MSC Guidelines for Review of Structural Plans for Fiberglass Reinforced Plastic (FRP) Vessels

Procedure Number: H1-12 Revision Date: 6/30/2025

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References:

a. 46 CFR Subchapter T, Subpart C- Hull Structure
b. 46 CFR Subchapter R, Subpart 167.20 - Hull Requirements, Construction and Arrangement of Nautical School Ships, Subpart 168.05 - General Requirements, Subpart 169.300 - Construction and Arrangement
c. ABS Guide for Building and Classing High-Speed Craft (Series)
d. 1978 ABS Rules for Building and Classing Reinforced Plastic Vessels
e. Lloyd's Rules and Regulations for the Classification of Yachts and Small Craft
f. Navigation and Vessel Inspection Circular (NVIC) No. 5-01: Guidance for Enhancing the Operational Safety of Domestic High-Speed
g. Vessels International Code of Safety for High-Speed Craft (HSC Code)
h. NVIC No. 8-87: Notes on Design, Construction, Inspection and Repair of Fiber Reinforced Plastic Vessels

Recommended Reading

a. Larsson, Lars and Eliasson, Rolf E. Principles of Yacht Design. New York: McGraw Hill, 2007
b. Lloyd's Rules and Regulations for the Classification of Special Service Craft
c. 1986 ABS Guide for Building and Classing Offshore Racing Yachts
d. Design Guide for Marine Applications of Composites, Ship Structure Committee Report No. 403, November 1997
e. Scott, Robert J. Fiberglass Boat Design and Construction. Jersey City, New Jersey: Society of Naval Architects and Marine Engineers, 1996
f. Marine Safety Manual (MSM), Vol. IV, Section 6.G – Hull Strength And Loading In Vessel Design

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Contact Information:

If you have any questions or comments concerning this document, please contact the Marine Safety Center (MSC) by email or phone. Please refer to the Procedure Number H1-12.

Email: MSC@uscg.mil
Phone: 703-872-6729
Website: http://homeport.uscg.mil/msc

Responsibilities:

Using applicable portions of references (a) through (h), the submitter shall provide sufficient documentation and plans to indicate compliance with the applicable requirements. The submission shall be made electronically to the above email

address or, if paper, in triplicate to the MSC's address found on the above website. To facilitate plan review and project management, all plans and information specified in these guidelines should be submitted as one complete package through a single point of contact for the project.

Applicability:

Subchapter T: In general, all vessels must be built to one of the structural design standards referenced in 46 CFR 177.300, and plan review may be conducted by either the Officer in Charge, Marine Inspection (OCMI) or the MSC. The MSC may also accept either a systematic analysis based on engineering principles or an applicable design standard of another classification society as sufficient evidence that the vessel's structures have adequate safety and strength (46 CFR 177.340) on a case by case basis.

As an alternative to structural approval under 46 CFR 177.300, a vessel that has been in satisfactory service for at least 5 years, or is similar to another vessel with the same size, power, and displacement built to the same scantlings that has been in satisfactory service for at least 5 years, may request structural approval from the OCMI per 46 CFR 177.310. This approval is commonly referred to as the "5 year rule." If the hull structure is accepted by the OCMI, structural plans and calculations do not have to be submitted to the MSC for action.

If a vessel is not more than 65 feet in length, carries 12 or fewer passengers, and does not meet the standards of 46 CFR 177.300 or 46 CFR 177.310, structural approval may be obtained from the OCMI under 46 CFR 177.315 in lieu of submitting structural plans and calculations.

Subchapter R: Public nautical school ships are prohibited from being constructed of FRP (46 CFR 167.20-1). Civilian nautical school ships must be built to the same structural requirements as similar sized passenger vessels (46 CFR 168.05-1).

Sailing school vessels must be built to the structural design standards established by a recognized classification society (46 CFR 169.309). Sailing school vessels that carry more than 100 persons or have overnight accommodations for more than 49 persons are prohibited from being constructed of FRP since the structural fire protection requirements in 46 CFR 169.311 cannot be met by FRP.

SOLAS: A SOLAS vessel cannot be constructed of FRP because FRP does not meet the minimum structural fire protection requirements for SOLAS.

HSC Code: All vessels must be built to the structural design standard of an approved classification society, and must be capable of withstanding the static and dynamic loads which can act on the craft under all permitted operating conditions.

Structural Standards:

The structural standards developed by ABS and Lloyd's Register in references (c) through (e) are acceptable to applicable vessels per the requirements of 46 CFR 177.300. The latest version of the applicable structural standard should be utilized.

A request must be made to the Marine Safety Center to use any other rule set, which provides an equivalent level of safety, in accordance with 46 CFR 175.540.

Classification Society Review:

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 OCMI receives copies of the classification society's approval letter(s). If the ABS Guide for Building and Classing High-Speed Craft (ABS HSC) is used for structures, the wave height versus speed data must be included on the Certificate of Inspection (COI).

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. If the ABS HSC Guide is used for structures, the wave height versus speed data must be included on the COI.

If the vessel is not classed or load-lined but the hull structure has been reviewed and approved by a classification society for other reasons:

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."

High Speed Vessel Review Note:

High-speed vessels can be divided into two categories: domestic-only vessels built to the guidance of reference (f) and those constructed to reference (g). These vessel's structures may be analyzed at a range of speeds and significant wave heights in order to define their permissible operating envelope. Additionally, calculations should be performed for both the maximum and minimum loading conditions to capture all possible accelerations.

For domestic vessels, the speed versus significant wave height data must be representative of the vessel's service (protected waters, partially protected waters, and exposed waters). Speed versus significant wave height data should comply with the following:

1. The minimum acceptable significant wave height for ABS structural calculations is 1.5 feet. Therefore, all calculations using the ABS HSC Guide must use significant wave heights of 1.5 feet or more for all speeds at which the vessel is intended to operate. No calculations using a significant wave height less than 1.5 feet will be accepted.

2. A Reasonable Operating Speed (ROS) is the minimum sustainable speed for returning to port in the event of adverse weather. The ROS should be acceptable to the vessel operator and the OCMI. At a minimum, the ROS should be based on the following route specific minimum significant wave heights unless otherwise agreed upon with the OCMI:

Route Specific Minimum Significant Wave Heights	
Protected Waters(lesser of)	L/12 or 3.0'
Partially Protected Waters	8.5'
Exposed Waters	13.0'

3. Any significant wave range above 1.5 feet can be requested, however the standard significant wave height ranges, in feet, are 0 to 1.5, 1.5 to 3.0, 3.0 to 5.0, 5.0 to 7.0, 7.0 to 8.5, 8.5 to 11.5, 11.5 to 13, and at 3 foot intervals for significant wave heights above 13 feet. The entry for seas in excess of the limiting significant wave height should specify "Seek Shelter at Slow Speed."

4. The minimum significant wave height and allowable speed may provide the basis for maximum vertical acceleration, but structural pressures also vary based on wave height. Calculations should address the full range of the operational envelope.

5. Vessels being built to the Lloyd's Special Service Craft rules must use the appropriate route specific minimum significant wave height as shown above, as well as the Service Group designator appropriate for the vessel's intended service and operating area. In addition to other factors, the Service Group designator is based on the

operating area's distance from safe refuge. The minimum Service Group designator for different routes are:

Route Specific Minimum Service Group Designator	
Protected Waters	G1
Partially Protected Waters	G2
Exposed Waters	G3

Vessels built to the HSC Code are not defined by their route, but can apply any speed versus wave height data to their structural calculations that the designer proposes. These limitations will form one aspect of the operator's speed versus wave height operating envelope (along with stability requirements of HSC Code 2.6.11.1 and 2.6.11.2, and the safety performance requirements of HSC Code Annex 9).

All speed versus wave height data should be included in the structural plan review letter that is copied to the OCMI. The letter should request the OCMI to specify this data on the COI and advise the operator to post the significant wave height to speed restrictions near the navigation position.

For vessel owners that have had their structures reviewed by ABS on behalf of the Coast Guard, the owner of the vessel must give authorization to ABS to provide the analyzed speed versus significant wave height data to the Marine Safety Center.

Documentation from Submitter:

General Documentation:

Check that the following items are included in the submittal package:

- A detailed list of all plans noting what action is desired (approval, information only, etc.). See Plans section below for list of required plans. Each plan should include a title block including the vessel name or hull number, date, drawing number, revision number, revision date, etc.
- A copy of the Application for Inspection of U.S. Vessel (CG-3752A) submitted to the OCMI.
- 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 versus 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.

- If the vessel is classed: A copy of the classification society's structural approval letter(s). Ensure that the OCMI also receives copies of the classification society's structural approval letter(s) and copies of the classification society's approved drawings for their use in the inspection and certification process.
- If the vessel is load-lined: A copy of the classification society's structural approval letter(s) and a copy of all structural plans not being reviewed by the classification society. Ensure that the OCMI receives copies of the approval letter(s) for the plans reviewed by the classification society and copies of the classification society's approved drawings for their use in the inspection and certification process.
- If the vessel is not classed or load-lined but the hull structure has been reviewed and approved by a classification society for other reasons: A copy of the class society's approval letter, approved drawings, and any associated significant wave height versus speed charts.

Materials:
Check that we received the following information (if applicable) in the submittal package:

- Resins: Specifications that include the types (general purpose or fire retardant) of all resins and gel coats used.
- Reinforcements: Specifications that include the fiber type and form, weave, fiber orientation, weight, and physical data, of all reinforcing materials used.
- Core Materials: Specifications that include the material type, density, and mechanical properties of all cores used.
- Plywood and Timber Members: Specifications that include the type, density, grade, and mechanical properties of all plywood and timber members used.
- Laminate Schedules**:** A laminate schedule for each laminate used in the design that includes the type and orientation of reinforcements, sequence of plies, and the assumed or calculated mechanical properties and thicknesses. This information must be indicated on the scantling drawings themselves or as a separate drawing which includes all of the laminate schedules.

Plans:
Check that the following plans are included in the submittal package, if applicable to the vessel. Representative sections must be submitted when scantling plans are not available.

- Bottom construction, floors, girders, inner bottom plating, etc.
- Deck plans
- Framing plan
- 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).
- Pillars and girders

- Scantling profile and decks
- Superstructure and deckhouses
- Watertight bulkheads
- Watertight doors and framing
- Structural details of engine foundations, deck fittings, deck to hull joints, interior joints, shell details such as chine and transom, through hull penetrations, boundary angles, flanges or tapes, mechanical fasteners, panel stiffeners, brackets, openings in girders, structural intersections, tripping brackets, stanchion supports, stiffener endings, snipes, bulkhead penetrations, and cutouts
- Typical sections for areas of unusual structure
- General arrangement (for reference only)
- General material specifications

Calculations:

Ensure that the structural standard used to demonstrate compliance is:

(1) a standard permitted by the vessel's specific subchapter, and
(2) applicable to the vessel.

Check that the following structural calculations are included in the submittal package, if applicable to the vessel:

- Keels, sterns, shaft struts, and tunnels
- Bottom shell plating and attached stiffeners including the keels
- Side shell plating and attached stiffeners
- Strength deck plating and attached stiffeners
- Longitudinal hull girder strength
- Hull transverse, torsional, and shear strength (multi-hull only)
- Other deck plating and attached stiffeners
- Watertight bulkheads and attached stiffeners
- Deep-tank bulkhead plating and attached stiffeners
- Other structural bulkheads and attached stiffeners
- Superstructure and deckhouse plating and attached stiffeners
- Stanchions
- Rudders
- Crane foundations and under-deck stiffening
- Unusual structure requiring direct analysis (novel designs, connection or foundation details, hydrofoil appendages, etc.)
- Racking load calculations (large multi-level superstructures with few transverse bulkheads and/or supporting stanchions)
- Structural details of panel stiffeners, brackets, openings in girders, structural intersections, tripping brackets, stanchion supports, stiffener endings, snipes, bulkhead penetrations, and cutouts
- Ferries must include vehicle loading calculations

Structural Continuity:

If longitudinally framed, check to ensure the following:

- Bulkheads, partial bulkheads or web frames are arranged to provide effective transverse rigidity and to support the ends of the superstructure or deckhouse.
- Longitudinal frames are supported by effective transverse structure.
- 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, ensure that they are not used in the longitudinal hull girder section modulus calculations.

If transversely framed, check to ensure the following:

- Deck and bottom girders are provided. Girders may be intercostal at transverse bulkheads provided continuity of strength and end fixity are maintained.
- Transverses are arranged as continuous web rings and girders are aligned with stiffeners at bulkheads. Alternatives will be specifically considered.

For all vessels, check to ensure the following:

- The attachments of all internal structural members provide end fixity and effective load transmission.
- The webs of all members are effectively attached to the shell, deck or bulkhead plating, to their supporting members, and to face bars.
- Hard spots, notches, and other structural discontinuities are minimized.
- Openings in structural internal members are clear of concentrated loads and areas of high stresses.
- Openings in decks are framed to provide efficient support and attachment for the ends of deck beams.
- Portlights below the main weather deck are of substantial construction and capable of being closed and secured watertight.
- Engines are supported and secured by substantial girders, suitably stiffened, supported against tripping and supported at bulkheads.

Material Testing:

Contact the cognizant OCMI to determine:

- Amount and frequency of laminate testing required
- Type of test panels required (hull cut-outs/plugs, hull laminate extension tabs, or separate test panels)

Since vessel plans and calculations are typically submitted prior to completion of the vessel hull structure, MSC approval is based on the assumed material properties and thicknesses. If test results determine that the laminate's properties and/or thicknesses are less than those used in the design, the plans and/or calculations must be appropriately updated and resubmitted to MSC for approval. See NVIC 8-87, Chapter 3, for more details.

The table on the following page lists tests recommended by NVIC 8-87 along with some added recommendations. While this list should be sufficient for most vessels, vessels constructed with novel materials or using a design standard other than those mentioned above require our review of appropriate tests. Each class society lists the tests and test numbers that their rules are based upon and may require different values to use their equations. When in doubt, feel free to discuss this issue with the cognizant OCMI or MSC, and the test lab.

When material property test results are presented to MSC, we will use the minimum property values for all our calculations, as opposed to an average of the tested material property values.

Property	ASTM Test	Single Skin	Sandwich	Comments
Flexural Strength & Modulus	D790	R	N	None
Tensile strength and modulus	D3039[1] or D638	C	R	For single skin, when vessel L > 100' For sandwich, both skins
Compressive strength and modulus	D3410[2] or D695	C	R	For single skin, when vessel L > 100' For sandwich, both skins
Shear strength, perpendicular and parallel to warp	D732	C	C	Shear typ. not primary means of failure. Test as needed.
Interlaminar shear strength	D3846	C	C	Where glass content >= 40%
Glass content and ply-by-ply analysis	D2584	R	R	For sandwich, both skins
Core to skin bondline	C297[3]	N/A	R	None
Core shear strength and modulus	C273	N/A	C	Only if spec. sheet not available

Structural Fire Protection:

Ensure that the resin used is fire retardant and meets MIL-R-21607 as required by 46 CFR 177.410(b). Please provide documentation to satisfy the OCMI in this matter. Specific laminate schedules, regardless of resin type, may be considered fire retardant if testing determines that the schedule has an ASTM E-84 flame spread rating of not more than 100. The test results must be submitted to MSC for review. A list of currently accepted Fire Retardant Polyester Laminate Resins are included in Attachment 1.

Note that gel coats do not need to be fire retardant. See reference (h), chapter 1.F.3.

If the resin used is general purpose, check to ensure the following:

- The additional requirements of 46 CFR 177.410(c) concerning cooking and heating appliances, sources of ignition, fire detection and extinguishing systems, machinery space boundaries, and furnishings are met, and

- The limitations imposed by 46 CFR 177.410(d) concerning overnight passenger accommodations, gasoline engines and fuel tanks, and flammable/hazardous cargo are met.

Attachments:

1. List of Accepted Fire Retardant Polyester Laminate Resins
2. Multi-hull vessels – simplified cross-structure evaluation

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 the Marine Safety Center (MSC), the unit responsible for implementing this guidance.

Attachment 1

ACCEPTED FIRE RETARDANT POLYESTER LAMINATING RESINS

The resins below meet Mil-R-21607. This list was compiled by Commandant (G-MSE-4) on November 17, 1997 and updated on August 17, 2007.

Company	Resin(s)
Advance Coatings Company Depot Road, Westminster, MA 01473	Advaco #3510
Ashland Chemical Company Resins and Plastics Divisions P.O. Box 2219, Columbus, OH 43216	Hetron 92 Hetron 355 Hetron 24370 Hetron 27196 Hetron 28429
Koppers Company, Inc. Organic Materials Group Pittsburgh, PA 15219	Dion 6395 Dion 6395T Dion 6431 Dion 6692, Dion 6692T Dion 6692TSD Dion 601 Koplac 3403
McWhorter Technologies, Inc. 400 East Cottage Pl. Carpentersville, IL 60110	752-448(-) series
Reichold AS (formerly Jotun Polymer A/S) Box 2061, N-3202 Sandefjord, Norway	NORPOL 842-842 (formerly PX-7342), NORPOL 850 series, NORPOL PX-4528 & PX-4528I
Reichold Chemicals, Inc. RCI Building White Plains, NY 10602	Polylite 33-440 Polylite 33-441-00 Polylite 33-442-00 Polylite 94-179 (var. of 33-441) Dion FR 9300-00
Scott Bader Company Limited Wollaston, Wellingborough, Northamptonshire NN8 7R1, England	Crystic 302
Silmar Division, Vestron Corporation 12335 South Van Ness Avenue Hawthorne, CA 90250	Silmar S-517 Silmar S-517A Silmar S-517B
USS Chemicals Div. Of United States Steel, Polyester Unit, 1605 Elizabeth Avenue West Linden, NJ 07036	Laminac EPX-187 MR 357 MR 12165
ICI Americas, C.R.P., Wilmington, DE 19897	ALTAC 792
Interplastic Corp., 2015 N.E. Broadway Minneapolis, MN 55413	CoRezyn 105-58 CORVE8440B CORVE8441B
Alexander/Ryan Marine & Safety Co. 2000 Wayside Dr., P.O. Box 9363 Houston, TX 77261	Qingdao Beihai Shipyard Resin 918# Glass Fiber EWR 200-90

Attachment 2

MULTIHULL VESSELS – SIMPLIFIED CROSS STRUCTURE EVALUATION

Most design standards have sections on the structural requirements for evaluating the cross-structure of a catamaran in torsion, bending, and shear. For example, in the ABS High Speed Craft Guide, the forces are developed in Part 3, Section 6, and the analysis is conducted in Part 3, Appendix 3/B.

However, a more conservative, yet simpler method is to conduct the following analysis. The analysis is roughly equivalent to one hull coming out of the water when the vessel is operating at its full load displacement, such that the cross-structure must support half of the vessel's weight in bending.

1. Find the full load displacement, W, in **pounds**
2. Find the distance from the inboard side of one hull to the center of the other, L, in **inches**
3. Find the allowable stress for the material, σ_{all}, in **psi**
4. Find the required section modulus (in^3) of the cross-structure by solving the equation: $SM = (0.5*W * L)/\sigma_{all}$
5. Determine if there is sufficient section modulus
6. If there is insufficient section modulus, the ABS or equivalent rules may be used.