



**PKBWM**

PAŃSTWOWA KOMISJA BADANIA  
WYPADKÓW MORSKICH

# 96/17

**very serious marine accident**

**PRODIGY 2  
SAILING YACHT**

Sinking of the yacht due to the ballast fin breaking off on  
the North Sea on 13 October 2017

**March 2019**

**FINAL REPORT**



Investigation of the very serious accident of the sailing yacht "Prodigy 2" was conducted based on the Act of 31 August 2012 on the State Marine Accident Investigation Commission (Dz. U. [Polish Journal of Laws] of 2012, Item 1068, as amended), together with the norms, standards and recommended conduct procedures binding for the Republic of Poland and agreed within the International Marine Organization (IMO).

According to the provisions of the above-mentioned Act, the aim of investigating a marine accident or incident is to establish the circumstances and causes of its occurrence in order to prevent future marine accidents or incidents, and to improve marine safety.

In an investigation it conducts, the State Marine Accident Investigation Commission does not determine the guilt or responsibility of the persons participating in the marine accident or incident.

This report cannot constitute evidence in penal proceedings or other proceedings aimed at establishing the guilt or responsibility for causing the accident that the report concerns (Art. 40 Par. 2 of the Act on SMAIC).

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## 2. Facts

On 13 October 2017, the “Prodigy 2” yacht departed from Cuxhaven at 06:35 hours local time, intending to sail towards the English Channel and exit into the Atlantic Ocean. There were 3 crew members on board.

At 08:15 hours, the yacht left the Mittelrinne fairway in the Neuwerk-Reede anchorage region, and sailed further to the west just outside the fairway, passing with its starboard the buoys marking the south boundary of the fairway.

At about 18:25 hours, the boatswain holding the watch and the captain staying inside the yacht felt a tremor and heard a loud crack. The captain and the boatswain speedily inspected the yacht rooms on the stern and amidships, failing to discover anything unexpected.

About 2 minutes after the first crack, two more, weaker ones followed. This time the sound was clearly coming from below the feet inside the central cabin. After lifting the floor hatch, a strong inflow of water to the bilge was noticed. First one of the bilge pumps switched on automatically, and after a moment the other one. The crew removed the sails. The engine was started at low revolutions for a few minutes, and the yacht was directed to the shore in order to set it on a shoal. The captain estimated that the capacity of the pumps was too low to pump out the inflowing water.

Seeing the rising water level, the captain ordered the crew to abandon the yacht and started to launch a pneumatic life raft on water. At 18:38 hours, the captain transmitted the DISTRESS signal of alarming in danger over a stationary VHF radiotelephone with DSC. The MRCC Bremen center immediately confirmed the signal and launched a rescue action.

At about 18:42 hours, the crew moved to the life raft, connected with a painter to the yacht, which was already drifting without sails


At 19:14 hours, the “Nordic” salvage tug (FRG flag) arrived at the accident site and took up the crew, using the tug’s rescue boat. A helicopter of the SAR services lifted the shipwreck survivors from the tug’s deck to land, to Wilhelmshaven.



*Illustration 1: Route of the yacht on the accident day<sup>1</sup>*

### 3. General information

#### 3.1. Yacht data

Yacht name:	“Prodigy 2”
Flag:	Polish
Owner:	Quale sp. z o.o. Łódź, Polska
Classifying institution:	PRS
Notified  entity	PRS no 1463
Yacht type:	Cutter
Call sign:	SPG 4690
IMO identification number:	None
Displacement (mLDC):	30.81 t
Construction year:	2017
Shipyard no 1:	Libra Yacht Sailnet Service Wąbrzeźno

<sup>1</sup> Route of the “Prodigy 2” yacht according to the AIS data recorded by Vesselfinder LTD.



Shipyard no 2:	Kalif Yacht Kamila Błazucka Osielsko
Engine power:	inbuilt engine 102.9 kW (Vetus – Detz DTA44-455A)
Width:	5.00 m
Total length:	17.89 m
Draught:	3.00 m
Hull construction material:	polyester-glass laminate
Minimum/maximum crew:	2/8 persons (according to the Safety Certificate)

### 3.2. Yacht journey information

Ports visited during the journey:	Cuxhaven, Germany
Port of destination:	Canary Islands
Navigation type:	Ocean navigation
Crew information:	3 persons of Polish nationality

### 3.3. Yacht accident information

Type:	very serious marine accident
Accident date and time:	13 October 2017 ca 18:30 hours LT
Geographical position during the event:	$\varphi = 53^{\circ}46.57' N$ , $\lambda = 007^{\circ}21.25' E$
Geographical region of the event occurrence:	ca 2 Mm north from the Baltrum island North Sea, German coast
Water region character:	coastal waters
Weather during the accident:	good visibility, SW 3-4° B wind, sea condition 3, water temp. 13°C
Yacht's operating condition during accident:	en route under sails
Amount of fuel on board:	ca 240 l diesel fuel
Accident effects for the yacht:	sinking of the yacht
Accident effects for the people:	crew suffered no injuries
Effects for the environment:	no water pollution was established.





*Photograph 1. "Prodigy 2" yacht*

### **3.4. Shore Services and Rescue Action Information**

In response to the call by the captain, who at 18:38 hours sent the DISTRESS signal of alarming in danger over a stationary VHF radiotelephone with DSC, the rescue action was joined by the German Maritime Rescue Coordination Center Bremen (MRCC Bremen). The Center announced an alarm for rescue vessels: "Nordic" (18:44), "Gruben" (18:45), "Secretarius" (18:51), SAR Helgoland (18:45) helicopter and SAR helicopter from Glucksburg (19:23). The vessel closest to the action site was the "Nordic" rescue tug, which arrived in the neighbourhood of the life raft with accident survivors at 19:14 hours. During the rescue action, communication between the yacht crew members and the rescuers was maintained using a portable VHF radiotelephone taken from the yacht. The "Nordic" tug commenced the action, and using a rescue boat immediately lifted the survivors from the raft. At 19:21 hours the yacht crew members were moved to the tug's deck, from where at 19:28





hours the SAR helicopter lifted them onboard and flew to the Wilhelmshaven base in order to provide the survivors with the necessary medical assistance.

The second helicopter sent to the action from Glucksburg had been recalled before coming to the action site, since the survivors had already been lifted. In Wilhelmshaven, ambulances and fire services were waiting, ready to provide immediate assistance. After such assistance had been determined unnecessary, the yacht crew was transported to a nearby hotel.

In the meantime, the “Nordic” tug lifted onboard from water the RIB boat, the raft and the SART transponder from “Prodigy 2”. Next, the “Secretarius” rescue vessel attached to the yacht, which was lying on the port side and drifting, a big, white side fender and a red buoy, and “Nordic” attached to it in addition the SART transponder. At 20:00 hours on 13 October 2017, MRCC Bremen announced termination of the rescue action. At 20:50 all rescue vessels, except for “Nordic”, were released from the action and returned to their bases, reproducing the condition of readiness to undertake rescue actions. The “Nordic” tug was securing marine traffic and remained close to the drifting “Prodigy 2” yacht. Starting from 00:00 hours on 14.10.2017, securing of the marine traffic was the task of the specialist “Mellum” vessel. Around 06:33 hours, the yacht drifted to an area of depth below 5m, and the monitoring vessel remained outside the 5m isobath due to its own draught.

On 15.10.2017, at 13:08 hours “Mellum” transferred securing of the “Prodigy 2” yacht to the “Ems Server” vessel from the Ems Marine Offshore company. At that time, the yacht was drifting to the north of Drehbargen, along the 1m isobath. On 16.10.2017, at 11:10 hours the wreck was lying on the sea bottom near the Langeoog beach, at the position of 53°45.73’N and 007°34.58’E.

At a later time (18/19 October 2017), the vessel participating in the action of raising the wrecked yacht and transporting it to the Hooksiel harbour was the specialist “Hebo Cat 7” vessel from the Baltic Taucherei- und Bergungsbetrieb Rostock GmbH company, hired by Wasserstraßen- und Schifffahrtsamtes (Inland Shipping and Forwarding Agency) and insurer of the yacht.



*Photograph 2. Wreck of the “Prodigy 2” yacht, drifting after the accident*

#### **4. Description of accident circumstances**

On 13 October 2017, the “Prodigy 2” yacht left the city marina in Cuxhaven at 06:35 hours LT = CEST (04:35 UTC), with the intention to sail towards the Dover Strait, and further to the English Channel and exit to the Atlantic Ocean. There were 3 crew members onboard. The yacht had spent the preceding 2 days in the Cuxhaven harbour, waiting for the end of storm weather.

At 06:45 hours the yacht passed to the eastern side of the Elbe mouth fairway, near the 32a/Medem Reede 2 buoy, and went outside the fairway, passing the buoy with its port side. Until 07:10 hours, the yacht sailed outside the fairway, passing near the shallows located to the east of the fairway. It passed buoy no 32 with its port side. On this section, the yacht sailed at the 4.6 – 5.0 speed, against the weakening current of the ending flood tide.

At 07:15 hours, the yacht returned to the fairway and sailed on its east side, correctly passing the buoys with its starboard. The yacht’s speed increased in the consecutive 5 minute intervals from 5 kn to 5.9 kn, 6.3 kn, 6.6 kn, 6.9 kn, 8.1 kn, 8.8 kn.



At 07:45 the yacht laid on a western course, and kept sailing along the middle of the Mittelrinne fairway.

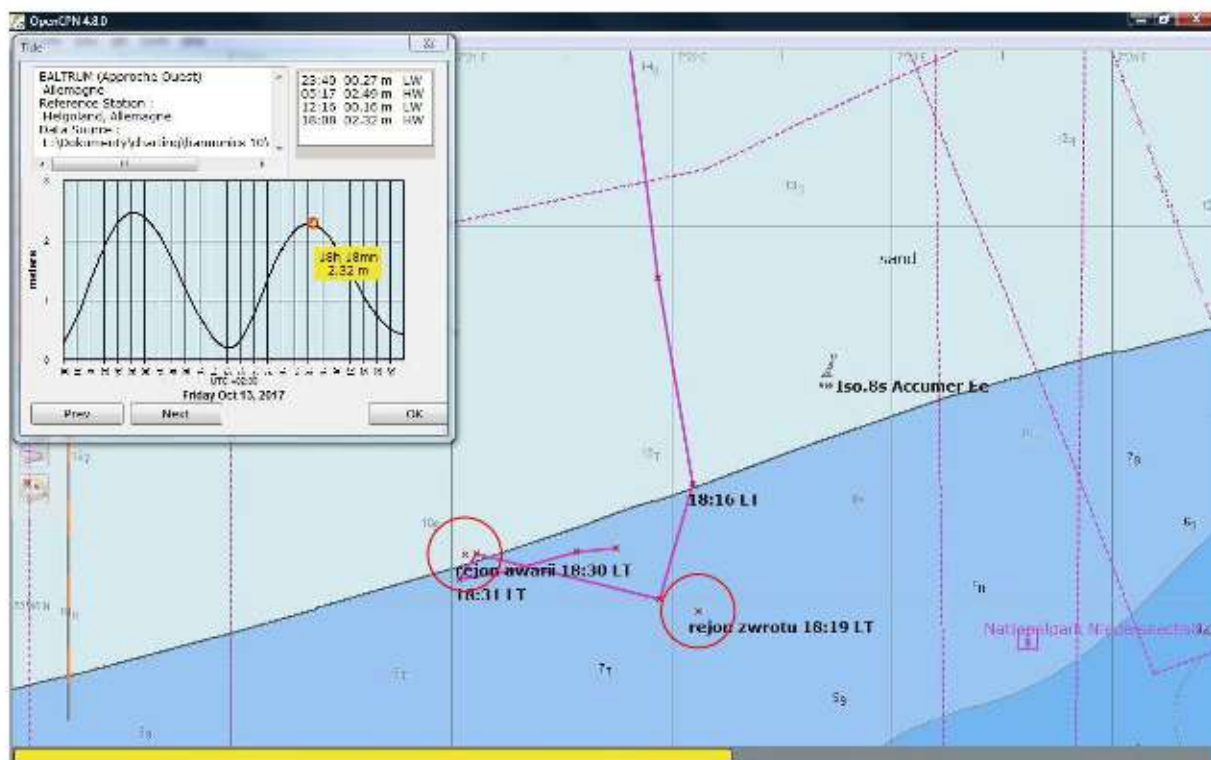
At 08:15 hours, the yacht left the fairway in the Neuwerk-Reede anchorage region, and sailed further to the west just outside the fairway, passing with its starboard the buoys marking the south boundary of the fairway. At 09:50 hours, after passing the Scharhornriff shallows, the yacht started tacking along the coast in the general western direction, passing consecutively the mouths of Alte Weser, Neue Weser and Jade.

Outside the maneuvering times, the yacht was steered with the automatic pilot. The watches were held single-handed. Pursuant to the captain's order, the turns were carried out to ensure sailing in the TSS "Terschelling - German Bight" coastal traffic zone, without entering waters more shallow than 10 m. Due to the wind blowing from SW, the port tack was advantageous. When approaching to the shipping route, the yacht turned to a disadvantageous starboard tack, which led directly to the south, towards coming closer to the land. The depths were observed at the echo sounder. Navigation was carried out on an electronic plotter with Navionics maps and two 12-inch displays – located at the helmsman's post and at the navigation table inside the yacht.

Tacking in this way, the yacht passed East Friesian islands: Wangerooge, Spiekeroog, Langeoog, and the traverse of the Accumer Ee Straight, separating Langeoog from Baltrum.

At 18:19 hours the yacht, approaching to the Baltrum Island coast on a southern course, made a turn to the port tack at the position of  $\varphi = 53^{\circ} 45,97' N$   $\lambda = 007^{\circ} 22,12' E$ . Before the turn, the yacht was sailing with partially reefed mainsail and gennoa at the speed of 6 - 7 kn, and an angle of heel ca  $12^{\circ}$  (according to the captain's estimation). The watch was held by the boatswain, who carried out the turn in the assistance of the captain, who had entered the cockpit for that purpose. After the turn, the yacht in a few minutes' time gained speed to over 6 kn, continuing sailing in the direction of  $KD=284^{\circ}$ .





*Illustration 2: Detailed recording of the route in the failure region<sup>2</sup>*

At about 18:25 hours, the boatswain holding the watch and the captain staying inside the yacht felt a tremor and heard a loud crack. The third crew member, sleeping in the bow cabin, did not wake up, and was only called later, to abandon the vessel. At the first moment, the crew thought that the reason for the tremor or noise was a door or hatch banging shut, or a heavy object falling. They did not feel the slowing down of the yacht's movement or any disturbance in it. The captain and the boatswain speedily inspected the yacht rooms on the stern and amidships, failing to discover anything unexpected.

About 2 minutes after the first crack, two more, weaker ones followed. This time the sound was clearly coming from below their feet inside the central cabin. After lifting the floor hatch, a strong inflow of water to the bilge was noted. First one of the bilge pumps switched on automatically, and after a moment the other one.

The crew removed the sails. The engine was started at low revolutions for a few minutes, and the yacht was directed to the shore in order to set it on a shoal. The captain estimated that the capacity of the pumps was too low to pump out the inflowing water.

<sup>2</sup> Route of the "Prodigy2" yacht according to the AIS data registered by Vesselfinder LTD.

Seeing the rising water level, the captain ordered the crew to abandon the yacht and started to launch on water the pneumatic 8-people Survitec Zodiac life raft, fastened with belts to a bracket open from the outside on the stern pulpit. Launching of the raft required first lowering the 3-meter RIB boat, carried on davits behind the transom, which blocked the raft. To speed up launching of the RIB boat on water, the captain cut the slings fastening the boat.

At 18:38 hours, the captain transmitted the DISTRESS signal of alarming in danger over a stationary VHF radiotelephone with DSC. The MRCC Bremen immediately confirmed the signal and launched a rescue action.

The crew only took a small part of personal belongings from the yacht, and about 18:42 hours moved to the life raft, connected with a painter to the yacht, which was already drifting without sails. The crew took to the raft a portable VHF radiotelephone, over which the captain maintained further communication with the rescue center and the vessels participating in the action.

The painter was cut off, and for a short time the crew could observe the sinking yacht, filming it and taking photos with a mobile phone. In the last photo, taken at 18:52 hours, despite the low image definition, we can see the yacht without any list, still showing the sternlight



*Photograph 3. "Prodigy 2" yacht without crew (source: crew member)*

A few minutes later the yacht turned over to port, and was drifting, with a visible white spot of the torn off laminate layer on the starboard side of the bottom, covered with dark anti-fouling paint.

At 19:14 hours, the “Nordic” salvage tug (DE flag) arrived at the accident site and took up the yacht crew, using the tug’s life boat. A helicopter of the SAR services lifted the shipwreck survivors to the land, to Wilhelmshaven.

The yacht wreck drifted further on the surface towards the east, finally settling down on 16 October at the shore of the Langeoog island, near the position of  $\varphi = 53^{\circ} 45.73' N$   $\lambda = 007^{\circ} 34.58' E$ , around 8 miles from the accident site. The waves hitting the yacht led to its total destruction.

The ballast fin torn off from the hull together with part of the sheathing has not been found.



*Photograph 4. Wreck of the yacht tossed onshore at the Langeoog island*

## **5. Analysis and Comments about Factors Causing the Accident with Regard to Examination Results and Expert Opinions**

The cause of the “Prodigy 2” yacht’s sinking was loss of the keel by the yacht.



The conducted investigation failed to unequivocally determine the factors that had a decisive influence on the keel tearing off during the sailing. When analyzing this very serious marine accident, the Commission focused on the following issues:

- defects in design of the yacht structure,
- defects in carrying out the shipyard work,
- mechanical damages suffered during the yacht's use.

When examining the yacht design, the experts established that the designer and the notified entity carried out the strength calculations based on PRS regulations concerning sea yachts<sup>3</sup>, whereby the compliance degree of those regulations requirements with the requirements of the PN-EN ISO 12215 standard was unknown. The analysis of strength calculations of the monolithic hull sheathing keel strip of the yacht carried out during the accident investigation confirmed compliance of the design with requirements of the PN-EN ISO 12215 standard. The conducted strength analysis of the keel strip excluded defectiveness of the yacht's structural design in that area.

The smaller dimensions of the washers designed and manufactured for attaching the ballast fin to the hull led to increasing the local pressures, which resulted in partial damage to the internal laminate coatings, and could have brought about wrong transmission of the forces on hull bracings and loss of the ballast fin. If there was insufficient room for the washers, the builders should have considered joining the individual washers to each other in a structural way, which would have increased the mounting strength, at the same time reducing local stresses and pressures.

The Commission was unable to conduct its own strength tests of hull samples for the reasons referred to in Section 5.2 of this report. Based on the received test reports and its own expert opinions, the Commission assumed that the low laminate quality in construction of the monolithic hull sheathing keel strip of the yacht in the region of ballast fin mounting contributed in an essential way to the ballast fin tearing itself off.

A frequent reason for the ballast tearing off is mechanical damage resulting from the yacht entering a shoal or hitting an obstacle, or suffered during overland transport. "Prodigy 2" was a new yacht, launched just 6 months before the accident. According to the information obtained from the captain of the "Prodigy 2" yacht, who was always present onboard during the sailing, the yacht has never suffered any failure of this type.

<sup>3</sup> Rules for the Classification and Construction of Sea-going Ships, Part II, Hull (1996 as amended. No 1/1998) and Part III, Hull Equipment (1996 – uniform text, as at 01.12.2013), published by PRS Gdańsk,



In the expert's opinion, it is not ruled out that brushing against a submerged obstacle in the past could have initiated a slow process of the keel falling off. This type of event could occur in an unobservable way, but a correctly designed and built yacht should not have suffered such catastrophic effects as a result of a single, weak contact with an obstacle.

Examination of the whole sailing history of "Prodigy 2" in order to indicate such events is not possible due to the lack of data. The yacht was equipped in a recorder of sailing parameters, but it was destroyed during the accident. The course of sailing on the last day of the cruise was only examined, by comparing positions of the yacht recorded by the AIS receivers with the navigation map. According to the captain's recommendations, the yacht was not to enter waters more shallow than 10 m, which is a safe depth for a 3m draught. During the day, the yacht crossed the 10 m boundary several times, but – taking into consideration the tide level – it did not enter dangerously shallow waters anywhere.

The turn preceding the accident occurred at a high tide level (HW Baltrum around 18:00 hours, tide range ca. 2.50 m) in the water of actual depth around 10 m. The analysis of yacht speed recordings from AIS messages recorded in 5-minute intervals indicates that the turn might have been carried out in a more "sweeping" manner than the earlier maneuvers on that day, which could have led to a final break of the strength of the defective place on the hull. Though the data from the AIS recordings cannot be interpreted as absolutely precise, they provide general indications regarding the sailing parameters<sup>4</sup>.

## **5.1. Human factors (errors and omissions)**

### **5.1.1. Yacht crew**

The yacht sailed for its last cruise with a crew of 3 experienced sailors. The captain possessed a Polish Yachting Association (PYA) yacht captain patent dating from 2015. The second crew member possessed a PYA sea helmsman patent of 2016. The third crew member possessed a PYA yacht helmsman patent issued in 2002. The yacht captain, who was also the initiator of building the yacht and its actual shipowner, had experience in ocean sailing on his previous

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<sup>4</sup> A recorded screen of the VTS monitoring stand implies that near the place of this turn a navigation risk denoted "Anker (NW No 675)" has been marked in the map. There is no warning about this number, or nearby position of character, in the German Sailing News of 2017 (Nachrichten für Seefahrer). The archive of corrections to Admiralty maps in that region is not available to the general public any more, for map no BA-1635 has already been given a new issue after the accident date (the list of temporal corrections for 2017 does not contain a similar danger in that region).





yacht “Prodigy”<sup>5</sup>. Among the crew members, one person only possessed a Polish certificate of VHF devices radio operator, which authorizes the owner to operate radio telephone devices working in the marine V frequency band. Since “Prodigy 2” was a commercial yacht, the crew should have had 4 basic safety training courses<sup>6</sup>. None of the crew members possessed such training.

It should be noted that sailing with a new yacht in a long sea journey without its previous careful testing in native inland or coastal waters is deemed highly risky and reckless. Especially given the fact that the yacht had been built in a newly established shipyard which could not boast of other correctly built yachts. Even renowned world shipyards before delivering a newly designed and built vessel carry out many test cruises and tests aimed at discovering and removing potential design and workmanship errors.

#### 5.1.2. Yacht builder

The yacht has been constructed with the help of several subcontractors. The construction manager did not have professional education in yacht construction, while experience in this area was based on many years of sailing practice, among others on the Prodigy yacht, and managing the “Intuition” yacht’s construction. Key for the accident investigation was the process in which the hull and ballast fin were created. In this case, the lamination works were entrusted to persons selected just before this process, partially from the Libra Yacht personnel. The quality of laminate was dependant to a significant degree on the qualifications and skills of this team of people<sup>7</sup>. The quality analysis of the work performed during the lamination process points to the insufficient qualifications or skills of persons carrying out this task and gives evidence to poor supervision by the contractor.

#### 5.1.3. Life raft

When abandoning the yacht following the accident, the crew encountered an obstruction when attempting to launch the life raft, since access to the raft had been blocked by the RIB boat suspended on davits behind the transom. In mild conditions present back then, this had no impact on the safety of people, but in harsher conditions it could have led to tragic consequences during a failure of this type, which usually leads to the instantaneous or very

<sup>5</sup> See final SMAIC report no 49/14 “Zatonięcie the yacht *Prodigy* na Atlantyku w dniu 23 listopada 2014 r.” [Sinking of the Prodigy yacht on the Atlantic on 23 November 2014]

<sup>6</sup> According to the Safety Certificate No 525/GDY/2017 issued on 29 September 2017.

<sup>7</sup> Item 8, Standard PN-EN ISO 12215-4:2005. Small craft -- Hull construction and scantlings -- Part 4: Workshop and manufacturing





quick sinking of the yacht.

“Prodigy 2” was equipped in an inflatable life raft located in a bracket on the stern pulpit, fastened there with belts. There is no obligation in the requirements to use a hydrostatic release ensuring an automatic release of the raft, but the requirements do include a provision related to easy access to rescue equipment<sup>8</sup>.

## 5.2. Mechanical factors

The hull was made without supervision of a notified body and without carrying out the relevant strength testing based on a sample from a control plate. Following the yacht's accident, the Zucker&Partner consulting company from Hamburg began investigative activities as commissioned by the yacht insurer – AXA Versicherung AG. Zucker&Partner experts carried out the first inspection of the yacht's wreckage on the mudflat on the shore of Langeoog on 16 October, before the wreckage had been lifted and transported to Hooksiel, where they inspected it again on 19 October. Zucker&Partner experts collected laminate samples from the damaged areas of the yacht's bottom and prepared the photographic documentation of the damage. The preliminary factual report summarising the yacht's condition in terms of damage had been drafted on 19 November 2017

On 11 November 2017 Zucker&Partner commissioned the GMA Werkstoffprüfung GmbH testing laboratory to analyse the collected samples. GMA drafted a report of this test on 22 December 2017.

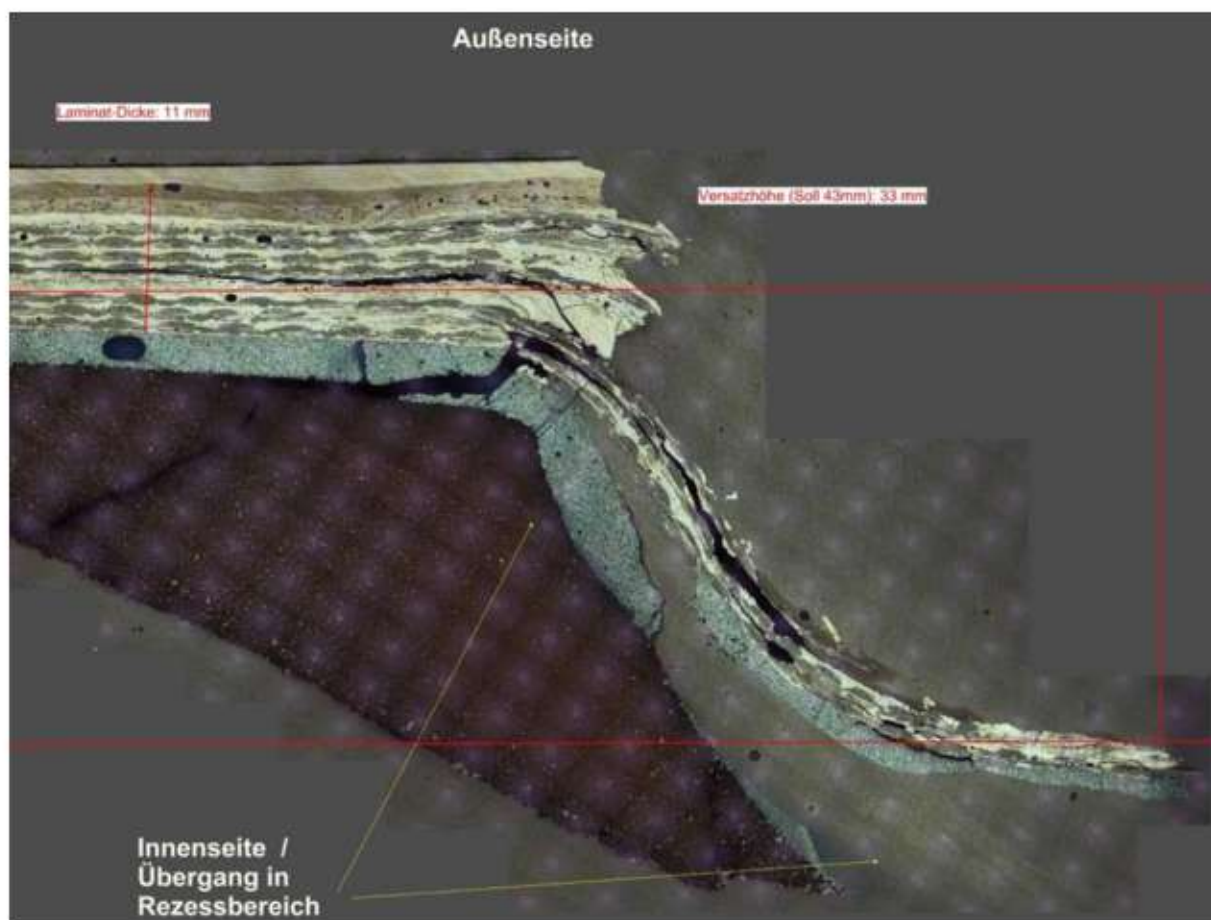
In conclusion of the testing, GMA determined that “the thickness of laminate in the transition into the recession area is 10 mm instead of the required 24 mm, which corresponds to a 55% decrease. The quality of bonds and the adhesion of individual laminate layers to each other are to a large extent insufficient. This is most likely related to the manufacturing conditions / construction conditions and the related material damage”.<sup>9</sup>

<sup>8</sup> Item 3.7, Annex No 2 to the Regulation of the Minister of Development of 2 June 2016 on requirements for recreational craft and personal water craft. (Dz. U. [Polish Journal of Laws] of 2016, Item 807))

<sup>9</sup> GMA-3664 testing report (translated from German by A. Banaszek)



Photograph 5. The area where the material sample was collected from (source: GMA – 3664)



*Photograph 6. Macro-section of a fracture at the transition into the recess region – where the sample was collected from (source: GMA – 3664)*

The decrease of laminate thickness to 10 mm (without the gel-coat) indicated in the report in the area where the design indicates the size of ca. 24 mm required an additional analysis.

It had to be considered that the laminate thickness is a derivative of: the reinforcement content, the use of mats alone or mats and combimats and the lamination technology employed.

The thickness of 24 mm is the value provided for laminates reinforced with mats with ca. 28.5% reinforcement content.<sup>10</sup> At a typical reinforcement content somewhere between 35% and 50% for mixed reinforcement laminates, according to the specifications on the drawing above, the final laminate thickness is between 13.6 mm (for 50%) and 19.5 mm (for 35%)<sup>11</sup>. In view of the above, it should be concluded that the laminate thickness (reinforcement) in the analysed section is too low compared to the assumed strength requirements.

<sup>10</sup> Tab. 5.3.1 p. 21, Rules for the Classification and Construction of Sea-going Ships, Part II Hull (1996 as amended. No 1/1998), published by PRS Gdańsk

<sup>11</sup> Tab. 5.3.2 p. 22, Rules for the Classification and Construction of Sea-going Ships, Part II Hull (1996 as amended. No 1/1998), published by PRS Gdańsk



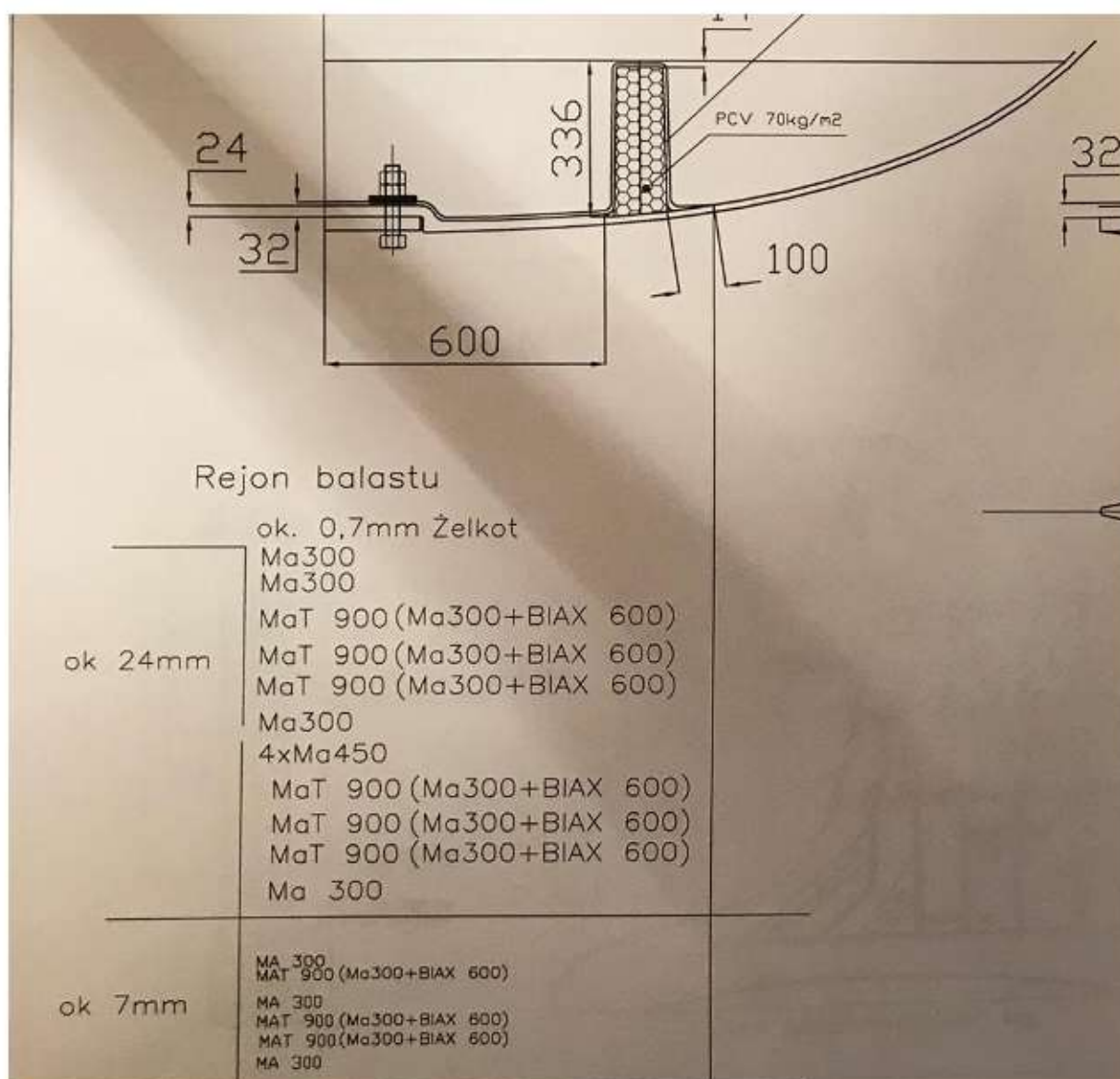


Fig 1 Fragment of drawing 09/16 Kalif 58 by CORS

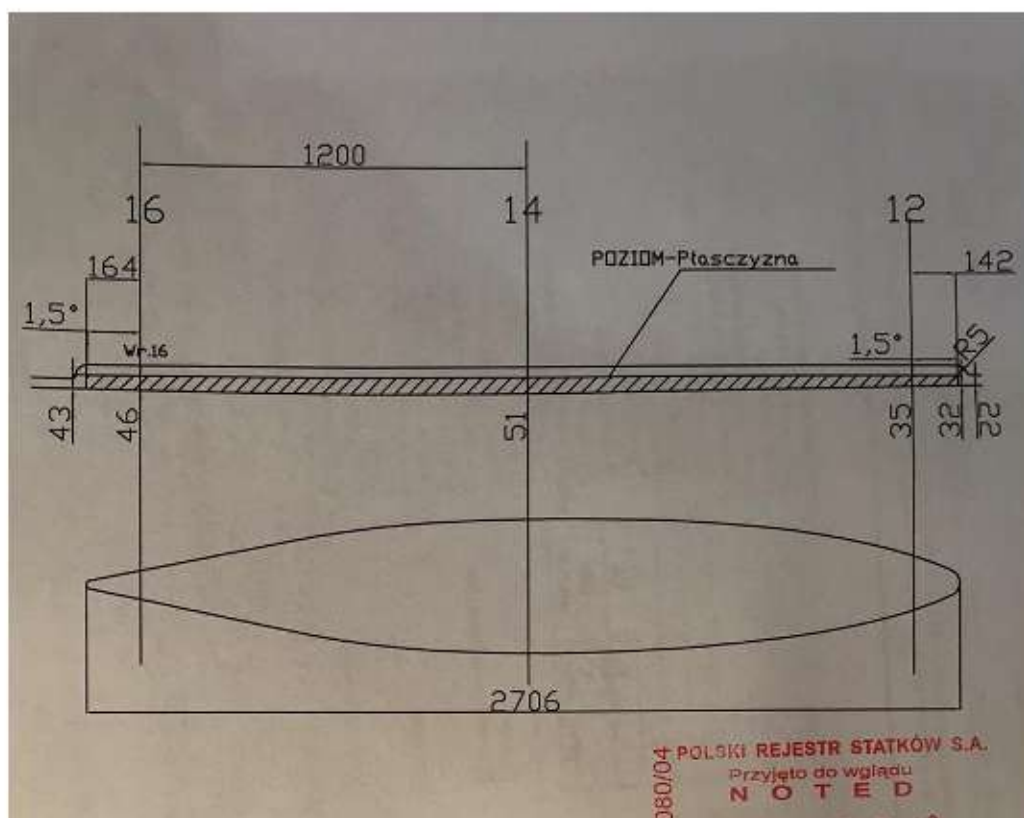
The commission did not carry out any additional strength analysis of the samples from the recess area due to the yacht owner having cut out this strip of sheathing earlier. The owner stated that the obtained sheathing fragments were used to carry out their own strength testing and the remaining fragments were retained for the purposes of any possible compensation proceedings.



*Photograph 7. Strip of sheathing cut out by the yacht owner (source: yacht owner)*

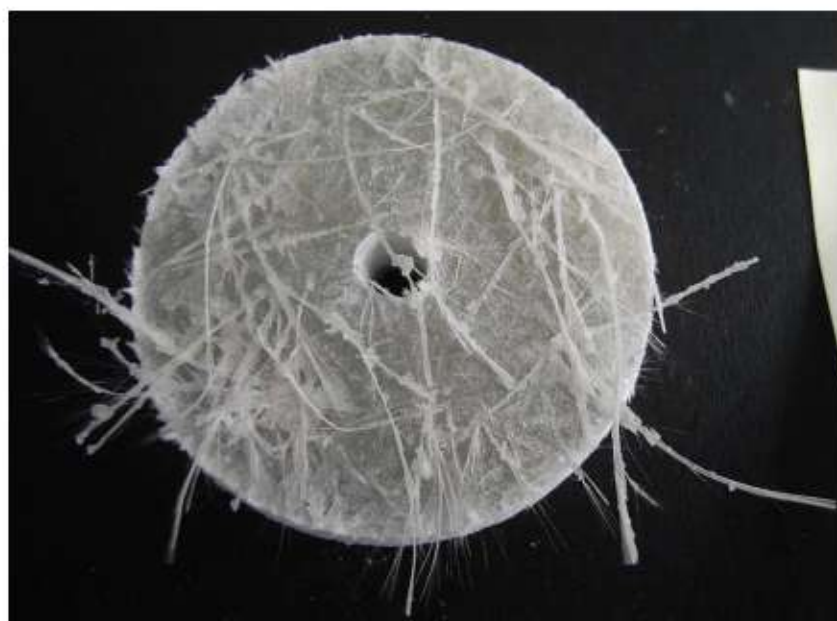
Photograph No 6 shows the result of a recess depth measurement and it was ca. 33 mm.

The ballast recess plan drafted by CORS for the Kalif 58 model provided for a variable depth from 32 mm in the bow section to 43 mm in the stern section in order to eliminate the 1.5° rise of the hull (deviation from the base plane) in the recess area. During the construction of “Prodigy 2”, the recess was constructed with a constant depth of ca. 33 mm. The plate mounting the ballast fin to the hull had a constant thickness of 30 mm and was hidden completely in the recess.



*Fig 2 Ballast recess according to plan 09/16 CORS for the Kalif 58 model*

Another element that had an impact on the mechanical properties of laminates was the quality of their execution.



*Photograph 8. Visible loose glass fibres with resin "drops" attached  
(source: GMA – 3664)*



The samples subject to analysis and the inspection of the hull showed glistening areas of delaminated hull. The laminate could be separated and torn out by hand.



*Photograph 9. Condition of laminate on the yacht's hull (source: Zucker & Partner Gmb)*

The quality of the monolithic bottom strip of sheathing in the area of the ballast fin's mounting to the yacht's hull was found to have been low. During the inspection, low adhesiveness of some laminate layers to each other has been discovered. The completely smooth surfaces of individual laminate layers without the indicated adhesiveness are a proof of the thesis mentioned above. This could have been caused by the yacht manufacturer's failure to maintain the execution technology of individual works in the lamination process of the hull sheathing. Of particular importance was maintaining breaks between the lamination of individual layers and their thorough cleaning and roughening before commencing to laminate further layers. The failure to maintain the quality of these works caused intermediate layers to form on the surface of laminates (e.g. paraffin-like substances) and the failure to mechanically remove them resulted then in the lack of adhesiveness between individual laminate layers. This contributed to a significant weakening of the laminate as a monolith and the appearance of numerous delaminations in the laminate, as well as the failure to transmit forces from the keel onto the hull bracing. In consequence, larger loads were being transferred

by the bottom layers of the delaminated laminate instead of working as a monolithic form, as provided for by the yacht designer. There are also visible traces of wrong or improper percolation of individual layers of glass fabric with resin. This was also a cause for the easy separation of individual layers from each other.

A proof of the low quality of the lamination process may be traces of glue on the sheathing ( colour blue on the photographs) in areas outside of the bracing. It is worth pointing out here that the load-bearing capacity of the glue mentioned above is low.



*Photograph 10. Traces of glue outside of the bracing foam (source: Zucker & Partner GmbH report)*

The glue should have been removed during the lamination of areas outside of the bracing. The failure to do this contributed to the delamination process, which was particularly dangerous in the direct vicinity of the bracing, where various layers of laminate passing under the bracing foam and over the bracing foam join together. A natural mechanical notch forms in this place and, at the same time, this is an important node transmitting forces originating from the keel. The discovery of glue here disturbed the functioning of this structural node, weakening it significantly, which could have led to the incorrect transmission of forces to the bracing and the tearing off of the keel.





### 5.3. Organizational factors

#### 5.3.1. “Prodigy 2” yacht construction, supervision and certification process calendar

1. 2014 r – an agreement between the investor and Libra Yacht Sailnet Service for the one-off construction of the “Stadtship 56” yacht, ending in the construction of a hull model in 2015,
2. 17.07.2014 – an application by Libra Yacht Sailnet Service for product certification for compliance with Dir. 94/25/EC for the 17.3m LOA yacht and the 95 kW engine, design cat. A for compliance assurance module B,
3. 9.09.2014 – conclusion of agreement no 131/2014 between Libra Yacht Sailnet Service and PRS for the certification of the product mentioned above,
4. 2014 – establishment of “Kalif Yacht Kamila Błazucka”,
5. 27.01.2015 – approval of part of the “Libra 58” documentation by PRS, including the lamination process,
6. May 2015 – the shipowner’s decision to change the contractor from Libra Yacht Sailnet Service to Kalif Yacht Kamila Błazucka; agreement with “Kalif Yacht” shipyard for the “turn-key” construction of the vessel and the start of the construction of the “Quale 60”-type “Prodigy 2”,
7. 10.08.2015 – cleaning of the moulds before the start of the lamination process,
8. 20.08.2015 to ca. 15.09.2015 – hull lamination process,
9. 24.08.2015 – gel-coat application,
10. 15.09.2015 – lamination of the bottom grillage,
11. 29.10.2015 – departure from the Libra Yacht hall and the stripping of the hull and deck laminates,
12. 30.10.2015 – transport of the yacht’s hull and deck to the Kalif Yacht hall,
13. 20.11.2015 – notification of the change of contractor to PRS and amendment to the agreement No 131/2014 together with the change of the yacht type from LIBRA 58 to MONDO 58,
14. 18.03.2016 – approval of part of the “Kalif 58” documentation by PRS, including the ballast region and recess,





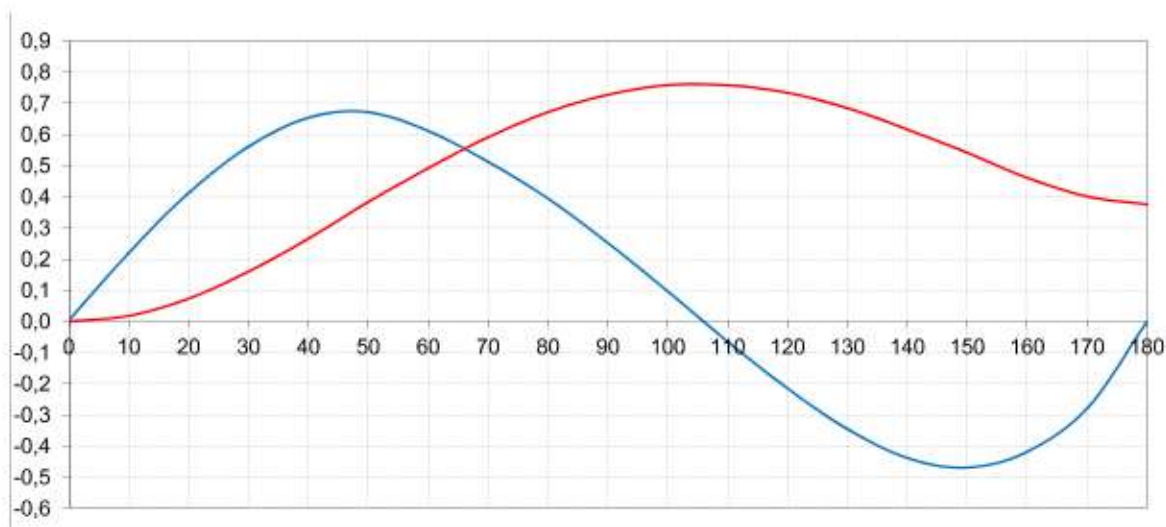
15. 06.2016 – approval of part of the “Libra 58”, “Kalif 58” and “Quale 60” documentation by PRS.
16. 15.07.2016 – establishment of “Quale sp. z o.o.”
17. 26.03.2017 – approval of part of the “Quale 60” documentation by PRS (short ballast, design drafted on 2016-02-22).
18. 28.03.2017 – “Prodigy 2” measurement taken by a surveyor – the yacht builder,
19. 12.04.2017 – decision by PYA to name it “Prodigy 2”,
20. 12.04.2017 – issue of a Yacht certificate by PYA. Owner – “Quale sp. z o.o.”,
21. 9.05.2017 – the yacht is transported to Gdańsk and, following the rudder and ballast installation, launched in Wiślinka,
22. 15.06.2017 – first inclining test in Górki Zachodnie,
23. 15-16.06.2017 – first cruises on the Gdańsk Bay and a decision to extend the ballast,
24. 23.06.2017 – approval of part of the “Cors 60” documentation by PRS (long version of ballast),
25. 11-13.08.2017 – ballast extension at Jastarnia,
26. 22.08.2017 – another inclining test following the ballast extension,
27. 29.08.2017 – EC type testing certificate (module B) for “Quale 60”, design cat. A,
28. 29.08.2017 – Testing report (Module A1) for C.1.1 Engine noise emission,
29. 29.08.2017 – Certification report for the QUALE 60-type sailing yacht – module B together with verification forms for the essential requirements for compliance with Directive 2013/53/EU and stability assessment charts for compliance with the requirements of Standard PN-EN ISO 12217-2:2016-02,
30. 4.09.2017 – Declaration of conformity for “Prodigy 2”. CIN No KYS00001D717, issued by the yacht manufacturer,
31. 18.09.2017 – Radio license valid until 18.09.2027
32. 19.09.2017 – PRS class certificate valid until 29.08.2022,
33. 29.09.2017 – Safety certificate valid until 29.08.2022
34. 13.10.2017 – the yacht is involved in an accident when traversing Baltrum.

### 5.3.2. Supervision over yacht construction

According to the application of 17 July 2014, the notified body undertook the certification of the product – “Prodigy 2” yacht – for compliance with Directive 94/25/EC. Aside of approving the documentation, no actions were taken prior to 19 November 2015, when the yacht’s hull and deck were already at the premises of KALIF YACHT. The notified body had not been present during the construction of the hull at the place where it was being build, that is at the premises of Libra Yachts. On 20 November 2015 Kalif Yacht requested an amendment to the product certification agreement on behalf of the shipowner, including the change of the contractor, model name and place of the yacht’s construction. In 2016 the notified body visited the yacht’s construction site three times, and two more in 2017 before the vessel was transported to Gdańsk.

Two inclining tests were carried out in Gdańsk in order to determine the stability parameters of the vessel.

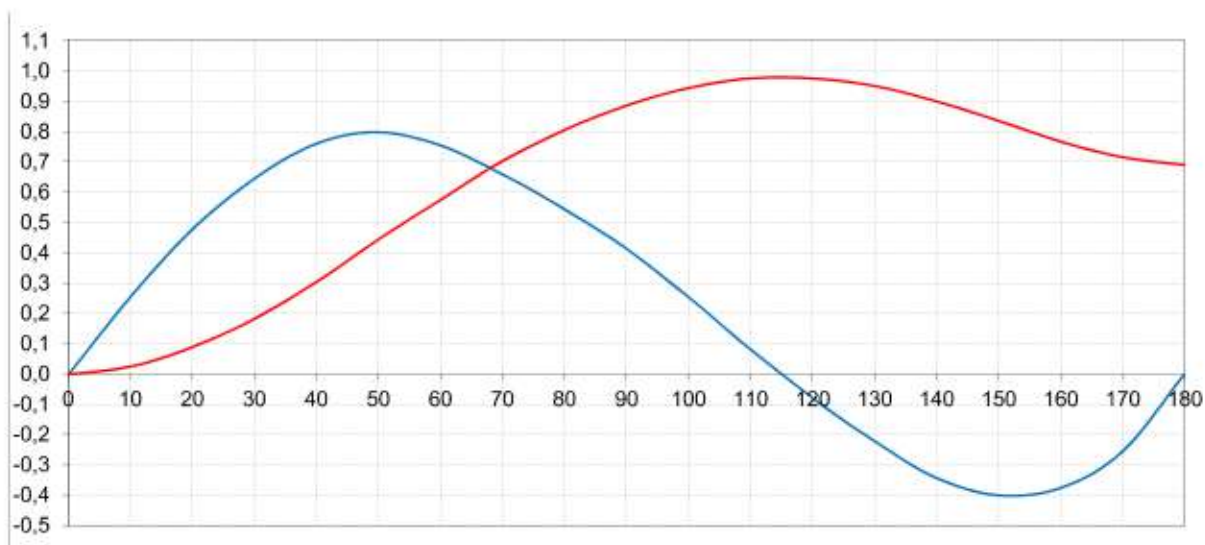
The first test was carried out on 15 June 2017



*Fig 3 Diagram of the righting lever curve for “Prodigy 2” for the following loading condition – for going out to sea, i.e. 10 persons + 100% supplies (15.06.2017)*

After completing the operation of extending the ballast fin and moving the battery, another inclining test was carried out on 22 August 2017.

The notified body did not supervise the ballast fin extension and only approved the change in documentation.



*Fig 4 Diagram of the righting lever curve for “Prodigy 2” for the following loading condition – for going out to sea, i.e. 10 crew members + 100% supplies (22.08.2017)*

Having determined the above facts, the Commission determined that in this case the notified body combined the following supervisory functions:

- Certification-related, resultant from the product certification for compliance with the directive (originally 94/25/EC and later 2013/53/EU),
- Classification-related, resultant from the PRS classification regulations.

Together, the provisions concerning both these supervisions impose the obligation to be present during all the stages of the vessel’s construction and to carry out the relevant quality inspections of the hull and finishing works. In the case of “Prodigy 2”, the hull construction stage had not been supervised. As part of supervision, PRS took control measurements of the laminate hardness and ascertained compliance with the requirements of the regulations.

#### **5.4. Influence of external factors on marine accident occurrence**

At the time of the accident, sailing conditions were moderate – a moderate wind was blowing from the south-west at 3-4<sup>th</sup> B, sea state was at 0.5 – 1.0m, visibility at over 10 NM, with full cloud cover, and water temperature at +12°C. The weather conditions had no impact on the occurrence of the analysed accident.



## 6. Description of Examination Findings Including the Identification of Safety Issues and Conclusions

The “Prodigy 2” yacht involved in the accident was sailing under the Polish flag and was registered as a commercial sailing yacht. Even though it had been built essentially in order to complete a recreational cruise around the world, the yacht-building project had evolved – from the original plan of building a 56-feet blade yacht using the *one-off* method – to the commercial plan of starting the manufacture of 60-feet yachts with the use of GRP and with a fin keel that “Prodigy 2” was to be the prototype for. For this purpose, the later captain of “Prodigy 2” established “Quale sp. z o.o.” and the “Quale Yachts” shipping company. Next, “Kalif Yacht Kamila Błazucka” from Toruń was set up and engaged in the construction of a complete yacht pursuant to the design of the “Cors” construction company from Gdańsk, established in 2001 and experienced in designing smaller yachts<sup>12</sup>.

### 6.1. Yacht design

The “Prodigy 2” yacht’s documentation presented for approval of the notified body was a combination of designs made for the following yacht models: “Libra 58”, “CORS 60”, “Kalif 58” and “Quale 60”. In the end, this yacht model was named “Quale 60”. The documentation had been approved between 31.10.2014 and 19.08.2017. Both the designer and the notified body performed the relevant calculation in order to verify the construction and design of components based on the Rules for the Classification and Construction of Sea-going Ships<sup>13</sup>. For the purposes of analysing this accident, the Commission verified the strength calculations for the keel strip of the “Prodigy 2” ballast yacht’s monolithic hull sheathing for compliance with the requirements of Standard PN-EN ISO 12215.

The following design assumptions for the yacht’s ballast were adopted.

<sup>12</sup> According to [www.kulinski.navsim.pl](http://www.kulinski.navsim.pl): “Countless designs for: sails, rigging, ballasts and other components, LR4 workboat – design and construction, “Conrad 20” - joint construction, “Dar Przemysła” - co-designer and joint construction, Conrad 46 - joint construction, TS CONRAD 777 (CORS QTC) - joint design, joint construction, building on his own, PINICA ALU 8m (Austria) – design and construction, PINICA 12m (Austria) – joint design and joint construction, Motorcat 30 - joint design and construction, SPIRIT 640 Hybrid - joint design and construction, CORS 730 - design, construction, building on his own, CORS 500 - design, construction, building on his own, CORS T3 - design, construction, building on his own, Trimaran TNT 34 - joint design, joint construction, CORS T2 - design, construction, building on his own, CORS 27 - design and construction, KALIF 58 feet – design and construction, Tender 725 (Holland) - design and construction.”

<sup>13</sup> Rules for the Classification and Construction of Sea-going Ships, Part II, Hull (1996 as amended. No 1/1998) and Part III, Hull Equipment (1996 – uniform text, as at 01.12.2013), published by PRS Gdańsk,

Name	Value
Ballast version	Steel and lead ballast, Long version B
Total weight of ballast	7200 kg
Weight of the ballast's lead casting	6000 kg
Weight of the ballast's class A shipbuilding steel	Ca. 1000 kg
Keel height	2247 mm / 2277 mm
Height of the keel's centre of gravity from the mounting	1574 mm
Number of bolts mounting the keel to the recess	19 pcs M30x150 with partial thread, mat. A2
Number of nuts mounting the keel to the recess	19 pcs M30, mat. A2
Number of lock-nuts mounting the keel to the recess	19 pcs M30, mat. A2
Maximum spacing of bolts mounting the keel to the recess	293 mm
Recess length	2706 mm

The carried out numerical analysis allowed for formulating the following conclusions:

1. The technical documentation for the keel strip of the "Prodigy 2" ballast yacht's monolithic hull sheathing and steel and lead ballast's structure together with the mounting, drafted by CORS as commissioned by Kalif Yacht, has been drafted correctly and is compliant with the requirements of Standard PN-EN ISO 12215.
2. The thickness value for the monolithic sheathing of the yacht's hull in the area where the ballast is mounted (recess), adopted in the technical design, has been adopted correctly and meets the strength requirements of Standard ISO 12215 with a significant reserve (over twofold thickness reserve).
3. The value of contact area between the entire ballast fin and the monolithic sheathing of the yacht's hull in the area where the ballast is mounted (recess), adopted in the technical design, has been adopted correctly and meets the strength requirements of Standard ISO



12215 related to the permissible pressure force with a significant reserve (over twelvefold reserve of strength).

4. The strength index value for the floor section adopted by the designer in the technical design meets the requirements of Standard ISO 12215 related to the minimum strength index value for the floor section with a significant reserve (over fourfold reserve of strength).

5. The diameter value for the bolts mounting the ballast to the hull structure adopted by the designer in the technical design meets the strength requirements of Standard ISO 12215 with a significant reserve (over fourfold reserve of strength).

Three other elements in the design documentation were also analysed:

- 1) Thickness of the hull laminate (discussed in 5.2 Mechanical factors),
- 2) Size of washers for the bolts mounting the keel,
- 3) Radius of the bottom sheathing edges in the vicinity of the recess.

The following sizes of 10 mm thick A4 washers are listed on sheet 03/17 of the CORS 60 yacht plans:

- washers for single bolts – 15 pcs, dimensions 96 x 96 (mm),
- double washers – 2 pcs, dimensions 180 x 96 (mm)



*Photograph 11. Starboard view of the torn off recess and laminate layers (source: GMA-3664)*



Photograph 11 clearly shows the “pulling” of double (2 pcs) and single (3 pcs) washers through the internal hull sheathing layer. According to PRS regulations, the dimensions of washers for bolts mounting the keel should not be smaller than four times the mounting bolt diameter. In this case M30 bolts were used, thus the minimum washer diameter should be no less than 120 mm<sup>14</sup>. In order to meet this requirement, the washers should have the minimum dimensions of 106 x 106 (mm).

Another element subject to the analysis was the small radius of only 5 mm of the bottom sheathing edge in the area of the transition into the recess listed on sheet 09/16 for the “Kalif 58” design. The commission received a confirmation that this value is treated by all the stakeholders in the construction and supervision process (designer, builder and the notified body) as a pointer and not a strict requirement, because the technological process is the determinant for the curvature attainable when applying laminate layers depending on the type of reinforcement in use and the direction it is arranged in.

## 6.2. Yacht construction

The yacht’s construction theoretically began with the moment of the contractor – Libra Yacht Sailnet Service, Wąbrzeźno – submitting to PRS on 17 July 2014 an application for product certification and assessment of compliance with the requirements of Directive 94/25/EC amended by directive 2003/44/EC. The applicant had chosen compliance assessment module B and indicated the hall at M. Skłodowskiej Curie Street in Toruń as the place of construction. By May 2015 models had been prepared and then the ordering party decided to change the contractor. The new contractor was Kalif Yacht Kamila Błazucka from Osielsko, while a person with prior experience in building the aluminium “Intuition” mega-yacht (of type “Conrad 76”) became the technical manager of the construction. The new contractor hired a few boatbuilders who worked at the previous Contractor, began building the moulds and then started the hull and deck lamination process in the hall at the previous contractor’s premises. Below the waterline, the hull was a monolithic laminate, while the sides were made with the use of the *sandwich* technique, using a PVC interleaf. After the completion of the hull and deck lamination and stripping process, the laminates were transported to a new hall at Polna Street in Toruń.

<sup>14</sup> Item 4.1.2, Rules for the Classification and Construction of Sea-going Ships, Part III, Hull Equipment (1996 – uniform text, as at 01.12.2013), published by PRS Gdańsk



*Photograph 12. Stripping of the yacht's hull (source: <http://kalifyacht.eu/projekty.php>)*

The process had been documented photographically. No records of the environmental conditions during the construction process were retained<sup>15</sup> and neither a control plate had been prepared nor any strength testing carried out.<sup>16</sup> After transporting the laminates to the new hall situated at Polna Street in Toruń, the yacht's construction continued for around 15 months with the participation of subcontractors. No compliance assurance procedure<sup>17</sup> nor work instructions for the individual stages of the yacht's construction had been drafted. No final inspection report had not been prepared at the completion of the yacht's construction<sup>18</sup>.

<sup>15</sup> Item 3, Standard PN-EN ISO 12215-4:2005. Small craft -- Hull construction and scantlings -- Part 4: Workshop and manufacturing

<sup>16</sup> Item 4.6, Rules for the Classification and Construction of Sea-going Ships, Part II, Hull (1996 as amended. No 1/1998), published by PRS Gdańsk

<sup>17</sup> Item 10, Standard PN-EN ISO 12215-4:2005. Small craft -- Hull construction and scantlings -- Part 4: Workshop and manufacturing

<sup>18</sup> Item 9, Standard PN-EN ISO 12215-4:2005. Small craft -- Hull construction and scantlings -- Part 4: Workshop and manufacturing



On 9 May 2017 the yacht was transported to Gdańsk, to the Galeon Wiślince shipyard, where the rudder and the ballast fin (the fin and bulb keel)<sup>19</sup> were installed. Following the launch, the yacht sailed to the AZS harbour in Górki Zachodnie for sail and rigging installation. Following the inclining test on 15 June 2017, the yacht underwent short two-day cruises on the Gdańsk Bay. The test results confirmed that the yacht was – in the owner’s opinion – too “soft” (low GM value) and, furthermore, had a slight trim by the stern, causing insufficient bow draught for the effective operation of the bow thruster at the average draught of around 2.6m. Between 11 and 13 August 2017 the ballast fin was extended in Jastarnia by installing an insert between the fin and the bulb keel.



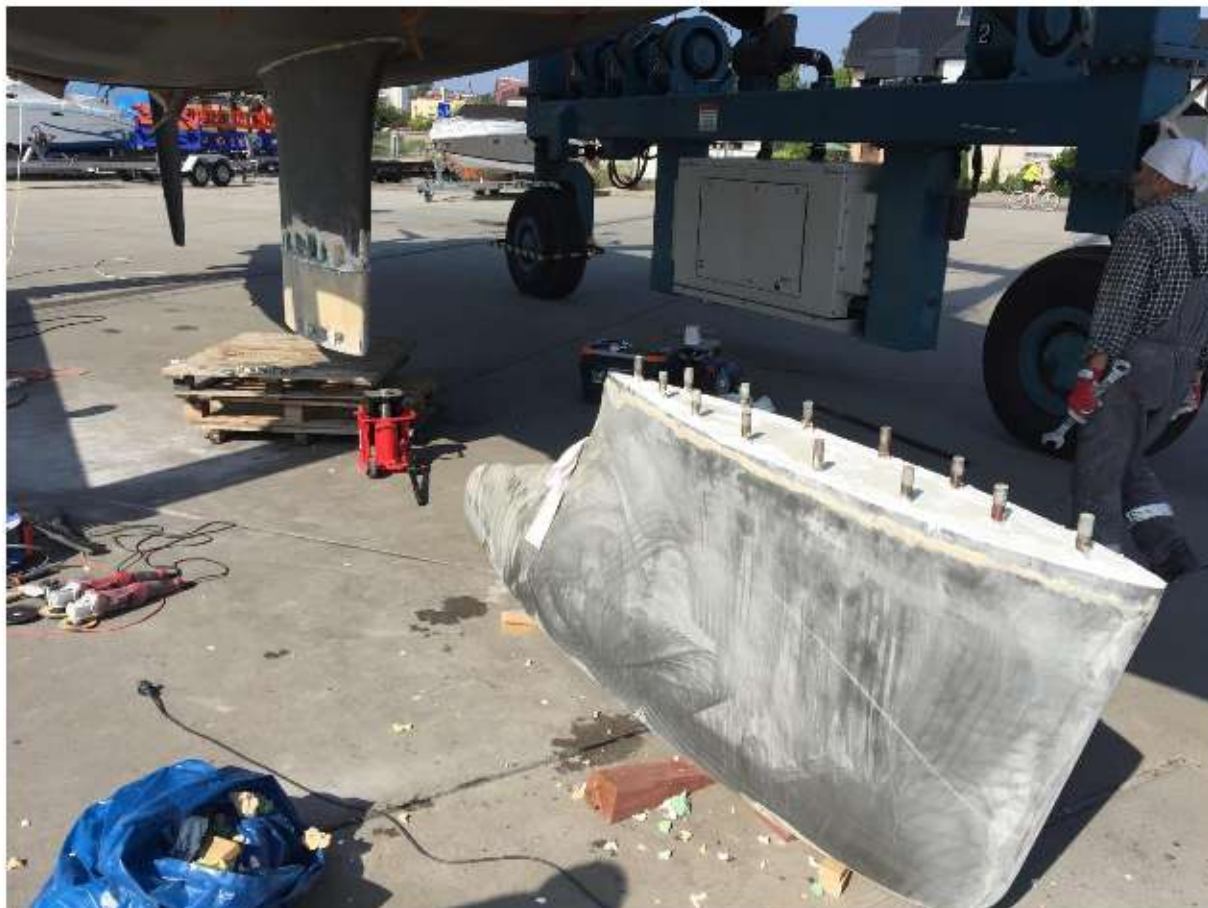
*Photograph 13. Separation of the fin from the bulb keel (source: yacht builder)*

At the same time as the extension of the ballast fin, the battery was moved from its location behind the recess towards the front, by around 2.7m. Following both changes, the yacht sailed

<sup>19</sup> Item 3.4, Standard PN-EN ISO 12215-9:2012. Small craft -- Hull construction and scantlings -- Part 9: Sailing craft appendages



on an even keel with a draught of ca. 3 m. During a stop at Gdańsk, the yacht was equipped in stern davits and a RIB-type boat before leaving for the scheduled cruise.



*Photograph 14. Connection of the insert with the fin (source: yacht builder)*

The additional boat limited the ability to use the inflatable raft installed on the stern pulpit to a significant degree. The boat's installation had been agreed neither with the classification officer nor with the maritime authority issuing the safety document<sup>20</sup>. The above alteration did not comply with the regulations<sup>21</sup>. Despite such an obligation, the contractor did not provide the shipowner with the yacht's operating manual.<sup>22</sup>

<sup>20</sup> Item 19.1.4, Rules for the Classification and Construction of Sea-going Ships, Part III, Hull Equipment (1996 – uniform text, as at 01.12.2013), published by PRS Gdańsk

<sup>21</sup> “Art. 24 - If, following one of the inspections mentioned in Art. 20, significant changes occurred in the hull, devices or equipment of the inspected ship, this ship cannot be used for sailing without another suitable inspection” – Act of 18 August 2011 on Maritime Safety (i.e. Dz.U. [Polish Journal of Laws] of 2018, Item 181)

<sup>22</sup> Item 2.5, Annex No 2 to the Regulation of the Minister of Development of 2 June 2016 on requirements for recreational craft and personal water craft. (Dz. U. [Polish Journal of Laws] of 2016, Item 807)



*Photograph 15. Mounting of the bulb keel to the insert (source: yacht builder)*

After completion of the yacht outfitting process and a short cruise from Kołobrzeg to Bornholm, the trip that ended in the loss of the ballast fin and, in consequence, of the yacht on 13 October 2017 began

## **7. Recommendations concerning safety**

The State Marine Accident Investigation Commission saw it justifiable to issue recommendations concerning safety, constituting proposals of actions that could contribute to preventing similar accidents in the future, to the following entities:

### **7.1. Polski Rejestr Statków S.A.**

The Commission recommends carrying out product certification for compliance with the provisions of Directive 2013/53/EU based on the essential requirements specified in Annex 1 to this directive or based on own regulations for the classification and construction of sea-going ships, provided that they include at least an equal level of requirements and are undergoing periodical verification. Furthermore, the Commission points to the necessity of a



clear specification of the moment in the vessel's construction from when it is not possible to commence PRS supervision in order to obtain the \* mark in the class symbol<sup>23</sup>.

## 7.2. Kalif Yacht Kamila Blazucka

The Commission recommends a detailed analysis of the remarks included in this report, in particular in relation to the regulations in force in order to ensure that further yachts are built according to the requirements.

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<sup>23</sup> Item 3.2.1 11., Rules for the Classification and Construction of Sea-going Ships, pt. and Classification regulations (2012 as amended. No 1/2013) published by PRS Gdańsk





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AIS - Automatic Identification System
BA - British Admiralty
CE - Product conformity mark
CEST - Central European Summer Time
DGzRS - Deutsche Gesellschaft zur Rettung Schiffbrüchiger
DIS - Draft International Standard
DSC - Digital Selective Calling
HW - High Water
IMO - International Maritime Organization
ISAF - International Sailing Federation
ISO - International Standards Organization
SC - Safety Chart
PT, SB - Port, Starboard
GRP - Glass-reinforced plastic
LT - Local Time
MAIB - Marine Accidents Investigation Branch
MISLE - Marine Information for Safety and Law Enforcement



MRCC - Maritime Rescue Coordination Center

SMAIC - Państwowa Komisja Badania Wypadków Morskich (State Marine Accident Investigation Commission)

PN-EN - Polska Norma - Europejska Norma (Polish Condition of standard – European Condition of standard)

PRS - Polski Rejestr Statków S.A. (Polish Registry of Shipping)

RCD - Recreational Craft Directive

RIB - Rigid Inflatable Boat

RSG - Recreational Craft Sectoral Group

RYA - Royal Yachting Association

SAR - Search and Rescue

SART - Search and Rescue Radio Transponder

TSS - Traffic Separation Scheme

EU - European Union

VHF – Very High Frequency radio waves

OCCP - Urząd Ochrony Konkurencji and Konsumentów (Office of Competition and Consumer Protection)

USCG - United States Coast Guard

UTC - Universal Time Coordinated

## **12. Information sources**

Accident report,

Yacht documents issued by: PYA, PRS, OEC and the MA in Gdynia,

Materials and documents received from: the designer, builder and PRS S.A.,

Photographs and films received from: crew members, Stefan Zucker & Partner GmbH, PRS and the builder,

SMAIC hearings,

Reports from the SAR operation,

Expert opinions drafted by:

– GMA – Werkstoffprüfung GmbH as commissioned by Stefan Zucker & Partner GmbH,

– A. Banaszek – SMAIC expert,

– P. Carlson – SMAIC expert.



### **13. Composition of the accident investigation team**

team leader – Tadeusz Wojtasik – SMAIC president

team member – Marek Szymankiewicz – SMAIC secretary