MSC Guidelines for Review of Structural Plans for Steel and Aluminum Vessels

Procedure Number: GEN-03 Revision Date: 12/4/2017

S. E. HEMANN, CDR, Chief, Hull Division

References

a. 46 CFR Subchapter H, Subpart 72.01 - Hull Structure
b. 46 CFR Subchapter I, Subpart 92.01 - Hull Structure
c. 46 CFR Subchapter K, Part 116, Subpart C - Hull Structure
d. 46 CFR Subchapter L, Subpart 127.210 - Structural Standards
e. 46 CFR Subchapter M, Subpart 144.205 - Structural Standards for a new vessel
f. 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
g. 46 CFR Subchapter T, Part 177, Subpart C - Hull Structure
h. 46 CFR Subchapter U, Subpart 190.01 - Hull Structure
i. Consolidated text of the International Convention for the Safety of Life at Sea (SOLAS) 2004, Chapter II-1, Part A-1
j. International Code of Safety for High-Speed Craft, 2000, Chapter 3
k. Marine Technical Note (MTN): 02-96: Plan Review Guidance for Hovercraft
l. MTN: 05-94: Special Considerations Regarding Racking Loads in the Structural Analysis of Large Multi-level Superstructures on Passenger Vessels Operating on Protected or Partially Protected Waters
m. Navigation and Vessel Inspection Circular (NVIC) 9-81, “Coast Guard Guidance Regarding Shipboard Helicopter Facilities”
n. NVIC 6-99, “Plan Review, Inspection, and Certification Guidance for Vessels Built to the International Code of Safety for High-Speed Craft and Additional Information Regarding Non-Code High-Speed Vessels”
o. Marine Safety Manual (MSM), Vol. IV, Section 6.G
p. IMO Resolution A.673 (16), “Guidelines for the Transport and Handling of Limited Amounts of Hazardous and Noxious Liquid Substances in Bulk on Offshore Support Vessels.”
q. NVIC 11-80, “Structural Plan Review Guidelines for Aluminum Small Passenger Vessels”
r. American Bureau of Shipping (ABS): “Rules for Building and Classing Aluminum Vessels, 1975”

Contact Information

If you have any questions or comments concerning this document, please contact the Marine Safety Center by e-mail or phone, referring to Procedure Number: **GEN-03.**

E-mail: MSC@uscg.mil
Phone: 202-795-6729
Website: http://www.dco.uscg.mil/msc

Applicability

This Plan Review Guideline (PRG) explains the requirements for seeking structural plan approval from the Marine Safety Center (MSC) for most vessel types. The MSC will review the required plans for compliance and issue a structural approval letter. All submittals must include calculations showing compliance with the selected structural rules or guides. This PRG is applicable to vessels constructed under the following 46 CFR Subchapters and international regulations:

Subchapters H and I (except Sub I deck barges – See PRG C1-09, "Review of General Arrangement, Structures and Structural Fire Protection Plans for Non-Tank Barges Inspected under 46 CFR Subchapter I"): All vessels must be built to the standards of the American Bureau of Shipping (ABS) in effect at the time of construction. When a vessel is of a design not contemplated by ABS, special consideration will be given to the design. The current standards of other recognized classification societies may also be used upon approval by Commandant (CG-ENG-2).

Subchapter K: In general, all vessels must be built to one of the structural design standards referenced in 46 CFR 116.300. However, the MSC may also accept a systematic analysis based on engineering principles as sufficient evidence that the vessel's structures provide adequate safety and strength.

Subchapter L: All vessels must be built to the standards of ABS in effect at the time of construction. The current standards of other recognized classification societies, or any other established current standard, may also be used upon approval by Commandant (CG-ENG-2).

Subchapter M: In general, all vessels must be built to the appropriate structural design standards referenced in Table 144.205(a). However, current standards of a recognized classification society, other than ABS, may be used provided they are accepted by the Coast Guard as providing an equivalent level of safety. Additionally, the MSC may also accept a systematic analysis based on engineering principles as sufficient evidence that the vessel's structures provide adequate safety and strength and shall be done in accordance with 46 CFR 136.115.

Subchapter R: Public nautical school ships must be built to the current ABS Rules for Building and Classing Steel Vessels or to the current Navy or Coast Guard Construction Specifications. Civilian nautical school ships must be built to the same structural requirements as similar sized passenger vessels. Sailing school vessels must be built to the structural design standards established by a recognized classification society.

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 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. Alternate design standards which have been accepted include:

- Lloyd's Register Special Service Craft
- DNV-GL High Speed and Light Craft

The MSC will evaluate calculations performed in accordance with NVIC 11-80 to demonstrate compliance with 46 CFR 177.300 or 46 CFR 177.340 on a case-by-case basis. In all cases the vessel must meet the applicability of NVIC 11-80.

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 Officer in Charge, Marine Inspection (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 cognizant OCMI under 46 CFR 177.315 in lieu of submitting structural plans and calculations.

Subchapter U: All vessels must be built to the ABS standards in effect at the time of construction. When a vessel is of a design not contemplated by ABS, special consideration will be given to the design. Wet weight handling gear must comply with 46 CFR 189.35-9(c)(1).

SOLAS: All vessels must be built to the standards of a recognized classification society in effect at the time of construction.

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 operating conditions in which the craft is permitted to operate.

Structural Standards

The following structural standards developed by ABS and Lloyd's Register are acceptable to applicable vessels per the requirements of 46 CFR:

ABS Rules for Building and Classing Steel Vessels
ABS Rules for Building and Classing Steel Vessels Under 90 Meters (295 Feet) in Length
ABS Guide for Building and Classing High-Speed Craft
ABS Rules for Building and Classing Steel Vessels for Service on Rivers and Intracoastal Waterways
ABS Rules for Building and Classing Steel Vessels Under 61 Meters (200 Feet) in Length
ABS Rules for Building and Classing Steel Vessels Under 61 Meters (200 Feet) in Length with the appropriate conversions from the 1975 ABS Rules for Building and Classing Aluminum Vessels (Applicable for Subchapter T vessels under 100 feet.)
ABS Rules for Building and Classing Aluminum Vessels
Lloyd's Register of Shipping Rules for the Classification of Yachts and Small Craft

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 will generally be approved without further review.

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 receives a copy of all structural plans and any approval letter(s) for the plans reviewed by the classification society. MSC may choose to review structural calculations as deemed necessary.

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:

The MSC will determine whether it is appropriate to accept the classification society's approval, or complete an independent review. If the classification society's approval is accepted, 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 NVIC 5-01 "Guidance for Enhancing the Operational Safety of Domestic High-Speed Vessels" and those constructed to the International Code of Safety for High-Speed Craft (HSC Code). These vessel's structures may be analyzed at a range of speeds and significant wave heights in order to define their permissible operating envelope.

Vessels evaluated using a high speed rules are examined assuming a maximum allowable draft and associated structural design limit (SDL) or maximum displacement for which the vessels has been evaluated and found to comply with the associated structural rule set. A vessels' approved SDL will be indicated in the vessels structural approval letter and correspondingly will be indicated in the relevant stability documentation.

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

- The minimum acceptable significant wave height for ABS structural calculations is 1.5 feet. Therefore, all calculations using the ABS HSC must

use significant wave heights of 1.5 feet or more for all speeds the vessel is intended to operate at. No calculations using a significant wave height less than 1.5 feet will be accepted.

- 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. Generally, and at a minimum, the ROS should be based on the following route specific minimum significant wave heights:

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

- 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 of 13 feet and above. The entry for seas in excess of the limiting significant wave height should specify "Seek Shelter at Slow Speed." This limits a vessel on protected waters to seas less than 3 feet.

- Deviations from the above route specific minimum significant wave heights will be considered on a case-by-case basis but must be based on definitions and standards in the applicable rule set (such as distance from harbor of safe refuge) and approved by the local OCMI.

Vessels built to the HSC Code are not defined by their route, but can apply any speed vs. wave height data to their structural calculations. These limitations will form one aspect of the operator's speed vs. 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).

Vessels being built to the Lloyd's Register 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 being built to the DNV-GL High Speed and Light Craft rules must use the appropriate route specific minimum significant wave height as shown above, as well as the Service Area Restriction designator appropriate for the vessel's intended service and operating area. In addition to other factors, the Service Area Restriction 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	R0 – R3
Partially Protected Waters	R4
Exposed Waters	R5 – R6

All speed vs. 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 vs. significant wave height data to the Marine Safety Center.

Aluminum Vessel Review note

In accordance with 46 CFR 177.300 (d)(ii), vessels less than 100 ft in length may use the ABS Rules for Building and Classing Steel Vessels under 61 meters (200ft) in length with the appropriate conversions from the ABS Rules for Building and Classing Aluminum Vessels. These conversion factors are the Q and Q_0 material factors described in section 2.19 of the Aluminum Vessel rules. This section

describes the manner in which to apply them to the scantling requirements in the steel vessel rules.

- The use of a particular material factor is based upon the structural member loaded by anticipated stresses.

    a. Q_0 is defined in 2.19.1 as the material factor based upon a structural member experiencing static or low frequency stresses.

    b. Q is defined in 2.19.2 as the material factor based upon a structural member subjected to dynamic loading.

- Use of the material factors should incorporate these steps:

    a. Determine which material factor is applicable from within the aluminum rules, either Q or Q_0.

    b. Compute structural strength requirements using steel vessel formula and multiplying by the aluminum material factor and an additional factor of .9, accounting for aluminum's resistance to corrosion.

    c. The resultant number is the required section modulus, or plate thickness, for the same structural member in an aluminum vessel.

Plans

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

- A detailed list of all submitted plans noting what action is desired (approval, information only, etc.). Each plan should include a title block including the vessel name or hull number, date, drawing number, revision number, revision date, etc. See below for list of required plans.
- A copy of the Application for Inspection of U.S. Vessel (CG-3752) submitted to the OCMI.
- A general description of the vessel and its functions such as: length overall, length between perpendiculars, breadth, depth, block coefficient, 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.

The following plans and information should be 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.
- ❑ Pillars and girders
- ❑ Scantling profile and decks
- ❑ Shell expansion †
- ❑ Superstructure and deckhouses
- ❑ Watertight and deep-tank bulkheads
- ❑ Miscellaneous non-tight bulkheads which are used as structural supports †
- ❑ Watertight doors and framing
- ❑ Windows and framing †
- ❑ Stairs, ladders, and handrails
- ❑ Helicopter deck structures
- ❑ Structural details of 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
- ❑ Modular quarters stacking structure
- ❑ Interior and exterior machinery and equipment foundations, including cranes†
- ❑ General material specifications
- ❑ General arrangement (for reference only)

† at the request of the OCMI

Calculations

The structural standard used to demonstrate compliance must be:

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

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

- ❑ Keels, stems, shaft struts, and tunnels

- Bottom shell plating and attached stiffeners
- 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
- Stair load calculations †
- Crane foundations and under-deck stiffening††
- Modular quarters stacking calculations
- Helicopter deck calculations
- 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)
- Fatigue analysis (hovercraft, ACV, SES, or any novel design using high strength aluminum alloys to achieve "flight or partial flight operations")
- 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

† not required for Subchapter T vessels
†† at the request of the OCMI

Survival Craft Launching Appliances

In accordance with 46 CFR 199.150(e), each launching appliance's structural attachment to the vessel must be designed, based on the ultimate strength of the construction material, to be at least 4.5 times the load imparted on the attachment by the launching appliance and its fully loaded survival craft under the most adverse combination of list and trim.

Structural Continuity

If longitudinally framed, 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 transversely framed, 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, 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 equal construction as the surrounding shell plate 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.

Materials

For all welded sections, the welded properties of the material shall be used.

Steel: ASTM A36 steel or other equivalent steel may be used in the construction of vessels only if the steel meets or exceeds the minimum material properties of the steel required by the rule set. In the event that a structural rule set does not specify the minimum material properties for the steel to be used, all steel must meet minimum material properties for ABS Grade A steel. High-strength steel should meet the construction requirements in the applicable ABS Rules.

Aluminum: All aluminum alloys used must have with the ability to resist intergranular and exfoliation forms of corrosion when in contact with seawater or when used in the marine environment. Aluminum alloys with magnesium content greater than or equal to 3% must be tested, inspected, and certified in accordance with ASTM B928 specification by the manufacturer.

Any aluminum alloy that is listed in the ABS Rules for Materials and Welding – Aluminum and Fiber Reinforced Plastics (FRP) Part 2, chapter 5, section 5, tables may be used in vessel construction. Marine grade aluminum certified by Lloyd's or DNV is also acceptable for use in vessels if the material properties meet or exceed the minimum properties required by the rule set.

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, who is responsible for implementing this guidance.