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NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 02-16

Subj: INSPECTION GUIDANCE FOR SAIL RIGGING AND MASTS ON INSPECTED SAILING VESSELS

Ref: (a) Subchapter T - Small Passenger Vessels Under 100 Gross Tons:
46 CFR 176.402 (c)(1), 176.700, 176.800, 176.802.(a)(3), 177.202 (b)(12) and 177.330
(b) Subchapter K – Small Passenger Vessels Carrying more than 150 Passengers or Overnight Accommodations for more than 49 Passengers:
46 CFR 115.402 (c)(1), 115.700, 115.802 (a)(3); 116.202 (b)(14) and 116.330
(c) Subchapter R – Sailing School Vessels
46 CFR 169.221 (a), 169.222, 169.203, 169.239, 169.305 (a)(13), (14) and 169.309

1. PURPOSE. This Circular provides guidance to vessel owners, riggers, marine surveyors, other marine service providers, and Coast Guard marine inspectors regarding inspection of sail rigging, masts, and associated components for inspected sailing vessels and the use of preventative maintenance as a good marine practice.

2. ACTION.

a. Officers-in-Charge, Marine Inspection (OCMIs), vessel owners and operators, or their representatives, are encouraged to take advantage of the procedures and guidelines detailed in this Circular. Area Commanders, District Commanders, Sector Commanders, Commanding Officer Marine Safety Center, and OCMIs are encouraged to apprise industry representatives of this Circular and apply its provisions appropriately. This Circular will be distributed by electronic means only and is available on the World Wide Web at http://www.uscg.mil/hq/cg5/nvic/default.asp.

b. Coast Guard Marine Inspectors should refer to the enclosed guidance when conducting inspections on sailing vessels. It is important to follow the recommended frequencies of maintenance and inspections. Excessive frequencies (e.g., for unstepping the rig) may

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impose unnecessary expenses for the owner/operator without appreciable findings. Enclosure (1), along with its appendices, provides guidance for the purpose of assisting vessel owners/operators and U.S. Coast Guard personnel with the inspections and recommended documentation of maintenance for sail rigging and masts on inspected sailing vessels.

c. The use of this guidance will assist sailing vessel owner/operators to adequately assess the safe condition of their sail rigging systems through the use of a documented preventative maintenance plan.

3. DIRECTIVE(S) AFFECTED. None.

4. BACKGROUND.

a. In 2005, the entire rig of a U.S. tall ship was carried away as a result of a single, failed component in the standing rigging; fortunately, no injuries or fatalities occurred.

b. In 2006 and 2007, two separate dismastings occurred aboard Coast Guard inspected catamarans in the Hawaii region; each tragically resulted in a passenger fatality. Post-casualty investigation analysis revealed rigging equipment failure as the primary causal factor in both cases (activity numbers 2833864 and 2895732; accessible at http://cgmix.uscg.mil/IIR/IIRSearch.aspx). Following these serious marine casualties, a comprehensive review and inspection of the Hawaiian fleet of 59 sailing vessels was conducted where approximately 20% were found to have significant mast and rigging deficiencies. These deficiencies included excessive corrosion, fractures in the masts, missing bolts, spreaders, and mast fittings.

c. Post-casualty analysis and follow-up inspections highlighted the need for the Coast Guard, in collaboration with the commercial sailing vessel industry, to develop a standardized inspection, examination, and maintenance regime for sail vessel rigging nationwide to improve safety of commercial sailing vessel operations.

d. In 2008, after a third catamaran dismasting, Sector Honolulu along with the U.S. Coast Guard Headquarters Traveling Inspection Staff led a workshop with local sailing vessel owners, operators, rigging suppliers, riggers, naval architects and marine surveyors to develop an inspection regime for sail vessel rigging. As a result of that collaborative effort, Sector Honolulu Inspection Note #13 dated October 16, 2008, established a recommended inspection and examination regime for sail vessel rigging that then became the standard for the nation's inspected sailing vessel fleet.

e. To date, there have been 37 reportable marine casualties involving inspected sailing vessels, 18 of which have involved masts, spars and rigging failures on both contemporary and traditional rigs. Dismastings were mostly attributed to, but not exclusively limited to multi-hulled sailing vessels.

5. DISCUSSION.

   a. Sail Rigging Inspections. Under 46 CFR 176.802(a)(3), 115.802 (a)(3) and 169.309 regular rigging inspection is already prescribed; however, the regulations do not establish specific time intervals for unstepping the mast. Given the high risk for and potential fatal consequences of a rigging failure, preventative maintenance is critically important for sailing vessels. The basis for any preventative maintenance plan is a robust examination regime to determine, with some level of confidence, component service life and replacement intervals in order to prevent equipment failures and related marine casualties.

   b. Condition of the Sail Rigging. Sailing vessels and their rigging are made up of a complex system that must stay intact and function properly else risk catastrophic failure that could result in a significant marine casualty. Sail rigging is also exposed to a complex variety of dynamic stresses in service. Variable operating conditions such as climate, wind strength, and weather and sea state, among other influences, imposes dynamic stresses that affect the working life of the rig and its components. Corrosion is also ever present based on materials used and exposure to the salinity of the marine environment. Proactive and thorough periodic examinations by vessel owners and operators are essential to monitor wear and corrosion, determine service life and replacement cycles, and help identify potential rigging failures before they occur. There may not always be obvious visual cues to prompt replacement or renewal of rigging equipment. Continuous monitoring, with an understanding of the equipment in use, is essential to maintain safe operating conditions.

   c. Vessel Specific Rigging Maintenance Regime. The inspection and maintenance regime set forth in Enclosure (1) and its appendices are intended to assist vessel owners and operators in determining the reasonable service life and replacement interval of rigging components as based on the vessel's operations, environmental conditions, vessel type (i.e., monohull vs catamaran) and other factors.

   d. This NVIC incorporates the best practices for sail vessel rigging of all types and sizes based on input from sailing vessel operators, Coast Guard marine inspectors, riggers, and marine surveyors. Publishing this guidance enhances consistency with the inspection process and helps sustain proper rigging maintenance and awareness in the commercial sailing fleet.

6. DISCLAIMER. This guidance is not a substitute for applicable legal requirements, nor is itself a rule. It is not intended to nor does it impose legally binding requirements on any party. It represents the Coast Guard's current thinking on this topic and may assist industry, mariners, the general public, and the Coast Guard, as well as other Federal and state regulators, in applying statutory and regulatory requirements.

7. ENVIRONMENTAL ASPECT AND IMPACT CONSIDERATIONS.

   a. The development of this NVIC and the general policies contained within it have been thoroughly reviewed by the originating office in conjunction with the Office of Environmental Management, and are categorically excluded (CE) under current USCG

CE # 33 from further environmental analysis, in accordance with Section 2.B.2. and Figure 2-1 of the National Environmental Policy Act Implementing Procedures and Policy for Considering Environmental Impacts, COMDTINST M16475.1 (series).

b. This directive will not have any of the following: significant cumulative impacts on the human environment; substantial controversy or substantial change to existing environmental conditions; or inconsistencies with any Federal, State, or local laws or administrative determinations relating to the environment. All future specific actions resulting from the general policies in this NVIC must be individually evaluated for compliance with the National Environmental Policy Act (NEPA), DHS and Coast Guard NEPA policy, and compliance with all other environmental mandates.

8. DISTRIBUTION: No paper distribution will be made of this Circular. An electronic version will be located on the following Coast Guard website: http://www.uscg.mil/hq/cg5/nvic/.

9. RECORDS MANAGEMENT CONSIDERATIONS. This Circular has been thoroughly reviewed during the directives clearance process, and it has been determined there are no further records scheduling requirements, in accordance with Federal Records Act, 44 U.S.C. 3101 et seq., NARA requirements, and Information and Life Cycle Management Manual, COMDTINST M5212.12 (series). This policy does not create significant or substantial change to existing records management requirements.

10. FORMS/REPORTS. None.

11. REQUEST FOR CHANGES. Recommended changes to this Circular and questions regarding implementation should be directed to the Domestic Vessel Compliance Policy Division (CG-CVC-1) at CG-CVC-1@uscg.mil.

P. F. THOMAS
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Assistant Commandant for Prevention Policy

Encl (1): Inspection Guidance for Sail Rigging and Masts on Inspected Sailing Vessels

Inspection Guidance for Sail Rigging and Masts on Inspected Sailing Vessels

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Inspection Guidance for Sail Rigging and Masts on Inspected Sailing Vessels

ACKNOWLEDGEMENTS

This NVIC was developed as the result of over six years of rigging awareness and lessons learned in the field aboard the inspected sail vessel fleet, including the implementation of Honolulu Inspection Note #13, incorporation of sail vessel training at the Marine Inspector's Course in Yorktown, beneficial input from experienced sailing professionals, as well as commercially-available rigging inspection training created specifically for Marine Inspectors.

Special thanks to the following industry partners and Coast Guard personnel who assisted in the evolution of this document by providing lessons learned on best practices and real-life experiences.

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LT Nicole Auth, Sector Honolulu, HI
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I. Overview

a. *General*: This NVIC provides inspection guidance that is specific to sail rigging equipment for inspected commercial sailing vessels. The goal of this inspection guidance is to ensure critical components of the sail rigging are replaced on a routine schedule before they experience failure.

Note: When there is a component failure that results in a reportable marine casualty, as defined in 46 CFR 4.05-1, the owner or operator shall notify the nearest Coast Guard Sector or Marine Safety Unit.

b. *Variables to Consider: Rigging Equipment Service Life/Replacement Intervals*: There are many variables in rig design, component materials and attachment methods that should be considered when determining equipment service life and replacement intervals. These intervals for sail rigging and components vary according to vessel design characteristics including the following:

i. Mast/spar construction material (e.g., solid, laminated, hollow/wood, steel, aluminum, carbon fiber, composite);

ii. Mast installation (e.g., keel or deck stepped, fixed, rotating or unstayed without standing rigging);

iii. Sail rig type and or technology (e.g., marconi, gaff or square rigged);

iv. Standing rig system complexity (e.g., minimally vs. heavily stayed);

v. Vessel type (e.g., monohull or multi-hull);

vi. Service route variables and local wind/sea state (e.g., protected vs. exposed waters);

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

viii. Design safety factor and review process (e.g., rig pedigree, load assumptions and/or independent engineering review);

ix. Nature of operations (e.g., high performance or low stress); and

x. Area of operations in terms of propensity for corrosion (e.g., heat, salinity and climate).

II. Preventative Maintenance Plan (Rigging Inspection Regime):

a. *Written Maintenance Plan*: All inspected sailing vessel owner/operators should have a written Preventive Maintenance Plan (PMP) that specifically addresses their vessel's sail rigging equipment and components. Maintenance of the rigging is the most critical

factor toward ensuring safe operation of the sail rigging and its components, and thus helps ensure the safety of passengers and crew. The PMP, when carried out, will be comprised of inspection of the sail rigging components per Section III below.

b. *Contents*: A PMP, should include, at a minimum:

i. General Description: A description of the sailing vessel, including the type of rig, drawings and/or photographs of the vessel itself.

ii. Examination/Maintenance Schedule: The PMP should include the maintenance schedule of the rigging and associated equipment. These maintenance examinations should establish routine as well as very detailed examination protocol; everything from deck-level rigging prior to sailing, to the cycle of regular inspections aloft, and including comprehensive annual inspections with component disassembly as needed.

iii. Inventory of Rigging Components: The PMP should include an inventory of all rigging components, including the age of component, size, type of material, and a replacement schedule for all rig components based on inspection results, service history, and manufacturer or designer recommendations. Not all components have the same service life in all conditions. Due consideration should be given to the service, rig type, level of maintenance, sizing and other factors as appropriate regarding the replacement of or the renewal intervals for rigging components. The variable factors discussed in paragraph I.b. should also be taken into account.

iv. PMP examples: Several examples are provided as Appendices to this Enclosure to assist owners/operators with their PMP. Appendix (1) provides a generic list of key components that should be addressed in a PMP. Appendix (2) contains a sample template of a rigging equipment inventory document and a general inspection outline for the rigging equipment on a sailing catamaran. The Appendices are for general information and may not apply to all rigs.

c. *Documenting Exams/Maintenance*: All rigging examinations and maintenance conducted by the vessel crew and/or third party rigging surveyor should be documented (e.g., written reports, surveys, or photos). Documentation of exams and maintenance should include documenting the condition of equipment, maintenance performed to the equipment, and the replacement of equipment. This information is especially helpful in assessing life-cycle trends and objective evidence for revising rigging component maintenance and replacement schedules.

i. Tall Ships America (TSA)[1] – Recommended Protocol for Rig Inspection and Template for Rig Inspection Checklist: In 2012, Tall Ships America published a

[1] Tall Ships America is an international group of over 150 sailing vessels that, at the time of this NVIC's publication, has in its membership over 60 inspected U.S. flag vessels certificated for underway operations, in addition to a number of Moored Attraction Vessels as well as registered naval vessels from various countries. As an organization, they have been a resource supporting Coast Guard efforts to understand rigging inspection issues in the traditionally rigged fleet.

"Recommended Protocol for Rig Inspection and Template for Rig Inspection Checklist." This protocol is designed to assist member vessel operators in conducting and documenting routine monthly inspections of rigging and related structures aboard their vessels. **It also recommends keeping a Rigging Maintenance Logbook to document deficiencies and corrective actions and to make this logbook available to attending Coast Guard Marine Inspectors at scheduled inspections**. This protocol should be adapted and modified by the vessel operator into a format most suitable to the individual vessel. It should be noted that this protocol is not a substitute for implementing a PMP, as discussed above, and rig inspection checklists should be incorporated as part of the overall plan.

III. Inspection of Sail Rigging

a. *Coast Guard Inspections*: If a vessel maintains a PMP, it is an excellent tool that will help streamline vessel inspections conducted by the Coast Guard. Coast Guard Marine Inspectors can review a vessel's PMP, if one is maintained, and evaluate its implementation against the condition of the rigging. At a minimum, this review should be conducted at each annual inspection. Further, Marine Inspectors should determine whether the PMP is being carried out by the vessel crew or by a third party rigging surveyor or both, and assess the credentials and experience of those conducting rigging examinations and maintenance aboard. In reviewing the PMP, Marine Inspectors should determine if any rigging components were replaced in-kind or changed to another type of component throughout the year, and if the replacement or change was for reasons other than normal scheduled intervals. For a vessel that does not maintain a PMP, the Officer in Charge, Marine Inspections (OCMI) and/or Marine Inspector may require a third party rigging survey in order to verify the condition of the sail rigging and components.

i. Breakdown, disassembly, or removal of standing or running rigging: Before components are broken down, disassembled, or removed for inspection, it is critical to know how to safely disassemble components because disassembly can significantly alter the tune of the rig. Therefore, after components of a sail rigging have been disassembled and before a vessel goes back into service, a Coast Guard Marine Inspector should attend for operational tests and sea trials. Special attention must be given to the "tune" of the rig in its entirety. As an example, the improper tuning of one component can adversely impact loads elsewhere on the rig.

ii. Marine Inspectors Going Aloft: Coast Guard Marine Inspectors are not expected to go aloft because the Coast Guard does not provide Personnel Protective Equipment specific to Marine Inspectors conducting surveys aloft. Attending Marine Inspectors may use binoculars or other visual aids from the deck level to identify the condition of the rigging aloft. If an area or item of concern is identified aloft (from the deck level), it will be incumbent upon the operator by any available means, such as an aloft survey conducted by a third party rigging surveyor or qualified crewmember, to provide evidence of the condition of the rigging components in question. When made available by the owner or operator in a shipyard or other commercial environment, Coast Guard Marine Inspectors may use man-lift cranes such as "pettibones" or "cherry pickers" to assist with inspection of a vessel's rigging.

iii. Deficiencies: If deficiencies in the condition of the rigging are found, requirements for corrective action may be issued. Requirements for corrective action should normally be made only after a visual inspection of the rigging, dialogue with the vessel owner or operator, and an assessment of the vessel's implementation of a PMP has been made. Based on the variables listed in paragraph I.b., the OCMI will set the time frame to comply with requirements associated with corrective action, which may include operational controls. For example, an auxiliary sail vessel with a rigging deficiency may be restricted from operating under sail, but be allowed to operate under engine power, until the rigging deficiency is rectified; or, the deficiency may be confined to a particular section of the rig, such as the head rig, where a restriction from using the foresail may be imposed until head rig repairs are made, etc.

iv. Coast Guard Documentation Requirements: Upon completion of a vessel's scheduled annual Coast Guard inspection, the Marine Inspector will ensure the following items are documented and retained in the vessel's permanent file and/or in MISLE:

1. Detailed description of the rig and associated gear;

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

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

4. Types of furlers and tensioning systems; and

5. A 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.

vii. Attending Tall Ships of America (TSA) Vessels: Coast Guard Marine Inspectors attending TSA vessels should review the TSA protocol aboard member vessels, ensuring it is appropriately detailed for the complexity of the rig as part of the comprehensive rigging examination regime envisioned by the above mentioned checklist: "Recommended Protocol for Rig Inspection and Template for Rig Inspection Checklist."

b. *Third Party Rigging Surveys*: There are two types of third party rigging surveys: voluntary and Coast Guard-required for cause. In the latter, the owner or operator furnishes a third party rigging surveyor. A third party rigging surveyor used to conduct, for example, an annual inspection of the sail rig does not substitute for the vessel owner/operator from implementing a PMP or conducting and documenting preventative maintenance inspections.

i. A report from a third party rigging surveyor may be required when a PMP is not in place and/or not being carried out to help the OCMI and/or Marine Inspector determine the operating condition of a vessel's sail rigging and components. When

used, the reports of an independent third party rigging surveyor should address the elements of a PMP. Inspected sailing vessel owners and operators may voluntarily use the reports of independent third party rigging surveyors on a regular basis to supplement their own regime.

ii. Within the sail vessel rigging industry, there is no independent certification or standard qualification criteria for conducting rigging surveys. However, the goal of a third party rigging survey, in the context of this inspection circular, is to provide a comprehensive inspection of the **entire** rigging system – aloft and at and below deck level (alow), including the integration of the rig system to the hull structure (e.g., mast steps, compression posts, beams, chain plates, anchoring points aloft and at deck level, fastenings, etc).

iii. When the Coast Guard requires a third party rigging survey for cause under the authority of 46 CFR 176.840, 115.840, or 169.259, it is for the purpose of determining that the vessel and its equipment are suitable for the service in which it is employed. The Coast Guard Marine Inspector will be in attendance for the survey and a copy of the surveyor's report will become part of the vessel's inspection record with the Coast Guard. **Furthermore, when the Coast Guard requires a third party rigging survey, the intent is that the survey include a rigging survey aloft.** Because an examination of the rigging aloft requires sound expertise and judgment, it is in the interest of both the owner or operator and the Coast Guard to ensure that a surveyor with demonstrated experience in rigging aloft examinations perform the required survey. Therefore, prior to contracting for surveyor services, vessel owners or operators are encouraged to notify the cognizant OCMI, or the OCMI's representative, regarding which surveyor will be performing the survey. Doing so will allow the OCMI, or the OCMI's representative, the opportunity to communicate to the vessel's owner or operator if there are any concerns regarding a surveyor's level of expertise.

iv. Third party rigging surveyor qualification screening protocol should include, but not be limited to, a review of the selected surveyor's (1) bio or resume, (2) sample work product to ensure individual has the requisite experience for the rig type being surveyed and has normal work practice that include comprehensive rigging inspections and going aloft, and (3) documentation of findings and recommendations for repair/replacement of rigging components as appropriate. Appendices (3) and (4) are samples of content to review when evaluating a rigging surveyor.

v. Underway rigging examination/survey: While inspecting the rig in the static mode is generally adequate to fulfill the intent of the third party survey, the attending Marine Inspector or the contracted surveyor may require the vessel to get underway in representative conditions of wind speed, sea state, etc., to effectively inspect the rigging system under dynamic load, including rig tune, mast column behavior, load-lead paths, operation of winches, condition of halyards with sails hoisted and working ends exposed, operational maneuverability, and handling of the vessel. There have been many instances of small passenger vessel sail rigs passing static rigging

inspections dockside, but shortly thereafter, experiencing a critical operational or mechanical deficiency while underway.

vi. Large, historic, period rigs other than basic fore and aft technology are typically far more complex and may be beyond the expertise of yacht rigging surveyors or typical rigging service providers. This may present a resource challenge when a third party rigging survey for a "tall ship" is deemed necessary pursuant to 46 CFR 176.840, 115.840, or 169.259. Most inspected commercial sail vessels in this category are members of Tall Ships America (TSA). Because of the strict adherence to the "Recommended Protocol for Rig Inspection" developed by TSA, there have not been many instances in which a third party survey for a Tall Ships member vessel was deemed necessary. However, in those instances when a third party survey is deemed necessary pursuant to the aforementioned regulation cites, the OCMI may, on a case-by-case basis and after taking into consideration the relevant third party rigging screening protocols in paragraph III.b.iv above, accept a survey that has been performed by part of that membership group who possesses the rigging expertise specific to historic tall ships.

vii. Owners may enroll in certain rig certification programs and be considered equivalent to meeting the inspection regime recommended by this guidance document. Those owners should enroll and be able to show current completion of a Coast Guard reviewed rig certification program. Currently, the Coast Guard is aware of and has reviewed only one outside rig certification program provided by Germanischer Lloyd (GL) Group. In 2013, GL published "Guidelines for Inspection and Maintenance of Tall Ships." Now merged with Det Norse Veritas (DNV), DNV GL offers a condition survey service for tall ships that are associated with the above mentioned guidelines. See details at http://www.gl-group.com/infoServices/rules/pdfs/gl_i-4-4_e.pdf. Vessels enrolled in this program, essentially a rig certification program available to all vessels (including those not classed[2] by DNV GL) and based on mandated regular third-party inspection conducted by DNV GL designated rig inspectors, will be considered as meeting an equivalent standard to the inspection regime recommended in this document. Rig certification programs are not necessarily limited to DNV GL. Any company that wishes to have their rig certification program reviewed by the Coast Guard, for equivalence to this inspection regime, should contact the Office of Commercial Vessel Compliance (CG-CVC) at CG-CVC-1@uscg.mil. Likewise, owners may inquiry about the list of reviewed rig certification programs by also contacting CG-CVC at the aforementioned e-mail address.

viii. When making his or her assessment, the attending Coast Guard Marine Inspector shall review the findings of the rigging surveyor (overall assessment of the rigging system, recommendations made, conclusions reached, etc.) and indicate agreement

[2] Classed means that a vessel meets the classification society requirements that embody the technical rules, regulations, standards, guidelines and associated surveys and inspections covering the design, construction and through-life compliance of a ship's structure and essential engineering and electrical systems.

with results or express reason for disagreement, to include addressing additional concerns.

ix. If deemed necessary by the Coast Guard Marine Inspector, disassembly or "backing down" rig tension may be required pursuant to 46 CFR 176.840, 115.840, or 169.259. The degree of disassembly, untensioning, etc., will be based on the third party rigging surveyor's findings and recommendations. While the third party rigging surveyor's findings and recommendations offer the OCMI valuable insight and information about the condition of the rigging components and associated equipment, he or she is not strictly bound by it and, when exercising discretion, may allow continued operations contingent on increased monitoring and inspection if the risks can be effectively managed. Deficiencies should be documented into actionable written requirements that include a specific timeframe to comply, which, depending on the circumstances, could be long-term, short-term, or "no sail."

x. A Coast Guard Marine Inspector is not required to attend third party surveys used by the vessel owner/operator for normal maintenance or as part of an already approved rigging maintenance program.

c. *Supplementary Inspection Techniques Beyond Visual Examinations*: Regular rigging inspection in the context of this guidance document is intended as preventative 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.

i. NDT is appropriate when questions of materiel integrity exist after close visual examination. The use of NDT may be required by the attending Marine Inspector or recommended by the third party rigging surveyor. Hull integrity and strength in way of chain plates, masts, mast steps, and other critical attachment points shall be carefully evaluated. If a rigging component and/or structures are found with evidence of significant deterioration such as fractures, excessive pitting or corrosion, the particular component shall be renewed or replaced in-kind. Repairs or alterations to equipment that affect the safety of the vessel shall be done in accordance with 46 CFR 176.700, 115.700 or 169.235. The OCMI has the discretion and authority to request review by the Marine Safety Center (MSC). See section IV below.

d. *Guidance for Inspection and Replacement of Standing Rigging and Components*: The replacement cycles outlined in this section are recommendations based on industry published guidelines. Replacement cycles are vessel specific and based on the variables discussed in Section I.b. above, manufacturer's specifications and recommendations, prior rigging inspections, as well as inspection observations by the attending Coast Guard Marine Inspector. Owners should use empirical data from rig design parameters (safety factors), manufacturer's recommendations, vessel use, environmental conditions and the condition of the rigging at the time of evaluation to establish their replacement intervals. Special attention should be given to components and equipment used in a high ambient heat and water salinity environment. 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.

Recommended references on rigging and sail vessel inspection are provided in Appendix (5) and preventative cleaning maintenance for stainless steel rigging components are provided in Appendix (6).

i. Stainless Steel Wire Rigging: The following guidelines apply to bare 316 grade stainless steel wire cable that is not "served," coated or otherwise covered. The intervals are not absolute but considered good marine practice. Industry published guidelines for the replacement or renewal of stainless steel wire cable are based on many variables, including heat, geographic location and salinity of the water. NAVTEC "Rigging Service Guidelines" notes the following life expectancy based on those variables:

    1. Heat & water salinity maximum (FL, HI, Caribbean) – 5 to 10 yrs.

    2. Heat & water salinity medium (East/West Coast of U.S.) – 10 to 15 yrs.

    3. Fresh water climate – 15 to 20 yrs.

    Replacement intervals outside these guidelines may be considered on a case-by-case basis with the approval of the local OCMI where an individual norm can be justified due to design, condition and service exposure. Establishing individual norms may also result in shorter intervals under certain circumstances. In the absence of maintenance history, OCMIs are encouraged to start the replacement interval discussion based on the above and then tailor it to local conditions while ascertaining the condition of fleets within their area of responsibility.

ii. Stainless Steel Wire and Terminals: 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 associated anchoring points. The two most common methods of cable attachment are swage (factory compression end fittings) or swageless (mechanical field or shop installed end fittings). See additional guidance and examples in Appendix (7).

iii. Stainless Steel "Swageless" Mechanical Compression, Terminals: Mechanical rigging terminals are designed to create various types of wire rope or rod terminations depending on the required application at the anchoring point. These fittings are known to be very reliable with excellent longevity when properly sized and assembled for the application. The mechanism operates by creating an aggressive clamping action on the wire rope using an internal, conical and collapsible wedge/cone, which separates the wire-core wire strands from the cover strands. When assembled, the mechanical clamping action on the wire end resembles the "Chinese finger-lock" principle. See the following link for an example: http://hayn.com/marine/tech/himod/install.html.

Common trade names for wire compression fittings include: Norseman, Sta-Lok and Hayn (Hi-Mod). All three manufacturers claim to exclusively use 316 series grade stainless steel in their production, which provides a reasonable degree of corrosion resistance and high level of service reliability in the marine environment. Mechanical terminals are also known to be reusable in subsequent rigging wire replacement cycles, generally recommended not to exceed 2 to 3 wire replacements. If rigging terminal reuse is intended when recycling the rigging wire, these fittings should be closely examined for indications of cyclic fatigue or excessive elongation of clevis pin holes. As with all stainless steel rigging components, the service life of these fittings can also vary and so should be given close scrutiny whenever wire cables are inspected. As with all other stainless steel marine hardware, fittings subject to increased salinity, temperature and load cycles will require more frequent component replacement.

All three manufacturers indicate that their wire terminals are capable of being disassembled for inspection, and then reassembled for continued use. While this is true to some degree, only the Hi-Mod terminals are fully capable of disassembly inspection as the rigging wire is not permanently deformed over the internal compression cone or encapsulated in the recommended water sealant used to fill the air space inside the terminal body with Norseman and Sta-Lok fittings.

Disassembly of mechanical rigging terminals for inspection should only be required when there is visible evidence of corrosion. When required, the disassembly process should be done with care and awareness in an effort to avoid galling or stripping the female-threaded terminal body or the male-treaded end fitting. If this occurs, it renders the entire rigging component non-repairable, requiring replacement. **Disassembly of mechanical compression terminals should not be considered a routine inspection procedure.**

iv. Galvanized Steel Wire Rigging: Galvanized steel wire is in common use aboard vessels with historic period or simple working rigs. In addition to the galvanized coating, wire rope on traditional or period rigs is normally “wormed, parceled, and served” a three-step process to seal and cover the wire rope protecting it from the elements and corrosion. Worming involves using tarred marline to follow the lay of the wire rope and fill it out to a smoother surface for serving. If the lay is shallow, the wire may only be tarred. Parceling is the winding of tarred pieces of canvas around a wire rope that has been wormed. Serving completes the operation by binding small cord, spun yarn or marline around an already wormed and parceled wire rope.

When properly applied and maintained, standing wire rigging protected in this manner can last indefinitely. The most common reason for early replacement is chafing, broken strands or something other than just simple corrosion. Wire rope with this type of treatment should only be uncovered for further examination when inspection indicates the covering has been penetrated as evidenced by visible corrosion (rust).

v. Galvanized Steel Wire Fittings: Stainless steel swages or swageless fittings are not normally used on galvanized wire rope. Galvanized steel wire, especially when used on historical or period rigs may be spliced and fitted with a thimble, for use with a shackle when attaching directly to strap chain plates or chain plates composed of individual links that incorporate dead eyes and lanyards. Similar to the inspection of the wire itself, splices or turnbacks with wire seizing as terminal fittings should be visually inspected to determine their condition. Evidence of rust, broken wires, excessive racking (in the case of seized turnbacks), or displaced/sunken strands (in the case of splices) would be cause for closer inspection and/or judicious spot removal of the protective service. When not spliced, galvanized wire rope eyes may be made and secured mechanically with wire clamps. The clamp consists of a saddle and a u-bolt with nuts. The saddle should be installed over the standing part of the wire and the u-bolt over the bitter end section. There are usually a minimum of two clamps and preferably three, evenly spaced and wrenched down tight. Smaller rigs may use Nicopress fittings to secure wire eyes. Nicopress is a trade name for oval shaped compression sleeves designed to be slipped over the standing and bitter ends, then mechanically pressed on to both wires simultaneously with a special tool. Wire pendants are commonly attached to centerboards using these fittings.

vi. Poured, Socketed Wire Terminals: More often utilized in classic/period rigging applications with galvanized steel wire, these fittings are also used to terminate stainless steel wire in a number of contemporary rigging systems. The sockets are typically cast from steel or bronze with significant cross sections and scantlings that generally exceed the breaking strength of the wire or cable by a very large factor. These terminals are routinely used and regulated in the lifting appliance industry (elevators), where the working load limit (WLL) is generally 20% of the wire/cable breaking strength, but there are no similar regulations or standards in the sail vessel rigging industry. Sail rigging safety factors are considered in the design phase but are not specified by regulation and vary depending on a sail vessel's origin or intended purpose. While proof load testing (such as "pull testing") provides a level of confidence in the completed assembly, this testing method could be excessive, damaging to the fitting, or prove inconclusive if conducted without parameters. Historic and/or more-recently-built classically-rigged-vessels are more likely to have designs empirically developed over time with substantial scantlings and redundant standing rigging components, typical of the world before precise computer modeling and calculation. Marine Inspectors should use caution when considering "proof load testing," as it may not accurately assess the assembly's function within the rigging system if individual components are of varying ultimate breaking strengths.

vii. Fiber Rigging: These systems, particularly those using the latest synthetics, are specialized installations that come in a variety of materials and associated end fittings. They are being increasingly used to replace natural fiber rope rigging on period traditional rigs of all sizes. The manufacturer should be consulted for details on inspection and longevity.

viii. 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. Rod rigging terminals must be disassembled for inspection and/or subject toNDT at regular intervals as recommended by the product manufacturer or as necessary based on service records. While rod and rod-heads generally last longer than wire rigging, re-heading will eventually be necessary as specified by the manufacturer.

ix. Chain Plates: Strap-type chain plates and attachment bolts may be removed and made available for inspection at the discretion of the attending Marine Inspector. Vessels with embedded chain plates and attachments, especially if stainless steel, may require further inspection/removal based on age, material and operating conditions. These potentially destructive inspections may be minimized by removing a representative sample and closely evaluating its condition prior to making the determination to remove more chain plates for inspection.

Similarly, chain plates made up of chain assemblies or links on historic or period traditional rigs may be visually inspected and disassembled or removed for close-up inspection and/or subject to NDT for evaluation at the discretion of the attending Marine Inspector.

x. Mast tangs, Toggles and Anchoring Points Aloft: Similar to chain plates as discussed above, mast tangs, toggles, fasteners and anchoring points aloft shall also be made available for inspection by disassembly as necessary to determine fastener condition and replacement cycles.

e. *Sail Furling Systems*:

Sail Furling Systems, also referred to as "roller-furling" systems, are very common on modern-day/contemporarily rigged vessels and becoming more common on new-built, period/classically rigged vessels. Since appearing on the market in the 1970s, these systems have proven quite reliable. While furling systems are more frequently used with headsails, jibs, and staysails, they are becoming more commonly used for mainsail furling with in-mast and on-boom furling systems as well.

When a sail furling system fails to operate, and, if for any reason, the sail cannot be removed, this can put the safety of the vessel and passengers at risk. For this reason, sail furling system and equipment inspections should be conducted on an annual basis to confirm proper functioning of the system including the ability to remove the sail. **Testing sail furling systems and equipment is most effectively conducted while underway with the sails powered up.**

During annual inspections, Coast Guard Marine Inspectors should examine the operation of the roller furling systems by asking to have the sail opened and closed to confirm proper operation and lower the halyard to demonstrate the sail moves freely in the furling extrusion. The head of the sail should be lowered enough so it passes freely past the uppermost foil section connector (about 10 ft).

Furling drum and torque tube assemblies that conceal essential standing rigging, headstay, terminals and turnbuckle should be disassembled for inspections on an annual basis in the presence of a Coast Guard Marine Inspector or qualified third party surveyor. Caution should be used and manufacturer's instructions followed when conducting roller furling system disassemblies. If unfamiliar with this procedure, the vessel owner or operator should consult with a professional rigger for assistance until proficient with the process.

f. *Running Rigging*: While the primary focus of this guidance document is to ensure an appropriate examination of the condition of the standing rigging and the associated components that contain the stationary rig, it is equally important to inspect the condition of the running rigging and associated equipment. Inspections should be conducted with due consideration for system complexity including components in high load bearing service with high consequence should failure occur. Relevant components include running back and check stays employed in dynamic mast standing rigging systems, highly loaded halyards and sheeting systems of both period and contemporary rigs. Boom topping lifts, quarter lifts, multi-purchase tackle systems, belaying points, as well as the condition and fastening of running blocks adjacent to passenger passageways on deck and in all applications aloft should also be given careful scrutiny. Equipment issues include the following:

i. Condition of cordage or wire rope: Many factors influence service life, such as age; designed load rating and use application; ultraviolet light deterioration; point loading; designed radius and effective operation of turning blocks and sheaves; rope deformation; chafe; parted yarns on wire rope; and condition of splices, thimbles and shackles, including shackle seizing where applicable.

ii. Winches – manual, hydraulic or electric: They are used on nearly all contemporary and many traditionally rigged vessels. Typical manual winches can easily multiply force on the order of 40 to 1. Hydraulic/electric winches are capable of even higher ratios. Winch failure of any kind can lead to catastrophic results. Disassembly for inspection and servicing should occur on a regular and scheduled basis. Documentation of winch service cycles should be included in the records of the vessel's rig inspection log. Coast Guard Marine Inspectors may require winch disassembly if acoustic or visual observations indicate corrosion or disrepair or if there is no record of servicing. Winch mounting fasteners to mast or deck surfaces should also be pulled for inspection every few years to ascertain condition. Special consideration should be made for the condition of winches used to haul crew members aloft to conduct maintenance and required inspection. Fastener inspection should include drum pawls when winches are disassembled.

iii. Boom Vangs and Hydraulic Tensioners: Generally, these are used on contemporary rigs, performance sail craft, retired race boats and large cruising boats to shape and bend the mast/boom to achieve desired sail trim in changing conditions. Local loading of components and their attachment points can be high, especially at anchoring points on booms and mast bases. Fastenings and welds on extruded

aluminum spars need to be inspected closely for fractures due to normal service stress on these components.

iv. Lifts and Lazy Jacks: Topping lifts need to be rigged correctly to keep booms in place when sails are lowered or doused to prevent passenger or crew injury. When lazy jacks are relied upon in lieu of topping lifts, they should be capable of suspending booms in all operational circumstances (i.e., max loading). Topping lifts should be inspected closely in rigs where the sail does not carry the weight of the spar or where the rig is otherwise "topping lift dependent." Boom goosenecks or other pivot points must also be inspected for continued serviceability, with attention to welds, fasteners, axis pins, axis bores, etc. Excessive wear on axis points should be addressed in a timely fashion.

g. *Unstepping the Rig*: The purpose of unstepping the rig is to provide a close-up visual inspection of the entire rig including the mast and mast step as well as critical attachments of shrouds and stays at both the mast and hull (chain plates). See Appendix (7) for typical stainless steel end fitting details. Clevis and cotter pins, toggles, as well as cable or rod end fittings can be inspected more thoroughly when the rig is un-stepped. Disassembly should be to the extent necessary to properly examine all connections, cable terminations and anchoring points. Owners/operators, surveyors and Marine Inspectors shall pay close attention to corrosion, lead-to-load alignment, any modifications, and the addition of equipment mounted directly to mast structures. See Appendix (8) for corrosion inspection points and Appendix (9) for paths to spar and rigging failure.

Inspection intervals specific to sail vessel rigs: Pursuant to 46 CFR 176.840, 115.840 and 169.259, the OCMI has broad authority to require "any additional test or inspection deemed necessary to determine suitability for the service in which the vessel is employed." The guidance in this document is to facilitate the inspection process with respect to sail vessel rig inspection, including unstepping masts at intervals acceptable to the OCMI and is designed in support of the Coast Guard's statutory and regulatory missions to safeguard lives, protect property and preserve the marine environment.

i. Multi-hulls: Multi hulled vessels with typical extruded aluminum or composite masts with inaccessible steps should have their masts removed to the ground for inspection at a minimum interval of six (6) years.

ii. Monohulls: Mono-hulled vessels with deck stepped configurations, determined to be inaccessible by the OCMI, should be unstepped at 6 year intervals.

iii. Vessels with wood masts, spars and appendages: Wood masts (timber or made) should be unstepped once every 10 years for a comprehensive inspection of spar condition as well as attachment hardware on the ground. "Made" spars include but are not limited to box chamber, strip planked, faceted or solid laminated.

iv. Alternative rig inspection timeframes: Other intervals, whether shorter or longer, for unstepping the rig may be considered on a case-by-case basis, where an individual vessel's norm may justify an alternative interval due to design, condition and service

exposure. Large, Period, Traditional rigs or other specialized rigs may be considered for alternative unstepping timeframes. Other justification might be made for vessels that are routinely and seasonally down rigged sufficiently to allow an alternate method of evaluation. All justification to implement an alternative timeframe should be approved by the cognizant OCMI as part of a comprehensive rig maintenance program. Known examples are local fleets that do not leave an OCMI zone such as the Windjammer Fleet in Maine or the 12 Meter Racing Fleet in Rhode Island, whose practices are fully documented with the cognizant OCMI. Establishing individual norms may also result in shorter intervals under certain circumstances. In the absence of maintenance history, OCMIs should determine, based on the myriad factors identified in I.b. above, the time frame that a vessel's mast should be unstepped for appropriate examination. Without compelling justification, that time frame should not exceed 10 years. Consideration should also be given to staggering the schedule of mast unstepping and disassembly for inspection of vessels with multiple masts. Similar alternate proposals, including but not limited to the use of NDT techniques, may be considered for steel vessels with steel spars that are integral with the hull if deemed reasonable and acceptable to the cognizant OCMI.

For the purpose of repair and/or replacement, information on acceptable parameters for spar grade wood is included in Appendix (10).

v. All other non-wood keel stepped rigs: They shall be evaluated on a case-by-case basis. Industry literature should be consulted for recommended maintenance inspection intervals. For more information, please refer to the Navtec Rigging Service Guidelines which can be downloaded at: www.navtecriggingsolutions.com. OCMIs should pay special attention when dealing with former purpose built racing rigs to determine an appropriate interval, especially if the design safety factor of the rig is unknown or has not been reduced in the sail plan for its new career as a passenger vessel. In addition to establishing and maintaining a routine maintenance program (such as wire renewal/replacement), all sailing vessel operators are encouraged to propose a suitable mast unstepping schedule for consideration by the local OCMI. In all cases, masts of any material can be ordered unstepped on any rig type if, at the discretion of the attending Marine Inspector, closer examination is needed based on the visible condition of the mast and/or components.

vi. For vessels operating in saltwater that fall under a regulatory two-year haul-out cycle, it is anticipated that unstepping the rig will be concurrent with scheduled drydock exams. It is recognized that unstepping is not necessarily limited to when a vessel is in drydock. For larger traditional or period rigs, unstepping may, in fact be more easily done afloat. After the rig is re-installed and statically tuned, a Coast Guard Marine Inspector shall attend for operational tests and sea trials as appropriate prior to permitting the vessel to go back into service.

h. *Sail Condition:* Close scrutiny should be given to vessels whose propulsion is listed on the Certificate of Inspection as "sail" vs. "auxiliary sail." On sail-only vessels, sail is the primary propulsion, so condition obviously matters moreso. Factors to consider include

age, covered stowage to protect against U.V. deterioration, frequency of operation with sails set, and normal sailing conditions with passengers embarked such as prevailing wind speeds. Sails on sail-only propulsion vessels should be visually examined for rips, patches, abrasions, excessive sail tape repairs, pin holes in panels, torn cringles or evidence of broken stitching, particularly in way of intended reinforcements at the head, clew and tack as well as at reef points if installed and used. Requirements for repair or replacement should be carefully considered and take into account the whole sail plan. Factors to consider would include the normal number of sails set, the sail configurations approved by the Coast Guard to determine redundancy, spares aboard, and the ability to make sail if any sails blow out in service. Attending Marine Inspectors may consider the opinion of a sail maker in determining the remaining service life of sails.

i. *Recommended Emergency Safety Equipment*: Based on lessons learned from marine casualty events involving dismastings, a cutting tool of a sufficient size and strength to cut through vessel rigging is highly recommended on board inspected sailing vessels. Having a cutting tool to free the rig from the vessel in the event of dismasting will help prevent further damage to the hull and any crew/passengers from being entrapped by the rig on deck.

IV. Sailing Vessel Design and Plan Review

a. *Marine Safety Center (MSC) - Plan Review*: OCMIs should require that all rigging systems be reviewed by the Coast Guard Marine Safety Center (MSC) during initial certification or following modifications to the rigging system. In an effort to standardize and improve the plan review process, the MSC has issued Plan Review Guideline (PRG) H1-15, MSC Guidelines for Review of Rigging Systems for Sail Vessels, which outlines procedures for submitting plans and calculations to the MSC. There are no prescriptive requirements for review of rigging systems; therefore, the MSC's review is focused on the suitability of the submitter's methodology and validity of the assumptions made in the design process. It is the responsibility of the submitter to demonstrate that all mast and rigging components are adequately sized for the intended route and service.

Plan review cannot effectively evaluate every potential condition a vessel may experience during operation. In addition, the effects of fatigue and tuning may not be considered during plan review. Therefore, a holistic approach to evaluating a particular rigging system's adequacy must be taken. Coast Guard Marine Inspectors may consult at any time the Traveling Inspection Staff (CG-5P- TI) or the MSC for assistance.

When evaluating historic or period rigging systems, Coast Guard Marine Inspectors should keep in mind that these types of rigs have to a great extent a robust level of redundancy in structure and load paths.

b. *Sail Vessel Plan Review - New Construction or Initial Certification*: OCMIs should require that all rigs be reviewed by the MSC during initial certification. The following regulations apply under "Plans and information required:"

i. 46 CFR 177.202(b)(12) and 116.202(b)(14): *"On sail vessels: Masts, including integration into the ship's structure; and rigging plans showing sail areas and centers of effort as well as arrangements, dimensions, and connections of the standing rigging."*

ii. 46 CFR 177.330 and 116.330:*"The design, materials, and construction of masts, posts, yards, booms, bowsprits, and standing rigging on a sailing vessel must be suitable for the intended service. The hull structure must be adequately reinforced to ensure sufficient strength and resistance to plate buckling. The cognizant OCMI may require the owner to submit detailed calculations on the strength of the mast, post, yards, booms, bowsprits, and standing rigging [to the MSC] for evaluation."*

iii. 46 CFR 169.309(b), (c) and (e): *"Masts, posts and other supporting structures are to have adequate strength to withstand the highest loading imposed by the sail systems during all normal and emergency conditions. Particular attention must be given to the integration of the masts and rigging into the hull structure. The hull structure must be adequately reinforced and stiffened locally to ensure sufficient strength and resistance to plate buckling. The design, materials, and construction of masts, yards, booms, bowsprits, and standing rigging must be suitable for intended service. Detailed calculations with respect to the strength of the sail system may be required. Approval by a recognized classification society may be considered satisfactory evidence of the adequacy of the sail system. Special consideration will be given to the structural requirements of vessels not contemplated by the standards of a recognized classification society and to the use of materials not specifically included in these standards."*

Note: These three regulations are specific to sail vessel requirements and are similar in scope and intent, with added flexibility for sailing school vessels as many were existing prior to the those regulations went into effect. Vessels certificated under 46 CFR Subchapter I, with primary propulsion as sail and permitted to carry volunteers and/or passengers for hire, will be guided by the same inspection principles specific to sails and associated components as prescribed in the above regulations, and the guidance found in this document.

c. *Sail Vessel Plan Review – Rigging Repair or Modification*: The following regulations apply under "Repairs and alterations:"

i. 46 CFR 176.700, 115.700 and 169.235: *"Repairs or alterations to the hull, machinery, or equipment that effect the safety of the vessel must not be made without the approval of the cognizant OCMI, except during an emergency… The owner, operator or managing agent shall submit… details of any proposed alterations to the cognizant OCMI [for approval]… Drawings are not required…for repairs or replacements in kind… The OCMI may require an inspection and testing whenever a repair or alteration is undertaken."*

The Coast Guard considers repairs or alterations to the rigging system of an inspected

sail vessel to fall within this criterion. Also within the scope of alterations that must be reported to the OCMI before being undertaken are upgrades that incorporate new technology, that are not replacement-in-kind, or that may impose new or different hull loading than originally designed/envisioned. Examples include changing components, systems, or configurations (angles) that have no operating history on the vessel, such as spar or rigging material (e.g., wood or aluminum to carbon fiber or steel cable standing rigging to synthetic fiber, etc.).

ii. OCMIs shall require submission to the MSC all plans and other specified material of sailing vessel rigs that have experienced failure of the rig while under sail, whether or not the rig was reviewed by the MSC during initial certification. Vessels certificated under Subchapter I as cargo and miscellaneous vessels have similar notification requirements under 46 CFR 91.45. Accordingly, rig failure aboard a vessel certificated under Subchapter I will fall under the same notification protocol.

d. *Modification or Changes to Rigging or Sail Plan*: The OCMI 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 be determined by the OCMI prior to carrying passengers for hire. OCMIs should consider requiring MSC review of rigging or sail plans that alter the rigging systems structural arrangements, loads, or connections, and when vessel stability is impacted.

Part of the annual rigging inspection will include a discussion with the Coast Guard Marine Inspector of any changes to the rig and associated hardware as well as verifying the approved sail plan as necessary. Modifications or repairs that may affect the safety of the vessel include but are not limited to:

i. Changes that are not replacement in kind;

ii. Changes to sail plan and/or sail material (hi-tech fabrics harness more energy for the existing rig to absorb);

iii. Changes in weight aloft;

iv. Significant changes in leads of running or standing rigging;

v. Complete rig change-out or renewal;

vi. Structural repairs in way of standing or running rigging attachments;

vii. Any repairs to masts and spars (woodwork, welding or composite lay-up);

viii. Addition or subtraction of standing or running rigging;

ix. Addition or removal of roller furling systems;

x. Addition of hardware that due to installation details will lead to increased corrosion; and

xi. Any hull modifications that would increase stability (reduction of vertical center of gravity, increases and decreases in displacement) and therefore increase the loading on the rigging system.

RIGGING KEY COMPONENTS LIST

Rigging Survey:

1. **General Rig Description**

2. **Mast Step**
   - Compression Post; Base condition (drainage); Mast Partners

3. **Chainplates**
   - Materials & condition; Fasteners

4. **Deck Hardware**
   - Travellers and blocks; Tracks for sheets & blocks; Shackles; Boom vang; Furling gear

5. **Winches**
   - Mast mounted; Deck/cabin top mounted; Line stoppers

6. **Spars**
   - Penetrations; Tangs; Spreaders & bases; Boom and gooseneck fitting;
   - Spinnaker/Whisker poles; Masthead hardware & sheaves; Antennas, light, wind indicators

7. **Stays/Shrouds**
   - Wires; Terminals Ends/Swage & Swageless Fittings; Turnbuckles & toggles
   - Chain Shrouds/Links/Deadeyes & Lanyards; Running backstays; Clevis pins & cotter pins

8. **Running Rigging**
   - Halyards; Splices; Shackles; Sheets; Blocks

9. **Sails**
   - Correct sail area; Battens; Reinforcements & chafe patches; Reefing points; Stitching

10. **Catamarans**
    - Crossbeam; Ladder & attachments; Dolphin/Pelican striker & bridle arrangement

RIGGING INVENTORY/PREVENTIVE MAINTENANCE INSPECTION TEMPLATE (SAMPLE)

Inspected Passenger Vessel ( ) Official #( )

SCOPE OF INSPECTIONS:

- **Purpose for survey: USCG required inspections with report including rig inventory / index of components**

- Comprehensive spar, standing and running rigging systems inspections with mast out
- Mast column, spar attachments, rigging terminals, toggles, securing pins, mast welds and halyard sheaves were closely examined for anomalies, corrosion, fastening deformation or elongation of attachments. Fair-leading evaluation of standing and running systems
- (On deck) Similar to the above inspection of wires, terminals toggles, etc. Also to include turnbuckle hardware, terminals, toggles connections to chain plate heads and fair-leading of all equipment.
- Below decks; the chain-plate hardware fastenings and foundations were inspected, fasteners replaced
- The mast compression load path (deck, main beam, bulkhead) were examined for indications of fatigue, material or structural failure

FILE NUMBER	
SURVEY PREPARED FOR	
WHERE INSPECTED	
ATTENDANT DURING INSPECTION	
LENGTH – BEAM - DEPTH	
GROSS – NET TONNAGE	
HULL MATERIAL	
USCG CERTIFIED FOR	
STABILITY LETTER	
VESSEL BUILDER	
HOME PORT	
OFFICIAL # REGISTRATION	
OWNER'S ADDRESS	
SAIL AREA	
SPAR/RIG DESIGNER MANUFACTURER INSTALLER	

Rigging Configuration: (Narrative description)

VESSEL NAME	TYPE	OFFICIAL # REGISTRATION	LOA	BEAM	DEPTH	TONNAGE NET/GROSS	STABILITY LETTER	SAIL AREA	DATE INSPECTED/ PURPOSE OF SURVEY
	Inspected passenger vessel.								

MAST/S TYPE	BUILDER	SECTION / SEAMS / TAPER	STEP/PARTNERS	AGE	TUNING	COLUMN	PULLED FOR INSPECTION? INSPECTED ALOFT?
						No Deficiencies	Mast installed new in 2003 Inspected standing and removed Aug - Oct 2013 for mast-out credit for COI
							Replaced in 2011

SHROUD/STAY	WIRE TYPE/ DIAMETER	TERMINALS ALOFT/ TERMINALS A-LOW	CLEVIS PIN	MAST CONNECTIONS ALOFT DECK CONNECTIONS	AGE	COMMENTS
Upper/cap shrouds	1/2" 1X19 SS	Swage stud into articulating socket aloft Swage stud to turnbuckles a-low.	7/8" on deck 3/4" aloft,	Carbon "clam shells" fastened and bonded to mast aloft	2011	All fittings removed for inspection 10/13 during mast-out inspection
Head-stay	Same above	Same	Same	Same	2011	Connections inside furling unit inspected as part of annual service program
Head-stay bridles	5/8" 1X19SS	Hi-Mod mechanical terminals with turnbuckles	1" each end	Integral aluminum lug on bow-beam ends, Three-Point link plate at center	2012	No deficiencies noted with bridles or link plate. Link plate replaced in 2010
Superior diamonds	-15 (7.52mm) Nitronic 50 rod	Mechanical cold formed rod-head terminals	5/8" each end	Through mast link plates aloft and alow	2003	Upper diamond plate original, aluminum. Lower link plate replaced with same gauge stainless steel plate
Inferior diamonds	-4 (4.37mm)	Same above	3/8"	Same above	2003	Original link plates noted in good condition

Surveyor's comments - spars & standing rigging system:

Standing rigging and anchoring points noted in excellent condition during survey. Shroud and bridle wires recently replaced. Chainplate fasteners replaced during 2013 dry dock. Spars, boom and bow beam noted in good condition. Some corrosion affecting paint on bow beam should be treated in short order.

Diamond rods are original equipment (2003) are approaching the end of their (Navtec recommended) service life. Rod assembly was disassembled for comprehensive inspection in 2011 in the presence of USCG inspectors. No deficiencies were noted, all rod heads were found in excellent condition at the time. Replacement of rods was proposed for this (2013) dry-dock cycle even though no deficiencies existed which would dictate such replacement. The operator has requested that the system is modified to (more conventional) 1 X 19 SS wire & fittings. Diamond-rods are scheduled to be replaced during next annual inspection in October, 2014 with modifications as stated. Plan of proposed changes will be submitted to USCG OCMI for approval prior to changes made

Running Rigging

SHEET/HALYARD	MATERIAL TYPE/SIZE	FAIR LEADS	BLOCKS	CONDITION/COMMENTS
Mainsheet	Dacron Sta-set X 7/16"	Adequate	Adequate to anticipated loads	All running rigging noted in good condition
Jibsheet	Same	Same	Same	
Main halyard	Class II rope	Same	Same	
Jib halyard	Same	Same	Same	

WINCH - LOCATION	MANUFACTURER/SIZE/TYPE	SPEEDS	MOUNTING	UNIT CONDITION/COMMENTS
Main halyard At base mast	Harken 16	1	Secure	Running rigging equipment noted in good condition
Jib halyard At base of mast	Same	Same	Same	Same
Headsail Furling	Harken MK 4	1	Same	Same

Standing and running rigging inspection and preventative maintenance schedule

Daily: Visual (walk-through) inspection of all deck and eye level standing and running rigging fittings.
Visual inspection, from deck level, of mast and fittings aloft. Inspections to be conducted by the Captain and or experienced Crew members.

Weekly: Cleaning of all deck level toggles and swages with light abrasive pads followed by a **close** visual inspection of all deck level fittings. Check for wear on all running rigging lines. Thorough cleaning and anti-corrosion lubrication of both backstay toggles, turnbuckles and swages.

Monthly: Close inspections **aloft** conducted by Captain or experienced Crew Member. Checking for missing cotter pins, parted strands on shrouds or stays, splits in swage tails and furling system and halyard attachments.

Semi-annual (every 6 months): Comprehensive rigging inspection of entire system by qualified party to include tuning if required.

Six year cycles (minimum): Mast removal for full inspection including disassemblies of fittings, wear measurements taken, dye testing if applicable on any fittings in question, cleaning and lubricating of all turning blocks, testing and random sampling of chain plate fastenings, replacement of parts as necessary. This inspection shall be conducted in the presence of the designated USCG Marine Inspector to log credit for mast-out inspection cycles.

A log of the inspections and maintenance described in this schedule shall be maintained by the Captains and Crew of the vessel and shall be kept on board for review as requested by USCG Marine Safety Inspectors.

THIRD PARTY RIGGING SURVEY (SAMPLE A)

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 NAVTEC –* ***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.

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,

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

(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	1/4	.6400 averaged
Aft lower shroud	3/8	5/8/.6250	1/4	.6450 averaged
Jib bridle chain plate lugs	1/2	7/8/.8600	1/2	.8860
Jib bridle link plate	1/2	7/8/.8600	1/2	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

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.

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 SERVICE GUIDELINES.

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: _____

THIRD PARTY RIGGING SURVEY (SAMPLE B)

REPORT OF MARINE SURVEY
Auxiliary Coastal Trading Schooner
( )

FILE # ( )
Spars and Rigging Survey
for USCG –COI

Photo of vessel

Dates Of Survey Inspections		
Original, in-water rigging	•	Jan. 26, 2009
Second, out of water, dry-dock	•	March 17, 2009
Re-commissioning work-list	•	May 8-9, 2009
Completed commissioning survey with USCG, MSS3 ( ) for COI credit	•	June 12, 2009
Final spars, standing and running rigging inspection while the vessel was hauled for dry-dock	•	Dec. 23, 2009

Vessel Information	•	
Official #	•	
Hull #	•	Same
Year Built	•	Feb. 14, 1945
Location	•	.
Builder	•	
Principle Dimensions	•	
Register length	•	59’ 9”
Sparred length	•	70’ est
Beam	•	15’ 5”
Depth	•	8’ 4” est
Net Tons	•	28 reported
Displacement	•	85,770 lbs reported
Hailing Port	•	.

SCOPE OF INSPECTIONS CONDUCTED

- Main, foremast, bowsprit & main-topmast were stripped to wood for inspection and repairs as necessary as cataloged in the body of this report
- Bowsprit heel was cropped away and replaced over a length of 50% (approximately) of the run with 12/1 ratio lamination
- Spar appendages, spreaders, cross-tress, trestle trees, gaff booms, hounds, mast trucks etc, were replaced or restored as necessary
- The entire standing/staying rigging gang was replaced
- All mast hardware, bands, rings, gammon, and kranse irons were sand-blast stripped and restored or replaced as necessary. All cases of elongated bore for shackles or clevis pins were weld-filled and re-drilled to correct tolerances. All metal was re-galvanized and painted with appropriate marine coatings
- Bow-stem fitting was replaced anew with new fasteners
- All running rigging was replaced anew
- Blocks and tackle were replaced or professionally restored as necessary
- Ratlines and climbing gear were replaced anew
- Spars and appendages were refinished with marine coatings

Notice of vessel modifications from original rigging plan associated with the vessel's previous, expired Certificate of inspection for USCG records.

All changes to the rigging system were directed by Capt. ( ) to improve the staying system. Significant changes were discussed and reviewed with USCG Inspection staff and the Undersigned surveyor, as follows:

- Fixed aft/cap shrouds were fitted to the foremast to improve foremast after-staying configuration. Equivalent chain plates and fastening were utilized at deck level
- The superior bob-stay chain was fitted with a dolphin striker-strut to open the staying angle of the stay from the stem to the outer bob-stay kranse iron to decrease the loads exerted by the jib-stay onto the bow. The previous angle was too shallow and generating more compression than support.

Requested By •

Address •

Rigging System Inventory & Information:

Abbreviations noted in table below:

WØ- wire diameter PIN - shackle or turnbuckle pin diameter

RIG COMPONENT	TYPE	WØ	SH	TB	PIN	P/S	AGE	COMMENTS
Main shrouds fore & aft pair	Galv 7X19	5/8	3/4	1”	7/8	Yes	7/09	Increased wire size from 9/16 to 5/8
Main topmast cap shrouds	SS 7/19	3/8	1/2	3/4	5/8	Yes	7/09	No changes to original rig (Ø change)
Mainmast running backs	SS 7/19	1/2	5/8	NA	NA	Yes	7/09	Ø change
Main-topmast running backs	SS 7/19	3/8	1/2	NA	NA	Yes	7/09	Ø change
Main-topmast forestay	SS 1/19	3/8	5/8	3/4	5/8	No	7/09	Ø change
Triadic (main to foremast)	SS 1/19	3/8	1/2	3/4	3/4	No	7/09	Ø change
Foremast lower shrouds fore & aft pair	Galv 7X19	5/8	3/4	1”	7/8	Yes	7/09	Increased wire size from 9/16 to 5/8
Foremast after cap shrouds pair	Galv 7/19	5/8	3/4	1”	7/8	Yes	7/09	Modification to system (see notes, page ?)
Foremast shrouds on spreaders	SS 7/19	3/8	1/2	3/4	5/8	Yes	7/09	Ø change
Bowsprit whisker guys	SS 7/19	1/2	5/8	3/4	NA	Yes	7/09	Ø change
Bowsprit foot rope wire	SS 7/19	3/8	1/2	NA	NA	Yes	7/09	Ø change
Bowsprit superior bob-stay chain	Galv chain	9/16	7/8	7/8	7/8	No	7/09	Modification to system (see notes, page #)
Bowsprit inferior bob-stay chain	Galv chain	9/16	7/8	7/8	7/8	No	7/09	Improved connection to kranse iron aft of dolphin striker strut
Jib Stay	SS 1/19	1/2	NA	3/4	3/4	No	7/09	Jibstay aloft: swaged stud & turnbuckle w/ 3/4” double jaw toggle. A-low: swaged marine eye & 7/8” DJT (7/8 galv bolt thru kranse)
Fore Stay	SS 1/19	1/2	NA	3/4	3/4	No	7/09	Same as above with 7/8” eye jaw toggle a-low

SH– shackle size P/S - parceling and service

TB - turnbuckle Galv - galvanized wire

SS - stainless steel wire or fitting

Component	**Age**	**Comments**

Mainmast	Orig.	Mast was stripped to wood and inspected by the undersigned and USCG prior to repairs and refinishing. Areas of soft wood were cropped and restored prior to recoating with appropriate marine finishes
Main Trestle Cheeks	Orig.	Removed and inspected prior to refinishing and improved re-application. Mast section rebates were surfaced and bedded prior to joining trestle cheeks. Bedding compounds used in all applications throughout restoration project
Main Trestle Trees	7/09	Replaced with purple heart hardwood timbers. Dimensions increased to allow for improved fastenings. Sacrificial hardwood bolsters were added to trestle tops to shoulder shrouds and halyard stops to prevent wear on trestle edges
Main Crosstrees	7/09	Replaced with purple heart timbers. Dimensions increased to allow for improved fastenings.
Main Topmast	Orig.	Topmast was stripped to wood. Inspected by marine surveyor and USCG. Wood rot was noted at mast, heel-rope hole. Heel of mast was cropped away with replacement of section on 12/1 ratio. Heel rope opening adjusted to improve ease of lowering the topmast. New purple heart truck installed. Improved suspension of topmast head halyard block
Mainmast Spreaders	7/09	Newly fabricated of purple heart. Dimensions were slightly increased, spreader roots were also increased in cross-section to allow for improved fastening. Brass bushings were installed in spreader roots to prevent wear on axis bolts. Spreader tips were also increased in dimension to provide better grip on cap shrouds.
Mainmast Hardware		
Futtock Shrouds	Orig.	Futtock-rods were reused while their crosstree brackets were renewed. UHMW plastic runners were installed on bracket ends to prevent chafe on undersides of spreaders.
Mainmast Cap Ring	Orig.	Blasted clean for inspection. Elongated pin bores were welded closed and re-drilled to tolerance. Mast cap thru-bolt diameter increased to 3/4". Mast was sleeved in way of the thru-bolt with brass tubing and bedded.
Triadic Bail	7/09	Bail was increased in gauge to 1/2 rod with 3/8 lugs at mast cap thru-bolt
Main Peak Halyard Band	Orig.	Cleaned/inspected, pin-fastener bores tolerance confirmed or corrected, re-galv and painted.
Trestle Trees Bracket	7/09	Improved main-topmast system (see photos page 5)
Peak Halyard Hardware	7/09	Removed from original configuration (eyebolts thru trestles and cross trees) Now slung over bolsters on leathered wire strops
Quarter Lift Hardward	7/09	Same as above
Main Topmast	Orig.	Topmast heel was cropped away to remove a section of rot which originated at the heel rope thru-mast hole. New section was scarfed in with required 12/1overlap using epoxy resin adhesive. Topmast running blocks were we slung from the spar allowing for ease of lowering. A lateral square hole was bored into the mast heel at the trestles to allow using a proper fid to stand the topmast onto. The new fid is of adequate cross section and built of purple heart. Fid is also held captive as it is double-notched into the trestles and to its own undersides. Finally secured with lashings. (significant improvement over original design)

Foremast		Mast was stripped to wood and inspected by the undersigned and USCG prior to repairs and refinishing. (found in generally good condition) An area of damage where the gaff jaws (un-leathered) bore away at the soft wood in the full hoist elevation on the fore part of the spar was cropped and renewed. Other areas of wood damage where spreader hardware and mast bands had been allowed to compress toward deck was cropped and renewed accordingly. Improved shouldering on the spar to support hardware was employed. *Finally, as stated on page one, after-cap shrouds were added to the rig to achieve superior back-staying to the fore-rig.*
Foremast Spreaders	7/09	Re-configured, purple heart, spreaders were installed. Numerous deficiencies to the previous system were corrected with this modification including: The shrouds now have a clear path to deck and not in compression contact with the spreader roots as previously. The recess into the fore/aft face of the spar was improved to support the new spreader bows. Refastening was accomplished with improved fastening schedule. Spreader tips are increased in cross section to provide a better grip on the cap shrouds. Cap shrouds are held captive in tips on protective copper covering strips.
Foremast Hounds	7/09	Remade with purple heart and installed into fortified rebates into mast sides. Previously the hounds were found creeping to deck with failed fasteners and poor insets into the spar.
Foremast Spreader Lifts	7/09	(1/4" SS wire rope) Installed similar to original but with improved spreader tip fastening

Foremast Hardware	**Age**	**Comments**
Foremast Cap Ring	Orig.	Cap ring was blasted clean, inspected, elongated bores were filled and drilled to correct tolerance. Metal was re-galvanized and coated
Foremast Peak Halyard Rings	Orig.	Upper and lower bands/rings were treated as similar to the above statement
Foremast Spreader Hardware	Mixed	New fasteners used throughout. Spreader brackets reused.
Bow Sprit	Orig.	Bowsprit heel was found rotted in way of the Sampson post and in areas under the gammon iron. Heel was cropped away and renewed with a scarfed in section of Douglas fir on the required 12/1 ratio. Epoxy glued and thru-bolt fastened on adequate spacing. Soft wood under outer and inner cranse irons was treated prior to refinishing
Bow Sprit Hardware	Mixed	Outer cranse iron ring was blasted clean, inspected, elongated bores were filled and drilled to correct tolerance. Metal was re-galvanized and coated. The inner kranse iron ring was modified to achieve more surface area of grip on the bow sprit. Previously the iron was being drawn deeply, on an angle into the chamfered shoulders of the sprit. The new ring is longer (fore/aft) and allows for the addition of a dolphin striker strut to be employed in the head rigging. Four thru-bolts provide adequate clamping power on the sprit. The gammon iron was also treated as stated above prior to reinstallation
Sprit Hardware Continued	Mixed	Sprit whiskers tangs were remade anew of bronze with the connecting lugs oriented on an improved axis. The tangs were thru-fastened into repaired topsides with adequate backing
" "	7/09	Bow stem head fitting was made anew and refastened into restored wood on the stem with adequately backed fastenings
Gaff Spars And Booms		All were stripped to wood and inspected by the undersigned and USCG prior to repairs and refinishing, (found in generally good condition) with the exception of the foresail gaff where rot and termites had destroyed the gaff jaw end of the spar. The gaff was renewed with improvements to the jaw. All hardware was reinstalled with renewed fasteners and proper bedding compounds

Chain Plates	Mixed	Vessel records and correspondence with the vessel's previous shipwright confirmed that the chain plates were pulled, inspected, clevis pin bores corrected to tolerance, hot-dipped galvanized and reinstalled with new fasteners approximately 10 years ago. The plates were inspected by the MS and USCG while the rig was out of the boat. No deficiencies were noted. Two new, similar chain plates were installed on port and starboard for the new foremast after/cap shroud set installed with the re-commissioned rig.
Turnbuckles & Equip.	7/09	All renewed with this re-commissioned rig. Correctly sized to loads, toggled where required and secured with seizing
Running Gear	Mixed	Each of the blocks employed in the running rigging system were disassembled, rebuilt and or replaced with either better designed or better installed (fairleads) equipment. Attention to fair leading was paid as there were numerous mis-leads in the previous system. New shackles were used throughout the system.
Running Rigging	7/09	All of the running rigging was replaced anew. 3-strand, Dacron line was employed. All lines were noted correctly reeved for their service with thimbled splices where called for
Main/Fore Quarter-lifts	7/09	Boom lifts were significantly improved with correct tackle and mast suspension system
Deck Hardware	Mixed	All inspected for fairleads, fasteners and backing. Any deficiencies were corrected
Ratlines	7/09	Renewed and nicely fitted/installed
Main Boom Gallows	Orig.	Deck level foundation was restored under gallows stands and on cap-rail/bulwarks. The gallows was reinstalled with new fasteners and well backed below decks.

Survey Summary:

The restoration and re-commissioning of the spars and rigging systems aboard the schooner **( )** were conducted under the oversight and direction of Master Rigger, Capt. ( ), while much of the actual physical construction was conducted by ( ) with assistance from apprentice riggers. All spars and wooden appendages were restored / re-fabricated by, or under the direction of, Master Shipwright, ( ) and Ship's Carpenter, ( ).

The restoration process was monitored by the undersigned surveyor and USCG, Marine Inspector, ( ). All modifications were addressed according to USCG protocol for T-Class Vessels with prior review by the undersigned and Mr. ( ). Upon commissioning, the standing and running rigging systems were inspected by the parties named above. Sea Trials were conducted and all systems, reportedly, performed satisfactorily.

The vessel was inspected for this report by the undersigned surveyor to meet requirements for USCG Passenger Vessel Certification and to qualify for insurance coverage.

Surveyor's Statement:

In accordance with the request for a marine survey of the sailing vessel "( )" for the purpose of evaluating her present condition and fitness for passenger service, I hereby submit my conclusions based on the preceding report. The subject vessel was personally inspected by the undersigned on the dates named in this report.

Conclusion:

The statements of fact contained in this report are true and correct. The reported analyses, opinions and conclusions are my personal unbiased, professional analyses, assumptions and limited conclusions.

I have no present or prospective interest in the vessel that is the subject of the report and I have no personal interest or bias with respect to the parties involved.

My compensation is not contingent upon the reporting of a predetermined value or direction in value that favors the cause of the client, or the attainment of a stipulated result, or occurrence of a subsequent event.

Disclosure:

No warranty or guarantee, expressed, or implied, is made as to conditions of equipment, hull, gear or any other item or aspect of the vessel, other than as stated herein and as observed at the time of the survey dates noted in this report.

RECOMMENDED REFERENCES

These recommended references were compiled through Coast Guard interaction with industry partners and on-line research. Almost all, including historic reprints are readily available new and or used through various on-line purchasing venues.

GENERAL

1. Skene's Elements of Yacht Design by Francis S. Kinney
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2. Principles of Yacht Design by Lars Larsson & Rolf E Eliasson
   ISBN 0-07135-393-3
3. The Complete Rigger's Apprentice by Brion Toss
   ISBN 0-07064-840-9
4. Surveying Small Craft by Ian Nicholson
   ISBN 0-924486-58-9
5. The Boater's Guide to Corrosion by Everett Collier
   ISBN 0-07-155019-4
6. The Sailing Dictionary by Joachim Schult
   ISBN 0-924486-37-6
7. Surveying Fiberglass Sailboats by Henry C. Mustin
   ISBN 0-87742-347-4
8. Inspecting the Aging Sailboat by Don Casey
   ISBN 0-07-013394-8
9. Cordage Institute
   http://www.ropecord.com/cart/cartpubs.asp
10. Handbook of Fibre Rope Technology by H.A. McKenna, J.W.S. Hearle, N. O'Hear
    ISBN-10: 1855736063
11. Federal Specification RR-W-410-G; Wire Rope and Strand - 20June2010
    http://www.loosco.com/resource-library/specifications/index.php
12. Naval Ships Technical Manual Chapter 613 – Wire and Fiber Rope and Rigging
    U.S. Department of Defense.
13. Wire Rope User's Manual, 2nd Edition
    Wire Rope Technical Board
14. West Coast Wire Rope Guide
    West Coast Wire Rope and Rigging, Inc.
    http://www.wcwr.com/home/catalog
15. Line: Tying it up, Tying it down by Jan Adkins
    ISBN – 10: 0937822833
16. The Marlinspike Sailor by Hervey Garrett Smith
    ISBN-10: 0070592187
17. Moving Heavy Objects by Jan Adkins
    ISBN – 10: 0937822825
18. The Ashley Book of Knots by Clifford W. Ashley
    ISBN-10: 0385040253
19. The Complete Book of Knots by Geoffery Budworth
    ISBN-10: 1558216324

20. Handbook of Seaman's Ropework by Sam Svenson
    ISBN-10: 0229117074
21. Splicing Wire and Fiber Rope by R. Graumont
    ISBN-10: 0870331183
22. The Sailmaker's Apprentice: A guide for the self reliant sailor by Emiliano Marino
    ISBN-10: 0071376429

CONTEMPORARY

1. Rigging Service Guidelines by Navtec Rigging Solutions
   www.navtecriggingsolutions.com.
2. Guidelines for Design and Constructruction of Large Modern Yacht Rigs
   Germanisher Lloyd
   http://www.gl-group.com/infoServices/rules/pdfs/gl_i-4-2_e.pdf
3. Guidelines for the Type Approval of Carbon Strand and PBP Cable Rigging for Sailing Yachts
   Germanisher Lloyd
   http://www.gl-group.com/infoServices/rules/pdfs/gl_i-4-3_e.pdf
4. Understanding Rigs and Rigging by Richard Henderson
   ISBN 0-87746-383-4
5. Hall Spars and Rigging – Deck Set Up; Mast Tuning and Care; Mast and Vang Manuals
   http://www.hallspars.com/category_s/2231.htm
6. Cruising Rigs and Rigging by Ross Norgrove
   ISBN-10: 087742155

TRADITIONAL

1. Tall Ship Rigs by Germanischer Lloyd
   http://www.gl-group.com/infoServices/rules/pdfs/gl_i-4-1_e.pdf
2. Guidelines for the Maintenance and Inspection of Tall Ship Rigs by Germanischer Lloyd
   http://www.gl-group.com/infoServices/rules/pdf/gl_i-4-4_e.pdf
3. ABS Rules for Building and Classing Wood Vessels, 1942
   American Bureau of Shipping
4. Hand, Reef and Steer – Traditional Sailing Skills for Classic Boats by Tom Cunliffe
   ISBN-10: 1574092035
5. The Gaff Rig Handbook: History, Techniques, Developments by John Leather
6. The American Fishing Schooners: 1825-1935 by Howard I. Chapelle
   ISBN-10: 039303755X
7. Auxiliary Sail Vessel Operations for the Aspiring Professional Sailor by G. Andy Chase
   ISBN 0-87033-493-X
8. EAGLE Seamanship, 4th Edition: A Manual for Square Rigger Sailors
   CAPT. Eric C. Jones, USCG; LT Christopher Nolan, USCG
   ISBN-10: 1591146313

HISTORIC

1. Wooden Ship: The building of a wooden sailing vessel in 1870 by Jan Adkins
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2. The Art of Rigging by George Biddlecombe
   ISBN-10: 0486263434
3. The Kedge-Anchor or Young Sailors' Assistant by William Brady
   ISBN-10: 0486419924
4. The Rigger's Guide and Seaman's Assistant by Charles Bushell
   ISBN-10: 1130901580
5. American Merchant Seaman's Manual – 1942 by Felix M. and Allan Hoffman Cornell
6. The Seaman's Friend – A treatise on practical seamanship by Richard Henry Dana Jr.
   ISBN-10: 048629918X
7. Seamanship in the Age of Sail by John Harland
   ISBN-10: 08070219553
8. The Young Sea Officer's Sheet Anchor: Or a key to the leading of rigging and to practical seamanship by Darcy Lever
   ISBN-10: 0486402207
9. Seamanship by George S. Nares
   ISBN-10: 1145057748
10. Steel's Elements of Mastmaking, Sailmaking and Rigging by D.R. Steel
11. Masting and Rigging: The Clipper Ship & Ocean Carrier by Harold A. Underhill
    ISBN-10: 0851741738

OTHER:

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   Jamie White – Director, Texas Seaport Museum
   http://www.flckr.com/photos/squarerigger/sets/72157600183894973/with/4868979/

2. How to Worm, Parcel and Serve
   Wesley Heerssen, Captain, US Brig NIAGARA
   http://brigniagara.wordpress.com/2008/11/05/learn-how-to-worm-parcel-and-serve-20-min-video/

3. How to Turn in a Fiber Seizing
   http://brigniagara.wordpress.com/2006/11/18/a-quick-and-dirty-seizing-in-eight-minutes/

Preventative Maintenance Cleaning for Stainless Steel Rigging Components

This information was compiled through Coast Guard interaction with industry partners and other research sources. It is specific to industry experience with stainless steel hardware typically used for standing and running rigging including wire rope, end terminals, chain plates, mast tangs and associated anchoring or tensioning devices in inspected sail vessels. Absent specific regulations, this enclosure is informational.

PROPERTIES/CHARACTERISTICS OF STAINLESS STEEL MARINE HARDWARE: It is well recognized that (300 series) stainless steel alloys, typically used in sail-rigging hardware, are prone to premature deterioration under prolonged exposure to corrosive, air or water borne, chemical compounds and/or oxygen depriving surface contaminates. While 316 series stainless steel alloys typically exhibit superior corrosion resistance to surface contaminates, they are also vulnerable to premature deterioration when corrosive/acidic ***surface*** contaminates and/or accumulations of oxygen depriving particulates are allowed to accumulate.

ENVIRONMENTAL CONDITIONS: Airborne chemical compounds released by the burning of carbon based, fuels are known to contribute to the corrosive environment affecting marine hardware**.** Elevated, ambient temperature and concentrations of water salinity, typically associated with the tropical latitudes, are also known to accelerate the corrosive process. When these types of contaminants combine with salinity from sea air moisture for a period of time, conditions are right to accelerate deterioration in metallic standing rigging systems.

CLEANING: Industry literature suggests cleaning, as simple as regular rinsing with fresh water, be part of a routine maintenance to reduce the build-up of corrosive surface contaminants and increase rigging service life. Cleaning also facilitates the inspection process. Frequent cleansing combined with regular inspection are industry recommended best practices. See Navtec Rigging Service Guidelines.

There are two schools of thought on cleaning. The first is that spots or trails of discoloration can show where developing or existing problems are located. After the initial inspection, cleaning should be done, to see under the dirt, including any areas that may need further attention. The second school of thought is that all rigging should be cleaned before routine (level A) inspection. Cleaning exposes cracks or other anomalies that may be hidden under even mildly corroded surfaces, thereby allowing a more fair and accurate assessment to take place. In either strategy, the cleaning process itself also forces close up examination, creating better awareness of standing rigging components and their condition in service.

NOTE: *Best practices in the industry recommend against cleaning with caustic solvents, liquid penetrants or aggressive "rust busting" agents. Similarly, the use of highly abrasive pads, wire brushes or tools that will score the surface of stainless steel wire or rigging components should be avoided.*

THE INSPECTION PROCESS: When inspecting wire cables, look carefully for signs of corrosion, cracks, pitting and discolored strands. Rust on the wire cables and all associated hardware is caused by salinity from sea air moisture or spray. After a short period of time, it is not uncommon for a reddish brown rust film to begin to appear on the wire or rigging components, referred to as "rougeing" in the Navtec Rigging Service Guidelines. When coupled with other air contaminants, it will create a glue-like rusty grime. If allowed to accumulate, hose water or rain will not remove this rusty grime; it must be cleaned off manually to avoid further deterioration which will only get worse if left unattended over time. Periodic active cleaning and maintenance of standing rigging will slow and may even prevent the process from taking hold, thereby increasing the service life of the standing rigging system in general. Such practice will also help to troubleshoot problematic areas of concern and maintain the standing rigging system through its full life cycle.

NOTE: *Discoloration or corrosion in stainless steel can also be a by-product of the quality of the alloy, or introduced by tooling used during swaging of wire cable or straightening of rod rigging. Photographic records should be kept as part of a rigging log for review and analysis over time.*

TYPICAL STAINLESS STEEL 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 fittings are used to absorb non-linear loads between chainplates or mast tangs and turnbuckles or end fittings to allow load forces to align with shroud/stay angles 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.*

CORROSION INSPECTION POINTS

• Chainplates – deck penetrations and/or hidden surfaces

• Chainplate fasteners

• Any place that there are stress concentrations

• Dissimilar metal couplings

• All wire end fittings, mechanical and swage alike

• Stem fittings and fastenings

• Mast Steps

• Welds – Inter-granular corrosion where heat has changed the structure of stainless and carbides have precipitated on the surface

• Under winch bases and their mounting hardware

• Bonding/Lightning protection systems

• Bowsprit stem fittings

• Catamarans - The forestay load path and attachment to the hulls, including but not limited to bridles, gull stays and the bow tube or beam arrangements

PATHWAYS TO SPAR & RIGGING FAILURE
(Not Including Operator Error)

- **ORDINARY OR EXTRA-ORDINARY WEAR, FATIGUE**

  (accumulated or accelerated "work-cycles" on components)

- **MODIFICATIONS TO SYSTEM**

  (w/o understanding engineering or potential consequences)

- **ORDINARY OR ACCELERATED CORROSION**

  (dissimilar metals, environmental, stray current, wood rot)

- **DEFERRED OR POOR MAINTENANCE PRACTICES**

  (lack of comprehension, negligence, available funds)

- **POOR FABRICATION**

  (incorrect materials, assembly, product anomalies, defects)

- **IMPACT TO SYSTEM**

  (collision, lightning strike, severe knockdown, jibes "bad docking day")

WOOD SPAR GRADE STANDARDS

This information was compiled through Coast Guard interaction with industry partners and on-line research. Absent specific regulations, it should be used as a guide rather an absolute mandate and applied with discretion. Sources are historically based "rules of thumb" from government published standards or private resources and still considered good marine practice in the wood spar building trade today. The spar's use and place in the rig should also be considered. Defects in gaffs, booms and yards where loading is likely to be uneven may be more critical than masts that are largely in compression.

- MATERIAL

- Cut from live/green Douglas Fir or Spruce;
- Free from defects including but not limited to shakes, cracks, hollow butts or tops; pitch seams, bark inclusions, scars, rot, insects, insect/borer damage, nails, spikes or foreign material and holes – open or plugged; and
- Be close grained with an average ring count of not less than 6 rings per inch measured from the center of the heartwood to the outer edge of the sapwood at both ends.

- KNOTS

- No large or unsound/decayed knots, ring knots, knot clusters. Sound, tight knots are permissible but shall not exceed ¼ the diameter of the spar at the location of the knot. Knots if allowed should be avoided in areas of known stress, such as steps, gaff or boom ends, etc.; and
- No ring knots permitted if the series of knots occur within a 6 inch length of the spar and the sum of the knot diameters is more than 1/3 of the diameter at that point.

- SPIRAL GRAIN

- Should be avoided whenever possible. The grain should not visually twist more than one inch over 12 inches. A complete twist is 360 degrees. Maximum allowable twist is as follows:

Length	Maximum Twist
25 – 35 feet	1 complete twist in 20 feet
40 – 50 feet	1 complete twist in 30 feet
55 feet or longer	1 complete twist in 40 feet

- **CRACKS**: Are fractures perpendicular to the grain, a sign of failure and not acceptable

- CHECKS: Are separations parallel to the grain and part of the natural drying process. They are generally not of concern unless they threaten to continue through the thickness of the spar or are located such that water retention is problematic or has otherwise impacted spar integrity.

Note: *Spars with checks should be examined closely in service for evidence of movement or undue flexing when under strain. Checks open to the weather should be the subject of regular maintenance as well as close up visual examination and or sounding to detect early signs of rot.*