UNITED STATES COAST GUARD
U.S. Department of Homeland Security

MARINE SAFETY ALERT

Assistant Commandant for Marine Safety, Security and Stewardship

November 16, 2009 Alert 07-09
Washington, DC

SAILBOAT RIGGING DANGERS

Recently in the Florida Keys, the standing rigging of a 60' inspected passenger carrying sailing catamaran failed, causing its rotating *wing spar* mast to collapse. Evidence suggests that the port shroud parted where it exits a swageless mechanical end fitting located on the upper mast at a common shrouds/stay connection. Although there were a number of passengers onboard at the time there were no resultant injuries. A six year review of Coast Guard casualty data shows 28 similar type casualties involving inspected sailing vessels. Of those 28, nine involved the failure of mast, spars and rigging components leading to dismastings; six of those involved sailing catamarans. Two separate catamaran dismasting resulted in two fatalities.

Common among the dismasting casualties was the failure of the mast's standing rigging. While this investigation is ongoing, initial forensic metallurgical analysis of the failed cable strands showed visual corrosion and evidence of fatigue failure. The shroud cable and swageless end fitting had been installed seven years prior.

The Coast Guard **strongly reminds** all commercial vessel owners/operators, especially those of passenger carrying sailing catamaran's of similar build, of their responsibility to maintain their vessels, associated equipment, systems and components in a satisfactory condition suitable for their employed service at all times. Owner and operators should not wait until regularly scheduled Coast Guard inspections to identify problems but should be ever vigilant and implement routine inspection, maintenance, and repair procedures in accordance with good marine practice and in alignment with applicable requirements. Owners and operators should consult the vessel manufacturer or other naval architecture, marine engineering services or qualified rigger regarding any concerns they might have regarding the regular flexing and working of their vessel's standing rigging

Inspection requirements for small passenger vessels are found in 46 CFR 175-185. Additionally, Coast Guard Sector Honolulu, by consensus with their local sail vessel industry, developed Inspection Note #13 that outlines an enhanced inspection regime for sailboat rigging, masts and associated components for their inspected small passenger sailing vessel fleet consisting almost entirely of catamarans. This information is useful to both marine inspection personnel and vessel owners/operators and is available by searching the web using the key words: "Sector Honolulu Inspection Note #13". Manufacturer published guidelines on mast and rigging system maintenance can be found in "Rigging Service Guidelines" http://www.navtec.net/docs/RiggingService.pdf published by Navtec Rigging Solutions. Practical standing rigging inspection information from a marine surveyor's perspective is available at http://www.dixielandmarine.com/yachts/DLrigprob.html.

This safety alert is provided for informational purposes only and operational or material requirement. This does not represent an official endorsement of Navtech Rigging Solutions, Dixieland Marine Inc, its services, products, or employees. Developed by the Office of Investigations and Analysis, United States Coast Guard Headquarters, Washington, DC. Questions can be addressed to Mr. Ken Olsen at the email address below.

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U.S. COAST GUARD

Sector Honolulu
Inspection Note # 13
October 16, 2008

Inspection of Sail Rigging and Masts on Inspected Small Passenger Vessels

1. PURPOSE. This inspection note provides guidance to vessel owners, rigging surveyors, other marine service providers, and Coast Guard marine inspectors on the inspection regime of sail rigging, masts, and associated components for inspected small passenger sailing vessels operating within the Coast Guard Sector Honolulu marine inspection zone. Although not prescriptive, regular inspections of rigging are already mandated in existing regulations. The primary purpose of regular rigging inspection is to determine, with some level of confidence, component service life in order to prevent equipment failures and related marine casualties.

2. REFERENCES. Subchapter T - Small Passenger Vessels Under 100 Gross Tons.

   a. 46 CFR 176.402 (c)(1) and 176.802.(a)(3)

   b. 46 CFR 177.202(b)(12) and 177.330

3. DISCUSSION.

   a. Sector Honolulu investigated the condition of masts and rigging on inspected catamarans following two dismasting casualties that resulted in passenger fatalities. After the first casualty in late 2006, a Marine Safety Information Bulletin (MSIB) was issued by Sector Honolulu urging owners and operators to thoroughly inspect masts, spreaders, shrouds and hardware to ensure their suitability for continued service. In 2007, a second dismasting casualty occurred which highlighted the need for enhanced surveys of Sector Honolulu's inspected sailing fleet.

   b. Vessel Compliance Exams. As a result of two high profile serious marine incidents involving the catastrophic failure of masts on two inspected passenger sailing catamarans, Sector Honolulu completed a two month surge operation conducting compliance examinations on its entire passenger sailing vessel fleet. The compliance examinations focused on the inspection of mast structures, rigging systems and sail area as well as the overall vessel condition. Sector Honolulu inspectors visited all of the 59 sailing vessels in our fleet. Of the vessels inspected, 41 (70%) passed the compliance exams without discrepancies, while the remaining 30% exhibited a variety of conditions. Of particular interest,

eleven vessels were found to have serious deficiencies that resulted in the issuance of CG-835s requiring immediate action prior to resuming sail operations. These deficiencies included excessive corrosion, fractures or missing bolts in the masts, spreaders or mast arms. Three vessels were found to have excessive sail area, in one case over 200 square feet, on board and ready for use. These vessels were given "no-sail" CG-835s requiring the reduction of available sail area to the approved amount. This evaluation of the inspected sailing vessel fleet and initial results of the investigations highlight the need for specific guidance on sail rigging inspection and servicing. This need was further highlighted by a third dismasting casualty that occurred in the summer of 2008.

c. Industry Outreach. In early 2008, Sector Honolulu sponsored a small passenger vessel industry day which included a breakout session specific to sail rigging inspection. It was moderated by a Senior Traveling Marine Inspector from Coast Guard Headquarters and well attended by sailing vessel owners and operators, as well as rigging suppliers and surveyors familiar with the local fleet. Subsequently, Sector Honolulu held a follow-up meeting at the request of local rigging service personnel to sort out technical details. This inspection note is the result of that collective expertise and provides additional guidance applicable to all inspected small passenger sail vessels, with particular attention to catamaran sail rigging and associated equipment. Peer review was also conducted by several catamaran designers and builders who regularly submit their designs, including rigging to the Coast Guard Marine Safety Center for review and whose designs are represented in the local sailing fleet.*

* *Source: Roger Hatfield-Gold Coast Yachts; John Marples-Marples Multihull Designs; David Walworth-Walworth Yacht Designs; Kurt Hughes-Kurt Hughes Sailing Designs; and Pete Melvin-Morrelli and Melvin.*

4. DEFINING THE PROBLEM. Hawaii's small passenger sailing vessel fleet is comprised of 95% multi-hull vessels that operate in more extreme wind and sea conditions than are experienced by the national inspected sailing fleet, often with passenger loads at or close to the vessels' capacities. The inherent high initial stability of multihulls due to their beam and the resulting stiffness of the hull, especially when fully loaded, translate more force directly to the rig compared to similar sized monohulls that roll out (heel over) as wind pressure increases. This combination of unique sailing design and a high wind operating environment make regular inspection of key components critical to good preventive maintenance.

   a. Variables. The many variables in rig design, component materials and attachment methods as well as vessel general use makes it clear that there is no single solution. The service life of sail rigging varies according to each vessel's design, characteristics, and may depend on multiple variables including:

      i. Mast construction material (e.g. wood, aluminum, carbon fiber);

      ii. Mast installation (e.g. fixed, rotating or free standing);

iii. Rig type (e.g. masthead, fractional);

iv. Rig complexity (e.g. stiff mast minimally stayed – as few as 3, vs. flexible mast heavily stayed – as many as 16 or more);

v. Route severity (e.g. protected vs. exposed waters);

vi. Frequency and duration of operation (e.g. length of cruise; number of trips per day; hours under sail per week, month, or year);

vii. Design safety factor and review process (rig pedigree and/or review by USCG Marine Safety Center (MSC)).

The consensus of operators, marine inspectors, surveyors, service personnel as well as published information indicate that a vessel-specific rigging maintenance regime will best assist in determining the reasonable service life of components and overall safety based on individual operations and circumstances.

5. IMPLEMENTATION.

a. Inspection Regime. Small passenger sailing vessels operating in the Sector Honolulu zone shall develop and implement a regular rigging examination regime that will include, at a minimum:

i. A written preventive maintenance inspection schedule of the rig and associated equipment, as well as an inventory of rigging components including sizes and materials;

ii. A replacement schedule for all rig components based on inspection results, service history, and manufacturer's recommendations;

iii. All components of the preventive maintenance plan and replacement schedule shall be suitably documented (e.g. written reports, surveys, photos) and may be provided as proof of annual inspection of rigging and associated components;

iv. A report from a third-party surveyor may be required when a regular inspection regime and in-house expertise are not evident. When used, the reports of independent third party rigging surveyors should address the elements of a rigging regime described in Enclosure (1). Small passenger vessel operators may voluntarily use independent third party rigging surveyors in addition to their own regime.

The attending CG marine inspector will evaluate the inspection regime against conditions found onboard, including the expertise and ability of the company to conduct a meaningful in-house inspection. Enclosure (1) provides a generic list of key components that should be addressed in any inspection regime. Enclosure (2) is an example of the recommended content of a regular rigging survey based on an actual third party rigging

survey. This sample is for illustration purposes only to show the expected level of detail in a thorough survey report. An inspection regime should include manufacturer and/or designer recommendations, if available, for inspection intervals, proper tuning of the rig and replacement schedule of the rig components.

b. Catamaran Specific. The inspection of catamaran rigs shall specifically focus on the forestay load path and attachment to the hulls, including but not limited to bridles, gull stays and the bow tube or beam arrangements.

c. Component Inspection and Service Life. Regular rigging survey and inspection in the context of this guidance document is intended as preventive maintenance and shall be primarily based on a detailed visual examination of the rig and associated components, supplemented by the use of visual magnification (e.g. pocket microscope) and non-destructive testing (NDT) as necessary. The vessel owner/operator shall provide an inventory list to include age and recommended life span for all the components including the mast and wire rigging as part of their inspection regime.

The vessel owner/operator may substantiate the service life of rig components by considering the variables discussed in paragraph 4, manufacturer recommendations, operating experience, prior rigging inspection, and component replacement or repairs subject to oversight and concurrence by the attending CG marine inspector. Special attention should be given to components that are more than 10 years old. Components and/or rigs with minimal to no local service history should start with conservative inspection cycles and be examined very closely until operating history and subsequent inspection provides the confidence that a reliable life cycle trend is emerging.

6. INSPECTION INTERVALS AND GUIDANCE. The below replacement cycles outlined in this section are offered as general guidelines with the exception of un-stepping the rig. Replacement cycles of rigging may be modified based on materials, design criteria, or manufacturer's recommendations.

a. Un-Stepping the Rig. The purpose for un-stepping the rig is to provide a close-up visual inspection of the entire rig including the mast step as well as critical attachments of shrouds and stays at both the mast and anchor points (chain plates), see Enclosure (3) for details. Clevis and cotter pins, toggles, and cable or rod end fittings can be inspected more thoroughly when the rig is un-stepped.

i. CG inspection of an un-stepped mast will generally occur at a minimum interval of once every 6 years. Disassembly is not required except for rigging pins at cable terminations. As a multiple of the regulatory two-year haul out cycle for vessels operating in saltwater, it is anticipated that un-stepping the rig will be concurrent with scheduled drydock exams.

ii. Chain plates may also be removed at the discretion of the attending CG marine inspector.

iii. Once the rig is re-installed and statically tuned, CG marine inspector may attend for operational tests and sea trials as appropriate.

b. Wire Cable: Un-stepping the rig is also the time to consider renewals and/or replacements associated with rigging wire cycles. A rigging wire cycle is a recommended replacement/renewal duty life cycle interval. Industry sources consulted provided the following general guidelines for replacement/renewal subject to regular detailed visual examinations, environmental conditions and regular maintenance. The following guidelines apply to stainless steel wire rigging and are not absolute, but are considered good marine practice. A 6 year un-stepping interval would translate to a rigging wire cycle as follows:

Change wires every cycle or 6 years;
Change end fittings every 2nd cycle or 12 years;
Change chain plates every 3rd cycle or 18 years.

** Source: Morrelli and Melvin, Gold Coast Yachts, SECO South (Navtec)*

c. Wire Cable Fittings: Rigging wire cycles include not only the service life of the wire cable itself, but the end fittings used to make standing rigging attachments and the chain plates they are attached to. The two most common methods of cable attachment are swaged (factory compression end fittings) or swageless (mechanical field installed end fittings). Common trade names for swageless fittings include Norseman, Sta-Lok and Hayne. These fittings are usually composed of 300 series grade stainless steel, which provides greater corrosion resistance in the marine environment. The service life of these fittings can vary, and so should be given close scrutiny at regular intervals. In general, increased salinity, temperature, and load cycles will require more frequent component replacement.

d. Alternative Rigging.

i. Fiber Rigging. Cable rigging systems other than stainless steel are specialized installations that come in a variety of materials and associated end fittings. The manufacturer should be consulted for details on inspection and longevity.

ii. Rod Rigging. Rod rigging is a specialized application usually seen on purpose-built racing rigs, such as retired America's Cup boats. The end fitting is a cold formed rod head and unique to this style of rigging. They can and should be disassembled for inspection and/or NDT at regular intervals, similar to swageless mechanical end fittings. While rod will generally last longer than wire, re-heading is usually recommended after disassembly or as specified by the manufacturer.

e. Recommended Safety Equipment. Based on recommendations resulting from Hawaii's serious marine incidents, a cutting tool of a sufficient size and strength to cut through vessel rigging is highly recommended on board to free the rig from the vessel in the event of dismasting to prevent further damage to the hull or persons on board.

f. Modification or Changes to Rigging or Sail. Sector Honolulu and/or your local CG marine inspector shall be notified prior to any changes or modifications to the rig and sail plan of record. The level of plan review will depend on the degree of modification and will be determined by Sector Honolulu or your local CG marine inspector prior to carrying passengers for hire. Part of the annual rigging inspection will include a discussion of any changes to the rig and associated hardware as well as a verification of the approved sail plan as necessary.

g. Non-Destructive Testing. NDT is appropriate when questions exist after close visual examination. The use of NDT will be at the discretion of the attending CG marine inspector. Hull integrity and strength in way of chain plates, the mast step and other critical attachment points shall be evaluated. If a rigging component is found with evidence of significant deterioration such as fractures, excessive pitting or crevice corrosion, the particular component shall be renewed, replaced in-kind, or proven satisfactory through agreed upon NDT processes.

h. Deficiencies. If the rigging examination regime and or conditions found aboard are unsatisfactory, the marine inspector may apply operational control on the vessel until such conditions are resolved. For example, if the vessel does not have a complete inventory, including age and recommended life span, the marine inspector shall issue a CG-835 to require the company to provide the inventory list to include age and recommended life span for all the components, mast and wire rigging. The company shall be given 30 days to comply with the requirement.

i. Marine Inspectors Going Aloft. Sector Honolulu marine inspectors shall not go aloft in a harness using the vessel's lines. Inspectors can use binoculars from the deck level to identify anomalies. If the inspector identifies an item of concern from the deck level, the company can send an employee aloft to video tape the region for the marine inspector, obtain a third party rigging survey, or use certified machinery such as a "pettibone" or "cherry picker" man-lift crane.

j. Appeal Process. Vessel owners/operators are reminded that they may request reconsideration verbally or in writing through Sector Honolulu's chain of command starting with the Chief of Inspections. If unsatisfied with Sector Honolulu Officer-In-Charge, Marine Inspection (OCMI) decision, owners/operators also have the right to submit a formal appeal in writing to the Commander, Fourteenth Coast Guard District via the cognizant OCMI. Additional information on the appeals process is contained in 46 CFR 1.03.

7. DOCUMENTATION: Upon completion of the annual survey, the CG marine inspector shall document the following items in the vessels permanent vessel file and/or in MISLE:

a. Detailed description of the rig and associated gear;

b. Drawings or pictures of rig and location of key components;

c. Manufacturer, purchase and installation dates of all components;

d. Types of furlers and tensioning systems;

e. Description of sea trials including tests of all sailing configurations on all points of sail, condition of cleats and running rigging while operating and any potential hazard or sail/rigging arrangement that impairs navigation or passenger safety.

Recommended references on rigging and sail vessel inspection are provided in Enclosure (4). Should you have further questions, please contact the Sector Honolulu Chief of Inspections Division at (808) 522-8260 x261.

Enclosures: (1) Rigging Survey - Key Components List
(2) Mast/Rigging Sample Survey Report Content
(3) Cable End Fittings
(4) Recommended References

SECHONO INSPECTION NOTE #13 – Rigging Key Components List

Rigging Survey:

1. **General Rig Description**

2. **Mast Step**
   - **a. Compression Post**
   - **b. Base condition (drainage)**
   - **c. Mast Partners**

3. **Chainplates**
   - **a. Materials and condition**
   - **b. Fasteners**

4. **Deck Hardware**
   - **a. Travellers and blocks**
   - **b. Tracks for sheets and blocks**
   - **c. Shackles**
   - **d. Boom vang**
   - **e. Furling gear**

5. **Winches**
   - **a. Mast mounted**
   - **b. Deck/cabin top mounted**
   - **c. Line stoppers**

6. **Spars**
   - **a. Penetrations**
   - **b. Tangs**
   - **c. Spreaders and bases**
   - **d. Boom and gooseneck fitting**
   - **e. Spinnaker/Whisker poles**
   - **f. Masthead hardware and sheaves, etc.**
   - **g. Antennas, light, wind indicators, etc.**

7. **Catamaran**
   - **a. Crossbeam**
   - **b. Ladder and attachments**
   - **c. Dolphin/Pelican striker and bridle arrangement**

SECHONO INSPECTION NOTE #13 – Rigging Key Components List

8. Stays/Shrouds
- **a. Wires**
- **b. Terminals/Swages**
- **c. Turnbuckles and toggles**
- **d. Adjustable backstay**
- **e. Clevis pins and cotter pins**

9. Running Rigging
- **a. Halyards**
- **b. Splices**
- **c. Shackles**
- **d. Sheets**
- **e. Blocks**

10. Sails
- **a. Correct sail area of record**
- **b. Battens**
- **c. Reinforcements and chafe patches**
- **d. Reefing points**
- **e. Stitching**

SECHONO INSPECTION NOTE #13 – SAMPLE MAST/RIGGING SURVEY REPORT

FILE # _____

The following is a report of mast and rigging condition for the commercial passenger vessel_____, Official #_____, inspected by the undersigned beginning _____ and completed on _____. The inspections were conducted at _____ at the request of _____, master of vessel. _____ was also inspected under full sail during sea trials on _____ in brisk, ____knot winds off _____.

This survey was originally requested to meet USCG Sector Honolulu requirements for mast and rigging inspections on sail-powered small passenger vessel inspected under 46 CFR Subchapter T per Sector Honolulu Inspection Note #13 dated _____.

The method of survey was conducted as follows:

- Initial review of the rigging system design and installation
- The chain plates and their fastenings to the hulls were examined for wear or deficiencies.
- Original, re-used, hardware was **Dye Penetration Tested (DPT)** tested and inspected with magnification.
- The mast column and all shroud/stay connection fittings were examined from mast head to step
- The mast compression resistance load path was examined for indications of material or structural failure
- Running rigging systems were inspected for wear and proven for operation
- The mast and rigging systems were removed and disassembled for USCG inspection at ground level.
- Recommendations were made for replacement of various components and general maintenance work to be completed prior to the vessel returning to passenger service under sail
- Final sea trials under sail and rig tuning were conducted to complete this inspection.

Notes on recommendations made for changes, corrections or up-grades to existing systems or structures:
Any recommendations made are drawn directly from component manufacture recommendations, consult with the designer and or builder of the specific rig or recognized references on boat construction and or rigging including: Norman Skene-***Skene's Elements of Yacht Design;*** Larsson & Eliasson-***Principles of Yacht Design;*** Brian Toss-***Complete Rigger's Apprentice;*** Henderson-***Understanding Rigs and Rigging;*** *and NAVTECH –* ***Rigging Service Guidelines .***

Changes or corrections made, requiring USCG recognition and filing are highlighted as such
(NOTICE OF CHANGES/CORRECTIONS MADE FOR USCG RECORDS)

VESSEL DESCRIPTION: (example for illustration only)

_____ is a purpose designed and built, motor/sailing, commercial passenger catamaran certificated by the Coast Guard to carry up to 49 passengers and up to 4 crew on a ***"Limited Coastwise Route" not more than 20 miles from a harbor of safe refuge.*** The vessel hull construction is _____
_____

RIGGING DESIGN DESCRIPTION: (example for illustration only)

The rig is a marconi mainsail with twin headsails in a sloop configuration. The deck stepped mast is conventionally stayed, divided into 3 panels with two sets of (Ø aft rake) spreaders, laterally stayed with upper and intermediate shrouds and twin fore and aft lower shroud sets. Uppers and intermediates are "continuous" without terminations and nearly parallel to the mast from spreader tip to chain plate. Fore and aft staying is accomplished continuous twin back stays leading outboard to the aft hulls while twin head stays are secured (via a link plate) to split bridle legs leading to the foremost bows of the vessel.

SAMPLE

GENERAL INFORMATION:

FILE NUMBER:	FILE # _____
RIGGING SURVEY PREPARED FOR:	_____
NAME OF VESSEL:…….	_____
PURPOSE FOR SURVEY:……....	USCG required mast and rigging inspection
YEAR MAKE MODEL OF VESSEL:……..	_____, passenger, aux/sail catamaran
BUILDER:……..	_____
HOME PORT:……	_____
OFFICIAL #.....:……..	_____
USCG CERTIFIED FOR:…….	Near coastal passenger excursions, 49 passengers, up to 4 crew
OWNER:……	_____
OWNER'S ADDRESS:……	_____
WHERE INSPECTED:……...	_____
SEA TRIALS CONDUCTED……	Offshore, Waikiki (Ala Wai to Diamond Head)
ATTENDENT AT TIME OF SURVEYS AND SEA TRIALS….	Capt. _____, Operations Manager
LENGTH OVER ALL (L.O.A.):……	_____" (from USCG documentation)
PRIMARY PROPULSION……....:……	Aux/sail, diesel twin screw
GROSS TONNAGE……	37 " "
NET TONNAGE:……	29 " "
SAIL AREA…….	Not to exceed 1,646 sq ft per COI
ORIGINAL STABILITY LETTER…….	#16710, August 2nd, 1985
MAST/RIGGING DESIGNER MANUFACTURER:……...	Unconfirmed,

SAMPLE

STANDING RIGGING: (example for illustration only)

MAST COLUMN:
(NOTICE OF CORRECTIONS MADE)

Painted (white) , aluminum extrusion, 10" x 6.5",2 sections sleeved and mechanically fastened. The mast was removed for inspection (09/07) and re-rigging. ***An area of corrosion, noted by Mr. Tim Wilcox (USCG) at the heel of the mast was cropped back to good metal per this surveyor's recommendations***. Inspection was performed on the entire column. Dye Penetrant Testing (DPT) was conducted on fitting welds at the mast head and in way of the tang through-bolts holes. Other areas of high loading or compression were closely examined with visual magnification

SPREADERS/ SPREADER ROOTS:

Twin, matching sets of foiled aluminum spreader struts are attached to mast column with dual, fore and aft, SS brackets at the spreader roots. Brackets are SS machine-screwed to the mast wall. The dissimilar metals appear adequately isolated with very limited areas of aluminum corrosion noted at/under the brackets. The condition of the brackets and the fastening were closely examined with no deficiencies noted. The shrouds run fair and vertical in line with the mast while the design of the spreader brackets ensure that the spreader to wire angle-bisects remain equal on both sets. Custom fittings on the spreader tips entrap the shrouds from escape.

MAST STEP/PARTNERS:

Compression loads are distributed to a deck-stepped, aluminum mast base. The compression load path below is through the primary, perpendicular, cross beam bulkhead (2 1/2" thick) laminated structure additionally supported by a fore and aft panel under the mast step which is "stack laminated" with additional panels laterally. On deck the mast heel saddles a well fastened, close fitting, aluminum step which was inspected for deterioration and or developing weld failures.

BOOM AND GOOSENECK FITTINGS:

The boom is one continuous extrusion of aluminum, painted white. An acceptable margin of wear was noted on the SS casting and pivot pins of the gooseneck and with the pivot rod into the boom. Parts were lubricated and cotter pin secured upon re-commissioning. No internal purchases for out-haul or otherwise are employed here. 4 to 1mainsheet tackle is secured to the boom with a series of through bolted, SS, bails of adequate size.

CHAIN PLATES AND LINK PLATES

UPPER AND INTERMEDIATE SHROUDS/ Deck level chain plates
(NOTICE OF CHANGES MADE FOR USCG RECORDS)

Existing plates were reportedly original equipment. *Renewal was recommended with modification to increase metal gauge to 3/8 from 1/4 "per guidelines published in Skenes Elements of Yacht Design".* The previous, twin plates were also modified to a single plate from twin, continuous, 1/4 thick straps which were bolted into one another through the main beam bulkhead, with limited access to the fastenings. New (T-shaped) plates carry the upper and intermediate wires on a single plate and distribute the tensile loads across an equivalent surface area of the bulkhead. Location was unchanged. The new fastening schedule surpasses previous bearing capacities. Backing is adequately provided with 1/4" aluminum plate of the same outside dimensions as the T plate base (9" x 16"). Port and Starboard plates are correctly oriented to the shroud load path. ***See photo page # 3***

JIB BRIDLE PLATES 2:

Reportedly original, stainless steel lugs welded to rectangular plates, fastened with 4 (each) 5/8" bolts, through the bow compression beam and into the solid, laminated, hardwood bow sections. Lug thickness of 1/2" meets standards for 7/8" pin and 1/2" wire. Welds were inspected with 15x magnification.
NOTE, upon re-stepping the mast it was observed that the load paths of the bridles to the lugs are miss-oriented by a few degrees, especially on port. It is recommended that is corrected when the mast is next un-stepped for service and maintenance.

JIB BRIDLE TANGS:

These tangs join twin bridles to the bows and twin head stays link plate, reportedly replaced in 2004. Twin, sandwich type, tangs of 1/4, SS plate are used and drilled to accept 7/8 clevis pins on both ends. All tangs were DPT tested, inspected with magnification

SAMPLE

(15 xs) and measured for elongation wear in clevis pin bores. Four of the eight 7/8 clevis pins are original. New pins are on order and should be installed upon receipt.

FORWARD CROSS BEAM – JIB BRIDLES ATTACHMENT POINTS

(NOTICE OF CHANGES MADE FOR USCG RECORDS)

This beam is an aluminum mast section with internal bracing, providing a mounting platform for jib bridles and pelican striker plates. Additionally providing a connecting point for longitudinal beams employed in the boarding ladder system. Upon recommendations, the cross beam was replaced with an equivalent section of aluminum mast column, of equivalent cord, depth and gauge. This is a *recycled* mast section with internal reinforcement and bracing applied to the center span and end sections per original specifications. Fabrication and welding were professionally executed and visually inspected by the USCG and this surveyor. Re-fastening of the compression beam to the bows is achieved using 4, each, 18", 5/8, SS lag bolts which are epoxy bonded into the solid-wood bow sections. This bolting pattern also secures the jib bridle chain plates to the bows. ***See page # 9***

HEAD STAY/BRIDLE LINK PLATE:

(NOTICE OF CHANGES MADE FOR USCG RECORDS)

Newly replaced (09/07*) upon surveyor's recommendations, sized-up from 3/8" thick SS to 1/2" SS, T316*, to meet standards ***(Skene's***) for 7/8" pin & 1/2" bridle wires. Twin head stay wires are sized at 1/2 with 3/4 clevis pins***. See photo page # 10***

TWIN BACK STAYS CHAIN PLATES:

Reportedly replaced in 2004. 1/4" thick by 1-5/8" wide, SS straps, bolted through reinforced hull sections near inboard transoms coupled with external SS backing straps of similar dimensions. Chain plates were MDP dye tested and inspected under magnification. (See COMMENTS in the following, lower shrouds section on plate gauge). The plates are adequately oriented to load path in both directions.

FORE AND AFT LOWER SHROUDS CHAIN PLATES:

Reportedly replaced in 2004. 1/4" thick by 1-5/8" thick straps bolted through cabin house and interior hull structure aft and internal hull structure forward. Chain plates were DPT tested and inspected under magnification.

COMMENTS: *The 5/8 pin w/ 3/8 wire sizes would typically call for 3/8 to 7/16 gauge plate. As the loads are split between the two, fore and aft lower shrouds, bearing on 1/4 gauge chain plates is marginally adequate in this case. The split back stays, with the same wire and pin size, are similar in that they also divide tensile load bearing on 1/4 thick plates. With the aft lower chain plates, the lead angle of the plates is poorly oriented to the load path of the shrouds in the lateral angle. It is recommended that all 6 of these chain plates are replaced with plates of 3/8 thick metal at the clevis pin bore and bent to the correct load path angle when the mast is next un-stepped from the vessel.*

CHAIN PLATES AND LINK PLATES CONTINUED:

FORWARD (PELICAN STRIKER) PLATE:

Reportedly original hardware. 5/8 thick SS lugs welded to 1/4 SS plate, through bolted to forward perpendicular beam. Lugs and welds were DPT dye tested and inspected under magnification. This fitting is primarily engaged in suspending the forward compression beam with the pelican stay which joins the head stay link plate.

Chain/link plate bore (elongation) measurements 09/07

Shroud/stay	Wire dia.	Clevis pin dia.	Chain/link/plate/lug gauge	Load line elongation
Upper/cap shroud	3/8	5/8/.6250	3/8	New, Ø wear
Intermediate shroud	3/8	5/8/.6250	3/8	New, Ø wear
Forward lower shroud	3/8	5/8/.6250	¼	.6400 averaged
Aft lower shroud	3/8	5/8/.6250	¼	.6450 averaged
Jib bridle chain plate lugs	1/2	7/8/.8600	½	.8860
Jib bridle link plate	1/2	7/8/.8600	½	New, Ø wear
Pelican striker plate lug	3/8	5/8/.6250	5/8	.6600
Back stays plates	3/8	5/8/.6250	1/4	.6500 averaged
Twin headstay link plate	1/2	3/4/7600	1/2	New, Ø wear

SAMPLE

CHAIN PLATES SUMMARY:

The chain plate leads are well angled to the load paths in both planes except where stated otherwise above. Their mounting points, hull, cabin side, cross beam, etc were closely inspected for any indications of deterioration or structural deficiencies. Fasteners were inspected for corrosion, Restoration work was noted in the aft hulls where the back stay chain plates tie in to the hulls. The hull superstructure appears well preserved and fit to support anticipated rigging tension and mast compression loads.

TURNBUCKLES:

All are open-barrel and toggle with chrome plated bronze barrels and 316 SS strap T-toggles. Turnbuckle studs are wire swage terminals. All 13 rigging turnbuckles were replaced (09/07).

TANGS AND ATTACHMENTS ALOFT:

(NOTICE OF CHANGES MADE FOR USCG RECORDS)

Upper/lower and intermediate shrouds: Sandwich type, twin 3/16 thick, SS, dual tangs join the upper, intermediate and lower shrouds to the mast aloft. *Tangs were sized-up upon surveyors recommendation from 1/8 to 3/16 gauge SS to reach closer to standards for 5/8 pin with 3/8 wire loads (newly replaced 09/07)*. These tangs rest on the shoulders of 3/4 diameter, SS rod running laterally through the mast wall sections which are .250" thick. No compression tubes are employed here. *Original rod stock was 5/8 diameter, sized-up to 3/4 upon surveyor's recommendations and design.(newly replaced 09/07)* The protruding ends of the rods are threaded (not underneath the tangs) and secured with nuts held captive by cotter pins. Load path orientation of the tangs is as follows: Upper shrouds (correct) intermediate shrouds (approximately 5 degrees off load path but acceptable) lower shrouds (eye-jaw toggles on the aft lowers accommodate the staying geometry discrepancies with the lowers which have a wider base angle than the uppers while they share a single set of tangs aloft, load angle is acceptable. ***See photo page # 11.***

HEADSTAY AND BACK STAY LUG-EYES:

¾" aluminum stock welded to mast-head truck assembly. Lugs and welds were DPT tested and examined with 15x magnification. An acceptable margin of elongation-wear was measured and noted on the head and backstay lugs. These connection points are original (32 years old). No indications of weld failure, advanced wear or metal fatigue were noted under dye penetration and close examination; cyclic wear over 32 years will have an effect on the metal integrity. ***See photo page # 11.***

MAST HEAD BACKSTAY SPLITTER:

Twin backstays join a custom (reportedly built 2004) fitting of 1/4, SS, twin, triangular-plates. Twin 3/8 tangs are welded to these plates allowing connection to a single eye-jaw toggle which joins the masthead truck with 3/4 clevis pins. Welds were DPT tested and pin bores were measured for wear. An offset of the clevis pin holes on the fitting causes a minor wire deflection at the splitter. Replacement with a more appropriately designed fitting is recommended when the mast is next un-stepped from the vessel. ***See photo page # 10.***

TWIN HEAD STAY SPLITTER PLATES:

Twin, triangular 1/4, SS, plates, (reportedly replaced 2004) bored for 3/4 clevis pins join twin head stays to masthead truck via a single eye-jaw toggle. Full range of movement is provided for with this configuration. Plates were DPT tested and measured for wear.

WIRE ROPE, SHROUDS, STAYS AND BRIDLES:

All 316, 1x19, SS wire rope newly replaced 09/09. Wire diameters named above in CHAIN PLATES table.

HALYARDS, SHEETS, TOPPING LIFT:

Halyards replaced (09/07) with equivalent 9/16 braided line to 1/4 7 x 17 wire rope. Topping lift newly replaced (09/07) with equivalent plastic covered ¼, SS, wire rope. Twin jib halyards are freely suspended from the mast truck with Harken, 100mil turning blocks to accommodate 9/16 halyards. The main halyard runs through a single internal masthead sheave. All are correctly sized for service and were proven under sea trial for operation.

SAMPLE

RUNNING RIGGING - DECK HARDWARE:

Winch inventory as follows: Main sheet (Harken, 32-2 speed ST, *self tailing*) Jib sheets, (2, Harken, 64-2 speed, ST) Halyards, (2, Barient, single speed, non-tailing on mast). All 5 winches appear well fastened and were proved serviceable upon sea trials. The halyard winches were not removed from the mast to inspect fastenings!

Sheets and running lines are all well lead through their running leads. Blocks and deck hardware appear adequately sized and secured for their service. No deficiencies were noted other than a worn topping lift which is a 2 part tackle on the boom needing replacement.

SUMMARY AND CONCLUSION: (example for illustration only)

_____has been effectively restored in terms of (her mast staying hardware only) as of _____. The scope of this survey report is comprehensive and should meet all criteria for determining "fitness for intended service" for this commercial passenger vessel operating within the limitations of her C.O.I. The recommendations for replacement or renewal of deck hardware should be tended to during the next, mast out, inspection cycle in 6 years. Other minor recommendations should be accomplished in a timely manner.

Guidelines for mast and rigging inspection, maintenance and component replacement are drawn from recommendations made by NAVTEC RIGGING SOLUTIONS.

Including:

- Annual: comprehensive, ***mast standing***, inspection of mast and rigging system with rigging slacked off, turnbuckles opened and lubricated and rigging tension re-tuned.
- Six year cycles: Mast removal and disassembly of all components for comprehensive inspection.
- Replacement of stainless fittings every 5 to 10 years for vessels operating in the tropics.
- General inspection of rigging equipment by vessel's crew several times per year.

Surveyor's recommendations include:

- Monthly general inspections by crew using a check list tailored to the vessel's rigging systems.
- Weekly cleaning and thorough rinsing of all rigging hardware at deck level.
- Annual comprehensive inspection by qualified rigging surveyor which may include sea trials of the vessel under normal loading conditions in typical weather circumstances. To include, also: backing off rigging tension, removal of hardware where possible for inspection of chain plates, stem fittings, toggles, etc, updating of ship's (recommended) rigging maintenance log.
- Commercial vessels must be equipped with an **efficient** rigging cable cutting device. This device should be maintained in good operating condition and stored in an accessible location. Testing of such device with cable of equivalent dimension to the vessel's standing rigging should be practiced.
- Captain and crew should be trained and annually reviewed in: methods of safely going aloft, understanding and recognizing the early signs of hardware failure, proper rigging maintenance procedures, and appropriate response to rigging related emergencies or failures.

DISCLAIMER: (optional and normally found in commercial third party survey)

This report is the unbiased perspective of the undersigned surveyor, ***not to be considered a warranty or guarantee against mast or rigging failure either specified or implied.*** All components named in this report were closely inspected by this surveyor exclusively.

Note that: marine hardware (stainless steel and aluminum) failures can develop without visual indication. Therefore, diligent maintenance, proper use, frequent inspections and replacement of questionable or aged hardware are the best lines of defense against mast/rigging failures.

Signature and Date of person or persons responsible for the rigging survey:

_____

SAMPLE

SECHONO INSPECTION NOTE #13 – Cable End Fittings

Swaged Fittings: Swaged fittings are cold pressed onto the cable with purpose built equipment that applies a specified pressure which results in a uniform compression to within a specified diameter range based on cable size. Swaging is a one time event.

Typical grade 316 swage eye to terminate stainless steel rigging wire. May also be fork end or combined with a toggle or turnbuckle.

Check: *Swaged fittings should always be straight and installed properly aligned with the rig. Evidence of bends, excessive corrosion, broken wire strands at the fitting entrance, fractures or elongation of the clevis pin hole are all cause for close-up inspection, NDT and or renewal.*

Swageless Fittings: Swageless fittings are mechanical fittings designed to be field assembled. Common trade names include Norseman, Sta-Lok and Hayne.

Typical swageless grade 316 threaded eye fitting with socket and renewable cone visible.

Check: *Evidence of excessive corrosion, water intrusion, fracture or improper assembly are all cause for disassembly, close-up inspection, NDT and or renewal. Cones should be replaced upon re-assembly. Refer to manufacturer's recommendations for details.*

Toggles: These are used as universal joints and usually installed between chainplates or mast tangs and turnbuckles or end fittings to align fittings with the shrouds/stays to reduce fatigue.

Typical grade 316 Double Jaw Toggle.

Check: *Evidence of excessive corrosion, incorrectly sized or bent clevis pins; worn or oval pin holes; deteriorated, broken or missing cotter pins are all cause for disassembly, close-up inspection, NDT and or renewal.*

Enclosure (3)

Revised 9/4/08

SECHONO INSPECTION NOTE #13 – Recommended References

1. **Rigging Service Guidelines**
   Navtec Rigging Solutions
   Available at http://www.navtec.net/support/owners.cfm
   Also see: Product Notices/White Papers and FAQs

2. **Skene's Elements of Yacht Design**
   Francis S. Kinney
   ISBN 0-399-15004-8

3. **Principles of Yacht Design**
   Lars Larsson & Rolf E Eliasson
   ISBN 0-07135-393-3

4. **The Complete Rigger's Apprentice**
   Brion Toss
   ISBN 0-07064-840-9

5. **Understanding Rigs and Rigging**
   Richard Henderson
   ISBN 0-87746-383-4

6. **Surveying Small Craft**
   Ian Nicholson
   ISBN 0-924486-58-9

7. **The Boater's Guide to Corrosion**
   Everett Collier
   ISBN 0-07-155019-4

8. **The Sailing Dictionary**
   Joachim Schult
   ISBN 0-924486-37-6

9. **Surveying Fiberglass Sailboats**
   Henry C. Mustin
   ISBN 0-87742-347-4

10. **Inspecting the Aging Sailboat**
    Don Casey
    ISBN 0-07-013394-8