# United States Coast Guard

## Investigation into the S/V KIELE V Dismasting and Personnel Casualty

## On 03/25/2007

MISLE Activity Number: 2895732

U.S. Department of Homeland Security
United States Coast Guard

Commandant
United States Coast Guard

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16732
23 April 2009

**INVESTIGATION INTO THE S/V KIELE V DISMASTING AND PERSONNEL CASUALTY ON MARCH 25, 2007**

## ACTION BY THE COMMANDANT

The record and the report of the investigation into the subject casualty have been reviewed. The record, including the findings of fact, analysis, conclusions, and recommendations are approved subject to the following comments.

## ACTION ON RECOMMENDATION

Recommendation: Recommend Commandant draft and implement policy guiding the process related to mast and rigging inspections on inspected sailing vessels based on the conclusions as described in the ROI. Guidance should include, but not be limited to, rig tuning, non-destructive testing of the mast step and attachment points of the standing rigging, and the periodic frequency of unstepping the mast for inspection. This would provide standard guidance for both industry and Coast Guard inspectors on how to maintain and inspect commercial sailing vessels.

Action: We concur with the intent of this recommendation. We note that Sector Honolulu issued Inspection Note #13, "Inspection of Sail Rigging and Masts on Inspected Small Passenger Vessels," on September 11, 2008. This inspection note was developed with the assistance of a Senior Traveling Marine Inspector from Commandant (CG-546), the Marine Safety Center, and the local passenger sailing vessel industry. The note establishes a rigging examination regime with inspection and documentation requirements that is developed for each small passenger sailing vessel operating within Sector Honolulu. We are aware that other Officers in Charge, Marine Inspection (OCMIs), with the assistance of the Traveling Marine Inspection staff, are in the process of developing similar policy guidance tailored to the specific issues associated with small passenger sailing vessels in their areas of responsibility. We will pass Sector Honolulu's inspection note on to other Officers in Charge, Marine Inspection, and provide them with assistance in developing and implementing similar, local regimes for the small passenger sailing vessels in their areas of responsibility. Once local regimes have been established and a knowledge and experience base has been developed, we can revisit this recommendation and evaluate whether a national set of minimum standards for mast and rigging inspections are appropriate.

//s//
M. P. RAND
By direction

16732
JUL 23 2008

FIRST ENDORSEMENT on CG Sector Honolulu memo 16732 of 16 Jun 2008

[redacted]

From: Manson K. Brown, RADM
CGD FOURTEEN

To: COMDT (CG-54)

Subj: KIELE V (O.N. 628114) INVESTIGATION (CASE NO. 2895732)

1. Forwarded, recommending approval of the findings, conclusions, and recommendations.

2. In response to the mishaps aboard the Hawaii catamarans, NAHOKU II and KIELE V, Sector Honolulu and the D14 prevention staff initiated a comprehensive state-wide safety compliance check program of the 59 commercial sailing vessels certificated to carry passengers in Hawaii. The safety compliance check program was undertaken last summer in addition to the existing annual inspection cycle, and included a careful plan and record review followed by an on-site safety examination of rigging, unreported vessel modifications, and various other safety and structural concerns. Although this surge effort was largely successful in terms of identifying serious safety hazards aboard the remainder of Hawaii's passenger sailing vessel fleet, it also foreshadowed the critical gaps identified in the investigation report; namely, the apparent lack of objective national standards for evaluating the suitability of mast and rigging equipment.

3. I urge Headquarters to initiate prompt action to develop and institute national standards for the inspection of mast and rigging aboard inspected passenger sailing vessels, as well as review and reform, as appropriate, the rigging inspection component of the marine inspection training program.

4. Pending Headquarters action on the above, I have directed the D14 prevention staff and Sectors to continue to engage with industry, and to develop uniform standards and procedures for the inspection and maintenance of mast and rigging systems aboard all inspected sailing vessels in D14. I am also directing my prevention staff and Sectors to identify and recommend appropriate minimum training standards for marine inspectors who conduct inspections of passenger sailing vessels. It is appropriate for D14 to serve as the Center of Expertise for the inspection of passenger sailing vessels in the Coast Guard.

5. My point of contact is Commander Randall Farmer at (808) 535-3421.

#

Copy: CG PACAREA (Pp)
Sector Honolulu
Sector Guam

U.S. Department of Homeland Security
United States Coast Guard

Commander
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16732
JUN 16 2008

# MEMORANDUM

From: B.A. Compagnoni, CAPT
CG Sector Honolulu

Reply to Attn of: LT [redacted]
(808) 522-8264 x292

To: COMDT (CG-545)
Thru: CGD FOURTEEN

Subj: REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE DISMASTING OF KIELE V (O.N. 628114).

1. As a result of a high profile casualty involving mast failure on inspected passenger sailing catamaran KIELE V (O.N. 628114), the enclosed Report of Investigation was completed.

2. Please contact LT [redacted] if you have any comments or concerns regarding the report.

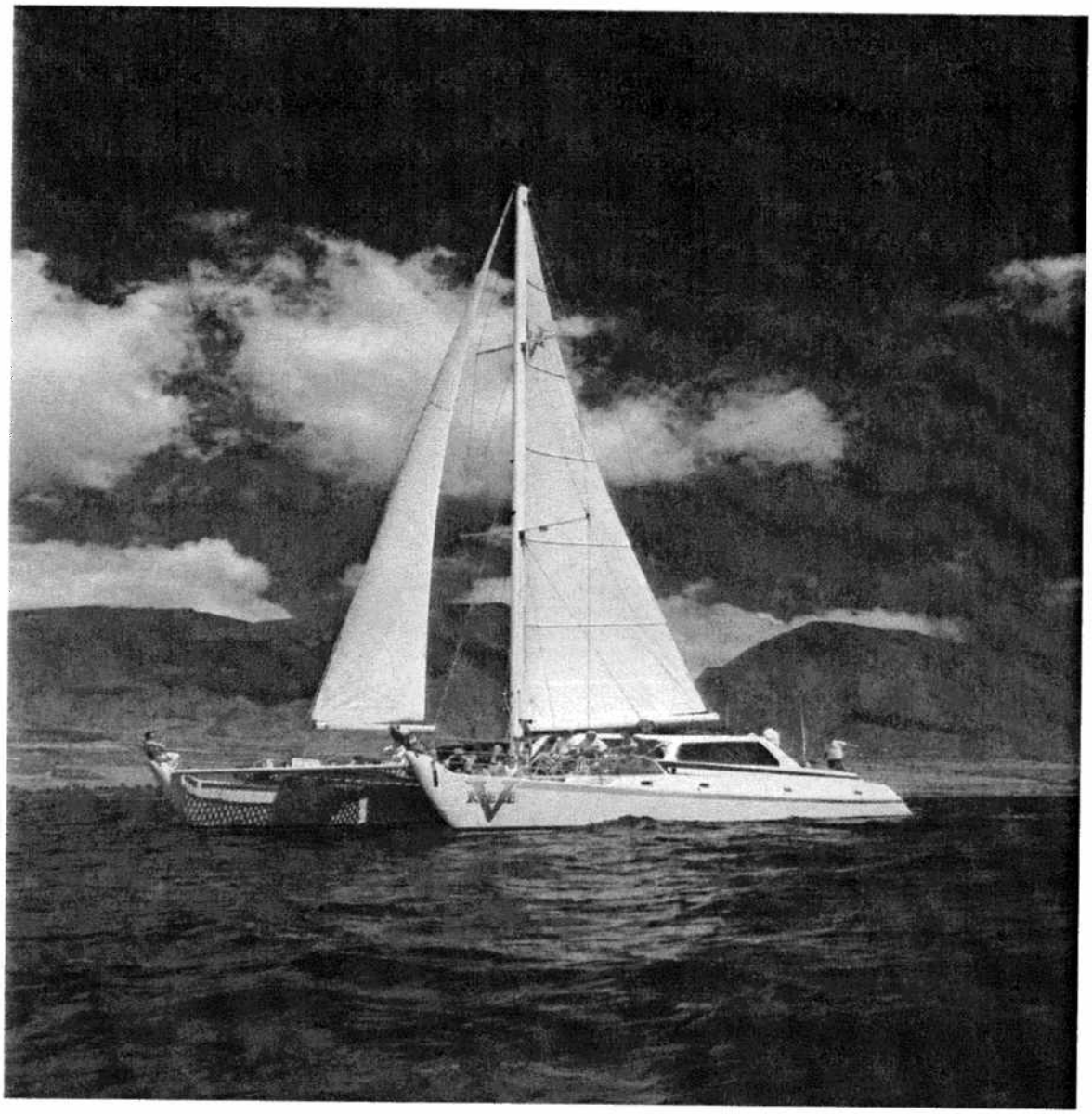
#

Enclosure: S/V KIELE V Report of Investigation.

# Coast Guard Summary of Investigation:

# S/V KIELE V (O.N. 628114) Dismasting and Fatality

# March 25, 2007



Investigations Division
Sector Honolulu, Hawaii

## Summary

At approximately 1650 on March 25th, 2007, while operating off the west coast of Maui, Hawaii, the sailing catamaran KIELE V, a Coast Guard inspected small passenger vessel, altered course to a port tack and commenced heading back to Ka'anapali Beach after the conclusion of a whale watching excursion. The vessel had on board 47 passengers, four crew, and one whale naturalist. The vessel was in seas estimated between three to five feet, with wind speeds of 20 to 25 knots. Approximately 10 to 15 minutes into the vessel's return leg of the trip, the vessel suffered a catastrophic mast failure which resulted in the base of the mast coming off its step and falling to the starboard side of the vessel. One adult male passenger was killed, and two others were injured, when the mast and its associated rigging collapsed. At approximately 1707, the Coast Guard received the report that the KIELE V had dismasted, and Coast Guard assets were routed to the scene. The passengers and crew of the KIELE V were transferred off the vessel due to safety concerns after the starboard engine room flooded, and the onboard dewatering equipment was unable to keep up with the incoming water. Just prior to 1900, the KIELE V was abandoned and last seen riding partially submerged in the water approximately 2 miles off of Kahana Beach. The following day, wreckage of the KIELE V (Figure 1) washed ashore on the southeast side of Molokai. Due to the vessel breaking apart on the reef off shore, only limited physical evidence was able to be recovered and examined during this investigation. At the time of the incident, the KIELE V was operating with a valid Coast Guard-issued Certificate of Inspection.

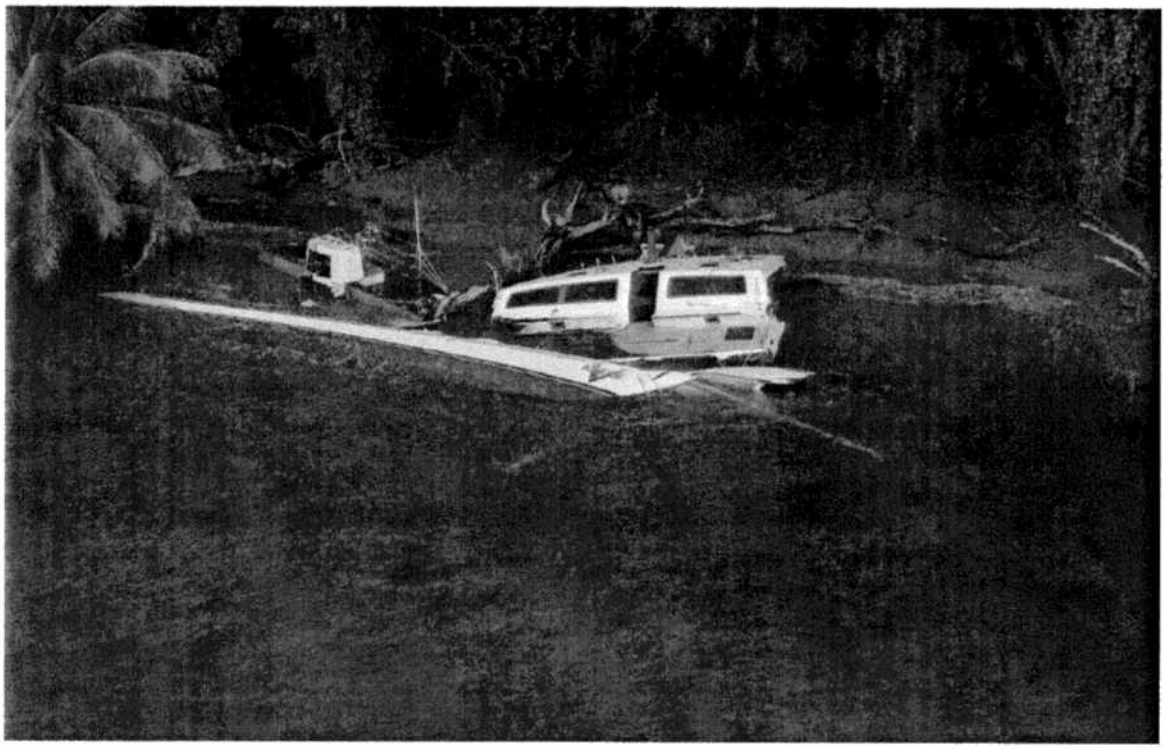


**Figure 1: Wreckage of the KIELE V that washed ashore on the south east side of Molokai.**

## Jurisdiction & Authority

KIELE V was an inspected U.S. flagged passenger vessel inspected under 46 Code of Federal Regulations (CFR) Part 176.

46 United States Code (USC) 6301 and 46 CFR Part 4 provides the authority to conduct marine casualty investigations, and sets forth the scope of the investigation.

## Level of Investigation

In accordance with Marine Safety Manual (MSM) Volume V Chapter Five, the investigation was conducted at the informal level.

## 1. Finding of Facts

### 1.1 Vessel Description

The KIELE V was owned and operated by Maui Boat Company, doing business at the Hyatt Regency-Maui Resort and Spa. The KIELE V was a cold-molded wood sailing catamaran, and had a (fiber) glass-over-double-sheet plywood laminate hull, with wood framed construction. The vessel's design was reviewed and approved by the 11th Coast Guard District on September 18, 1980. The KIELE V was sold by Kiele Catamarans, Inc., to the Maui Boat Company on May 30, 1989. The vessel's managing owner, as listed on the Certificate of Documentation, was Maui Boat Company, with a mailing address of Hyatt Regency-Maui, 200 Nohea Kai Drive, Lahaina, HI 96761.

### 1.2 Vessel Particulars

Name: KIELE V

Flag: United States

Service: Small Passenger Vessel (Inspected)

Official Number: 628114

Gross Tons: 21

Net Tons: 15

Length Overall: 50.4 feet

Width: 25 feet

Hull Draft: 3 feet

Homeport: Lahaina, Maui, Hawaii

Designer: C/S/K Catamarans of Newport Beach, CA

Builder: Master boat builder, Gil Iwamoto

Year Built: 1980

Date Launched: September 24, 1980

Delivery Date: October 01, 1980

Owner/Operator: Maui Boat Company, dba Hyatt Regency-Maui Resort and Spa.

The KIELE V had a 57'10" extruded aluminum mast, built of section 7512 aluminum, that was provided by Forespar, Inc., located in Rancho Santa Margarita, CA. (Enclosure

13) Twin sets of foiled aluminum spreaders were fitted, and two sets of diamond wires attached to the mast extended over the spreader tips to provide lateral support of the mast. A double back stay and single forestay secured the mast in the fore/aft position.

### 1.2.1 Catamarans.

Catamarans are boats (either motor or sail) consisting of two hulls joined together by a frame, deck, and/or superstructure. The purpose of the additional hull is to provide stability. On a sailing catamaran, the additional hull resists the lateral force of the wind on the sails. On a monohull (i.e. a boat with only one hull), this lateral force is countered by a ballasted keel. For example, the ballasted keel of a 45-foot monohull weighs several thousand pounds.

On a monohull, the mast is typically mounted on the keel. Since the keel is very heavy and often made of lead, it provides a very firm foundation for a mast. However, on a catamaran, the mast is stepped on the frame or deck connecting the two hulls. The deck between the two hulls of a catamaran flexes when underway. The amount of this flexing depends on the sea state, wind speed, and weight of the vessel, which changes with the number and weight of people onboard. To allow for this flexing, the standing rigging (shrouds and stays) must be adjusted with particular care.

## 2.1 Vessel Inspection History

At the time of the mishap, the KIELE V was operating as an inspected small passenger vessel[1] with a valid Coast Guard Certificate of Inspection (COI), issued on September 28, 2006 with an expiration date of September 28, 2011. (Enclosure 1) Under the COI, the minimum manning requirements for the KIELE V was one licensed master and two unlicensed deckhands. The KIELE V was permitted to carry up to 49 passengers, with an additional three persons that could serve in the capacity of the crew. The total number of

[1] Under 46 U.S.C.A. § 2101, a small passenger vessel generally refers to any vessel of less than 100 gross tons carrying more than six passengers, including at least one passenger for hire. These vessels ordinarily are subject to inspection under 46 Code of Federal Regulations Part 175.

people on board the KIELE V was not to exceed 55 individuals. The route of the KIELE V was limited to Lakes, Bays, and Sounds up to Limited Coastwise.[2]

Small passenger sailing vessels are required by 46 C.F.R. Part 170 and the Marine Safety Manual, Vol. IV, Section E.3 to operate in accordance with an owner-submitted sail plan. In the case of KIELE V, stability calculations were performed in accordance with 46 Code of Federal Regulations (CFR), 171.057 (b), and approved by the Officer in Charge of Marine Inspections (OCMI) in Honolulu on July 22, 2004. The approved Sail and Rigging Plan (sail plan) authorized the use of two sails, a mainsail and a jib, not to exceed 1,170 square feet of sail. Both mainsail and jib utilized full-length battens. (Enclosure 2) On December 1, 2003, prior to the Coat Guard's approval of the sail plan, a Coast Guard marine inspector witnessed an underway operational test of the rig. The standing rigging, except as noted on the Sail and Rigging Plan, was listed as 1x19 stainless steel wire. The vessel's calculated displacement was listed at 27,149 pounds.

On August 23, 2004, following approval of the sail plan, KIELE V was issued a permanent stability letter. (Enclosure 3) The permanent stability letter incorporates the results of the sail plan and the Coast Guard's stability analysis and imposes appropriate operating requirements on the vessel. In this case, the stability letter restricted the KIELE V's route to partially protected waters. Partially protected waters were specifically defined in the vessel's COI to include the Pacific Ocean area off the southern and western coasts of the island Maui between Cape Hanamanioa and Lipoa Point; the southern coast of the island of Molokai between Cape Halawa and La'au Point; and the island of Lanai, not to exceed twenty miles from a harbor of safe refuge. At the time of this casualty, the KIELE V was operating within the scope of its COI.

The vessel was last inspected by the Coast Guard and issued a COI on September 28, 2006, which was valid for five years from the date of issuance. During this inspection, there were three deficiencies noted by the CG inspector, two of which involved

[2] A Coast Guard-issued COI addresses specific manning, equipment, and operating requirements for a vessel in well defined areas or routes, including "rivers", "limited coastwise", "coastwise", "Great Lakes", "lakes, bays, and sounds", and "oceans".

documentation required to be maintained on board the vessel. None of these deficiencies involved the vessel's mast or rigging.[3]

### 1.2.2 Vessel Casualty History

The vessel history reveals that KIELE V had a recorded history of two dismastings prior to the incident on March 25, 2007; one in April of 1991, and one in April of 1996.

On April 23, 1991, the KIELE V was underway with 39 passengers and three crew when the port, lower spreader failed, causing the mast to fold to the starboard side of the cabin top, extending out over the stern quarter of the vessel. No one was injured. Winds were estimated between 15 and 25 knots, with seas of one to three feet. During this dismasting incident, the mast bent at a 90 degree angle, approximately 12 feet up from the base of the mast. The mast was described as an extruded aluminum spar made by Proctor of England, with an overall length of 65 feet. In the opinion of the marine surveyor, the cause of this dismasting was a fracture at the base of the port spreader, possibly caused by columnar loading, which allowed the spreader to collapse. (Enclosure 4) This mishap was a reportable marine casualty that was investigated under 46 C.F.R. Part 4 due to the fact that repairs to the vessel and rigging exceeded $25,000.

Subsequently, on April 29, 1996, the KIELE V dismasted with 14 passengers and three crewmembers aboard. According to the vessel's inspection history, the mast tore at the bottom starboard side of its heel, which is the base of the mast, allowing the mast to break off the vessel. Two passengers suffered minor injuries after being struck by parts of the rigging and apparently required no medical treatment other than the application of ice. At the time of the incident, the winds were from the southwest at eight to ten knots, with one foot swells. The KIELE V was on a close reach, moving at approximately 10 knots

[3] The first deficiency involved the lack of placarding for one of the vessel's portable fire extinguishers. The second deficiency involved posting the vessel's Certificate of Inspection, Stability Letter, and Personnel Flotation Device (PFD) donning procedures placard. The third deficiency was related to damage sustained by the vessel in September of 2006 when the KIELE V reported an allision with the loading dock at Ka'anapali Beach. During this allision, the vessel sustained damage to the outboard, starboard hull, amidships, approximately three and a-half feet above the chine. The damaged plywood was subsequently cropped out and renewed on October 17, 2006. No internal damage was seen by the Coast Guard inspector, and this deficiency was cleared on October 23, 2006.

when the incident occurred. (Enclosure 5) Although required by 46 CFR Part 4, this investigation found no evidence that a Coast Guard marine casualty investigation had been conducted on this dismasting; and there is no record showing that a CG2692 Report of Marine Casualty was submitted to the Coast Guard. The only evidence in Coast Guard files related to the nature and extent of this casualty was a report written 30 April 1996 by [redacted], a marine surveyor, which included a statement from [redacted], the vessel manager, that the mast was severely bent at the lower spreader and likely tore out of the mast step (Enclosure 5). Total estimated repairs were valued at $52,000.

A Coast Guard inspector conducting a credit drydock examination of KIELE V at Ala Wai Boatyard on May 17, 1996, noted that he had inspected the chain plates and their fastenings in place, mast rigging, tensioners, and mast step, and "All were in satisfactory condition." At the time of the inspection, the damaged mast had been removed and it was likely that this statement referred to the previously installed mast step. The main mast was replaced with a new mast that was supplied by Forespar, Inc., located in Rancho Santa Margarita, CA. in June of 1996. The same inspector returned to the vessel on June 14, 1996 and noted "Examined new mast installation. All found satisfactory." The inspector also conducted an underway sea trial of the vessel, which was satisfactorily completed. (Enclosure 6)

Current Coast Guard policy states that because suitable design, engineering, and tuning standards for modern rigging do not exist, the Coast Guard currently does not require that any particular rigging standard be met. 46 C.F.R. § 177.330 59 and comment, Federal Register 2022, dated 13 January 1994. Accordingly, requirements for masting and rigging generally are left to the discretion of the Coast Guard inspector. The KIELE V mast was last unstepped (removed) for inspection during its drydock in October 2005. As part of the vessel's drydock inspection, a rigging survey was required by the attending Coast Guard marine inspector.[4] This rigging survey was conducted in October 2005 by

[4] The Marine Safety Manual, Vol. II, Section B, Chapter 1, authorizes Coast Guard inspectors to consider surveys when evaluating the safety and overall condition of the vessel:

> In appraising the condition of a vessel and its equipment, the inspector shall

Mr [redacted], a marine surveyor, at the owner's expense. In his written report submitted to Coast Guard inspectors, Mr. [redacted] determined the mast and the standing rigging on the KIELE V were in acceptable condition. (Enclosure 7) The Coast Guard accepted this survey as evidence of the rig's material condition and suitability for service.

Prior to the accident, the vessel's most recent Coast Guard inspection was a COI inspection which was conducted on 29 September 2006. The vessel history does not indicate that a mast and rigging survey was conducted in connection with this inspection.

## 1.3 Environmental Conditions

On March 25, 2007, the weather included wind speeds of 20 to 25 knots, and wave swells between three and five feet. Wind gusts of 30 to 35 knots were reported, as well as an occasional swell of six feet. These conditions were typical of the area between Maui, Molokai, and Lanai, which contains three different currents that flow in through the Pailolo, Kalohi, and Auau Channels. The waters in this area between Maui and Molokai are locally referred to as the "Molokai Express" due to its strong currents. At the time of the incident, the winds were off the port quarter of the KIELE V. Visibility was approximately 15 miles, with clear skies, and air temperatures of around 80 degrees Fahrenheit.

## 1.4 Crew and injured passengers on board at the time of incident

At the time of the accident, the vessel was required to be manned at a minimum by a crew consisting of one master and two unlicensed deckhands. On March 25, 2007, the KIELE V was manned by a crew consisting of one master and three deckhands, all of which had CG issued licenses.

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use all available evidence, including the latest inspection findings, records of previous Coast Guard inspections, the opinions or records of other interested surveyors or inspectors, information furnished by the officers and crew, facts concerning the vessel's classification, and previous certification.

Mr. [redacted] was serving as the master of the KIELE V during the voyage on the afternoon of March 25, 2007. He had a valid Coast Guard master's license for steam, motor or auxiliary sail vessels of not more than 100 gross registered tons (domestic voyage) upon near coastal waters (issue number three, serial number 1070159). (Enclosure 8) Near coastal waters are defined as ocean waters not more than 200 miles offshore (46 CFR 10.103). Mr. [redacted] license was current, having been renewed on June 14, 2004 in Honolulu HI, with an expiration date of June 14, 2009. Mr. [redacted] had over 15 years of sailing experience on catamarans, and had been working on the KIELE V for over five years.

Mr. [redacted] was the relief captain during this particular voyage, and had a valid Coast Guard master's license for steam, motor or auxiliary sail vessels of not more than 100 gross registered tons (domestic voyage) upon near coastal waters (issue number one, serial number 1030470). Mr. [redacted] was also authorized to engage in commercial assistance towing. Mr. [redacted] license was current, having been issued in Honolulu, Hawaii on March 19, 2003, with an expiration date of March 18, 2008. (Enclosure 9)

Mr. [redacted] was acting as a deckhand on this voyage. He had a valid Coast Guard master's license for steam, motor or auxiliary sail vessels or not more than 100 gross registered tons (domestic voyage) upon near coastal waters (issue number one, serial number 1170028). Mr. [redacted] was also authorized to engage in commercial assistance towing. Mr. [redacted] license was current, having been issued in Honolulu, Hawaii on December 26, 2006, with an expiration date of December 26, 2011. (Enclosure 10)

Mr. [redacted] was acting as a deckhand on this voyage. He had a valid Coast Guard master's license for steam, motor or auxiliary sail vessels or not more than 50 gross registered tons (domestic voyage) upon near coastal waters (issue number two, serial number 1070508). Mr. [redacted] was also authorized to engage in commercial assistance towing. Mr. [redacted] license was current, having been issued in Honolulu,

Hawaii on November 19, 2004, with an expiration date of November 19, 2009. (Enclosure11)

Ms. [redacted] was an employee of Hyatt Regency-Maui, who was on board the KIELE V as a whale naturalist and a marine biologist. Ms. [redacted] did not have any duties that directly affected the safe operations of the vessel, and was otherwise not directly involved in the marine casualty.

Mr. Hal W. Pulfer II, a [redacted] year old male passenger, expired after being struck by the vessel's collapsing rigging. Mr. Pulfer was pronounced dead on March 25, 2007, by [redacted], Coroner/Medical Examiner for the Maui Police Department. The autopsy conducted on March 27, 2007, listed the manner of death as accidental, stating that Mr. Pulfer II died of traumatic injuries sustained in a boating accident. The accident caused severe and extensive cranial trauma with fracture of the skull and laceration of the brain parenchyma, including a severe atlanto-occipital separation, defined as trauma to the ligaments and supporting soft tissues of the cervical spine. The Autopsy Report number is MAF07-049. (Enclosure 12)

Two other passengers also received injuries that required medical attention beyond first aid. Ms. [redacted] and Mr. [redacted] were transported to Maui Memorial Medical facility for injuries sustained by contact with the falling rigging. At the time of the incident, both were standing aft, on the port side of the vessel.

## 1.5 Narrative of Events

On March 25, 2007, the KIELE V departed its Ka'anapali Beach mooring for its regularly scheduled whale watching tour on the west side of the island of Maui. The trip was scheduled to last from 1530 to 1730 in the afternoon. At around 1650, the master of the KIELE V maneuvered the vessel down swell, on a port tack,[5] to a heading that would take the vessel back to shore. The vessel's main sail was triple-reefed, meaning that the sail was lowered to a predetermined point and secured at the boom to reduce the area

[5] A sailing vessel is on a port tack when it is proceeding with the wind blowing from the port or left side.

being acted on by the wind. The vessel was proceeding at a broad reach, with winds coming from behind the vessel at an angle of less than 45 degrees off the port beam.. The KIELE V was making approximately 10.5 knots over ground.

Approximately 10 to 15 minutes into the return leg of the trip, the vessel experienced a catastrophic collapse of the mast and rigging, trapping Mr. Pulfer under the falling rigging and injuring two other passengers. The master attended to the two passengers that had been injured by the falling rigging on the stern of the vessel before initiating his first may-day call. At 1709, the Coast Guard received the initial distress call from the master of the KIELE V over channel 16 VHF. Concurrently, one of the crewmembers, Mr. [redacted], called 911 via a cell phone and notified the dispatcher of the dismasting and the vessel's approximate location. The vessel's crew conducted a muster of all the passengers to ensure that nobody had been knocked overboard by the mast or the rigging. After all passengers and crew were accounted for, the passengers were moved inside the enclosed cabin and instructed to don life jackets and to remain calm. At the same time, two deckhands up forward of the enclosed cabin unsuccessfully attempted to free Mr. Pulfer from the rigging that had trapped him up against the superstructure on the starboard side of the vessel. Mr. Pulfer was unresponsive at the time.

The master went forward and cut the wire rope shrouds with a hacksaw in order to free the mast and its associated rigging from the vessel. According to the master, none of the shrouds or stays had parted during the dismasting. Once the forward rigging was cut and removed, members of the crew lowered Mr. Pulfer to the deck, placing him forward of the cabin. Ms. [redacted] commenced first aid and CPR. The master also began cutting away the aft stays in order to free the vessel of the mast and the mainsail, which were submerged and pulling the stern of the vessel under water.

At 1738, Coast Guard Station Maui received notification via VHF that the KIELE V was taking on water through a hole in the starboard engine room. This 10 inch diameter (approximate) hole most likely was caused by the mast, or one of the mast spreaders, following the dismasting. One of the crewmembers initially attempted to dewater the

starboard engine room with a manual pump. After trying unsuccessfully to dewater the space for several minutes, the crewmember was instructed to go ahead and remove the life floats from the cabin top.

The GEMINI and the TERALANI III, both inspected Coast Guard passenger catamarans, arrived on scene approximately 15 minutes after responding to the KIELE V's distress call. The master decided to transfer the passengers from the KIELE V to the GEMINI and the TERALANI III due to the stability issues caused by the dismasting and the flooding of the KIELE V. The majority of the passengers were transferred to the GEMINI, with the remainder of the passengers and crew boarding the TERALANI III and CG 47313, a Coast Guard 47' Motor Life Boat (MLB). The MLB arrived on-scene at approximately 1815, and removed the remaining four crewmembers and the deceased passenger from the KIELE V. Two of the injured passengers, Ms. [redacted] and Mr. [redacted], were air lifted off the KIELE V by the Maui Fire Department's fire rescue helicopter and transferred to Maui Medical Center. Mr. Hal Pulfer was taken to shore by the Coast Guard 47' MLB. Prior to departing the scene, the Coast Guard recorded the KIELE V's last GPS position to be 20:58.065N and 156:43.56W.

After all personnel were removed from the KIELE V, the vessel was temporarily abandoned due to the approaching nightfall and the vessel's instability caused by the flooding of the starboard engine room. The next day the Coast Guard launched an Auxiliary fixed wing aircraft to search for the KIELE V, with negative results. On the afternoon of March 26, local property owners on Molokai located partial wreckage of the vessel on the south-east coast of Molokai. Due to the breakup of the wreckage on the offshore reef, only the vessel's mast step and the lower portions of the rigging were recovered for evidentiary analysis. Portions of the vessel's hull, the mast, spreader bars, sails, and standing rigging were never recovered.

## 1.6 Drug and Alcohol Testing Results

As per 46 CFR 16.240, the marine employer is required to ensure that all persons directly involved in a serious marine incident are chemically tested for evidence of dangerous

drugs and alcohol in accordance with the requirements of 46 CFR 4.06. At the marine employer's direction, the master and all three crewmembers of the KIELE V were directed to submit to alcohol and drug testing following the casualty. All alcohol and drug testing results on the crew of the KIELE V were [redacted].

Alcohol testing was conducted by the Maui Police Department at the Lahaina Police Station between 2000 and 2100. Alcohol testing was not conducted within the required time frame of two hours due to the crewmembers of the KIELE V addressing the resultant safety concerns following the dismasting.

Drug testing was conducted by Clinical Labs of Hawaii. The Medical Review Officer who reviewed the drug test results was Mr. [redacted], M.D.

## 2.0 Analysis

The KIELE V mast step (Figure 2) was recovered from the wreckage that washed ashore on the island of Molokai. Standing rigging, known as shrouds and stays, are tensioned to keep the mast upright. Stays commonly run fore-and-aft along the centerline of the vessel, and shrouds runs from the mast to the sides of the vessel. The mast step supports the base, or heel, of the mast, and is comprised of an aluminum base bolted to a stainless steel plate via six stainless steel bolts. The aluminum portion of the mast step had a welded collar, or lip, which is a protrusion that fits up inside the base of the aluminum mast. Post-accident analysis revealed that the KIELE V mast step collar was completely sheared-off during the dismasting, and was not recovered in the wreckage. However, the remainder of the mast step, which included the stainless steel base plate, was still attached to the vessel via four stainless steel fasteners (Figure 3). Two of the fasteners were four inch long lag bolts that were screwed into the vessel's wooden structure. The other two fasteners were five and a half inch bolts that were passed through the vessel's wooden structure and fastened via a nut, lock-washer, and flat washer in the void beneath the mast step mounting plate.

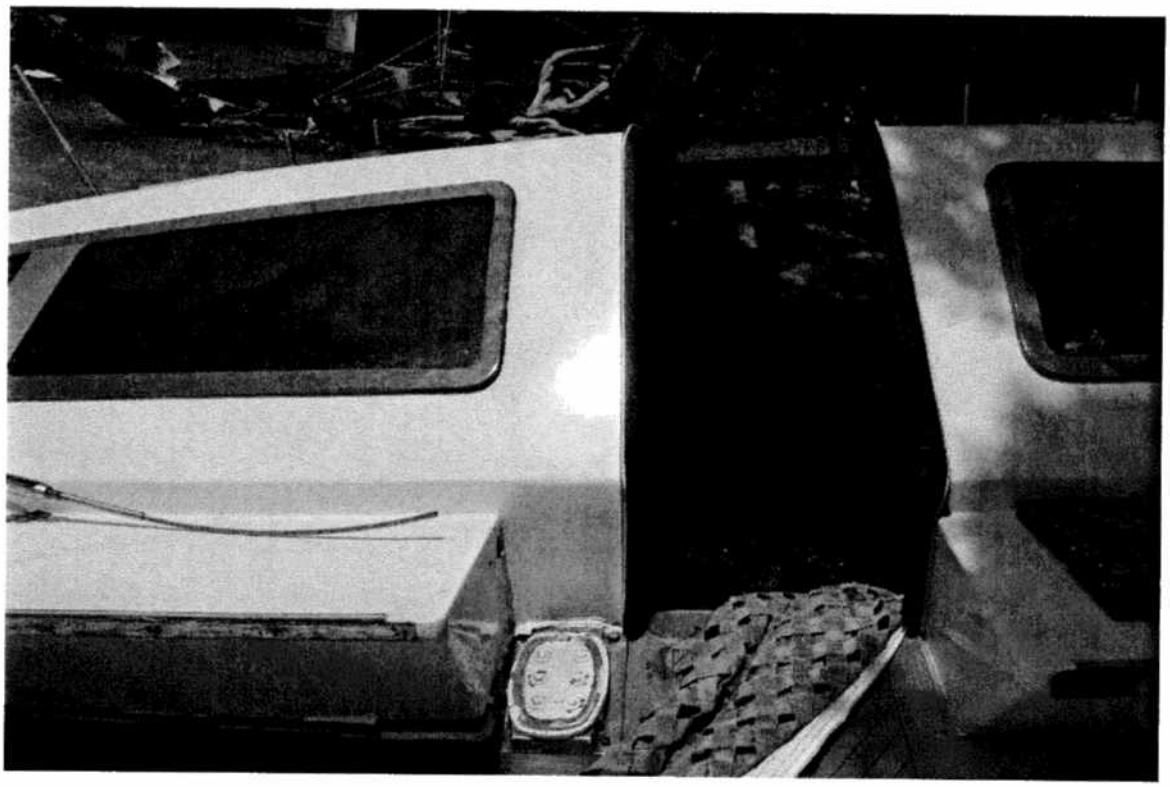

**Figure 2: Wreckage of the KIELE V, showing the attached mast step.**

The mast step recovered from the wreckage of the KIELE V was sent to Northwest Laboratories, Inc., in Seattle, WA for metallurgical examination. Mr. [redacted], M.S.E. and Forensic Engineer/Technical Director of Northwest Laboratories, conducted an examination of the submitted mast step by means of an optical stereomicroscope (up to 40 x magnification), and a Scanning Electron Microscope (SEM). The fractographic examination revealed the mast step failure to have originated at the forward position of the mast step. The port side of the mast step, at the nine o'clock position, was arbitrarily chosen as the zero degree position. A fatigue zone was found to extend between the 70°-110° position, on the forward portion of the mast step in the fillet weld connecting the aluminum base to the mast step's collar. The remainder of the weld failure was catastrophic in nature, which would indicate that the failure was created by a sudden overload. The failure at the 290°-70° location (port side of the vessel) was the result of tension, while the failure between the 110°-250° location (starboard side of the vessel) was the result of shear. A section containing the entire fatigue zone was removed and further examined. This fractographic examination confirmed the initial failure of the mast

step to be the result of a stress crack that originated at approximately the 80° position. The stress crack initiated at the root of the fillet weld located on the inside of the mast collar, and then spread across the weld throat. Some corrosion pitting in the stress crack was observed, indicating that the crack was present for an undetermined amount of time before the dismasting.

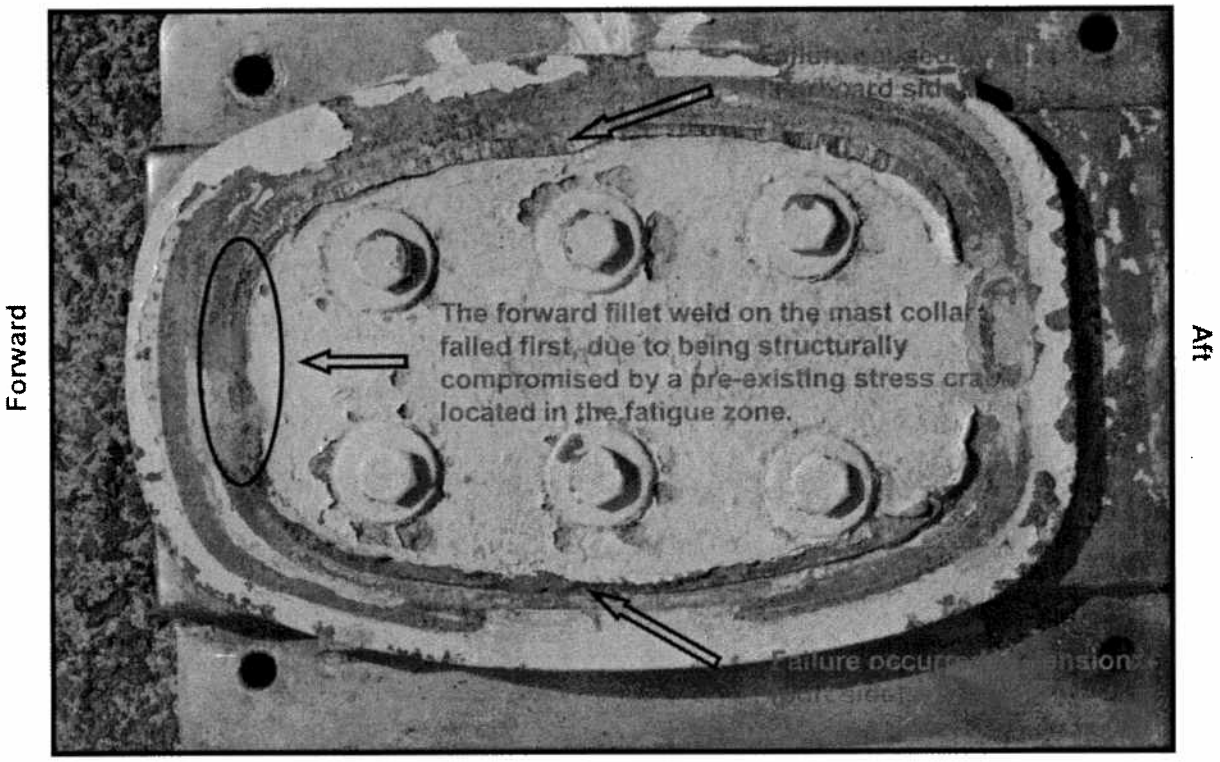


**Figure 3: Close up of the KIELE V mast step.**

By design, the masts of sailing vessels are intended to deflect under load (wind). The load is then transferred via the mast and standing rigging to the vessel itself. Due to the amount of flexing in a catamaran's hull, the proper tensioning of the standing rigging on a catamaran is of utmost importance. The mast step, and the associated collar, would have been subjected to a substantial amount of tortional twisting given the wind and

weather conditions on the day of the incident. In this case, the vessel was headed down-wind on a port tack, which would have subjected the collar of the mast step to counter-clockwise tortional loading. Assuming the collar of the mast step already was in a weakened state due to the existence of a stress crack, the mast step may have failed first, resulting in the mast foot being forced over the starboard side of the vessel by the compression force of the wind and rigging. As soon as the base of the mast came free, the mast column would naturally fall off to the side opposite of the prevailing winds. Unfortunately, without additional evidence, further information on the cause of the dismasting was not determined during this investigation.

## 3.0 Conclusion

- Investigation finds that the fatality and injuries to passengers aboard KIELE V resulted from the collapse of the mast while the rig was under compressive wind force during operation at sea. This collapse may have caused the failure of the mast step collar, due to fatigue in the area of the fillet weld connecting the aluminum base to the mast step collar. Expert analysis also identified a fatigue zone that encompassed about 40 degrees of the forward portion of the mast step and was manifested by a microscopic crack in the weld. This crack likely pre-existed the accident due to the presence of corrosion pitting evidenced in the stress crack. The mast failure occurred catastrophically at the base, most probably in a port to starboard direction, producing a hinge effect. Because the mast, spreaders, rigging, shrouds, stays, and sails, and most other hardware were lost at sea and not recovered, the investigation could not rule out the possibility that the failure of some other rig component may have set in motion a sequence of events that led to the step failure and mast collapse.

- Investigation did note that the design of the mast step that was in use since 1996 did not include any internal strengthening; such as the lattice framing that was incorporated in the mast step that was in use prior to the 1996 dismasting (See Figure 4). In addition, the master reported that the existing mast step extended up into the base of the mast approximately 8-12 inches. Due to the reported height of this mast collar, if there were any contact areas between the inside of the mast column and the

mast collar, the attachment point of the collar to the mast step may have been subjected to increased fore and aft loading.

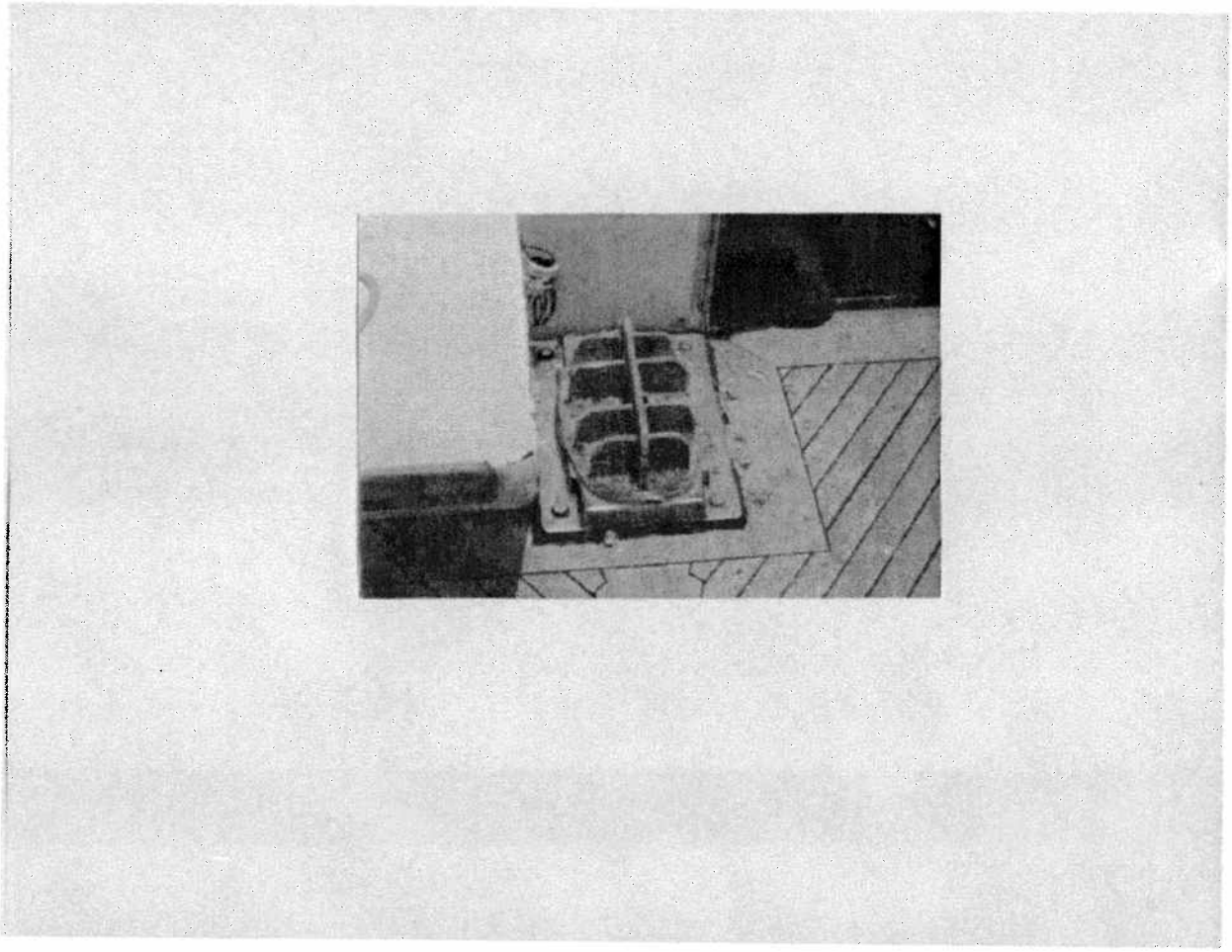

**Figure 4: Shows additional ribbing used to structurally strengthen the mast step collar. (This mast step was replaced after the KIELE V dismasting incident in April of 1996)**

There was no evidence that drugs or alcohol contributed to this casualty.

There was no evidence of negligence by the master or crew. During subsequent interviews, many of the passengers commended the master and crew for their calm demeanor and professional competence.

Investigation revealed that the KIELE V experienced three dismastings within a fifteen year operating period, two of which involved a failure at the vessel's mast step. Although an unusually high number of mast collapses potentially raises questions concerning the suitability of the rig's overall design, any linkage between these events would be speculative given the lack of physical evidence and the documented history of mast, mast step, and marine hardware replacement.

In summary, although the welded collar of the mast step failed, it could not be determined whether or not its failure was the cause of the dismasting, or if the mast step failure was a result of the dismasting. Due to the fact that the mast and the associated attachment points located on the mast were not recovered, it is impossible to determine if a spreader, fitting, or fastener higher up on the mast column failed first, resulting in the mast breaking off to the starboard side of the vessel.

The majority of the lower portions of the standing rigging, and associated attachment points, such as terminals, turnbuckles, tangs, and cotter pins, etc., on the KIELE V were located in the wreckage, and showed no signs of failure. The standing rigging that was still attached to the wreckage of the vessel showed signs of being cut, which corresponds with the efforts of the crew to free the mast from the vessel while attempting to free Mr. Pulfer and prevent the vessel from sinking.

Prior to the dismasting of the KIELE V, the most recent comprehensive mast and rigging survey was conducted by a commercial surveyor in October 2005. That survey involved an apparently detailed visual inspection following the unstepping of the mast that revealed no apparent discrepancies. There is no evidence that the Coast Guard conducted an examination of the mast and rig during the annual COI inspection on 29 September 2006, and in the absence of any Coast Guard or industry requirement prescribing the frequency, scope, or standards for a rigging inspection, such an examination was not required as a matter of existing policy.

The question remains whether an examination of the mast and rigging at some point after the 2005 survey and prior to the accident might have led to the detection of an anomaly that would have avoided the accident. Unfortunately, this investigation is unable to reach any conclusions on that important issue. Because the mast and most of the rigging were not recovered from the wreckage, this investigation could not determine whether some other component failure set in motion a sequence of events that led to the mast's failure at the mast step, or whether the failure initiated at the step, such as at the microscopic crack in the weld at the mast step collar. Moreover, the investigation is unable to determine whether or not the mast and rigging was in a substantially similar condition at the time it was last surveyed and at the time of the accident.

Given these uncertainties, the investigation concludes that the establishment and implementation of uniform annual standards for mast and rigging inspections, at the very least, could have increased the probability that inspectors would have identified a latent hazardous condition that ultimately caused or contributed to the mishap. This investigation does NOT conclude that implementation of such standards in this case would have resulted in the discovery of the hazardous condition, or avoidance of the accident. However, the current lack of an existing Coast Guard or industry standard for mast and rig inspections virtually ensured that any defect in the mast and rig would not be discovered or corrected prior to a catastrophic failure. In this regard, the Coast Guard's existing policy on rig inspections in 46 C.F.R. § 177.330, as explained in the Federal Register comment in 59 Federal Register 2022, dated 13 January 1994, did not provide inspectors with adequate appropriate tools with which to evaluate the KIELE V's rig.

Investigation notes that a history of three mast failures within a sixteen year period is highly unusual. While there is insufficient evidence to conclude that the three failures involved a related cause, this latest mishap underscores the need for heightened scrutiny of masts, mast steps, and rigging aboard catamarans. On the typical catamaran such as KIELE V, the mast is stepped on a frame or deck connected the two hulls, which undergo considerable flexing during operation. In addition, because of the catamaran's greater ability to resist capsizing, compressive forces of operation tend to be concentrated at the

mast and rigging. These factors increase the risk of a catastrophic dismasting with little or no advance warning. Accordingly, implementation of a uniform standard for masting and rigging of multihull sailing vessels, as well as the establishment of a fixed interval for unstepping of the mast for inspection of critical welds, fasteners, and internal surfaces is appropriate.

The following are needs and considerations identified as part of the investigation that went into developing the final safety recommendation.

**National Standards for Standing Rigging**

National standards do not exist for masting and rigging of sailing vessels. Minimum standards should be developed either through Navigation and Vessel Inspection Circulars and/or the Marine Safety Manual, e.g. developing a standard time interval for the un-stepping of the mast for inspection and requiring third party surveys.

**Sail Plan Review.**

Sail plan reviews and submissions to Sector Honolulu have been inconsistent in content. Submissions to MSC of a naval engineer's or marine architect's report certifying that the proposed sail plan and rigging configuration have been reviewed and that they are appropriate for the proposed service should include some common minimum design and construction standards for mast and rigging equipment on inspected sail vessels. For example, the report should identify with particularity the methodology used to ascertain the mast and rig's suitability.

**Rigging surveys**

Due to the complexity of modern sail boats, the Coast Guard must continue to rely on third party-prepared surveys, furnished at owner expense, to assist in determining the material condition of the mast and rig equipment during periodic inspections. In order for the Coast Guard to perform its oversight function, standards should be developed that will enable the OCMI to critically evaluate the

survey against objective criteria. An abbreviated example of a qualitative and quantitative rigging survey should include the following parameters:

- Initial review of the rigging system and comparison to the original sail plan
- Inspection of all fittings and terminals (with magnification where appropriate);
- Inspection of chain plates, clevis pins, toggles, terminals and wires for corrosion and wear;
- Measurement and recording of rigging tension of all stays and shrouds;
- Inspection of mast column and comparison to previous surveys;
- Inspection of spreaders and their alignment;
- Inspection of gooseneck and fittings;
- Inspection of mast step, including magnaflux dye penetration.

## 4.0 Safety Recommendations

Recommend Commandant draft and implement policy guiding the process related to mast and rigging inspections on inspected sailing vessels based on the conclusions as described in the ROI. Guidance should include, but not be limited to, rig tuning, non-destructive testing of the mast step and attachment points of the standing rigging, and the periodic frequency of unstepping the mast for inspection. (Example Attached) This would provide standard guidance for both industry and Coast Guard inspectors on how to maintain and inspect commercial sailing vessels.