REPORT ON THE SINKINGS OF THE SAILING VESSELS *GUNGA DIN* AND *ALLIANCE* DURING THE 2024 NEWPORT-BERMUDA RACE

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Background

The Newport Bermuda Race is run bi-annually on even calendar years. 162 vessels started the 2024 race at Fort Adams in Newport. The forecast was for light air the day of the start followed by consistent southwesterly winds building to 20-35 knots for the remainder of the race. There was a large southerly-flowing meander in the Gulf Stream adjacent to and slightly west of the rhumb line, which contained steep seas associated with wind against current.

Fourteen vessels retired, with seven reaching Bermuda and five returning to the United States. Two vessels sank. This report aims to examine the technical aspects leading to the sinkings as well as similar mechanical failures aboard vessels in the fleet. It includes recommendations for consideration by skippers anticipating a future offshore passage.

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S/V Gunga Din

THE SINKING:

Gunga Din was a 1988 Sweden Yachts 41 built in Stenungstund, Sweden to a design by Peter Norlin and Jens Östmann. She was built to Lloyd's Register Hull Construction standards and was delivered with a compliance certificate. She had been purchased by owner Bob Fye in late 2020, and this was to be her first offshore race under his ownership. The seven-man crew included four active or retired military officers, and all knew the vessel well, having participated in multiple overnight offshore sails during the spring. All seven had completed International Offshore Safety at Sea training.

During the 0000-0400 watch on Monday, June 24th, owner Bob Fye and his son, Dr. Alec Fye, were on watch when they noticed slack in the inner forestay and windward running backstay. Twice during that day they tightened both stays but noticed no other apparent concerns with the rig. Simultaneously, the crew noted an increasing accumulation of water in the vessel's bilge, occasionally setting off the high-water alarm, but the bilge was mostly kept dry by the installed electric bilge pump.

At approximately 0230 on Tuesday, June 25th, while approximately 120nm from Bermuda, a crewmember sleeping below on a leeward bunk awoke to the sound of sloshing water. The vessel was sailing on a close reach on starboard tack in seas approximately eight-feet tall and winds of 15-20 knots. After raising the alarm, the crew separated into three teams, with two people on deck sailing the boat and operating the deck-mounted manual bilge pump, three people focusing on dewatering the vessel and setting up the emergency dewatering pump and two people searching for the source of the water ingress.

Gunga Din carried on board a 4,700 gallon-per-hour (gph) emergency electric pump, which the crew was able to set up relatively quickly. Because the two-inch discharge hose supplied with the pump was a lay-flat design, the crew had difficulty keeping water flowing through a kink that developed in the hose as it made its way on deck. This was rectified by inserting a spare piece of semi-rigid sanitation hose into the kinked section to facilitate water flow.

The crew checked all through-hulls and associated hoses for the source of the leak, but no apparent source of flooding was found. Although significantly increased from the day before, the water was coming in at a rate that could be controlled with periodic operation of the high-capacity emergency pump. After rechecking the through-hulls again, the crew began lifting floorboards, many of which were screwed into place. Their methodic investigation determined that water was not coming from forward or aft of the centerline bilge compartment and did not appear to be coming from outboard, either port or starboard. Therefore, in a final attempt to determine the source, the crew began to cut away the installed mahogany cabin table surrounding the mast with a reciprocating saw in order to access the mast step and the area beneath it.

Meanwhile, although the boat remained relatively dry with the electric pump online, the crew began to have issues keeping the engine running long enough to charge the batteries. It repeatedly shut down for lack of clean fuel. Although they changed the fuel filter three times utilizing spares carried aboard, Bob Fye hypothesizes that the three days of heavy pounding on starboard tack dislodged enough sediment in the tank to repeatedly clog the suction tube located in the aft, port area of the fuel tank. At that time, with the source of water ingress still unknown, the crew issued a PAN PAN alert on VHF and contacted Bermuda Race Fleet Communications Office (FCO). While *Gunga Din*'s crew did not hear a response to their VHF call, the Tartan 37C *Desna* (owned by Adam Van Voorhis), which was located approximately 18 miles away at the time, received the call and attempted a response. At that time *Desna* altered course to assist *Gunga Din*.

After cutting away the cabin table and lifting the small floorboard immediately aft of the mast, Alec Fye was able to observe water flowing aft from underneath the mast step through "a spiderweb of cracks… emanating from fissures at the mast base." He later clarified that water was seen flowing aft through cracks in the athwartship fiberglass hull grid supporting the mast step as will be further discussed below. The flow of water increased with forward motion of the vessel and slowed when stationary. Likewise, although the flow of water was significant when first discovered, Alec Fye saw it slow significantly after the vessel was stopped and the sails lowered.

With daybreak and *Desna* having arrived on scene, the crew of Gunga Din assessed their options. With water entering the hull directly beneath the mast step, there was no practical way to “plug” the leak from the outside. Accessing it from inside would require removing the mast step, which in turn, required removal of the mast itself. Therefore, with rescue at hand, skipper Bob Fye made the decision to abandon the vessel.[1] An orderly transfer was to the waiting *Desna* was conducted using *Gunga Din*’s life raft in two separate trips.

FIGURE 1 – Photo of *Gunga Din* taken during the abandonment. The headstay is noticeably slack.

BACKGROUND:

Robert (Bob) Fye purchased *Gunga Din* in 2020 from the estate of the late Dayton Carr. Mr. Carr had owned the vessel since 1994. She was built with a shoal-draft “winged” keel. Mr. Carr used the vessel for Corinthian racing and, desiring better performance, commissioned

[1] Note that according to Bob Fye, *Gunga Din* did contact Bermuda Radio by satphone during the morning of the 25th but was unable to arrange a tow from such great a distance.

Pedrick Yacht Designs in 2004 to design a suitable replacement keel of deeper draft and optimized to the IRC rule. We are fortunate that David Pedrick, while now semi-retired, has kept very good records and willingly volunteered them and his assistance to this investigation.

According to Pedrick, the project had time and budget constraints, and thus the new keel would utilize the existing footprint and keel bolt layout. The new keel would be 12-inches deeper and would not contain appendages ("wings"). The new keel would, however, increase the righting moment by approximately ten percent in addition to providing improved upwind performance associated with deeper draft. Pedrick considered the existing structure adequate to support the additional righting moment. The keel replacement was completed in the Spring of 2005 (see Figure 2 below).

FIGURE 2 – Original and 2005 replacement keel.

In order to maintain consistent vertical and longitudinal centers of gravity, the new keel contained an area of "deadwood" for most of the aft 2/3rds, while the forwardmost part was bolted directly to the hull for strength (Figure 3). On installation, the replacement keel fit the existing keel stub quite closely (Figure 4).

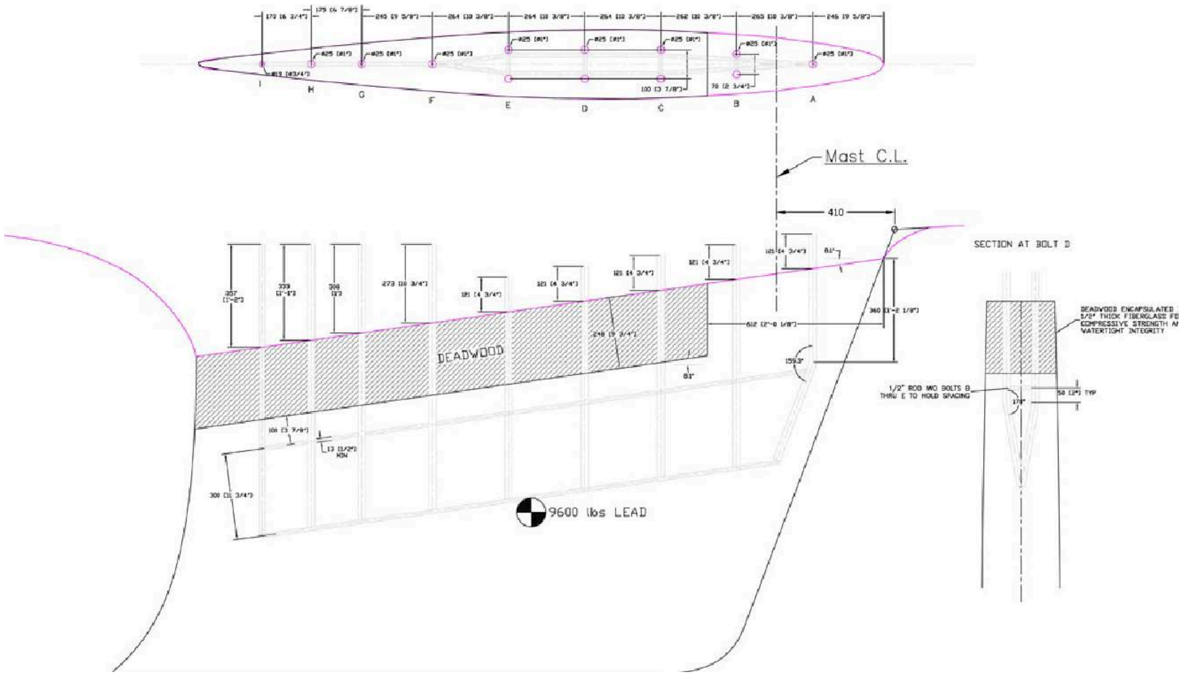

FIGURE 3 – Design drawings of the 2005 replacement keel on *Gunga Din*

FIGURE 4 – Note the tight fit of the replacement keel to the existing keel stub.

It is known that *Gunga Din* suffered two significant groundings, in 2019 and 2023. The first occurred while the vessel was racing under spinnaker and rounding Beavertail Point on Conanicut Island. Sailing World's "Doctor Crash" segment featured the incident in a subsequent issue, and Dayton Carr graciously responded. Among other things, he estimated the vessel came to a dead stop from approximately five knots of boat speed but reported she soon sailed off. He reported that a subsequent inspection showed little damage. Carr reported in his reply to "Doctor Crash" that the keel was inspected in water that night and out of the water a few days later. However, there is no mention of a substantial structural inspection of the area at that time.

Bob Fye reports *Gunga Din* struck a rock while transiting Woods Hole in July of 2023 while moving at approximately 2 knots. He, too, reports that the boat was hauled shortly thereafter and little apparent damage was noted. Also, Fye reported that as far as he knew, the fuel tank in the boat was original and he was unaware of whether the tank had ever been cleaned or the fuel polished.

Returning to the 2024 Bermuda Race, *Gunga Din* pounded heavily on starboard tack into steep, confused seas during her 18-hour passage through the Gulf Stream Saturday into Sunday. The crew noticed water accumulating in the bilge at times but reported the installed electric bilge pump kept the bilge mostly dry, and therefore they were not particularly concerned. The boat was reported to be shipping green water across the deck every ten minutes or so, which the crew believed was likely the source of the bilge water. As previously noted, the crew twice tightened the inner forestay and windward running backstay during the day before the incident in response to increased pumping in the aluminum mast.

<u>ANALYSIS:</u>

When Alec Fye located the water entering the vessel from underneath the mast step, he noted that the water appeared to be coming through a spiderweb of cracks in the bottom framing grid of the hull. As printed in Ferenc Mate's The World's Best Sailboats (1986), Sweden Yachts had adopted an integrated, molded hull bottom framing grid (Figure 5), an innovation at that time introduced by Pedrick Yacht Designs in 1979 after a request from Ericson Yachts for a more robust method to provide structural stability across the hull. According to Pedrick, this arrangement is "a molded grid of hollow, integral transverse and longitudinal ‘hat section’ framing… [with] ample contact area for bonding, consistency in materials and ease of manufacture.” It was quickly adopted by other manufacturers.

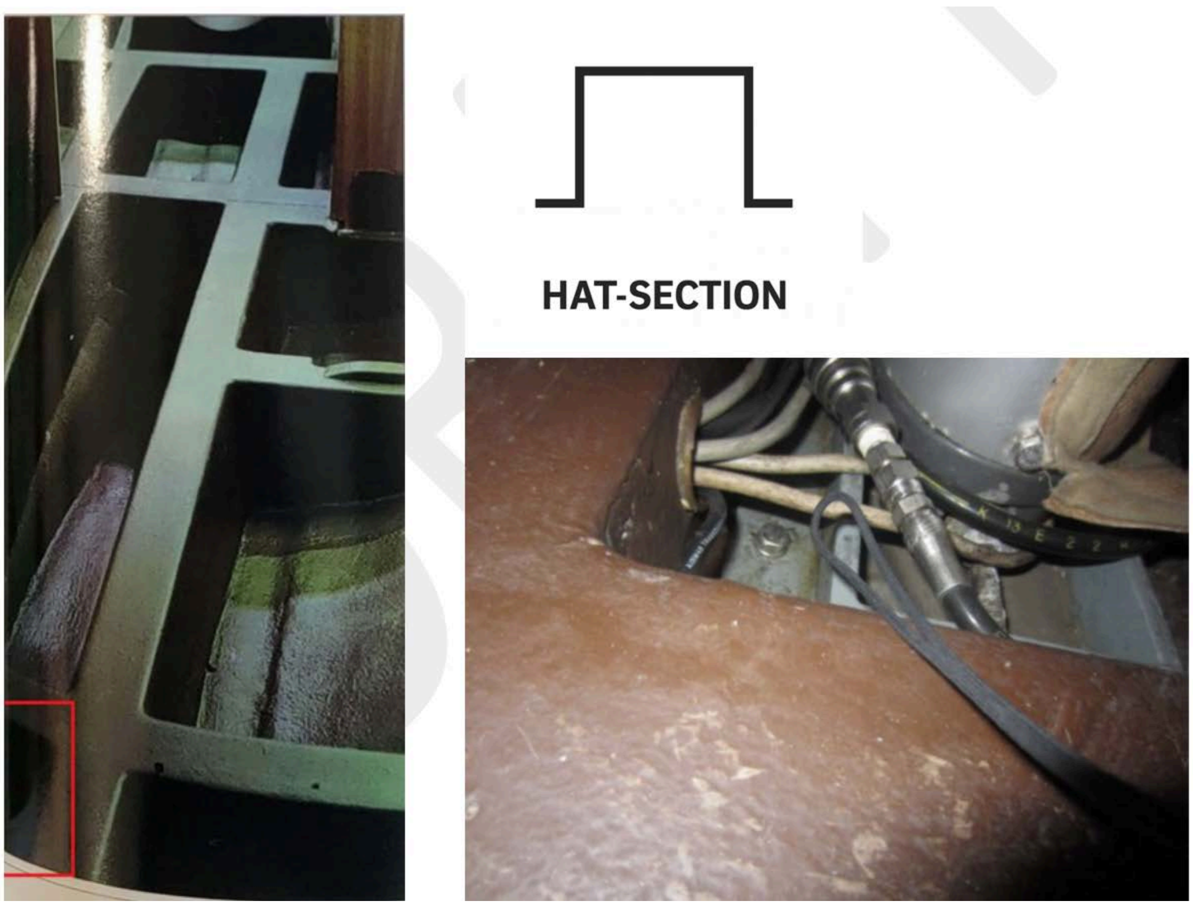

FIGURE 5 – Photo from Ferenc Mate’s **The World’s Best Sailboats** featuring the Sweden 41 with its innovative molded hull bottom framing grid. This photo shows a Sweden 41 under construction and shows the grid and keel root from forward looking aft. The red box indicates the location of the recess in which the mast step would later be installed. To the right is a depiction of a “hat section” and a photo of *Gunga Din*’s mast step recessed in the cavity.

As previously noted, Alec Fye had been relentless in his pursuit of the source of the water over a many hour period. He was equally relentless in describing to us what he saw, and he produced several very helpful diagrams (Figures 6-8). It should be noted, again, that when Alec located the leak, he was only able to see it by positioning his head sideways in the bilge and using a flashlight to peer underneath the mast step during periods in which the persistent flooding could be sucked dry by the emergency bilge pump.

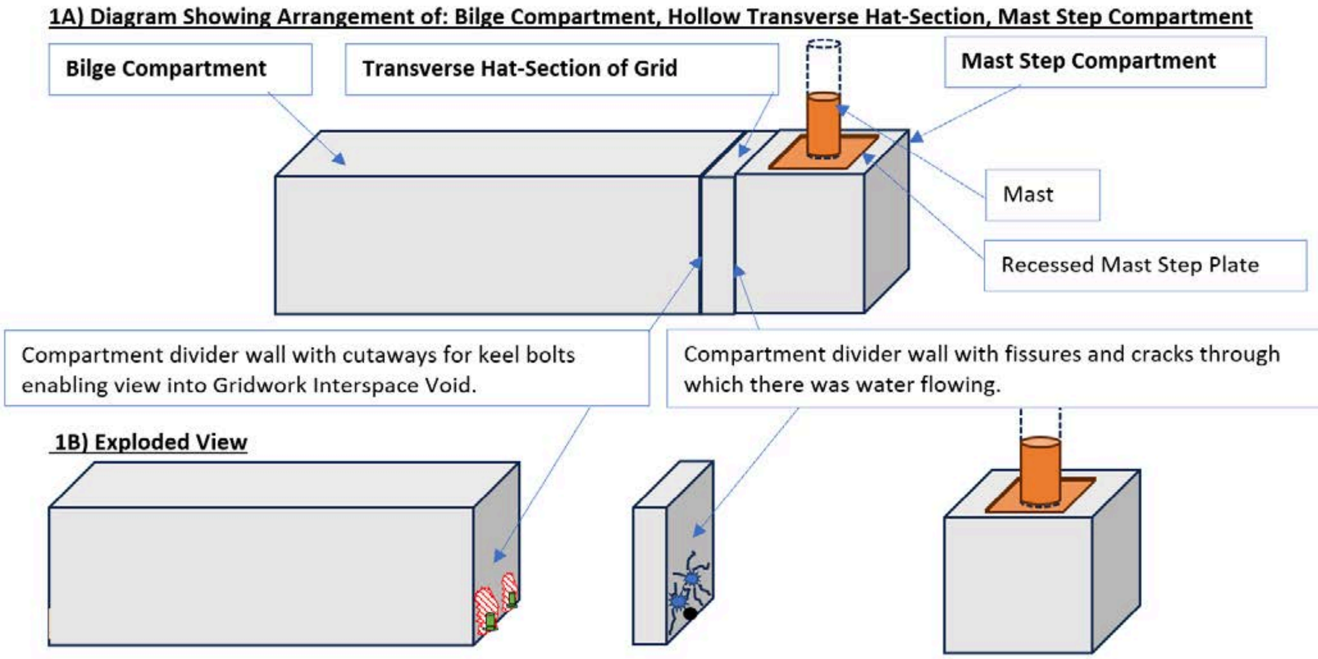

FIGURE 6 – Dr. Alec Fye's diagrams of the damage he observed.

Referring to Figure 6 and per Alec Fye's notes at the top, the set of boxes portrayed in 1A represents the space under the cabin sole (floorboards) that required removal of the salon table for access. The bow is to the right in this diagram. Although the spaces are drawn with enclosed sides, what's inside each box warrants explanation. The large, left box is the open-topped bilge bay between the inboard walls of the grid's longitudinals. The bilge bay's forward face is the same as the aft face of the next thin slice. The thin box represents the hollow transverse "hat-section" located at the after end of the mast step. This was part of the structural grid. The forward box represents the mast step compartment. The orange post and plate represent the mast and recessed heel plate.

The exploded view adds sketches of damage in both faces of the hollow "hat section." However, the damage was seen from aft. Details of damage have been sketched on their respective forward faces in Figure 6. The next two sketches (figures 7 and 8) show how these two faces appeared to Alec Fye when viewed from aft.

At this point, it is important to take note of modifications to the hull grid made by an unknown party at an unknown date. When Alec Fye looked forward from the open topped bilge bay (left box), he observed two jagged, crudely-cut holes in the aft face of the "hat-section" separating the open bilge bay from the mast step compartment. These holes, which may have been cut with a reciprocating saw around the time of the keel replacement, appear to have been made for the purpose of accessing the forwardmost pair of keel bolts. Alec Fye describes them each being approximately the size of a deck of cards. It was through these two holes that he could see the water streaming through a "spiderweb" of cracks in the forward face of the "hat-section."

It is a little unclear how these holes came to be, but it is possible that, although the new keel was designed to fit the existing bolt pattern, the forwardmost pair of bolts on the new keel were slightly forward of the old ones. Hence, the need to gain better access. It is equally possible they were made at some other time. Either way, these two jagged, irregular cutouts in a key structural member supporting the mast step most likely weakened it significantly – certainly compromising the designed strength and purpose of this key part of the structure.

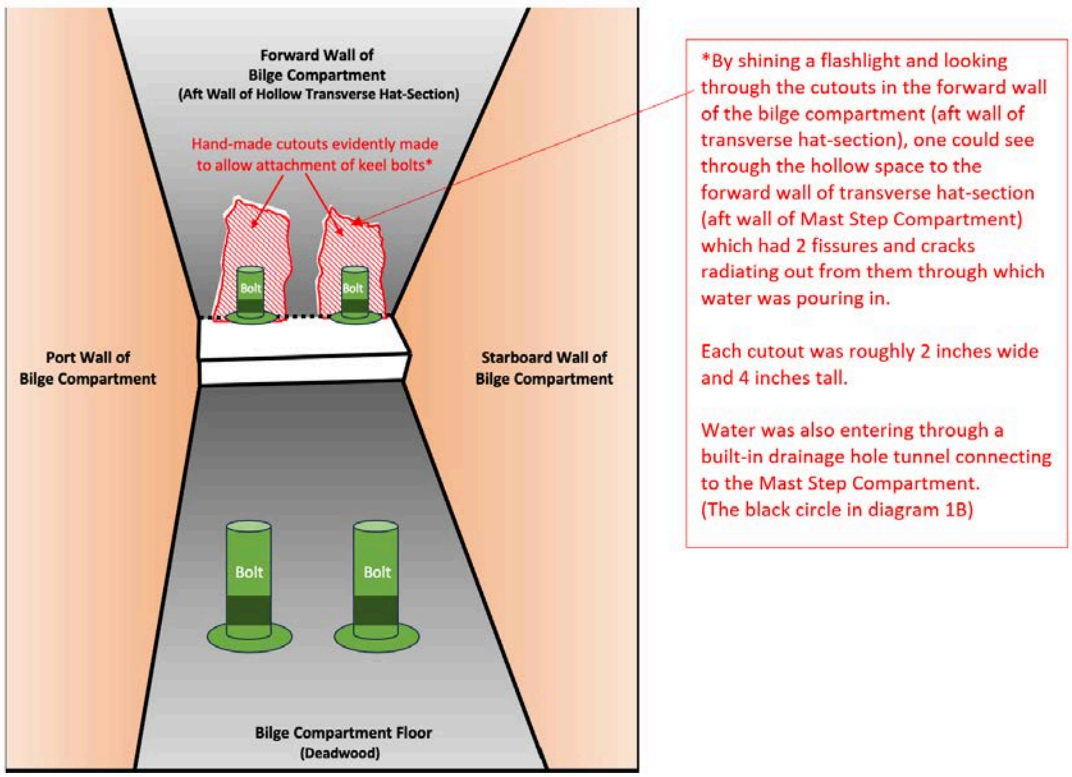

FIGURE 7 – Dr. Alec Fye's diagrams of the damage he observed.

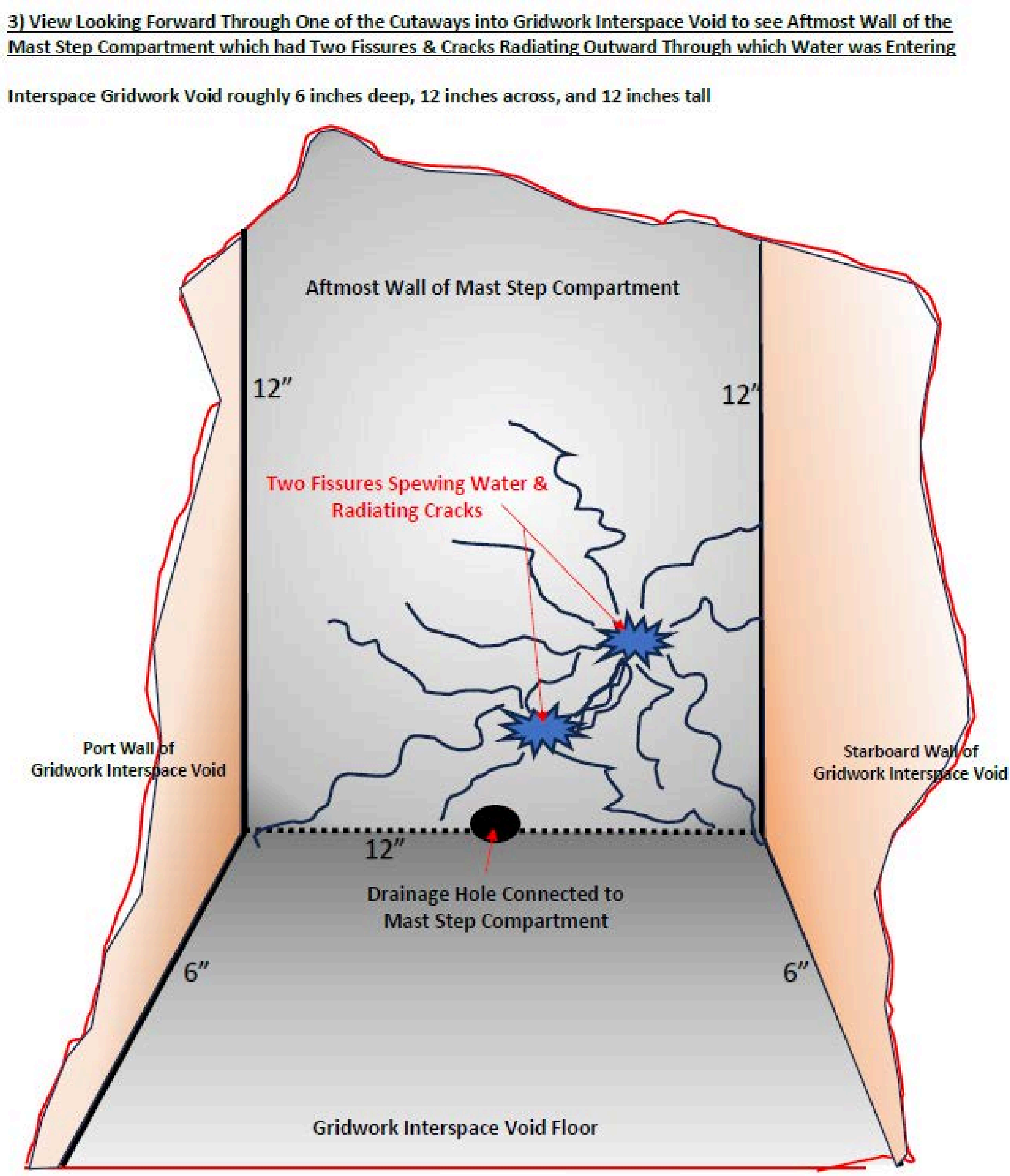

FIGURE 8 – Dr. Alec Fye's diagrams of the cracks he observed through which water was flowing. Note that water was also seen running aft through the pictured limber hole.

How did this spiderweb of cracks in the forward face of the "hat section" develop and what were its implications? As noted, this transverse member of the hull grid was directly aft of the mast step and in the area of the forwardmost pair of keel bolts. Although it cannot be said with certainty, the conditions leading to the formation of these cracks most likely have roots to the decision to cut crude access holes to better access the forwardmost pair of bolts.

The weakness in the hull grid created by these cutouts was then likely exacerbated by the two subsequent hard groundings as follows. When the toe of the keel impacts a rock at speed, the yacht's entire forward momentum rotates the hull bow-down. The aft end of the keel pushes up locally against keel's trailing edge region, while the keel's nose puts very high tension on the keel bolts at the connection to the keel stub. The yacht's rotation creates a very large upward buoyancy force in the bow that the forward keel bolts pull against. There is also a very large fore-and-aft shear load between the lead casing and fiberglass hull through the keel bolts.

The structural consequence of this is such that the nuts and washers on the forward keel bolts put very high downward stress into the immediate fiberglass hull. This can result in delamination fractures within the thickness of the fiberglass shell at the keel bolt holes, compression of the fiberglass and cracking in the resin. Additionally, the already weakened structure of the mast floor web provided diminished resistance to athwartships bending in the bottom of the keel stub from the surge in keel bolt tension. This causes permanent damage. Therefore, the combined effects of the modified hull framing grid structure exacerbated by the impact of two known groundings most likely weakened the area beneath the mast step to a degree that three days of heavy upwind pounding into steep, confused seas caused the mast to "jackhammer" its way into the weakened structure, ultimately causing catastrophic flooding. This process was apparent in hindsight in the gradual but visible loosening of the headstay, inner forestay and backstays that the crew observed, which indicated that the mast was being pushed down into the hull relative to the hull's chainplate foundations.

The exact nature of investigations undertaken after the first grounding in 2019 is unknown because few available records exist. Dayton Carr's letter to Dr. Crash indicates both in-water and out-of-water visual inspections were conducted after the incident. We know *Gunga Din* was surveyed at least three times between 2020 and 2024 by credentialed surveyors. However, even taken together, these investigations may not have been sufficient to determine the amount of damage. Visual inspections or even condition and valuation surveys may not indicate the potential extent of damage after a hard grounding or similar strike. A standard condition and valuation survey, such as one undertaken for a potential buyer or to determine a vessel's insurability, is not particularly invasive. Its purpose is to establish an overall record of what is visible to a surveyor in a few hours without extensive use of tools to remove panels or floorboard to expose what is behind them. An inventory of equipment is taken, a sea trial conducted and the hull is often tapped or gauged to determine the presence of moisture in the laminate. More comprehensive damage surveys, on the other hand, require full access to a known or suspected area of damage. When solid fiberglass laminates have been overloaded by impact or other sources of high stress, internal delamination of resin or fibers may be suspected. Such failure can be invisible except by ultrasound, radiography, dye-penetrant or taking hull samples. In addition, a damage surveyor must know when to recommend collaborating technical experts – including engineers, naval architects and boat builders – to fully understand the post-incident condition of the vessel.

As mentioned, delamination in thick laminates is usually not detectable visually. Nevertheless, removing all intervening furniture and visually examining the mast step area is the first thing to do. A haul-out with interior and exterior inspection by a qualified damage surveyor and/or a skilled fiberglass repair specialist would be the next option after a high-impact grounding. However, even such an inspection may not indicate the extent of damage. Therefore, it is highly recommended that in instances like this, the hull be further inspected by grinding back the gelcoat, taking hull samples and/or conducting electronic imagery.

We do know from interviews with the owner and Jamestown Boat Yard that *Gunga Din* was pulled from the water in November of 2023 for inspection and repairs. Photo evidence

(Figure 9) shows us that the yard performed some repairs to the intersection between the hull and keel, but those repairs do not appear to have extended into the hull itself. Therefore, it appears that while the intention and desire to investigate and repair the area prior to the 2024 Bermuda Race was there, the adjacent hull was not examined as part of the process. The easily accessible keel boats were also reportedly retorqued, but not the inaccessible ones.

FIGURE 9 – Photos of repairs to the hull – keel interface taken during November, 2023 repairs to the keel.

How did the weakened laminate manifest itself in a large inflow water? Without the evidence to inspect, we can only surmise. We know that in the day or so leading up to the abandonment, an increase in the amount of water accumulating in the bilge was observed. This could mean that a fore and aft crack had developed in the hull skin itself, most likely in the area of the keel root. When the rig was loaded up and the hull pounded into a sea, the stresses would open the crack, momentarily allowing more water in. Over time, the crack grows bigger to the point that water surges through it as evidenced by Alec Fye's observation of water "gushing" through the two holes in the aft web of the compromised "hat-section."

CONCLUSION:

Irrespective of the final mechanism for water ingress, this appears to be a classic circumstance of a chain of events occurring over many years and multiple owners leading to the sinking in June, 2024. *Gunga Din* was well-built to Lloyd's Register Hull Construction standards, which would have meant engineering, design and construction review. The keel was replaced in 2005, and we know of modifications to the hull grid apparently made to access certain keel bolts. In hindsight, when the need to better access the forwardmost keel bolts was encountered, either the bolts should have been recast or the structure in that area should have been properly modified to a naval architect's design. A 2019 grounding while racing under spinnaker does not appear to have triggered a structural inspection and likely only resulted in a cosmetic repair. A subsequent 2023 grounding resulted in an inspection of the upper portion of the keel but not the hull in that area. There is no evidence that the rig or cabinetry were removed between 2005 and 2024, meaning inspection from the inside was likely impossible. And the boat was sailed mostly coastally in the years leading up the Newport Bermuda Race and wet stored for the winter seasons, which can take a toll on compromised fiberglass laminate.

This accident may have been avoided, had the proper people known of the chain of events and the proper inspections been performed. Unfortunately, due to a change in ownership and boat yards, the full details probably were not known to any one party, and hindsight is 20/20. Every boat owner should be aware of this story and responsive to similar events in a boat's history. This case underscores the importance of thoroughly documenting, communicating, and independently verifying any significant structural changes to a vessel—particularly those involving the keel-hull interface—to safeguard long-term integrity.

The crew of *Gunga Din*, and especially Dr. Alec Fye, are to be commended for their dogged search for the source of water ingress. Dr. Fye's mental recordkeeping and subsequent explanation to the investigating committee, along with his impressive diagrams, were key to understanding what occurred in this circumstance. We are very grateful to him and the rest of the crew who spoke with us.

<u>RECOMMENDATIONS from the sinking of Gunga Din:</u>

1. The responsibility for maintaining a vessel's structural integrity over its lifetime is shared among owners, designers, builders, and surveyors, making careful documentation and transparent communication critical following any significant modifications. In this case, no single party was solely at fault; rather, the incident resulted from a convergence of factors. The loss of a well-built and well-maintained vessel under otherwise manageable conditions highlights how even small gaps in information can accumulate over time and how structural issues may remain undetected despite reasonable efforts. This case underscores the importance of comprehensive documentation, communication, and escalation to advanced inspection techniques when a vessel has undergone structural modification, even if no obvious signs of damage are present.

2. While Condition and Valuation surveys play an important role in assessing a vessel's overall condition, it is important to recognize their limitations. These inspections are not intended to be invasive and almost always do not include removal of furniture. Although *Gunga Din* underwent multiple professional surveys between 2019 and 2023, the hidden structural vulnerabilities were not identifiable through routine survey practices. This case highlights the importance of heightened scrutiny and targeted structural inspections when a vessel has a history of significant modifications or grounding events, even when routine surveys suggest satisfactory condition.

3. It is highly recommended that after a hard grounding a vessel be inspected by a qualified party who will grind back the gelcoat, take core samples and/or conduct ultrasound imagery. Visual inspection after such incidents is not adequate to unmask the potential scope of damage.

4. *Gunga Din*'s main salon cabin arrangement (captive around the mast) made accessing all areas of the bilge and all keel bolts nearly impossible. This is not ideal for ocean-going sailboats. It is recommended that all areas of the bilge be easily accessible (within minutes) and thorough inspection be conducted at least annually.

5. The American Bureau of Shipping (ABS) withdrew from oversight of recreational vessel construction and modification in the United States many years ago. In Europe, the Recreational Craft Directive and associated ISO standards fill this gap, and many newer production boats built worldwide meet these requirements and are subject to them upon significant structural modification. World Sailing includes a plan review process in the Offshore Special Regulations ("OSR") for newer builds as well. Older vessels which predate these practices present a challenge for Race Organizers. It is recommended that all vessels considering voyages such as the Newport Bermuda Race be compliant with one of these current standards.

6. The Newport Bermuda Race Safety Requirements ("NBRSR") is the document that specifies minimum vessel construction standards, safety gear and training for the race. This document is modeled after the US Sailing Safety Equipment Requirements ("USSER") which is promulgated by US Sailing as a standard set of safety requirements for use by offshore races. World Sailing publishes its own set of safety requirements called the World Sailing Offshore Special Regulations. Neither the 2024 USSER or NBRSR required a keel and rudder inspection, while the World Sailing OSR had adopted a keel and rudder inspection requirement (3.02.2 Structural Inspection) in 2020. The 2025 version of the USSER has now adopted a similar requirement, and it is this panel's recommendation that the Newport Bermuda Race specify a similar requirement for the 2026 race.

7. Similarly, World Sailing Offshore Special Regulation 4.30 (Emergency Pumps) specifies that vessels carry "either [a] fixed or portable pump to remove ingress water from any compartment…[that] shall have a minimum rated capacity of 200 l/m (3,200 US gal/min)… [and] be operated by battery, main engine powered or

separate engine." Notably, both *Alliance* and *Gunga Din* carried such pumps despite it not being a requirement in the 2024 NBRSR. We recommend the Newport Bermuda Race specify such a requirement for the 2026 race.

8. The crews of both *Alliance* and *Gunga Din* reported that the high-capacity pumps carried for emergency response were fitted with collapsible discharge hoses. Both crews encountered difficulty operating these pumps at capacity due to unanticipated "kinks" in the discharge hose where it exited the cabin. We recommend that crews anticipate this problem and devise effective solutions to mitigate it before embarking on a passage. At a minimum, this will require ample practice and could require alternative equipment from that supplied by the manufacturer.

9. As documented above, *Gunga Din* was unable to keep the engine running long enough to charge the batteries and operate the pumps. The crew reported changing clogged fuel filters at least three times, indicating a build-up of sediment in the fuel tanks that likely came loose in the confused seas. It is recommended that any vessel preparing to voyage offshore perform a thorough clean-out of the fuel tanks.

S/V Alliance

THE SINKING:

Alliance was a 2007 J/122 owned by Eric Irwin and Mary Martin. She was built by J Composites in Les Sables d'Olonne, France, to CE Category A. *Alliance* had participated in numerous offshore and overnight races, including the 2022 Newport Bermuda Race. Her crew was known to be well trained, and eight of the nine had taken an International Offshore Safety at Sea course.

In the early morning hours of June 23rd, 2024, while approximately 300 nm from Newport, *Alliance* was sailing on a close reach in +/-20 knots of wind. Because she was in the Gulf Stream, Alliance faced moderate seas (10-12') of short duration. On watch in the cockpit were four crewmembers who reported feeling one and possibly two sudden motions concurrent with a loud "metallic" banging noise at approximately 0248 Eastern Daylight Time. Helmsperson Lydia Mullan immediately felt the wheel no longer effectively controlled the rudder. Watch Captain Conor O'Neil called for all hands on deck, while Bill Kneller (main trim) rushed aft and opened the lazarette hatch to expose the steering gear. Kneller witnessed significant water in the vicinity of the rudder stock. The rudder stock itself was no longer supported at the upper bearing and was pivoting at the lower bearing. A picture taken approximately 40 minutes after the incident (Fig. 1) appears to show that the stock had dropped approximately three inches as evidenced by the apparent vertical displacement of the autopilot tiller arm below the end of the autopilot ram.

Figure 1 This picture, taken approximately 40 minutes after the incident, shows the damage and flooding to Alliance. The upper rudder bearing is visible mid-picture above the autopilot tiller arm, having slid down the rudder stock from its original position in the cockpit sole.

Eric Irwin, who had been asleep on the main salon cabin sole, immediately crawled aft in the starboard quarter berth and opened the hatch to the steering compartment. He reports seeing water and shards of fiberglass. The structure containing the lower rudder bearing had reportedly “rotated” forward, consistent with striking an object submerged beneath the vessel. Irwin observed a breach in the hull just forward of the lower bearing through which water was rushing. There was also a distinct burning smell which he and several others likened to the smell of a fiberglass fire.

After brief consultation with co-owner Mary Martin, it was agreed a Mayday should be issued, and Martin manned communications from that point forward until the vessel was abandoned. With all nine crewmembers awake, approximately half worked to lower sails and stabilize the boat while the remainder worked to energize pumps and dewater the vessel. A 1,000 gallon-per-hour (gph) electric pump was deployed within seven minutes of the incident, followed by a second, 3,700 gph pump shortly thereafter. Two crewmembers went forward to lower the J2 headsail, while the main was left hoisted. Although on starboard tack at the time of the incident, without steering the vessel tacked itself onto port and settled on a broad reach abeam to the seas.

The J/121 *Ceilidh* skippered by James Coggeshall heard the initial Mayday call and altered course toward Alliance's position. She observed *Alliance* on AIS at a distance of approximately 3nm and later received a DSC distress call position. Similarly, the Archambault 40RC *Banter* skippered by Matthew Gimple received the Mayday call and also altered course. By the time Ceilidh had arrived alongside, the crew of *Alliance* had determined to abandon ship, which was accomplished by liferaft transfer of all nine crewmembers to Ceilidh. All were safely aboard the rescue vessel by 0406 EDT. The last report from *Alliance's* Yellowbrick position tracker was received at 0530, after which she presumably sank.

Figure 2 The last known photograph of Alliance taken by a passing competitor shortly after dawn June 23rd.

BACKGROUND:

Alliance had been well prepared by her CCA-member owners. During the winter and spring of 2024, the rudder had been removed and the lower bearing replaced. The upper bearing was inspected and deemed serviceable. Because she had raced in the 2023 Marblehead to Halifax Race, *Alliance* had a keel and rudder inspection done by a marine surveyor in compliance with World Sailing Offshore Special Regulations section 3.02.2 (Structural Inspection) the previous winter. The same surveyor conducted two inspections during the winter of 2023-24, one of *Alliance's* disassembled rudder components and a final inspection once all work was completed prior to launching.

The crew was made up of nine people, including the co-owners as follows:

Eric Irwin (Owner and Person in Charge)
Mary Martin (Owner, Reserve Person in Charge and Navigator)
Conor O'Neil (Watch Captain)
Sam Webster (Watch Captain)
Ed Doherty
Lydia Mullan
Bill Kneller
Julija O'Neil
Mary Schmitt

The crew had sailed together often over the previous two years and held monthly videoconferences during the winter to coordinate preparations. All had sailed together in the Samuel Wetherill Race in May, prior to the Bermuda Race. Alliance was one of several vessels participating in a documentary to be produced about the 2024 Newport Bermuda Race and thus had a camera mounted on the backstay recording continuously.

At the time of the incident, *Alliance* was sailing southeast in the Gulf Stream meander making between 11.7 and 13.2 knots over the ground per the Yellowbrick tracker. On deck were Watch Captain Conor O'Neil, Julija O'Neil, Bill Kneller and Lydia Mullan. The others were below, and all report being asleep at the time of the incident. Conor O'Neil describes the impact as follows: "I felt something weird…we came off a wave, and what we hit was not a wave. I felt it right under the primary winch where I was sitting, "and then I looked back and in that moment is when we hit with the rudder." He continued, "I definitely saw Lydia [Mullan] hit the wheel… and it jerked from her hands." Mullan described the moment , "I initially didn't realize that it was an impact with something, like the first split second I was like, 'Did we like rip the mast track, did we pull the mainsheet out of the floor?' Because I felt the jolt and I heard the sound but I didn't – it wasn't immediately obvious to me that it was an impact below."

Because no one saw it, it cannot be stated conclusively that *Alliance* made contact with a submerged object. However, it seems likely they could have based on the details provided by the crew and additional information subsequently uncovered about the event. Watch Captain O'Neil reported possibly seeing the sharp corner of an object in the vessel's wake, which he initially thought was the rudder having come adrift. Mullan reports the sound as "metallic… It was definitely not a whale." The documentary video, which was recovered by the crew before they abandoned the vessel, is not particularly helpful in this manner. In addition to the footage being very dark, the ambient noise captured by the camera makes it difficult to identify any clues aside from the sound of the failure.

Asked to describe the motion of the boat immediately before the failure, both Conor O'Neil and Mullan describe the boat sliding sideways off a wave in such a manner that could explain why an object in the water would not have hit the keel before the rudder. Notably, multiple crewmembers believe there could have been two impacts. Although neither confirmed it at the time, both Irwin and Conor O'Neil believe that there might have been a second breach of the hull farther forward – presumably from the "first" impact – which would explain why the water was rising so quickly, even after a combined 4,700 gph pumping capacity (78.3 gpm) was deployed.

ANALYSIS:

This committee was unable to determine the exact sequence of events with respect to the failure of the upper and lower rudder bearings. Therefore, we are unable to definitively say whether one failed before the other, what caused the failures and therefore whether the failure of one led to the failure of the other. Multiple scenarios exist which could have led to the results *Alliance* documented, and this report does not attempt to identify the specific sequence of events. Presented below are multiple scenarios which lead to similar lessons for the offshore sailor.

It is known that the incident caused the upper rudder bearing to tear away from the cockpit sole where it was mounted and slide down the rudder shaft. At about the same time, movement of the rudder stock rotated the lower bearing housing and opened up a hole in the hull just ahead of it.

Figure 1 above shows that the upper bearing was intact when it slid down the rudder shaft and the mounting bolts remained in place. There is evidence of fiberglass and compound still attached to the mounting bolts, which could explain the burning smell Irwin and others noted immediately after the incident. It is likely the force required to unseat the bearing and the violence with which it became dislodged created tremendous heat in the surrounding structure, causing the “fiberglass burning” odor.

The lower rudder bearing was a self-aligning JP3 bearing manufactured in France. As previously mentioned, it had been replaced by a boat yard during the winter of 2023-4. Interviews with the technician who conducted the replacement did not indicate anything out of the ordinary was discovered during the process.

Figure 3 A photograph of the lower bearing on *Alliance* and its fiberglass and aluminum housing. This picture is taken from aft looking forward. Note the longitudinal support immediately aft of the structure.

When the lower bearing was replaced, the upper bearing was inspected. However, it was not removed or otherwise disturbed. The technician who inspected it did report that there was “slight” delamination in the skin coat, but this did not raise a concern, and the bearing appeared to be structurally sound. Notably, during a test sail that spring, Eric Irwin observed movement in the mounting flange of the upper bearing as viewed from above deck. He and Bill Kneller subsequently removed the six allen-head fasteners which were secured below deck by lock nuts, lifted the collar to re-bed it with compound and then resecured it. No further movement was noticed after that time.

Figure 4 The upper rudder bearing aboard *Alliance* when viewed from on deck. Note that the bearing is located immediately aft of the wheel well (visible) in the cockpit sole and is normally covered by a removable fiberglass plate.

As previously discussed, the upper rudder bearing on *Alliance* was flush mounted in a composite panel and secured by six through-bolted fasteners ("mounting bolts"). The opening in which the bearing was mounted was slightly larger than the outside diameter of the external vertical face of the bearing, such that when the fasteners were removed to re-bed the bearing in the spring of 2024, the bearing could be moved fore and aft and athwartships by "about 4 to 5 mm" according to Kneller. We have found that this is a common practice among vessels of similar vintage across a number of manufacturers. The result is that the horizontal forces exerted on the bearing are supported solely by bedding compound (if any) and the mounting bolts and not the deck structure surrounding it.

According to representatives of PYI, the US distributor for JEFA rudder bearings, the upper bearing mounting bolts are not designed or engineered to support the significant horizontal loads imposed by the forces of a deep rudder maneuvering in a large seaway.

Therefore, PYI recommends that the bearings be tightly fitted within the supporting structure such that the loads may be spread across a greater framework of support. Because the mounting bolts are not designed to support the lateral loads, they may loosen or fail altogether, leading to a loss of rudder support at the upper bearing.

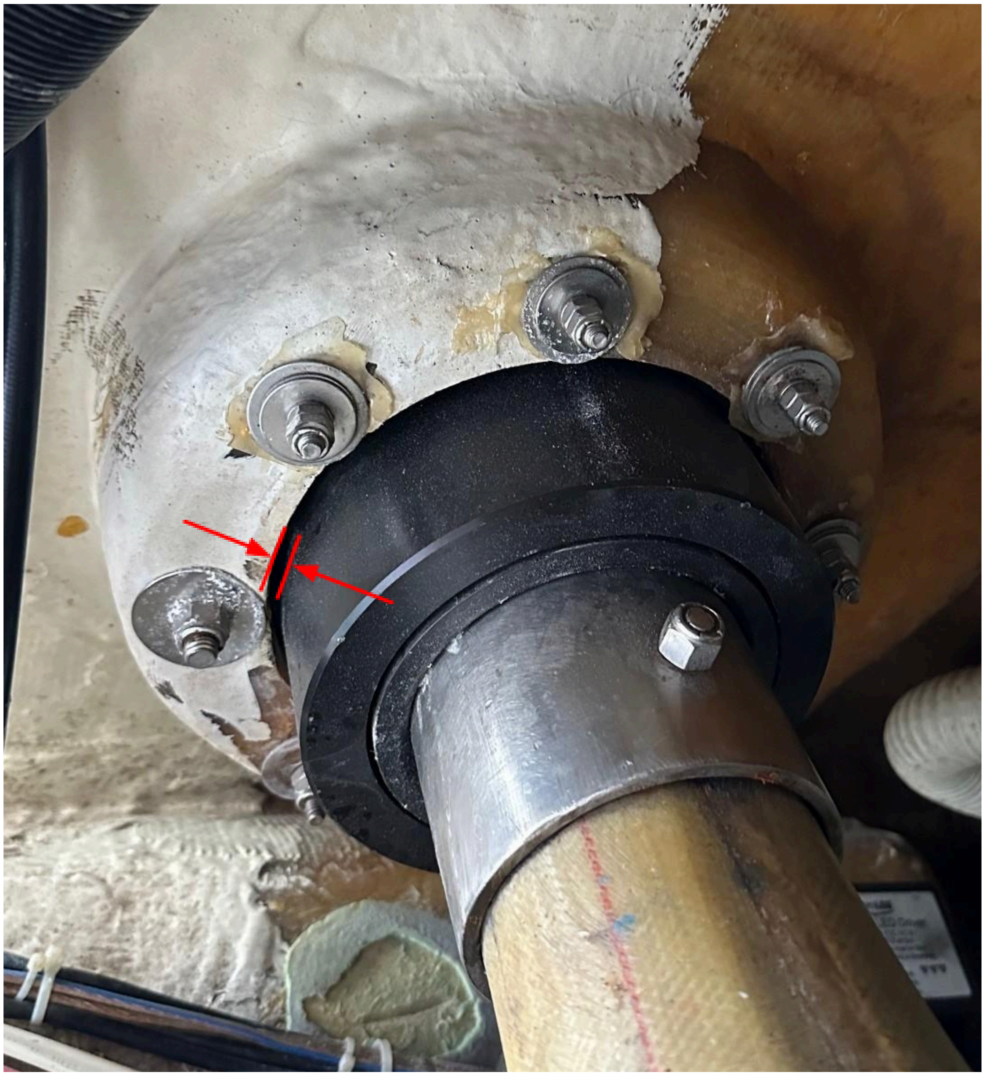

Figure 5 A loose-fitted upper rudder bearing (vessel type not specified). Note the gap between the external face of the bearing and the structure in which it is mounted. In this case, all lateral loads are dependent on the through-bolted fasteners.

Figure 6 Photo supplied by PYI, Inc., of a properly fitted upper rudder bearing (vessel type not specified). Note the tight tolerance between the outside of the bearing and the surrounding deck structure.

In our review, we identified at least two other vessels participating in the 2024 Newport Bermuda Race – *Ceilidh* and *Young American* – that encountered similar issues with upper rudder bearings becoming adrift. These are further discussed below.

Through the willing cooperation of J/Boats, we received information regarding construction of *Alliance* and other J/122s. This included lay-up schedules for the deck and drawings of the rudder installation. Using that information, we were able to calculate the approximate loads the upper bearing was subjected to as a function of boat speed and rudder angle (see Figure 7). With the knowledge that each of the six 6mm stainless steel mounting bolts would be subject to shearing at approximately 400 Megapascals (Mpa) of load, we were then able to compare the anticipated load on all six fasteners to the likely force exerted on the bearing under the observed conditions. The result is that a single bolt is subject to shear-failure at moderate conditions (more than 8-degrees of rudder angle at 8-knots, for instance), but the cumulative strength of all six bolts if evenly loaded presents much greater resistance.[2] In the case of Alliance, and referring to Figure 1 above, it is clear the failure was not in the fasteners which can be seen to be intact after the accident.

STRESS IN STEEL

As 20.1 STRESS (Mpa) IN 6mm DIA 316L FASTENER AT TOP BRNG AS A FUNCTION OF BOATSPEED AND RUDDER ANGLE

BOAT SPEED \ RUDDER ANGLE	1	2	3	4	5	6	7	8	9	10	11	12
1	1	2	2	3	4	5	5	6	7	8	8	9
2	3	6	9	12	15	18	21	24	27	30	34	37
3	7	14	21	27	34	41	48	55	62	69	75	82
4	12	24	37	49	61	73	85	97	110	122	134	146
5	19	38	57	76	95	114	133	152	171	190	209	228
6	27	55	82	110	137	165	192	219	247	274	302	329
7	37	75	112	149	187	224	261	299	336	373	411	448
8	49	97	146	195	244	292	341	390	439	487	536	585
9	62	123	185	247	308	370	432	494	555	617	679	740
10	76	152	228	305	381	457	533	609	685	762	838	914
11	92	184	276	369	461	553	645	737	829	922	1014	1106
12	110	219	329	439	548	658	768	877	987	1097	1206	1316
13	129	257	386	515	644	772	901	1030	1158	1287	1416	1545
14	149	299	448	597	746	896	1045	1194	1344	1493	1642	1791
15	171	343	514	685	857	1028	1200	1371	1542	1714	1885	2056
16	195	390	585	780	975	1170	1365	1560	1755	1950	2145	2340
17	220	440	660	880	1101	1321	1541	1761	1981	2201	2421	2641
18	247	494	740	987	1234	1481	1727	1974	2221	2468	2714	2961
19	275	550	825	1100	1375	1650	1925	2200	2475	2750	3024	3299
20	305	609	914	1219	1523	1828	2133	2437	2742	3047	3351	3656

Figure 7 Calculated force on upper rudder bearing on *Alliance* as a function of ruder angle and boat speed. Red indicates failure potential for a single 6mm fastener.

We then compared the required thickness of a single skin of fiberglass to support the calculated loads in the vicinity of the upper bearing (Figure 8). With an assumption that the rudder would "stall" (presenting maximum load on the bearing) at 12-degrees and the vessel reportedly moving at up to 10-knots through the water when the failure occurred, it was determined that a minimum of 2.1 mm of solid fiberglass would be required to absorb the anticipated loads. The layup schedule provided by J/Boats appears to show more than twice that in the vicinity. Hence, the fiberglass in which the bearing was mounted appears to have been of sufficient strength, but it is beyond the scope of this inquiry to comment on how much of a safety margin should be designed into a load-bearing panel such as this.

[2] Note that scenarios exist under which a single bolt would shear when acting as the primary load-bearing fastener before dragging through the fiberglass enough to spread the load to the next bolt and so on. This in theory could cause a cascade of events ending in the failure of all fasteners progressively and, ultimately, the entire installation.

Similarly, the presence of non-structural “filling” compound in the installation could also compromise strength, but we are not in a position to evaluate its role in this matter.

STRESS IN GLASS

MINIMUM REQUIRED GLASS SKIN THICKNESS(mm) FOR ALLOWABLE STRESS FROM (6) x 6mm FASTENERS

BOAT SPEED \ RUDDER ANGLE	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
2	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.08
3	0.02	0.03	0.05	0.06	0.08	0.10	0.11	0.13	0.14	0.16	0.17	0.19
4	0.03	0.06	0.08	0.11	0.14	0.17	0.20	0.23	0.25	0.28	0.31	0.34
5	0.04	0.09	0.13	0.18	0.22	0.26	0.31	0.35	0.40	0.44	0.49	0.53
6	0.06	0.13	0.19	0.25	0.32	0.38	0.44	0.51	0.57	0.64	0.70	0.76
7	0.09	0.17	0.26	0.35	0.43	0.52	0.61	0.69	0.78	0.86	0.95	1.04
8	0.11	0.23	0.34	0.45	0.56	0.68	0.79	0.90	1.02	1.13	1.24	1.36
9	0.14	0.29	0.43	0.57	0.71	0.86	1.00	1.14	1.29	1.43	1.57	1.72
10	0.18	0.35	0.53	0.71	0.88	1.06	1.24	1.41	1.59	1.76	1.94	2.12
11	0.21	0.43	0.64	0.85	1.07	1.28	1.49	1.71	1.92	2.14	2.35	2.56
12	0.25	0.51	0.76	1.02	1.27	1.52	1.78	2.03	2.29	2.54	2.79	3.05
13	0.30	0.60	0.89	1.19	1.49	1.79	2.09	2.39	2.68	2.98	3.28	3.58
14	0.35	0.69	1.04	1.38	1.73	2.08	2.42	2.77	3.11	3.46	3.80	4.15
15	0.40	0.79	1.19	1.59	1.99	2.38	2.78	3.18	3.57	3.97	4.37	4.76
16	0.45	0.90	1.36	1.81	2.26	2.71	3.16	3.61	4.07	4.52	4.97	5.42
17	0.51	1.02	1.53	2.04	2.55	3.06	3.57	4.08	4.59	5.10	5.61	6.12
18	0.57	1.14	1.72	2.29	2.86	3.43	4.00	4.57	5.15	5.72	6.29	6.86
19	0.64	1.27	1.91	2.55	3.18	3.82	4.46	5.10	5.73	6.37	7.01	7.64
20	0.71	1.41	2.12	2.82	3.53	4.23	4.94	5.65	6.35	7.06	7.76	8.47

Figure 8 – Required glass thickness as a function of rudder angle and boat speed.

It should be noted that the calculations presented above are necessarily approximate and assume uniform loads (flat water). The dynamic nature of a vessel at sea means that the actual loads encountered are probably significantly greater. Likewise, although the composite structure of the panel containing the bearing appears at first glance to be adequately robust, the unique geometric attributes associated with it being recessed in a small cavity below the cockpit present considerations that could require additional analysis. For instance, the single skin of the side faces of the bearing recess may have allowed enough movement of the entire assembly under load to “work” the fasteners in the glass and thereby loosen the interface between the bearing and panel. This was not investigated further.

As previously discussed, we identified two other vessels in the 2024 Newport Bermuda Race that encountered issues related to the upper rudder bearing losing support. During the morning of June 23rd, shortly after rescuing the crew of *Alliance*, the crew aboard the J/121 *Ceilidh* noticed movement in the flange of the top bearing manufactured by Jefa (note that, similar to *Alliance*, the top bearing of Ceilidh is mounted in the cockpit sole aft of the helm). The top bearing on *Ceilidh* was secured by four throughbolts with lock washers on the underside. When a crewmember went to tighten the throughbolts, he found two of the four had sheared completely at their heads. The crew located two similar bolts in the ship's spares, but less than an hour after replacing them, they noticed the flange moving again. Fearing the remaining bolts would also shear, the crew drilled four additional holes in the flange and into the solid fiberglass panel below it, which they used to add an additional four large self-tapping screws. This arrested any further movement of the flange and held until they arrived in Bermuda.

Figure 9 The repaired bearing aboard *Ceilidh*.

Similarly, the crew of the double-handed entry *Young American* noticed movement of the upper bearing but faced no additional problems after tightening the fasteners and monitoring the condition closely. The bearing on *Young American* was manufactured by Harken and contained eight mounting bolts through-bolted in the cockpit seat aft of the wheel. Similar to *Alliance* and *Ceilidh*, the bearing was loose-fitted in an oversized opening.

Several other vessels entered in the 2024 Newport Bermuda Race encountered steering gear issues. These included lost steering sheaves and wire rope failures, a crack in the housing surrounding a lower bearing and failure of structural supports at an upper bearing. The preponderance of steering failure points to the importance of regular maintenance for these vital systems.

A pin through the rudder shaft immediately above the lower bearing provides vertical support for the assembly, keeping the rudder from dropping out of the boat. Therefore, at least theoretically, the apparent approximate three-inch drop of the rudder assembly evidenced in Figure 1 is instructive. It is possible the drop is simply an optical illusion resulting from the angle the photo is taken from. For the rudder assembly to have dropped during the incident, either the pin would have to have become dislodged or the entire lower rudder bearing unit would have had to have dropped in relation to its original position in the hull. Once again, without the evidence to examine in hindsight, it is difficult to say exactly how this could have happened.

CONCLUSION:

The investigation was not able to determine definitively whether *Alliance* struck a submerged object. The calculations we were able to perform with the information provided to us by J/Boats certainly indicate that an external force could have been present. However, whether the vessel impacted a floating object is less important than the valuable lessons learned. It is known that *Alliance* suffered a catastrophic failure of boat structure at the upper rudder bearing accompanied by a tremendous amount of heat, causing the rudder shaft to lose support at the deck. At approximately the same time, the shaft pivoted at the lower bearing under the pressure from the rudder below, opening a breach in the hull that could not be stemmed by the crew, resulting in abandonment of the vessel.

RECOMMENDATIONS from the sinking of *Alliance*:

There are several lessons from the above incidents worth noting and being considered both by the Bermuda Race Organizing Committee and future competitors:

1. With advances in technology and design, critical components are facing increased point loads in normal sailing conditions. Design evolution to open-transom boats lowers the upper rudder bearing to the cockpit sole, necessarily creating significantly higher stresses on it due to the shortened lever-arm. As a result, proper structural engineering and bearing installation are paramount. Rudder bearings ought to be installed in strict compliance with manufacturer specifications. Upper bearings should be mounted in such a way that the significant forces on them are spread appropriately through sufficient surrounding deck or hull structure. This includes a tight fit between the bearing and the structure it is mounted in.

2. Owners, service providers, professional inspectors, and surveyors of offshore racing vessels should inspect the installation of the upper rudder bearing (if so fitted) to ensure the bearing fits snugly into the structure that houses it such that it is not dependent on the mounting bolts for lateral support. Provisions should be made to reinforce the bearing installation to more effectively transfer the lateral stresses on the bearing to the structure around it.

3. Rudder bearings require maintenance. Detailed instructions can be obtained from the bearing manufacturer, but it is recommended that the rudder be dropped so the bearings and surrounding structure can be inspected and cleaned at least every three years. Any difficulty or change in steering performance should be investigated immediately.

4. Steering systems installed in offshore vessels require maintenance. Check with the manufacturer of the vessel or specific steering system for appropriate intervals for general system inspections and replacement. Maintenance intervals include

inspecting the pedestal mechanism that converts the rotation of the wheel into rudder movement, inspecting and lubricating the chain and wire rope components and visually inspecting the pulleys, clevis pins, cotter pins, turnbuckles, etc.

5. The Newport Bermuda Race Safety Requirements ("NBRSR") is the document that specifies minimum vessel construction standards, safety gear and training for the race. This document is modeled after the US Sailing Safety Equipment Requirements ("USSER") which is promulgated by US Sailing as a standard set of safety requirements for use by offshore races. World Sailing publishes its own set of safety requirements called the World Sailing Offshore Special Regulations. Neither the 2024 USSER or NBRSR required a keel and ruder inspection, while the World Sailing OSR had adopted a keel and rudder inspection requirement (3.02.2 Structural Inspection) in 2020. The 2025 version of the USSER has now adopted a similar requirement, and it is this panel's recommendation that the Newport Bermuda Race include a similar requirement for the 2026 race.

6. Similarly, World Sailing Offshore Special Regulation 4.30 (Emergency Pumps) specifies that vessels carry "either [a] fixed or portable pump to remove ingress water from any compartment…[that] shall have a minimum rated capacity of 200 l/m (3,200 US gal/min)… [and] be operated by battery, main engine powered or separate engine." Notably, both *Alliance* and *Gunga Din* carried such pumps despite it not being a requirement in the 2024 NBRSR. We recommend the Newport Bermuda Race include such a requirement for the 2026 race.

7. The crews of both *Alliance* and *Gunga Din* reported that the high-capacity pumps carried for emergency response were fitted with collapsible discharge hoses. Both crews encountered difficulty operating these pumps at capacity due to unanticipated "kinks" in the discharge hose where it exited the cabin. We recommend that crews anticipate this problem and devise effective solutions to mitigate it before embarking on a passage. At a minimum, this will require ample

practice and could require alternative equipment from that supplied by the manufacturer.

8. Most boats racing in the Newport Bermuda Race are not designed with a watertight bulkhead to isolate the steering compartment in the event of flooding. As a result, a breach in the steering gear may result in flooding of the entire vessel. While not practical across all existing ocean-racing vessels, we recommend that designers, builders and refitters of offshore racing vessels consider installing a watertight bulkhead and/or a sufficiently high cofferdam surrounding the rudder stock and rudder bearings.