



## REVIEW OF STRUCTURAL PLANS FOR WOODEN VESSELS

Procedure Number: H1-13

Revision Date: June 4, 2024

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### **Purpose:**

This Plan Review Guideline (PRG) provides general guidance and information to the marine industry regarding the submission of wooden structure calculations and plans to the Marine Safety Center for vessels seeking certification under the applicable Subchapters:

- Subchapter C (Uninspected Vessels),
- Subchapter I (Cargo Vessels of less than 4,000 gross tons),
- Subchapter R (Sailing School Vessels carrying 100 or less persons or with overnight accommodations for 49 or fewer people), and
- Subchapter T (Small Passenger Vessels).

Note: Vessels seeking certification under Subchapter H, Subchapter I over 4,000 gross tons, or Subchapter K may not be constructed of wood due to structural fire protection requirements.

### **Contact Information:**

If you have any questions or comments concerning this document, please contact the Marine Safety Center by e-mail or phone. Please refer to Procedure Number H1-13.

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**Table of Contents**

1. Applicability: ..... 3

2. References: ..... 3

3. Structural Standards: ..... 4

4. Classification Society Review: ..... 4

    4.1 Vessels Reviewed for Classification: ..... 4

    4.2 Vessels Reviewed for Load Line Assignment: ..... 4

    4.3 Vessels Reviewed By Class Societies for Other Purposes: ..... 5

5. Submittal Checklist: ..... 5

    5.1 Required General Information: ..... 5

    5.2 Required Plans: ..... 5

    5.3 Required Calculations: ..... 6

    5.4 Required Material Specifications: ..... 6

6. Structural Continuity: ..... 7

7. FRP Overlay: ..... 8

8. Keel Dimensions: ..... 9

9. Special Consideration: ..... 9

10. Disclaimer: ..... 9

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## **1.0 Applicability:**

This Plan Review Guideline is applicable to wooden vessels certificated under:

1. Subchapter T vessels
2. Subchapter R Sailing School Vessels carrying 100 or less persons or with overnight accommodations for 49 or fewer people
3. Subchapter C
4. Subchapter I vessels of less than 4,000 gross tons (vessels certificated under Subchapter I and of 4,000 or greater gross tons may not be constructed of wood due to structural fire protection requirements of 46 CFR 92.07)

## **2.0 References:**

- a. Lloyd's Register Rules and Regulations for the Classification of Yachts and Small Craft (Amended to 1983)
- b. 1994 ABS Guide for Building and Classing Offshore Racing Yachts
- c. 2024 ABS Guide for Building and Classing Yachts
- d. 1978 ABS Rules for Building and Classing Reinforced Plastic Vessels
- e. 1943 ABS Rules for Building and Classing Wood Vessels
- f. Scantlings of 500 Small Wooden Passenger Vessels, 1958, OCMII New York.
- g. Navigation and Inspection Circular (NVIC) No. 7-95: Guidance on Inspection, Repair, and Maintenance of Wooden Hulls
- h. Wood Handbook, Wood as an Engineering Material, USDA Report FPL-GTR-113
- i. WOOD: A Manual for its Use as a Shipbuilding Material, Volumes I through IV, Department of the Navy, Bureau of Ships
- j. Marine Safety Manual (MSM), Vol. IV, Section 6.G
- k. Navigation and Inspection Circular (NVIC) No. 8-87 CH-1: Notes on Design, Construction, Inspection and Repair of Fiber Reinforced Plastic (FRP) Vessels
- l. Navigation and Inspection Circular (NVIC) No. 9-97 CH-1: Guide to Structural Fire Protection

**3.0 Structural Standards:**

Reference (a) is the wooden vessel standard incorporated by reference in Subchapter T for the design and construction of small passenger vessels. Direct reference to the Lloyd's Rules is based on the familiarity that Coast Guard inspectors and technical personnel have with reviewing a vessel designed to this standard. This standard should be applied to all wooden plank-on-frame vessels (carvel, clinker, strip, and double planked) up to about 100 feet in length. Special consideration may be warranted for vessels having speeds in excess of 20 knots per Part 2, Chapter 4, Section 3.1.2 of reference (a). Reference (c) can be used for larger cold-molded vessels. Reference (e) may be used for larger wooden vessels.

While reference (a) may also be used for the evaluation of plywood and cold molded vessels, it is not specific with regard to allowable skin thickness reductions, permissible frame types, or acceptable frame spacing adjustments on vessels using these construction methods. It is recommended that reference (b) or reference (c) be used to evaluate cold molded vessels.

The use of a first principle systematic engineering analysis is discouraged on wooden vessels. All of the accepted standards (except for reference (c)) are empirical and the resultant safety factors on wooden vessels are not defined. In addition, the properties of wood are not easily established, they vary considerably (even within species), they are greatly affected by the service environment and load duration, and they suffer further reductions due to material defects and imperfections. Unlike steel vessels, where allowable bending stress is the prime design consideration, wooden vessels must also be designed to account for both shear and bending deflections and for shear strength. Factors other than allowable stress, such as deflection, govern the planking scantlings. If an engineering analysis is submitted, the allowable wood stress should not exceed that of Table 5.1 in Volume III of reference (i). Reference (h) may also be used as a reference for material properties.

The ruleset that is selected for demonstrating structural compliance should take into account the commercial service of the vessel (as opposed to recreational service) and the intended route. The minimum acceleration,  $n_{cg}$ , for reference (c) is 1 g.

**4.0 Classification Society Review:****4.1 Vessels Reviewed for Classification:**

Approval of structural plans by a recognized classification society for the purpose of classification is generally considered satisfactory evidence of the structural sufficiency of the vessel. Therefore, any structural plans submitted for a vessel classed by a recognized classification society to the MSC may be approved without further review, with Branch Chief approval. Ensure that the Officer in Charge, Marine Inspection (OCMI) receives copies of the classification society's approval letter(s).

**4.2 Vessels Reviewed for Load Line Assignment:**

The MSC considers the structural plan approval by a recognized classification society assigning authority for the purpose of load line assignment as sufficient demonstration of compliance with the regulations. However, in a load line review, the assigning authority reviews only the major external strength members and ignores many structural components, such as internal bulkheads, that are

reviewed on a vessel seeking classification. Ensure that the MSC and the OCMI receive a copy of all structural plans. In addition, ensure that the MSC and the OCMI receive copies of the approval letter(s) for the plans reviewed by the classification society. MSC may choose to review structural calculations as deemed necessary.

### **4.3 Vessels Reviewed by Class Societies for Other Purposes:**

A decision will be made by the Branch Chief whether to accept the classification society's approval, or complete our own independent review. If we accept the classification society's approval, then follow the same procedure as above for "Vessels Reviewed for Classification."

## **5.0 Submittal Checklist:**

### **5.1 Required General Information:**

The following items should be included in the submittal package, as applicable:

1. A copy of the Application for Inspection of U.S. Vessel (CG-3752) submitted to the OCMI.
2. A detailed list of all plans noting what action is desired (approval, information only, etc.). Each plan should include a title block with the vessel name or hull number, date, drawing number, revision number, revision date, etc. See below for a list of required plans.
3. A general description of the vessel and its functions such as: length overall, length between perpendiculars, breadth, depth, estimated lightship and draft, load line draft, vessel speed, wave height vs. speed relationship (if applicable), service limitations, identification of novel designs and/or connection details requiring direct analyses, anticipated route, and types of cargo to be carried.

### **5.2 Required Plans**

The following plans should be included in the submittal package if applicable to the vessel. Representative sections must be submitted when scantling plans are not available:

1. Bottom construction, floors, girders, etc.
2. Deck Plans
3. Framing plan
4. Midship section – Identifying all cutouts, longitudinal stiffeners / girders that are not considered effective and all local loadings (i.e. wheel loads, foundation loads, concentrated or distributed loads).
5. Pillars and girders
6. Scantling profile and decks
7. Superstructure and deckhouses
8. Watertight bulkheads
9. Structural Details
10. Typical sections
11. Sections for areas of unusual structure
12. General arrangement (for reference only)

## MSC PRG, STRUCTURAL PLANS FOR WOODEN VESSELS

Procedure Number: H1-13

Revision Date: June 4, 2024

13. General material specifications
14. Masts and rigging (if applicable, see Plan Review Guideline H1-15 for additional information)

Note: if the vessel is of simple construction, and the OCMI is willing to accept it, MSC has accepted pictures with dimensions in lieu of drawings.

### 5.3 Required Calculations:

The following structural calculations should be included in the submittal package, if applicable:

1. Keels, stems, and shaft struts
2. Bottom shell plating and attached framing
3. Side shell plating and attached framing
4. Strength deck plating and attached framing
5. Hull and cross structure transverse, torsional, and shear strength (multi-hull only)
6. Watertight bulkheads and attached stiffeners
7. Deep-tank bulkhead plating and attached stiffeners
8. Non-tight structural bulkheads/tank boundaries and attached framing
9. Superstructure and deckhouse plating and attached framing
10. Other deck plating and attached stiffeners
11. Stanchions
12. Rudders
13. Masts and rigging
14. Unusual structure requiring direct analysis (novel designs and/or connection details, hydrofoil appendages, etc.)
15. Racking load calculations (large multi-level superstructures with few transverse bulkheads and/or supporting stanchions)

### 5.4 Required Material Specifications

The following information should be included in the submittal package, if applicable:

1. Wood Materials: Specifications that include the species, density, grade, specific gravity, moisture content and corresponding mechanical properties (modulus of rupture, modulus of elasticity, tensile strength parallel/perpendicular to grain, and compressive strength) of all plywood and timber members used. See Part 2, Chapter 4, Section 1.2 of reference (a) regarding lumber quality.
2. Wood Preservatives: Specifications that include its type and its effect on varnish, paint coatings, glues, and synthetic resins.
3. Wood Adhesives: Specifications that include the glue type and its compatibility with any wood preservatives used.
4. Fastener Materials: Specifications that include its type (screw bolts, drift bolts, carriage bolts, wood screws, lag screws, or nails), composition, physical properties, corrosion resistance

including its compatibility with the materials being fastened or insulation used, and a discussion on its suitability for the intended service.

Note: While marketed as a sealant/adhesive, we consider 3M 5200® to be a sealant only. Therefore, 3M 5200® is not an acceptable replacement for mechanical fasteners.

## **6.0 Structural Continuity**

The recognized classification society rules contain specific construction details and requirements which ensure hull structural continuity. The information below is general in nature and does not supersede specific classification society rule requirements.

1. If longitudinally framed, ensure the following:
  - a. Bulkheads, partial bulkheads or web frames are arranged to provide effective transverse rigidity and to support the ends of the superstructure or deckhouse.
  - b. Longitudinal frames are supported by effective transverse structure.
  - c. In general, longitudinals are continuous in way of transverse supporting members, except at transverse bulkheads where they may be intercostal provided continuity of strength and end fixity are maintained. If longitudinals are not continuous, they serve only as panel stiffeners and are not considered as primary hull structural members.
2. If transversely framed, ensure the following:
  - a. Deck and bottom girders are provided. Girders may be intercostal at transverse bulkheads provided continuity of strength and end fixity are maintained.
  - b. Transverses are arranged as continuous web rings and girders are aligned with stiffeners at bulkheads. Alternatives will be specifically considered.
3. For all vessels, ensure the following:
  - a. Where changes in thickness or structural section occur, they are gradual to prevent notches and other hard spots.
  - b. Openings in structural internal members are clear of concentrated loads and areas of high stresses.
  - c. Openings in decks are framed to provide sufficient support and attachment for the ends of deck beams.
  - d. Engines are supported and secured by substantial girders, suitably stiffened, supported against tripping and supported at bulkheads.
  - e. Wood preservatives shall not have a harmful effect on coatings, glues, or synthetic resins if used.
  - f. Wood adhesives are to be of a waterproof type having the necessary durability and strength. In general, gluing wood having a moisture content greater than 15% must be avoided. See Part 2, Chapter 4, Section 1.3.2 of reference (a). Also, note some references specify 12% or less moisture content.
  - g. In general, scarf joints should be employed when primary structural members butt together. Scarf joints may be either glued or glued and fastened. In accordance with reference (g), scarf joints should generally have a slope of at least 12 times the member molding. In some cases, the applicable ruleset will specify a minimum slope of the scarf joint. Reference (a) specifies a slope of not less than 6 times the member molding. When

- provided, the slope of the scarf should be based on the applicable rule set, or at least 1/12 if not specified.
- h. If scarf joints are used, they shall be staggered with other scarfed members in the same orientation. For example, scarf joints in longitudinal members shall be staggered such that they do not fall at the same longitudinal location as other longitudinal members with scarfs.
  - i. Butt joints on hull planks are allowed if they are properly separated and are fitted with butt blocks. Butts in adjacent planks are at least 3 frame spaces (or at least 5 feet) apart for transversely framed, longitudinally planked vessels. If there is a solid strake between them, they are to be at least 4 feet apart. Butts that fall in the same frame are to be separated by at least 3 solid strakes.
  - j. Butt blocks are to be adequately sized. If the frame spacing allows it, the length is to be at least 12 times the planking thickness and its width at least 1 inch greater than the strake width. Plywood is not to be used for butt blocks.
4. Check the mechanical fasteners for the following:
- a. Mechanical fasteners are of a material suitable for the service intended and are galvanically compatible with the materials being fastened or provided with the necessary insulation.
  - b. The number, size, type, and spacing of fasteners are adequate.
  - c. Brass fittings are not used and any ferrous fasteners are hot-dipped galvanized.
  - d. Stainless steel fasteners can be used only if ALL of the following conditions are met:
    - i. They are austenitic grade at least Type 304, preferably Type 316.
    - ii. They are NEVER used below the waterline (i.e. do not pass through wet wood).
    - iii. There is ample sealant under the head and in between mating surfaces.
    - iv. The item being fastened is less noble than stainless steel.

### **7.0 FRP Overlay:**

Reference (g) allows the use of an FRP overlay on wood vessels. This protective skin generally adds no strength to the vessel and should not be included in structural calculations. FRP over wood hampers efforts to properly inspect the wood; therefore, any plans outlying this arrangement should be brought to the attention of the OCMI. Simply adding an overlay to an existing vessel does not require plan approval from the MSC and should be directed to the cognizant OCMI for approval. Extensive effort must be taken to ensure the vessel is dried out before attempting to perform this procedure.

FRP overlay on a wooden vessel may be subject to the structural fire protection regulations of a vessel partially constructed of a composite material. More specifically per reference (k), a FRP overlay on the exterior of the hull and horizontal surfaces exposed to the weather do not need to use fire retardant resins. However, a FRP overlay in accommodations, service space, control stations and external vertical surfaces on the deck house should use fire retardant resin. If the vessel does not meet the requirements of 177.410(b), the equivalences specified in 177.410(c) may be applied. Equivalences can not be applied if the limitations in 177.410(d) exist. Use of general purpose FRP resin, or a thin FRP layer as an interior paint or decorative finish on a non-combustible surface is acceptable as long as it is for non-structural purposes. Decorative interior FRP finishes should be no thicker than 2mm if applied per section 2.7.1 of reference (l).



**8.0 Keel Dimensions:**

Table 4.4.1 of reference (a) provides minimum scantlings (molding and siding) for keels as a function of the length of the vessel. Alternate scantlings may be approved on a case by case basis as long as the implied requirements of reference (a) are met including minimum area, moment of inertia, and section modulus.

**9.0 Special Consideration:**

In accordance with 46 CFR 175.550, the cognizant OCMI may give special consideration to authorizing departures from the specific requirements of 46 CFR Subchapter T when unusual circumstances or arrangements warrant such departures and an equivalent level of safety is provided.

**10.0 Disclaimer:**

This guidance is not a substitute for applicable legal requirements, nor is it 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. You can use an alternative approach for complying with these requirements if the approach satisfies the requirements of the applicable statutes and regulations. If you want to discuss an alternative, you may contact MSC, the unit responsible for implementing this guidance