least once a year is an essential part of the maintenance of a wooden vessel. This caulking was predominantly done unassisted and not professionally by craftsmen. No research into the cause was carried out to establish the possible absence of longitudinal and torsional strength when leakage repeatedly occurred at the same points. The expert's proposals for improving strength were not implemented consistently.

6.2 Ship's command

The skipper was not appropriately qualified for the area of operation. For a 'recreational craft' of this design, at least one Sportseeschifferschein (German certificate for operating pleasure craft in coastal waters) and possibly also additional training in sailing traditional vessels would have been appropriate given the actual area of operation and objectives of the association.

The skipper was aware of the condition of the vessel and nonetheless opted for the route via Faxaflói and well offshore. Moreover, he ran the main engine for a prolonged period during the outward and return voyage while the sails were set, which placed an additional load on the hull in swell. The extent of the leakage was possibly worsened by sailing too aggressively against the waves and swell under engine power and sail.

6.3 Equipment and machinery

The FALADO VON RHODOS was equipped with enough manual pumps to clear normal water ingress. Against the established backdrop of the vessel taking on water, the other electrical pumps on board – supplied by the existing 230 volt power generator – could certainly have been used.
It was not possible to determine why the bilge pump driven by the main engine via a drive belt failed. The failure of one hand pump was explained by the fact that the rubber membrane was damaged after 90 minutes by objects floating in the water. The failure of the pumps taken on board by sea rescue personnel was also explained by the fact that the suction baskets clogged up quickly due to floating objects.

Therefore, it is obvious that the filter of the main engine bilge pump was also clogged. This was not examined, however. It is also possible that the mounting of the attached bilge pump, which was renewed in June 2010 and modified in April 2011, was damaged again, causing the pump to fail. According to the documentation, the pump was mounted on separate seating next to the main engine seating and powered by a drive belt. However, due to the soft aft section, it is also quite possible that the seating buckled, resulting in a mechanical fault on the pump.
Regular cleaning of the vessel's bilges, the limbers (limber hole), and the area in front of the pump suction baskets is essential to ensure smooth operation of the bilge. Statements as to the failure of the pumps suggest that such cleaning was not carried out sufficiently.

6.4 Approval and manning of the FALADO VON RHODOS

The FALADO VON RHODOS was built as a research vessel and replica of historical ships. According to the association, the vessel has been made available to other youth groups as a youth training vessel in the operating mode recreational craft. The association also states that youth groups have been taught traditional seamanship under the guidance of experts and educators. The designation and operating mode 'Youth Training Vessel' is not found in any rules. Furthermore, the object and addressee of the certificate printed on page 15, which contains this designation and is also stamped with a seal of the police commissioner of Berlin, are not evident to the BSU.

As already established in section 4.3, the Ship Safety Division (BG Verkehr) found it unnecessary to issue a safety certificate for the vessel because she was not exploited commercially. This does not merit any criticism. It is also already established there that the FALADO VON RHODOS was not a recreational craft.
The question as to what the FALADO VON RHODOS should be regarded as arises, however. Only the category 'Traditional Ship' is open to consideration.

The term 'Traditional Ship' is defined in Article 3(Q) of Directive 2202/59/EC:

'"Traditional Ships' means all kinds of historical ships and their replicas including those designed to encourage and promote traditional skills and seamanship, that together serve as living cultural monuments, operated according to traditional principles of seamanship and technique."

The term 'Traditional Ship' is also defined in Article 1(3) of Germany's Sportseeschifferscheinverordnung (certificate for operators of pleasure craft in coastal waters regulation):

"Traditional ships within the meaning of this regulation are historical watercraft or their replicas up to a hull length of 55 metres, for which public and, in particular, cultural interest exists in maintaining and presenting them underway and whose restoration and operation in accordance with the rules and skills of traditional seamanship serve to cultivate maritime heritage, and for which a safety certificate on the basis of the Safety Regulation for Traditional Ships has been issued under Article 6(1(3)) of the Schiffssicherheitsverordnung (German ordinance for the safety of seagoing ships), as amended."

Both definitions are largely identical, where the Sportseeschifferscheinverordnung also provides that a safety certificate has been issued. Under the present conditions and in view of the association's charter, in particular, there is much to suggest that the FALADO VON RHODOS was a traditional ship for this purpose.

Germany's Safety Regulation for Traditional Ships applies to traditional ships[2]. According to section 1.4 of the above, traditional ships are issued a Marine Insurance and Safety Association (now the Ship Safety Division (BG Verkehr)) safety certificate under certain conditions when applied for. However, the party responsible within the meaning of the Schiffssicherheitsgesetz (German ship safety act) is under no obligation to make such an application. This ultimately means that compliance with the rules of Germany's Safety Regulation for Traditional Ships is left to the discretion of the party responsible.

From that it is erroneously concluded that – if a safety certificate was not applied for and consequently also not granted – the vessel should be classified a recreational craft. According to the above – in particular, according to the definition in the above – Directive, which as a higher-ranking law prevails in cases of doubt, that is not the case. Section 1.3 of the Safety Regulation provides that the regulations for recreational craft are applicable to such ships only in cases – not relevant here – where a traditional ship has a hull length of 15 m or less.

It remains to be noted that a vessel like the FALADO VON RHODOS is not subject to any safety checks whatsoever under existing legislation. Findings of the BSU indicate that this is not an isolated case. This may be acceptable in cases where such vessels are used only for private reasons, but not when a more or less unlimited number of people are offered the opportunity to participate in sailing trips. The people participating in sailing trips need to be confident in the fact that the vessel is in a safe condition. That applies all the more when there are adolescents or possibly even children on board.

We must say in no uncertain terms that it is thanks only to various fortuitous coincidences that the foundering of the FALADO VON RHODOS did not end in a tragedy with fatalities. It is also clear that the accident would have been avoidable if the vessel had been assessed regularly. Bearing that in mind, it appears essential to review current legislation and, if necessary, close any omissions identified in the legal system.
As regards the vessel's manning, it has already been established in section 5.1 that the skipper did not have the requisite qualification to navigate a yacht or a traditional ship outside coastal waters. This is what happened, however. Even though there is no direct connection between this fact and the accident, it should be noted that traditional ships registered such are subject to virtually no restrictions on the manning of the vessel whatsoever.

[2] Gazette of the Federal Ministry of Transport, Building and Urban Affairs 2003, p. 205.

6.5 Summary

After a remarkably long service life, the loss of the vessel only ended without a loss of life because assistance arrived at the scene quickly. That all the Atlantic crossings ended well involved a lot of good fortune. The outcome of the marine casualty would have been more tragic if something happened to the vessel far off the coast during one of these long voyages.
At the time of the accident, the vessel was no longer seaworthy and at the end of her service life. It is reasonable to assume that there was an ingress of water in all parts of the hull and that it was no longer possible to move this volume of water out of the vessel using pumps. The following may be regarded as the causes of the water ingress:

- the inadequate dimensions of the vessel's structure and planking;
- improper caulking;
- inadequate longitudinal and torsional strength;
- insufficient vibration and shear capacity of machinery and propeller;
- extreme loads of the rigging at the stem and chainplate, and
- extreme swell-induced loads by operating in sea areas that are not suitable for the vessel's condition.

The accident could have been avoided if the Stapelfeldt shipyard's written warning and critical voices of specialists within the association had been heeded and if the expert's report had been implemented consistently in every respect.

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 Federal Ministry of Transport and Digital Infrastructure

The BSU recommends that the Federal Ministry of Transport and Digital Infrastructure review and if necessary amend or supplement existing standards relating to the safety requirements for so-called traditional ships or non-commercially operated ships that nonetheless are not recreational craft.

7.2 Owners and operators

The association Brigantine Falado von Rhodos gem. e.V., as well as every owner and operator of a traditional ship and the like are recommended to have the current condition of the vessel and her equipment inspected regularly for seaworthiness, even if there are no mandatory provisions for this.
Every vessel should be equipped with sufficient pumping capacity and the operability must be inspected and explained to the crew before every voyage.
The vessel's bilges, the limbers and the area in front of the pump suction baskets must be cleaned regularly.

8 SOURCES

- Documentation of JRCC Iceland
- Written statements
  - Owner, skipper and crew
  - Designer
  - Shipyards
  - Expert
- Documentation of the Ship Safety Division (BG Verkehr)
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- Official weather report by Germany's National Meteorological Service (DWD)
- Rules for Classification and Construction of Germanischer Lloyd
  . - Part 1 Ship Technology
  . - 0 Classification and Survey
  . - Part 3 Sporting Craft
  . - 13 Wooden Seagoing Ships, issued in 1964 and reprinted in 2008