



## REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

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### **Purpose**

This Plan Review Guideline provides guidance and information to the marine industry regarding the submission of stability calculations and drawings for Small Passenger Vessels seeking certification under 46 CFR Subchapter T.

### **Contact Information**

If you have any questions or comments concerning this document, please contact the Marine Safety Center (MSC) by e-mail or phone. Please refer to Procedure Number H1-01.

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Procedure Number: H1-01

Revision Date: September 25, 2023

## Table of Contents

1. Applicability .....	4
2. References .....	4
3. Definitions .....	5
4. Simplified Stability Test Requirements .....	6
4.1 Test Types: .....	6
4.2 Test Applicability: .....	6
4.3 Collision Bulkhead and Simplified Subdivision: .....	7
4.4 Test Coordination and Stability Letter Issuance: .....	7
4.5 Additional Information: .....	8
5. Submittal Checklist .....	8
6. Lightship Characteristics .....	9
6.1 Determination: .....	9
6.2 Stability Test - Deadweight Survey or Inclining Experiment: .....	9
7. Hull Model .....	9
8. Loading Conditions and Passengers Guidance .....	10
8.1 General: .....	10
8.2 Passengers and Crew: .....	10
8.3 Tanks: .....	12
8.4 Ballast (Fixed and Water): .....	12
8.5 Deck Cargo and Vehicles: .....	13
8.6 Other Loads: .....	13
9. Routes .....	14
10. Intact Stability .....	14
10.1 General Guidance: .....	14
10.2 Requirements: .....	14
10.3 Well Deck Vessels: .....	18
10.4 Cockpit Vessels: .....	18
10.5 Open Boats: .....	19
10.6 Rigid Hull Inflatable (RHI) Vessels: .....	20
11. Collision Bulkhead .....	20
11.1 Collision bulkhead required: .....	20
11.2 Location: .....	20
11.3 Structural Requirements: .....	20
12. Subdivision: 46 CFR 171.070 .....	21
12.1 Applicability: .....	21
12.2 Standard of Flooding: .....	21
12.3 Extents of flooding .....	21

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

12.4 Margin Line:.....	22
12.5 Tank Contents (Run-Off) and Permeability:.....	23
12.6 Watertight Doors: .....	23
12.7 Foam Flotation:.....	23
13. Damage Stability: 46 CFR 171.080.....	23
13.1 Applicability: .....	24
13.2 Criteria:.....	24
13.3 Extents of Flooding: .....	24
13.4 Tank Contents (Run-Off) and Permeability:.....	25
13.5 Watertight Doors: .....	25
13.6 Guidance for Application of Heeling Moment of 46 CFR 171.080(f)(4):.....	25
13.7 Foam Flotation:.....	26
14. Special Consideration .....	26
15. Disclaimer.....	26
16. Enclosures.....	26

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **1. Applicability**

This Plan Review Guideline (PRG) is applicable to stability calculations and drawings reviewed by the Marine Safety Center (MSC) for vessels certificated under 46 CFR Subchapter T.

If the vessel's stability is being reviewed by the American Bureau of Shipping (ABS) in accordance with reference (1), then MSC review of stability is not required.

## **2. References**

1. NVIC No. 3-97, "Stability Related Review Performed by the American Bureau of Shipping for U.S. Flag Vessels"
2. NVIC 7-91, "Determination of Cold Water Areas"
3. USCG Policy File Memorandum (PFM) 10-85, "Watertight and Weathertight Closure Devices"
4. MSC Plan Review Guideline (PRG) H1-17, "MSC Guidelines for Review of Stability of Sailing School Vessels"
5. Marine Safety Manual (MSM), Vol IV
6. Navigation and Inspection Circular (NVIC) No. 14-81, "Stability Tests; Waiving of for 'Sister Vessels'"
7. NVIC No. 17-91, "Guidelines for Conducting Stability Tests"
8. ASTM F1321, "Standard Guide for Conducting a Stability Test (Lightweight Survey and Inclining Experiment) to Determine the Light Ship Displacement and Centers of Gravity of a Vessel"
9. Marine Safety Center Technical Note (MTN) 04-95, "Lightship Change Determination; Weight-Moment Calculation vs. Deadweight Survey vs Full Stability Test"
10. MSC Plan Review Guideline (PRG) GEN-05, "Guidelines for Submission of Stability Test Procedures"
11. NVIC No. 3-89, "Guidelines for the Presentation of Stability Information to Operating Personnel"
12. Federal Register, Vol. 59, No. 9, page 2011, "Proposed Rules," dated January 13, 1994
13. USCG Naval Architecture Division (CG-5212) Memorandum, "Intact Stability Freeboard and Downflooding Angle Determination," dated September 5, 2008
14. Federal Register, Vol. 54, No.18, page 4422 "Notice of Proposed Rule Making, Section 170.170," dated January 30, 1989
15. Marine Safety Center Technical Note (MTN) 01-01, "Towline Pull Criteria for Vessels Equipped with Azimuth Thrusters (Z Drives)"
16. Marine Safety Center Technical Note (MTN) 1-08, "Marine Safety Center Review of Rigid Hull Inflatable Vessels"
17. USCG Policy File Memorandum (PFM) 2-89, "Location of Watertight Bulkheads on Passenger Vessels"

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **3. Definitions**

### **Catamaran Vessel**

A vessel with two parallel hulls that are connected with a buoyant cross structure.

### **Cold Water**

Water where the monthly mean low water temperature is normally 15 degrees Celsius (59 degrees Fahrenheit) or less. For specific geographic designation of cold waters by month, see reference (2).

### **Downflooding**

The entry of seawater through any opening into the hull or superstructure of a vessel (or portion of a vessel) due to heel, trim, or submergence of the vessel.

### **Downflooding Point**

Any opening in the hull or superstructure of the vessel that cannot be closed watertight and through which downflooding can occur. Common downflooding points include windows, compartment vents, and non-tight deck hatches.

For intact stability calculations, a weathertight opening may be excluded from being considered a downflooding point if it will remain closed while the vessel is underway. See reference (3) for further information. For monohull sailing vessel intact stability calculations, openings that cannot be rapidly closed watertight are considered downflooding points.

For damage stability calculations, openings that are fitted with weathertight closures and that are not submerged during any stage of flooding will not be considered downflooding points.

### **Non-Return Devices on Freeing Ports**

Non-return devices on freeing ports must be weathertight to boarding seas and allow for unimpeded drainage of water on deck. Devices must be rigid, acceptable for use in the marine environment and maintain their sealing ability. The verification of installed weathertight non-return devices shall be to the satisfaction of the Officer in Charge, Marine Inspection (OCMI).

### **Pontoon Vessel**

A vessel with two or more parallel watertight hulls which are structurally independent from the vessel's deck or cross structure.

### **Weathertight**

Water will not penetrate into the vessel in any sea condition. This also means being able to resist boarding seas. As addressed in reference (3), unless deadlight covers are installed, windows are not accepted as weathertight closures and must be considered as potential downflooding points. Ball check valves used in tank vents are generally accepted as weathertight closures.

### **Watertight**

Capable of preventing the passage of water through the structure in any direction under a head of water for which the surrounding structure was designed.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **4. Simplified Stability Test Requirements**

### **4.1 Test Types:**

As an alternative to meeting the requirements in 46 CFR Subchapter S, the cognizant Officer in Charge, Marine Inspection (OCMI) may approve one of the following tests, dependent on vessel type and operations:

1. Simplified stability proof test (SST) (46 CFR 178.330).
2. Pontoon simplified stability proof test (PSST) (46 CFR 178.340).
3. Operational test for monohull sailing vessels (46 CFR 178.325(c)) (as applicable).

### **4.2 Test Applicability:**

To be eligible for an SST, the vessel must satisfy the following criteria, as listed in 46 CFR 178.310(c)(1) - (4), 46 CFR 178.320(a) - (b), and 46 CFR 178.325(a)(1) – (8). If the vessel does not meet these requirements, it must comply with Subchapter S stability calculations (see Sections 6 through 13 of this document for further guidance).

1. All vessels (Monohulls, Catamarans, and Pontoon Vessels):
  - a. Less than 65 feet in length;
  - b. Does not have more than one deck above the bulkhead deck, or if without a bulkhead deck, does not have more than one deck above the deck from which freeboard is measured, excluding a pilot house;
  - c. It has a “usual” rig and hull form;
  - d. Its stability has not been questioned by the OCMI;
  - e. It is not a subchapter (R) sailing school vessel. See reference (4) for guidance on sailing school vessels.
  - f. Does not have an amidships tumblehome at the deck that exceeds 2 percent of the beam.
  - g. If operated on international voyages, does not carry more than 12 passengers.
2. For Power Monohull vessels:
  - a. Maximum of 150 passengers;
  - b. If the vessel carries more than 49 passengers, vessel must satisfy the simplified subdivision requirements of 46 CFR 179.220 – see additional details in section 4.3;
3. For Sailing Monohull or Auxiliary Sailing Monohull vessels:
  - a. Maximum of 49 passengers;
  - b. Only sailed (operated with sails set) during daylight hours; however, the vessel may be operated at night with the motor on and sails furled;
  - c. Not operated on exposed waters;
  - d. Minimum downflooding angle of 60 degrees;
  - e. If constructed with a cockpit, then the maximum cockpit length is 20 percent of the Length Over Deck;
  - f. If constructed with a cockpit and operating on Partially Protected Waters, the cockpit must be self-bailing.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

4. For Catamaran vessels:
  - a. Must be non-sailing, flush deck, and propelled by mechanical means only;
  - b. Maximum of 49 passengers;
  - c. Maximum of 12 passengers on an international voyage.
  
5. For Pontoon Vessels:
  - a. Operates on protected waters only;
  - b. Limited to two symmetrical hulls only;
  - c. Does not carry more than 49 passengers;
  - d. Does not make international voyages;
  - e. The cross section of each hull is circular or of wall-sided construction without tumblehome, and constant for at least 80 percent of the length of the hull;
  - f. The distance between the centerlines of the hulls is not less than 6 feet;
  - g. Each hull has a beam or diameter that is not less than 2 feet;
  - h. The hulls contain no machinery or tanks;
  - i. The deck accessible to passengers does not extend beyond:
    - i. The outboard edge of the hulls, and
    - ii. The forward or aft end of the hulls;
  - j. The top of the deck is not more than 6 inches above the top of the buoyant hulls.

## 4.3 Collision Bulkhead and Simplified Subdivision:

1. Collision Bulkheads - see section 11 of this document.
  
2. Simplified Subdivision
  - a. Monohull vessels that undergo a simplified stability proof test in accordance with 46 CFR 178.330 and meet the subdivision and damage stability applicability in 46 CFR 179.212(a) must comply with the simplified subdivision requirements of 46 CFR 179.220 per 46 CFR 179.212(c).
  - b. Simplified subdivision calculations are not applicable for vessels demonstrating compliance with subdivision and damage stability requirements of Subchapter S.
  - c. Open boats are not compatible with subdivision requirements as they do not have a watertight bulkhead deck, and therefore are limited to a maximum passenger count of 49 passengers.

## 4.4 Test Coordination and Stability Letter Issuance:

1. For monohull and catamaran simplified stability tests (SST):
  - a. The test is coordinated with and witnessed by the local OCMI.
  - b. The OCMI issues the stability letter for the vessel.
  
2. For pontoon simplified stability proof tests (PSST)
  - a. The test is coordinated with the local OCMI and witnessed by MSC.
  - b. MSC issues the stability letter.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## 4.5 Additional Information:

If a vessel meets the applicability for a simplified stability test and that test is conducted, only the guidance in Sections 1 (Applicability), 2 (References), 3 (Definitions), 4 (Simplified Stability Test Requirements), 8 (Passenger/Crew Weight Guidance), 11 (Collision Bulkhead), 14 (Special Consideration), and 15 (Disclaimer) of this document apply.

## 5. Submittal Checklist

In general, the following items should be included in a stability submission:

Item	Description	✓
1.	Letter of intent identifying what is included in the submittal and requested actions to be taken by MSC.	
2.	Copy of Application for Inspection	
3.	Description of the vessel operating envelope, including but not limited to: a. Route designation and classification b. Number of passengers c. Total persons carried d. Operating limits and/or restrictions (such as maximum draft, trim, wave height, speed, geographical boundaries) e. All plausible loading conditions for each particular vessel operation	
4.	Lines plan of the hull to at least the bulkhead deck. Also include the superstructure if it is considered buoyant. See section 6.B.1.a of reference (5) for guidance on the possible inclusion of deckhouses and superstructure in buoyant volume.	
5.	Computerized hull model (recommended, but not required)	
6.	Hydrostatics or curves of form and righting arm curves (or tables)	
7.	Tank Capacity Tables including liquid volume or weight, center of gravity location, and free surface moment for relevant tank filling levels	
8.	General Arrangements (at least plan and profile) showing: a. Outboard Profile b. Compartmentation (including collision and watertight bulkheads) c. Location and extent of bulkhead deck d. Watertight and weathertight doors, hatches, scuttles, and like closures e. Freeing ports and/or scuppers sizes and locations f. Downflooding points g. Locations and reference points of any draft or loading marks. See 46 CFR 185.602(b) and (c), and section 6.B.6 of reference (5).	
9.	Fixed ballast plan, or written ballast description for simple configurations (if applicable)	
10.	Approved lightship values or stability test lightship calculations	
11.	Intact stability calculations	
12.	Collision bulkhead calculations (if applicable)	
13.	Subdivision and damage stability calculations (if applicable)	
14.	Foam flotation plan and material information (if applicable)	
15.	Sail plans for sailing and auxiliary sailing vessels	



# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **6. Lightship Characteristics**

### **6.1 Determination:**

Lightship characteristics are to be determined using one of the following methods:

1. Sister to a vessel with known characteristics. See section 6.D.2. of reference (5) and reference (6) for additional detail.
2. Deadweight survey combined with an indisputably conservative assumed vertical center of gravity (VCG). See references (7) and (8) for additional detail.
3. Inclining experiment (full stability test). See references (7) and (8) for additional details.
4. For a vessel that has already been certificated, all weight changes must be tracked in accordance with reference (9).

### **6.2 Stability Test - Deadweight Survey or Inclining Experiment:**

1. In accordance with 46 CFR 170.085, a written stability test procedure must be submitted to MSC for review at least two weeks before the stability test. In all cases, the procedure must be approved by MSC prior to conducting the test or survey.
2. In accordance with 46 CFR 170.175(b), vessel owners and /or representatives shall make arrangements with the OCMI for a Coast Guard representative to witness the stability test.
3. References (8) and (10) provide guidance on the required elements for the stability test procedure.
4. If completing a deadweight survey, an indisputably conservative assumed lightship VCG should be submitted with the procedure.
5. The deadweight survey or inclining experiment results should be submitted in accordance with reference (10). Ensure that any transverse center of gravity (TCG) and associated heel / list is included in the lightship characteristics and associated loading conditions.

## **7. Hull Model**

If an electronic model is available, it is strongly recommended that this be included in the submission.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **8. Loading Conditions and Passengers Guidance**

### **8.1 General:**

1. Loading instructions must be simple and clear.
2. Loading conditions should cover the entire plausible range of operations. This generally includes, but is not limited to, the following conditions:
  - a. Full Load Departure with 100% consumables
  - b. Full Load with 50% consumables
  - c. Full Load Arrival (Burned Out) with 10% consumables
  - d. Minimum Operating Condition – Full crew onboard with 10% consumables, seven passengers, and no cargo.
3. Trim and Stability (T&S) Booklets
  - a. Trim and stability (T&S) booklets are generally not suitable for T-boats because the required level of professional competence associated with a 100-ton masters license does not adequately ensure the understanding or knowledge of variable liquid loading.
  - b. In accordance with 46 CFR 178.220, please contact MSC prior to the submission of stability calculations for a Subchapter T vessel that necessitates the use of a Trim and Stability Book.
  - c. If MSC permits the usage of a T&S Booklet, per the guidance of Section 6.C.4 of reference (5) and reference (11), the following additional items apply:
    - i. Vessel owner(s) must consult with their cognizant OCMI to determine the appropriate crew qualifications and manning levels for the intended operations. Any specific training and detailed operating manuals, as required to ensure safe operations, shall be to the satisfaction of the OCMI.
    - ii. The vessel owner must provide a letter to MSC "confirming that the owner will operate the vessel with personnel capable of using the detailed calculation section when the loading so requires."
    - iii. The general operating instructions section of the T&S booklet must state that the vessel is to be operated with personnel capable of utilizing the calculations within the T&S booklet.

### **8.2 Passengers and Crew:**

1. Assumed average weight per person (AAWPP)

The AAWPP of passengers and crew shall be, at a minimum, that computed in accordance with 46 CFR 170.090(d)(1). As of the publication date of this document, the current AAWPP of passengers and crew is at least 185 pounds per person.
2. VCG of persons
  - a. For vessels built, first certificated, or having undergone a major conversion on or after March 14, 2011, all passengers must be assumed to be standing with a VCG of at least 39 inches (1 meter) above the deck to which they are allowed access.
  - b. For vessels built prior to March 14, 2011, and have not undergone a major conversion since that date, all passengers must be assumed to be standing with a VCG of at least 36 inches above the deck to which they are allowed access.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

- c. In rare occasions, and if agreed upon by MSC and the OCMI, a passenger VCG of 30 inches above the deck (or 12 inches above the seat) may be permissible if passengers will remain seated at all times while underway. If agreed by MSC and the OCMI, this restriction shall be included on the vessel's COI.
3. Vertical distribution of passengers and crew on multideck vessels
    - a. Crew should be located at their normal operating stations, but at least at the main deck level.
    - b. Assuming all passengers are on the uppermost deck will allow for no restrictions on the number passengers permitted on the upper deck in the stability letter.
    - c. If passengers are assumed to be distributed on several decks, calculations should also include load cases with the maximum allowed passengers on the upper deck(s) and no passengers on the lower deck(s), as this may produce a more unfavorable stability condition.
    - d. Calculations shall assume passengers and crew are at the main deck level or higher as would be the case during an emergency situation.
  4. Transverse and longitudinal distribution of passengers and crew

The passengers and crew distribution shall reflect the arrangements of the vessel. For a symmetrical vessel, the passengers should be on centerline. However, for an asymmetric arrangement (such as on some ferry vessels), it would be prudent to assume a transverse position for the passengers associated with their occupation of the passenger compartment of the house. Passengers and crew cannot be used to compensate for the vessel's natural heel, trim, or variations in liquid loading.
  5. Total persons permitted onboard
    - a. Maximum number of passengers

The maximum passenger count for Small Passenger Vessels (Subchapter T) is 150, or 49 for overnight operations. For greater passenger counts, please direct submissions and inquiries to the MSC's Major Vessel Branch (H-2).
    - b. Number of crew

There is no limit on the maximum number of crew (as defined in the "Passenger" definition of 46 CFR 175.400). The minimum number of crew shall be to the satisfaction of the OCMI.
    - c. Persons limit per deck

46 CFR 176.113 is not intended to be used to determine the number of passengers permitted on a particular deck (as per the regulatory intent discussed in reference (12)). Instead, the limitation on passengers per deck is to be determined by stability calculations (such as the vertical distribution of passengers) and OCMI authority, such as for egress.
    - d. Low passenger counts (below the maximum permissible passengers)

For light vessels, sailing catamarans (which may be sail area restricted at lighter displacements), and RHIs (which may not submerge the collars at light loads), the submission should include consideration of a passenger count of seven.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## 8.3 Tanks:

### 1. Consumable Tank Loadings

Consumable tank loadings should generally be in accordance with the following table. On vessels that are not as sensitive to consumable loadings, it may be permissible to omit mid voyage conditions.

Tank Contents	Departure Condition	Mid Voyage Condition	Arrival Condition
Ship's Fuel	95% or greater	50%	10% or less
Potable Water	95% or greater	50%	10% or less
Sewage	10% or less	50%	95% or more
Ship's Lube Oil Storage Tanks	95% or greater	50%	10% or less
Ship's Waste Oil Storage Tanks	10% or less	50%	95% or more
Sump Tanks, pipes, filters, separators, etc.	Normal operating level	Normal operating level	Normal operating level

### 2. Free Surface

The free surface correction shall be in accordance with 46 CFR 170.285 for intact stability and 46 CFR 170.290 for damage stability. Depending on the tank configuration and desired operations, there are two options for applying the free surface:

#### a. Maximum Operator Flexibility

For maximum flexibility of loading and consumption of tanks, the stability calculations must assume a maximum free surface for all consumable tanks (ship's fuel, potable water, sewage, service oil, etc.) in all loading conditions.

#### b. Tank Burn Sequencing

If tank configurations and operations permit, the calculations may assume the maximum free surface of at least one transverse pair of tanks or a single centerline tank for each type of consumable and in all loading conditions. This assumption should be clearly indicated in the submission, and will be accompanied by the following restriction in the stability letter:

*No more than one centerline or port and starboard tank pair of each consumable may be partially filled (slack) at any one time.*

## 8.4 Ballast (Fixed and Water):

### 1. General

Per the discussion in section 6.E.9.h. of reference (5), any ballast necessary for stability compliance should be fixed, included in the lightship, and described in the stability letter. However, with appropriate restrictions, water ballast is permissible.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## 2. Fixed Ballast

In general, a drawing should be included in the submission that describes the type (concrete, steel, lead, etc.), weight, and location of fixed ballast. However, for very simple ballast configurations, a description of the type, weight, and location of the ballast is sufficient. Solid ballast shall be secured in accordance with 46 CFR 178.510.

## 3. Water Ballast (Freshwater or Saltwater)

In accordance with 46 CFR 178.510(d), water ballast, either as an active system or permanent, must be approved by MSC. Please contact the MSC Small Vessel Branch for additional guidance. Liquid ballast using other fluids (fuel, oil, drilling fluids, etc.) is prohibited.

## 8.5 Deck Cargo and Vehicles:

### 1. Profile Area

- a. For the purposes of stability compliance, the windage profile area of the vessel must include any deck cargo and/or vehicles. The profile for deck cargo / vehicles should generally be rectangular, with small undulations or gaps in the profile blocked off.
- b. In the absence of detailed information, the following cargo heights may be assumed:
  - i. Standard container height: 8 feet 6 inches above the twist lock base
  - ii. High-cube container height: 9 feet 6 inches above the twist lock base
  - iii. Standard 55 gallon steel barrel height: 2 feet 9.5 inches
  - iv. For cars and light trucks: A height of 7 feet above the main deck may be assumed. This corresponds to the height of a standard garage door.
  - v. For trucks: A height of 13 feet 6 inches may be assumed. This corresponds to the maximum legal height of vehicles for most states.
- c. If gunwales are taller than deck cargo, the profile area shall extend to the gunwale tops

### 2. VCG

The VCG of the deck cargo (above the deck upon which it is placed) should generally be half of the profile height.

### 3. Weight

- a. Deck cargo that is required to be onboard for stability compliance is not allowed.
- b. Vehicle weight should be appropriate for the intended service and should be agreed upon by the OCMI. In the absence of detailed information, the following may be assumed:
  - i. Cars and light trucks should be assumed to weigh at least 5,000 pounds each.
  - ii. Trucks / tractor trailer weights should be assumed to weigh 80,000 pounds each.

### 4. Structure

The deck structure shall be sufficient to support the anticipated cargo loading.

## 8.6 Other Loads:

### 1. Dive Gear

Consistent with 46 CFR 178.330(a)(4)(v), dive gear should be assumed to weigh at least 80 pounds for each person who will be diving (typically all passengers and at least one crew member).

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## 2. Luggage, personal effects, and provisions

As appropriate for the vessel type and operations, loading should include luggage, personal effects, bicycles, stores, and any other provisions. In particular, vessels with overnight accommodations must include personal effects and provisions.

If the luggage is placed low in the vessel (i.e. in a hold) with a low VCG, calculations should include load cases without luggage onboard as these may be most limiting.

## 3. Fishing gear and bait

For head boats / party boats, allowances for poles, bait, ice, and fish should be included in the submission.

## **9. Routes**

The route for stability (protected, partially protected, or exposed) is determined by the OCMI.

General route definitions are in 46 CFR 175.400, but the OCMI may specify more restrictive routes depending on local policy. Please coordinate with the OCMI to ensure the route assumed for the stability analysis is correct for the vessel's operations.

## **10. Intact Stability**

### **10.1 General Guidance:**

1. If the vessel is not eligible for a simplified stability test or pontoon simplified stability test, then the vessel must comply with the intact stability requirements of 46 CFR Subchapter S.
2. In accordance with 46 CFR 178.310(a) and (b), calculations shall be submitted for each condition of loading and operation.
3. All calculations computing the righting arm shall be with the vessel free to trim.
4. As written, the CFR criteria are applicable to flush deck vessels of usual proportion and form. See reference (13) and sections 10.3 through 10.6 below for guidance on other vessel configurations.

### **10.2 Requirements:**

Vessels must meet the following criteria (as applicable):

1. Weather Criteria: 46 CFR 170.170:
  - a. Applicable to all vessels.
  - b. Auxiliary sailing vessels may be assumed to be under bare poles. If a sailing vessel has no auxiliary propulsion, it is to have storm sails set and trimmed flat and may use an angle T of 14 degrees or the angle of heel to the deck edge.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

- c. The projected lateral area consists of the portion of the vessel and deck cargo above the waterline. Per the regulatory intent discussed in reference (14), the portion of the vessel above the waterline must have areas under railings, awnings, and canopies block off.
2. Righting Energy Criteria: 46 CFR 170.173:
    - a. Applicable to all mechanically powered vessels under 328 feet (100 meters) in length.
    - b. The applicable criteria, based on the intended route, are as follows:
      - i. Exposed Route: 46 CFR 170.173(b) or (c);
      - ii. Partially Protected Route: 46 CFR 170.173(e)(1);
      - iii. Protected Route: 46 CFR 170.173(e)(2).
    - c. These calculations shall reflect the submergence of any potential downflooding points. When considering the intact stability requirements, the following guidance for downflooding points applies:
      - i. Vent openings (machinery vents and other vents) shall not be below the bulkhead deck, and in general are considered downflooding points.
      - ii. Weathertight openings are not considered to be downflooding points if they remain closed when the vessel is underway.
      - iii. Windows above the margin line shall be considered downflooding points unless fitted with internal deadlight covers that are:
        - (1) equivalent in strength to the adjacent plating; and
        - (2) installed if rough conditions are anticipated.
      - iv. Ball check valves in tank vent lines are generally accepted as weathertight closures.
- Note:** Some catamaran vessels with an angle of maximum righting arm less than 15 degrees may possess sufficient stability characteristics and may request an equivalent level of safety to 46 CFR 170.173(c)(2). Contact MSC for additional guidance on requesting and demonstrating an equivalent level of safety.
3. Passenger Heel Criteria: 46 CFR 171.050:
    - a. Applicable to all vessels.
  4. Passenger Heel Criteria for Pontoon Vessels: 46 CFR 171.052
    - a. Applicable to pontoon vessels only.
    - b. Passenger crowding guidance
      - i. General

As the 2 square feet/person and 5 square feet/person criteria have differing energy standards, submitted calculations must assess both. Per 171.052(b), passengers are to be crowded in the most unfavorable combination of heel and trim. In practice, this generally includes the following crowding conditions:

        - (1) Bow
        - (2) Bow Quarter
        - (3) Side
        - (4) Stern Quarter
        - (5) Stern

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## ii. Detailed Crowding Guidance

In addition to the following, please refer to Enclosures (1) and (2).

- (1) Arrangements that impact passenger crowding, including fixed seating, fixed tables, helm, passenger restricted areas, etc., may be considered as based on arrangement drawings.
- (2) Crowding may be assessed using rectangles representing each person, or larger areas with the passenger weight centered at the centroid of the area.
- (3) Passenger Restricted Areas
  - (a) To achieve stability compliance, certain areas may be designated as passenger restricted areas (for example, the areas adjacent to and aft of the helm station, or an embarkation zone at the bow beyond the railing).
  - (b) These areas must be identified on an arrangement plan, and be clearly restricted with deck markings, chain, or similar on the vessel. This shall be accomplished to the satisfaction of the OCMI.
  - (c) Some vessels (i.e. dive boats) will require restricted areas to be occasionally accessed (i.e. dive ladder use). These areas must be subjected to passenger crowding for the total amount of persons allowed in the restricted area. Associated limitations (i.e. no more than X people are permitted on the stern swim platform at any time) shall be detailed in the submission.
- (4) Narrow Regions

Crowding is not required for regions where the distance between fixed items (i.e. a bulkhead and a rail, seatback and table, etc.) is less than 12". For 2 square feet and 5 square feet per person crowding, no single person need occupy an area smaller than 12" x 24" or 12" x 60", respectively. This means that, as an example for 2 square feet crowding, a person cannot occupy a space of 6" x 48".
- (5) Benches
  - (a) One seated person is spaced for every 18 inches of bench seating.
  - (b) Transverse seating
    - (i) If seats are in series (i.e. bus style) and have toe / kick space under the seat, assume 12 inches of legroom in front of the edge of the seat. Crowding in front of seats is not required unless there is more than 12 inches between the front edge of one seat and the back of the next seat.
    - (ii) For seats without toe / kick space ("box" seats that rest on the deck), crowding in front of the seats is not required unless there is more than 16 inches between the front edge of one seat and the back of the next seat.
    - (iii) If the seats are stand alone or facing each other, legroom is not permitted (crowding must be applied from the edge of the seat).
  - (c) Longitudinal seating

Legroom is not permitted (crowding must be applied from the seat edge).

## 5. Monohull Sailing Vessels Criteria: 46 CFR 171.055

- a. Applicable to vessels equipped with sails as a means for primary or auxiliary propulsion.
- b. Sail area

A is the projected lateral area of the portion of the vessel above the waterline computed with all sails set and trimmed flat. Sail overlap areas need not be included except parachute type spinnakers which are to be added regardless of overlap.



# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

- c. Range of stability:  
The vessel must have positive righting arms from 0 degrees to at least 90 degrees (Exposed Waters) or 70 degrees (Protected Waters or Partially Protected Waters)
  - d. Downflooding  
For the purposes of 171.055, the downflooding angle means the static angle from the intersection of the vessel's centerline and waterline in calm water to the first opening that cannot be rapidly closed watertight.
6. Catamaran Sailing Vessels Criteria: 46 CFR 171.057
    - a. Applicable to multihull vessels equipped with sails as a means for primary or auxiliary propulsion.
    - b. Sail area  
As is the total sail area, without reductions for overlapping sails.
    - c. Displacement  
The criterion is generally limiting at lighter displacements (W). Therefore, the analysis should consider an arrival condition with seven passengers and full crew.
    - d. Center of Effort  
The height of the center of effort of the sails,  $H_s$ , is relative to the deck, not the waterline or the underwater lateral area centroid.
  7. Towline Pull Criteria: 46 CFR 173.095
    - a. Applicable to vessels equipped to tow.
    - b. Downflooding  
For the purpose of the towline criteria, downflooding angle means the static angle from the intersection of the vessel's centerline in calm water to the first opening that does not close watertight automatically.
    - c. Propulsion  
The criteria apply to vessels with propellers and rudders. For vessels with Azimuthing (Z-drive) or Voith-Schneider propulsion, see reference (15) and section 6.E.2 of reference (5).
  8. Lifting Criteria: 46 CFR Part 173, Subpart B  
Applicable to vessels equipped for lifting (i.e. the vessel is equipped with a crane, davit, or A-frame).
  9. Weather Deck Drainage: 46 CFR 178, Subpart D
    - a. Applicable to all vessels.
    - b. The majority of pontoon vessels are considered flush deck vessels. However, if gunwales exist which completely enclose the deck and obstruct overboard drainage, the vessel is considered a well-deck vessel requiring draining reviewed under 46 CFR 178.430.
  10. Watertight Integrity: 46 CFR 179, Subpart C:
    - a. Applicable to all vessels.
    - b. Vessel bulkheads and penetrations, as applicable, shall comply with 46 CFR 179.310 through 179.360.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## 10.3 Well Deck Vessels:

Well deck vessels, as defined in 46 CFR 175.400, have a deck fitted with solid gunwales that impede the drainage of water over the side or have an exposed recess in the weather deck extending more than one-half of the length of the vessel measured over the weather deck.

1. Modified Weather Criteria: 46 CFR 170.170:
  - a. Angle of T is to be generally the lesser of 14 degrees or half the freeboard to the weather deck (not the top of the gunwale), except as noted in the following section;
  - b. For vessels that are fitted with non-return scuppers or non-return freeing ports, and operate on protected waters only, the angle of T is to be the lesser of 14 degrees, the full freeboard to the weather deck, or one-quarter of the distance from the waterline to the gunwale (measured when the vessel is in equilibrium).
2. Modified Righting Energy Criteria: 46 CFR 170.173:
  - a. For vessels fitted with scuppers and/or freeing ports without non-return drains, and operated on exposed or partially protected waters, the downflooding angle is at a compartment vent, or other opening into the hull or superstructure, located above the well deck;
  - b. For vessels that operate on protected waters and are fitted with non-return scuppers or non-return freeing ports, the downflooding angle is generally the first angle at which the gunwale is submerged;
  - c. In accordance with 46 CFR 170.173(d), calculations shall utilize a free to trim assumption. Therefore, the downflooding point along the gunwale for any loading condition may shift longitudinally.
3. Modified Passenger Heel Criteria: 46 CFR 171.050:
  - a. Angle of T is to be the lesser of 14 degrees or the freeboard to the weather deck (not the top of the gunwale);
  - b. For vessels that operate on protected waters and are fitted with non-return scuppers or non-return freeing ports, the angle of T is to be the lesser of 14 degrees or one-half of the distance from the waterline to the gunwale (measured when the vessel is in equilibrium).
4. Clarifications for Weather Deck Drainage: 46 CFR 178 Subpart D:
  - a. The required drainage may be achieved with freeing ports and/or scuppers;
  - b. If the well deck is located less than 10 inches above the waterline, the vessel is restricted to protected waters unless the vessel complies with the Subdivision and Damage Stability requirements outlined in Sections 12.0 and 13.0.

## 10.4 Cockpit Vessels:

Cockpit vessels, as defined in 46 CFR 175.400, have an exposed recess in the weather deck that extends not more than one-half of the length of the vessel measured over the weather deck. Per MSC policy discussed in reference (13), the following additional calculations apply:

1. Modified Weather Criteria: 46 CFR 170.170:
  - a. For vessels with non-return scuppers or non-return freeing ports, the angle of T is to be the lesser of 14 degrees or the angle measured to the immersion freeboard “i” as defined

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

- in 46 CFR 178.330(d)(3); note that the freeboard “f” in this equation is to be measured to the top of the gunwale at the location of least freeboard;
- b. For vessels without non-return devices, the angle of T is to be the lesser of 14 degrees or half the freeboard to the cockpit deck.
2. Modified Righting Energy Criteria: 46 CFR 170.173:
    - a. For vessels fitted with scuppers and /or freeing ports, and do not have non-return drains, the downflooding angle is at a compartment vent, or other opening into the hull or superstructure, located above the cockpit deck;
    - b. For vessels that are fitted with non-return scuppers or non-return freeing ports, the downflooding angle is generally the first angle at which the gunwale is submerged;
    - c. Per 46 CFR 170.173(d), calculations shall utilize a free to trim assumption. Therefore, the downflooding point may shift longitudinally along the gunwale.
  3. Modified Passenger Heel Criteria: 46 CFR 171.050:
    - a. For vessels with non-return scuppers or non-return freeing ports, the angle of T is to be the lesser of 14 degrees or double the angle measured to the immersion freeboard “i” per 46 CFR 178.330(d)(3). Note that the freeboard “f” in this equation is to be measured to the top of the gunwale;
    - b. For vessels without non-return devices, the angle of T is to be the lesser of 14 degrees or the angle at which the cockpit deck edge is first submerged (not the top of the gunwale).
  4. Clarifications for Weather Deck Drainage: 46 CFR 178 Subpart D
    - a. If the cockpit deck is located less than 10 inches above the waterline, the following provisions apply:
      - i. Non-return devices must be fitted to the deck drains;
      - ii. The vessel is restricted to protected waters unless the vessel complies with the Subdivision and Damage Stability requirements outlined in Section 12.0 and 13.0.

## 10.5 Open Boats:

Open Boats, as defined in 46 CFR 175.400, are vessels not protected from water entry by means of a complete watertight deck, or by a combination of a partial watertight deck and superstructure. Per MSC policy discussed in reference (13), the following calculations apply:

1. Clarifications for Energy Criteria: 46 CFR 170.173:

The righting arm curve should generally truncate at the angle of gunwale immersion, representing the angle of vanishing stability.
2. Modified Weather Criteria: 46 CFR 170.170:
  - a. The angle of T is to be the lesser of 14 degrees or the angle measured to one-quarter of the freeboard. The freeboard is measured to the gunwale.
  - b. In accordance with 46 CFR 170.170(d), calculations shall utilize a free to trim assumption. Therefore, the downflooding point along the gunwale for any loading condition may shift longitudinally.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

3. Modified Passenger Heel Criteria: 46 CFR 171.050:  
The angle of T is to be the lesser of 14 degrees or the angle measured to one-half of the freeboard. The freeboard is measured to the gunwale.
4. Clarifications for Weather Deck Drainage: 46 CFR 178 Subpart D:
  - a. These regulations are not applicable to open boats, however a system for dewatering is required and is to be to the satisfaction of the OCMI;
  - b. Decks must drain to the bilge.

## **10.6 Rigid Hull Inflatable (RHI) Vessels:**

For RHI vessels, please see the guidance of MTN 01-08, reference (16).

## **11. Collision Bulkhead**

### **11.1 Collision bulkhead required:**

In accordance with 179.210, a collision bulkhead is required if any of the below apply:

1. Carries more than 49 passengers;
2. Operates on exposed waters;
3. Has a length > 40 feet and operates on partially protected waters;
4. Has a length > 65 feet (subdivision and damage stability also applies); or
5. Is constructed of wood after March 11, 2001, and operates in cold water (as defined in the Definitions section of this document). Note that wooden vessels that operate in cold waters must also meet the subdivision requirements - see Section 12.

### **11.2 Location:**

In accordance with 179.310(b), the collision bulkhead must be located between 5% and 15% of the LBP aft of the forward perpendicular (FP). If the collision bulkhead is located farther aft than 15% of the LBP aft of the FP, this may be acceptable if the vessel is shown to meet the subdivision and damage stability requirements in sections 12.0 and 13.0 below with the entire buoyant volume forward of the collision bulkhead lost.

### **11.3 Structural Requirements:**

1. For strength, and in accordance with 179.310(b)(2), the collision bulkhead must be installed in a single plane with no recesses or steps.
2. Depending on the selected structural ruleset used for the design of the vessel, the scantlings requirements for the collision bulkhead may be increased relative to other watertight bulkheads. Please see the selected structural ruleset for additional guidance.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **12. Subdivision: 46 CFR 171.070**

The subdivision analysis (if required) checks for margin line submergence after losing all buoyancy between two main transverse watertight bulkheads (MTWBs). This could be caused by an allision, grounding, piping failure, or structural failure of the vessel. The vessel passes if the margin line is at, or above, the waterline following the loss of buoyancy of the space.

### **12.1 Applicability:**

In accordance with 46 CFR 179.212(a), include calculations in the submittal package demonstrating compliance with 46 CFR 171.070 (Type II Subdivision) in each condition of loading and operation if any of the following are true:

1. Length  $\geq$  65 feet,
2. Passenger count  $>$  49,
3. Is constructed of wood on or after March 11, 2001, operates in cold water, and carries any number of passengers, or
4. Is constructed before January 1, 2009, and carries more than 12 passengers on an international voyage.

### **12.2 Standard of Flooding:**

The standard of flooding is to be in accordance with Table 171.070(a), or Table 171.070(b) for ferry vessels (as defined in 171.070). For most Subchapter T vessels, a one-compartment standard applies.

### **12.3 Extents of flooding**

#### 1. Longitudinal

##### a. Minimum spacing

As summarized in the table below, the MTWB minimum spacing shall meet the requirements of 46 CFR 171.070(e)(1) or 171.070(e)(2) (depending on the LBP). In cases where the MTWBs are spaced closer than the minimum allowed, some of those MTWBs may be considered ineffective in the subdivision stability analysis to meet the minimum spacing requirement.

<b>LBP</b>	<b>Minimum Main Transverse Watertight Bulkhead Spacing</b>
$\geq$ 143 ft (43.5 m)	10 ft (3 m) plus 3% of the LBP
$<$ 143 ft (43.5 m)	Greater of 6 ft (1.8 m) or 10% of the LBP

##### b. Maximum spacing

No maximum spacing is specified in the CFR.

##### c. Aft most MTWB

Per the policy in reference (17), if the aft most MTWB is at least 5% of the LBP forward of the aft perpendicular (AP), then a one-compartment standard of flooding applies to the aft most compartment. However, if the aft most MTWB is less than 5% of the LBP

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

forward of the aft perpendicular (AP), the normal extent of damage applies (and the aft most compartment shall be flooded along with the compartment(s) immediately forward of the aft most compartment).

2. Transverse  
Shell to shell. See item 4 for modifications for multihulls.
3. Vertical  
From bottom and upward without limit. See item 4 for modifications for multihulls.
4. Multihull ('marans, 'toons, etc.) specific subdivision
  - a. Spacing between demihulls  
See Enclosure (3) for a diagram of subdivision penetration extents. Per section 6.E.12.c. of reference (5), if the separation between the demihulls is greater than the beam of a single demihull, subdivision is applied with flooding of both bow compartments simultaneously, and then asymmetric flooding of one compartment at a time down one side of the vessel. The vertical extent of damage is B/15 or 30 inches (whichever is greater). B is the sum of the waterline beam of all demihulls at the highest waterline. If the separation between the demihulls is less than the beam of a single demihull, subdivision is applied symmetrically along the length of the vessel as if it were a monohull.
  - b. Cross-flooding  
The assumption of asymmetric damage is predicated on the existence of longitudinal watertight bulkhead(s) to prevent progressive flooding between port and starboard hull compartments. If such separation does not exist for every subdivision, the damage stability and subdivision analysis must include both asymmetric and symmetric flooding scenarios. If the vessel fails (has margin line submergence), please contact MSC for additional policy guidance.

## 12.4 Margin Line:

1. General  
The margin line shall be in accordance with 46 CFR 171.015, and is dependent on the vessel's sheer and deck type (continuous, stepped, etc.).
2. The average sheer is calculated as follows:

$$Sheer_{ave} = \frac{(h_{FP} - h_{mid}) + (h_{AP} - h_{mid})}{2}$$

Where,

$h_{FP}$  = bulkhead deck height above baseline\* at the fwd perpendicular

$h_{mid}$  = bulkhead deck height above baseline\* at midships

$h_{AP}$  = bulkhead deck height above baseline\* at the aft perpendicular

\*Or any other horizontal reference plane, so long as the same reference plane is utilized for all measurements.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

Note that the quantities ( $h_{FP} - h_{mid}$ ) and ( $h_{AP} - h_{mid}$ ) can be negative.

### 3. Margin Line for Pontoon Vessels

The reference point for the margin line is the top of the pontoon hull, not the top of the deck.

### 4. Unique sheer lines

Please contact MSC if the sheer line of the vessel is not relatable to those shown in the CFR, and therefore the positioning of the margin line is not intuitive.

## 12.5 Tank Contents (Run-Off) and Permeability:

Subdivision (and damage stability) calculations shall not incorporate the emptying of tank contents (run-off) for any damaged tanks. Subdivision calculations must comply with the permeability requirements of 46 CFR 171.072. Damage stability calculations must comply with the permeability requirements of 46 CFR 171.080(c). In accordance with 46 CFR 171.080(c), our policy is to “double count” tank loading for damage stability calculations. This policy results in the most conservative means to account for any deviations from the tank loading restrictions and will not be waived by our office.

## 12.6 Watertight Doors:

In accordance with 46 CFR 179.330, watertight doors in main transverse watertight bulkheads are not permitted unless the following conditions are met:

1. The vessel will remain within 20 miles of shore, AND
2. The door either:
  - a. Separates a machinery and accommodation space, and the OCMI determines the door will be closed except when a person is passing through the door, OR
  - b. Commandant determines that due to the arrangement, the door will be closed except when a person is passing through the door. For determinations, the submitter should request approval of the door location(s) through the OCMI to Commandant (CVC-1) at [cgcvc@uscg.mil](mailto:cgcvc@uscg.mil).
3. Per 170.255(c)(2), an exception is made for vessels operating in the offshore oil industry.
4. Watertight doors of any kind are not permitted in the collision bulkhead.

## 12.7 Foam Flotation:

If acceptable to the OCMI, foam flotation material may be installed to reduced compartment permeability to achieve subdivision compliance. Foam floatation material must comply with the requirements of 46 CFR 179.240.

## **13. Damage Stability: 46 CFR 171.080**

Damage stability considers damage typically associated with a collision or allision. The damage stability analysis has different extents of damage as compared to the subdivision analysis. This analysis checks if the vessel has sufficient equilibrium stability, range of stability, and energy to

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

resist capsize or downflooding caused by the impact of the collision/allision, thereby allowing time for the rescue or evacuation of persons onboard following damage.

## 13.1 Applicability:

Applies whenever subdivision applies. In accordance with 46 CFR 179.212(a), include calculations in the submittal package demonstrating compliance with 46 CFR 171.080 (Damage Stability) in each condition of loading and operation if any of the following are true:

1. Length  $\geq$  65 feet,
2. Passenger count  $>$  49,
3. Is constructed of wood on or after March 11, 2001, operates in cold water, and carries any number of passengers, or
4. Is constructed before January 1, 2009, and carries more than 12 passengers on an international voyage.

## 13.2 Criteria:

1. For the purposes of damage stability, new and existing vessels are defined in 171.080(d)
2. For new vessels, the criteria of 171.080(f)(1)-(9) apply.
3. For existing vessels, the criteria of 171.080(e)(1)-(4) apply.

## 13.3 Extents of Flooding:

The extents of damage shall be in accordance with Table 171.080(a).

1. Longitudinal
  - a. For vessels less than 143 feet in length, and as per footnote 5 in Table 171.080(a), the longitudinal extent of damage is to be the greater of  $0.1L$  or 6 feet.
  - b. If any main transverse watertight bulkheads are spaced closer than the required extent, the bulkhead not meeting the spacing requirement will not be considered effective and should be considered damaged in the analysis.
  - c. See the subdivision section of this document for policies that apply to the collision bulkhead and aft peak bulkhead.
2. Transverse
  - a. The transverse extent is  $B/5$ , where  $B$  is the maximum waterline beam (at the deepest draft / heaviest load).  $B$  is for the overall vessel, and  $B/5$  is applied perpendicular to the centerline / plane, and along the intersection of the waterline and sidshell (such that the extent of damage is parallel to the sidshell/waterline intersection in plan view).
  - b. The damage scenarios should include lesser transverse penetrations as these may be more limiting. For example, damaging a wing tank may cause more list than damaging a wing tank and the adjacent inboard compartment.
  - c. See below for multihull specific criteria.



# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## 3. Vertical

From bottom and upward without limit. See item 4 for multihull specific criteria.

## 4. Multihull (‘marans, ‘toons, etc.)

The same extents as catamaran subdivision apply, inclusive of spacing between the demihulls and consideration of cross-flooding. Also see Enclosure (3) for a visual representation of penetration extents.

### **13.4 Tank Contents (Run-Off) and Permeability:**

Damage stability calculations shall not incorporate the emptying of tank contents (run-off) for any damaged tanks. Damage stability calculations must comply with the permeability requirements of 46 CFR 171.080(c). In accordance with 46 CFR 171.080(c), our policy is to “double count” tank loading for damage stability calculations. This policy provides the most conservative means to account for any deviations from the tank loading restrictions and will not be waived.

### **13.5 Watertight Doors:**

Watertight doors in bulkheads are not permitted unless the conditions stated in section 12.6 of this document are met.

### **13.6 Guidance for Application of Heeling Moment of 46 CFR 171.080(f)(4):**

Applies to new vessels (as defined in 171.080(d)(1)) only. 46 CFR 171.080(f)(4) requires a maximum heeling moment to be calculated from the four listed criteria (Passenger Heeling Moment, Asymmetric Escape Routes, Launching of Survival Craft, and Wind Heeling Moment) and used if it results in a required maximum righting arm (GZ) greater than 0.1 meter. The following guidance applies:

1. The Passenger Heeling Moment is the moment that is produced by passengers that, after damage, have emerged from all decks and have congregated on the deck from which they can leave the vessel (disembarkation deck).
2. The Asymmetric Escape Routes moment is produced by passengers emerging from other decks to the disembarkation deck via escape routes that are either on the port or starboard side of the vessel only; if the escape routes from other decks are located on both port and starboard sides, then they are considered symmetrical, and this potential moment need not be considered for the calculation.
3. 46 CFR 171.080(f)(5) states that the Passenger Heel Moment can be exempted from the heeling moment options if the vessel has forward and aft egress instead of port and starboard egress. In that case, the calculations must demonstrate that the vessel has sufficient longitudinal stability to prevent the immersion of the deck edge during the forward or aft egress.

# REVIEW OF STABILITY FOR SMALL PASSENGER VESSELS (T)

Procedure Number: H1-01

Revision Date: September 25, 2023

## **13.7 Foam Flotation:**

If acceptable to the OCMI, foam flotation material may be installed to reduced compartment permeability to achieve damage stability compliance. Foam floatation material must comply with the requirements of 46 CFR 179.240.

## **14. Special Consideration**

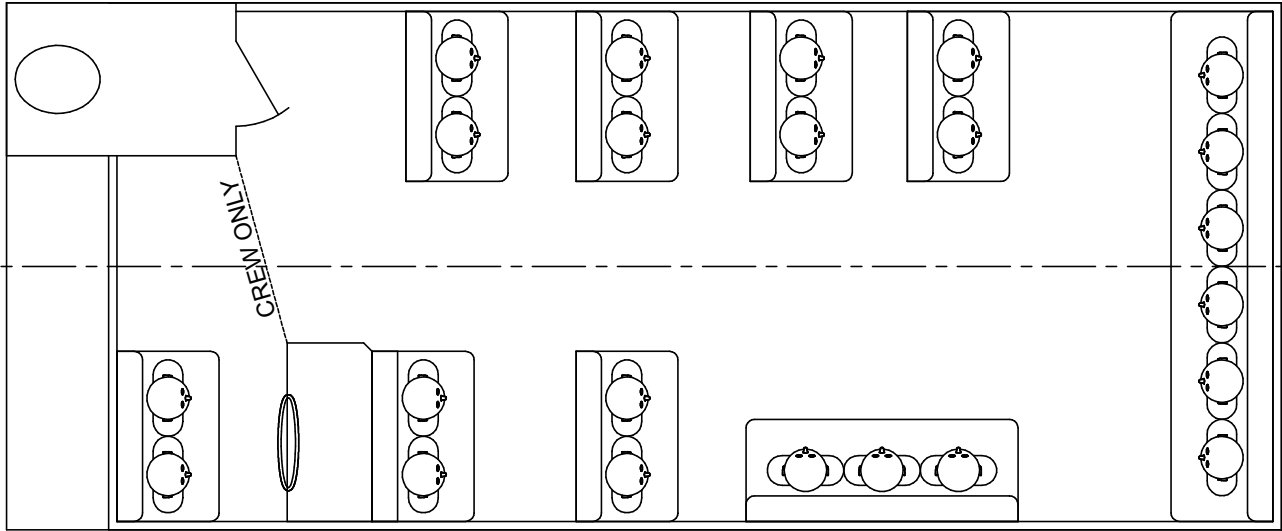
In accordance with 46 CFR 175.550, the cognizant OCMI may give special consideration to authorizing departures from the specific requirements of 46 CFR Subchapter T when unusual circumstances or arrangements warrant such departures and an equivalent level of safety is provided. The OCMI of each marine inspection zone in which the vessel intends to operate must approve any special consideration granted to the vessel.

## **15. 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 would like to discuss an alternative, you may contact the Marine Safety Center, the unit responsible for implementing this guidance.

## **16. Enclosures**

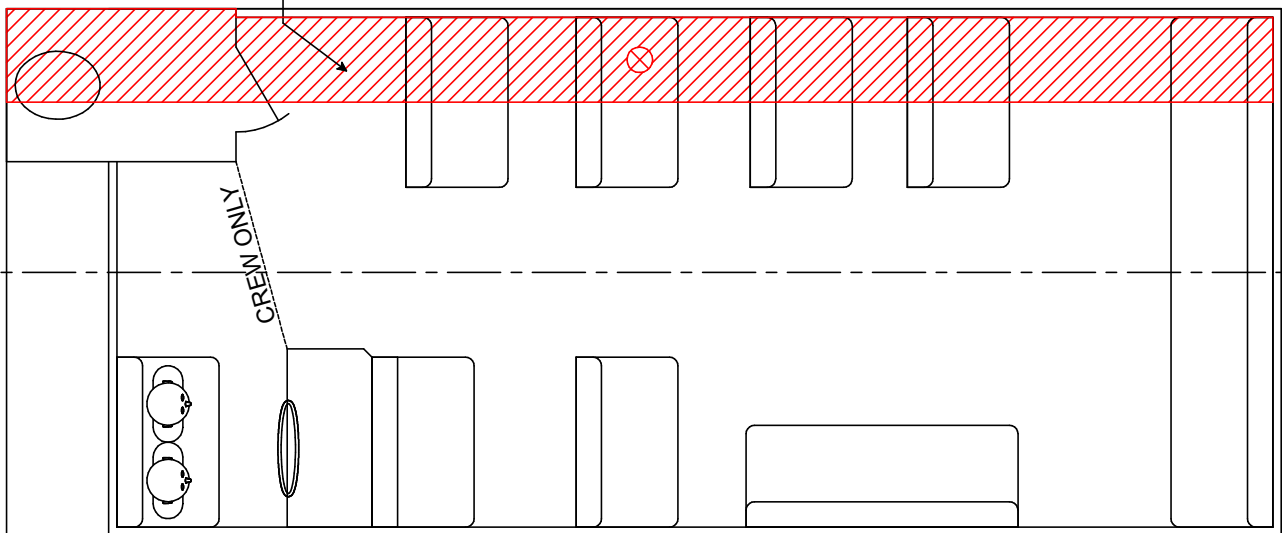
- (1) Pontoon Passenger Crowding - Simplified
- (2) Pontoon Passenger Crowding - Detailed
- (3) Damage Stability and Subdivision Penetration Extents



**Baseline Condition (No Crowding)**

21 Passengers

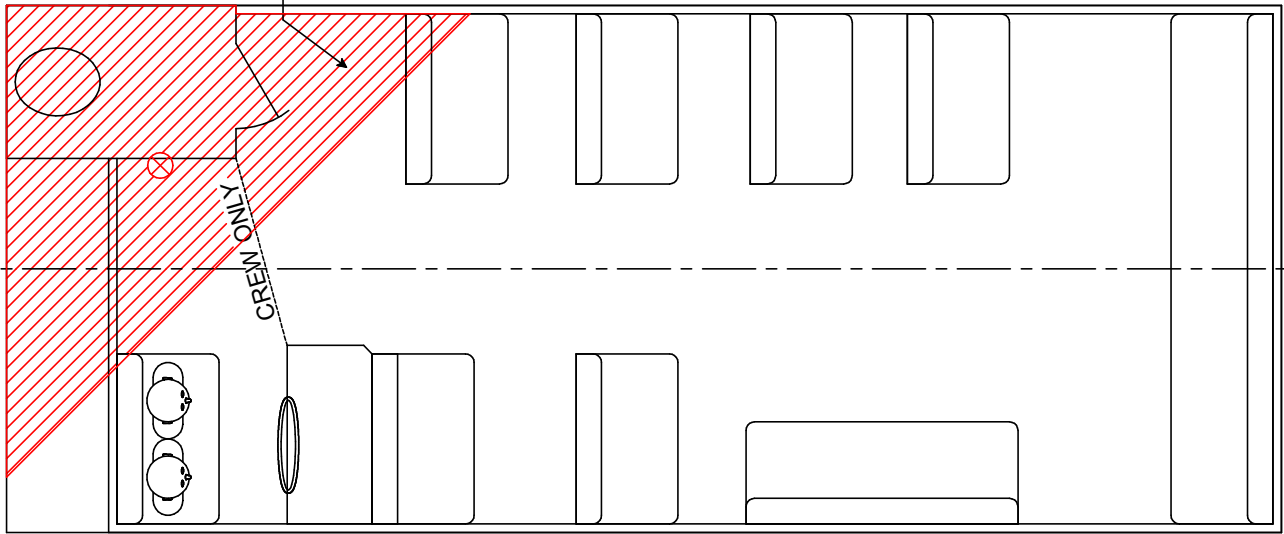
42 square feet = 21 passengers with center of gravity at center of area



**Port Crowding, 2 Square Feet / Person**

21 Passengers  
2 Crew

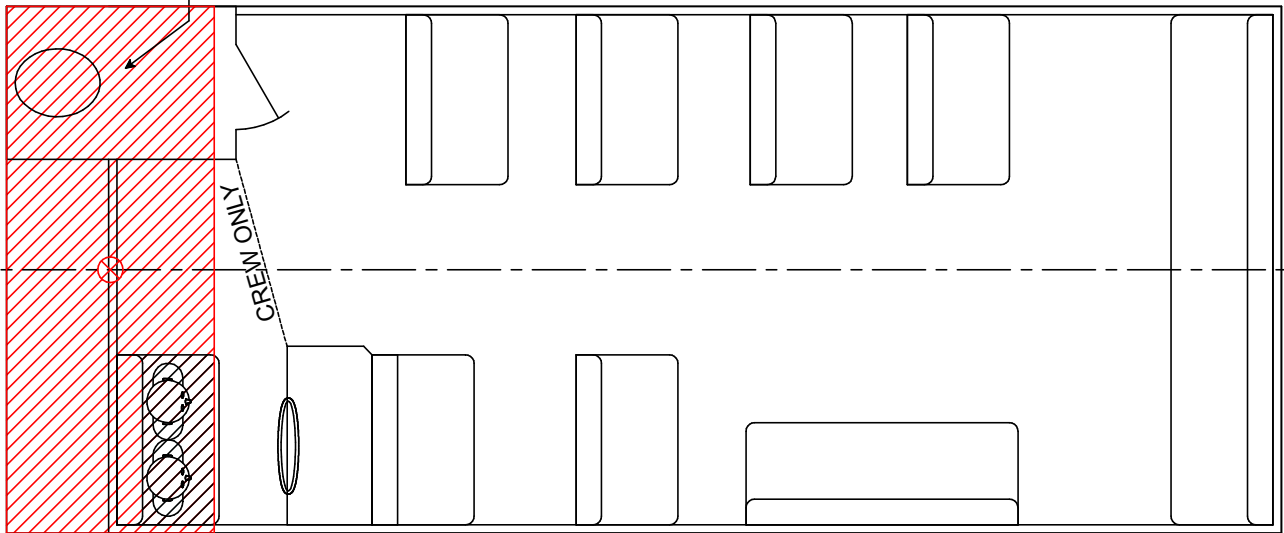
42 square feet = 21  
passengers with  
center of gravity at  
center of area



Port Quarter Crowding, 2 Square Feet / Person

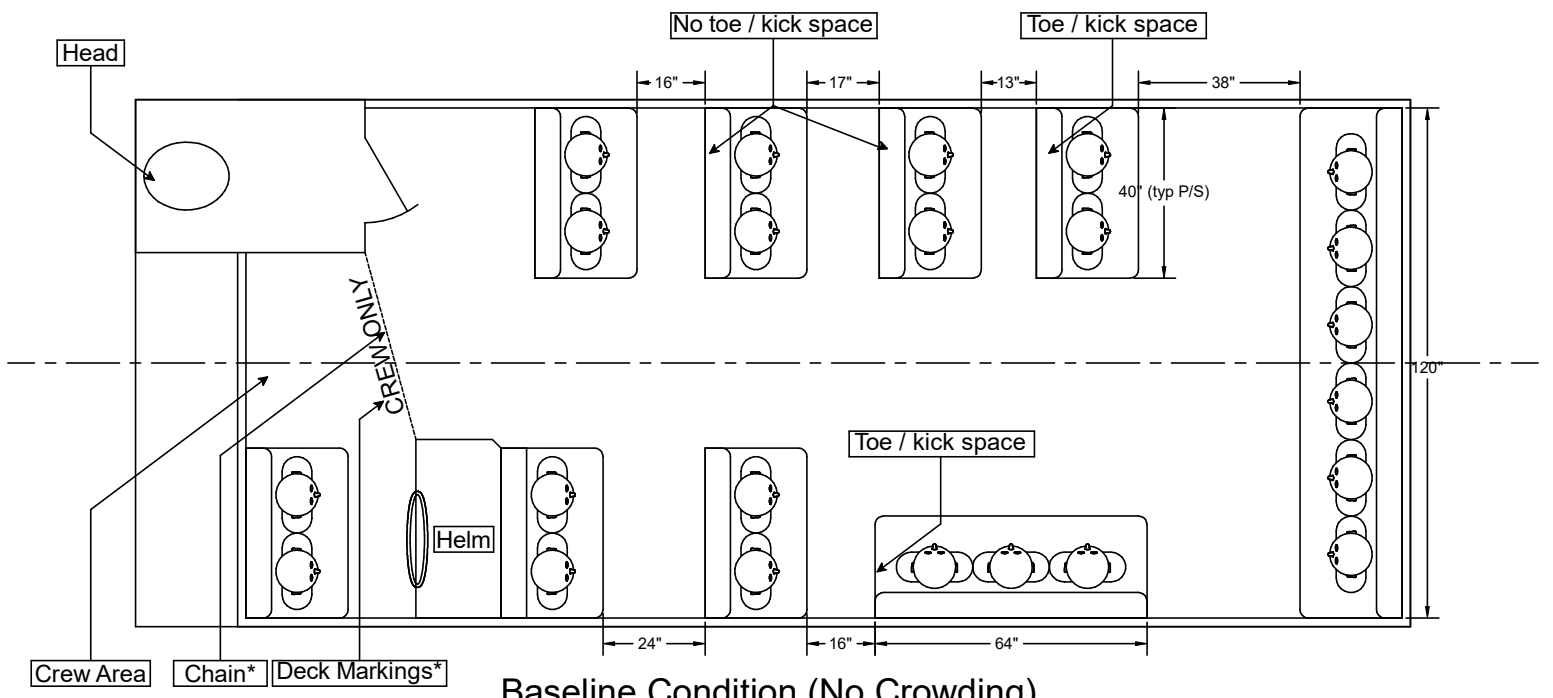
21 Passengers  
2 Crew

42 square feet = 21  
passengers with  
center of gravity at  
center of area



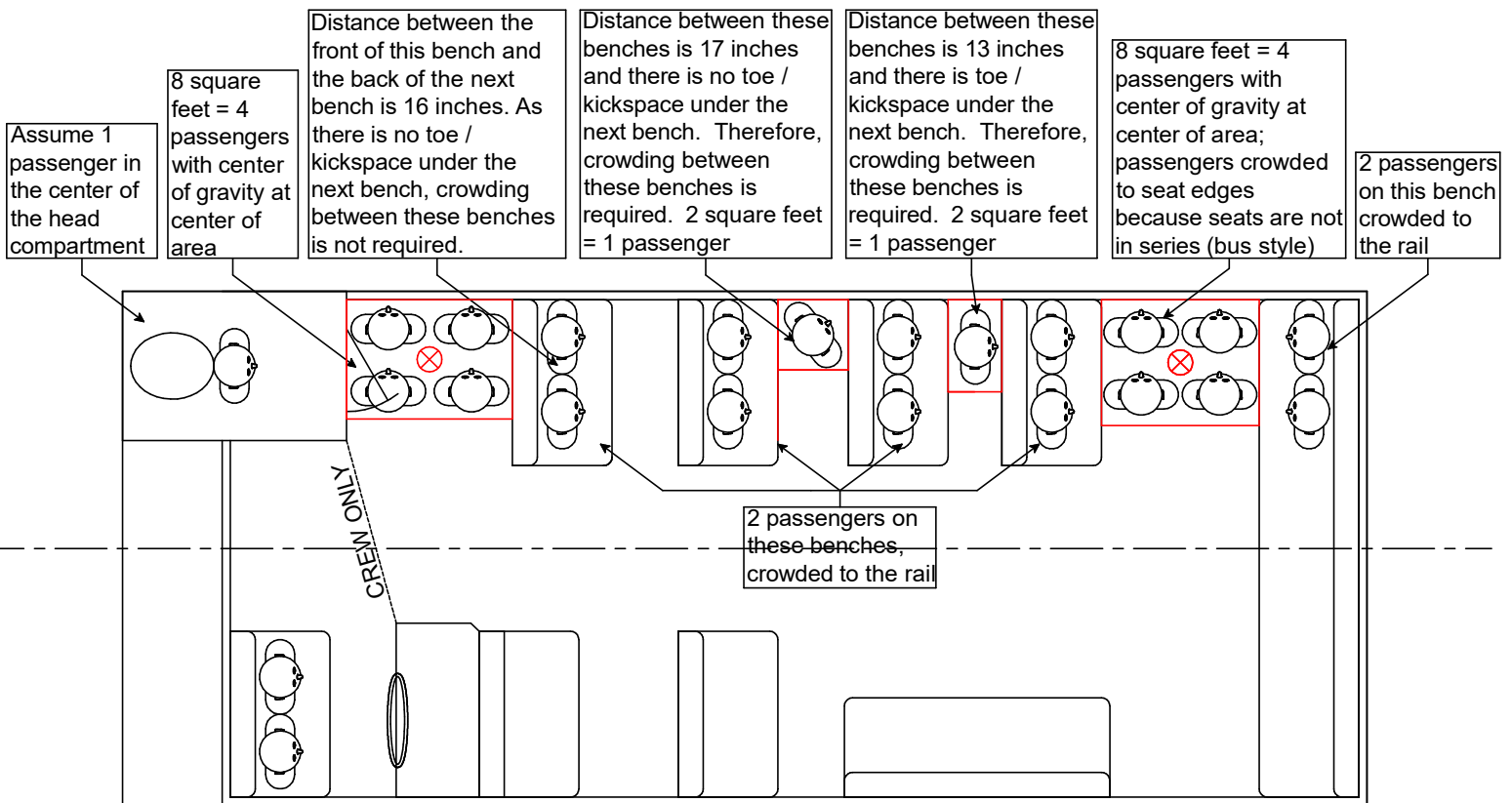
Aft Crowding, 2 Square Feet / Person

21 Passengers  
2 Crew



**Baseline Condition (No Crowding)**

21 Passengers  
2 Crew



**Port Crowding, 2 Square Feet / Person**

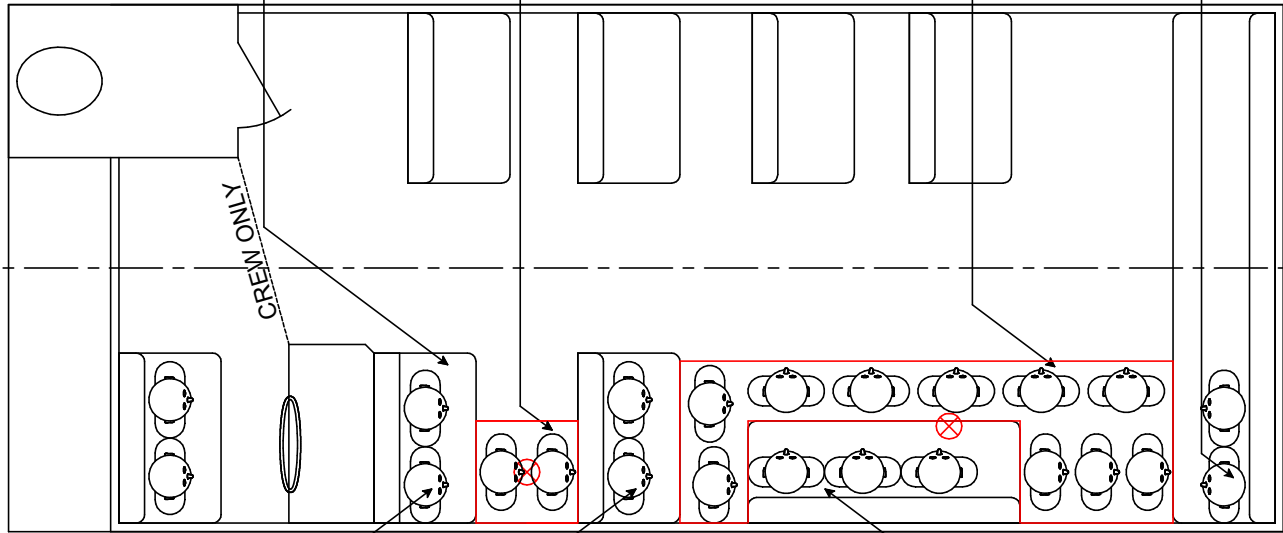
21 Passengers  
2 Crew

The distance between the front of this bench and the seat back of the next bench is 24 inches. Assuming 12 inches for legroom, this leaves 12 inches remaining. Therefore, crowding between these benches is required.

4 square feet = 2 passengers with center of gravity at center of area

20 square feet = 10 passengers with center of gravity at center of area. For transverse seating, passengers are crowded to seat edges because the seats are not in series (bus style). For longitudinal benches, passengers are crowded to the seat edge.

2 passengers on this bench crowded to the rail



2 passengers on these benches, crowded to the rail

### Starboard Crowding, 2 Square Feet / Person

21 Passengers  
2 Crew

3 passengers on this bench, crowded aft to bring aggregate passenger LCG closer to the Baseline Condition

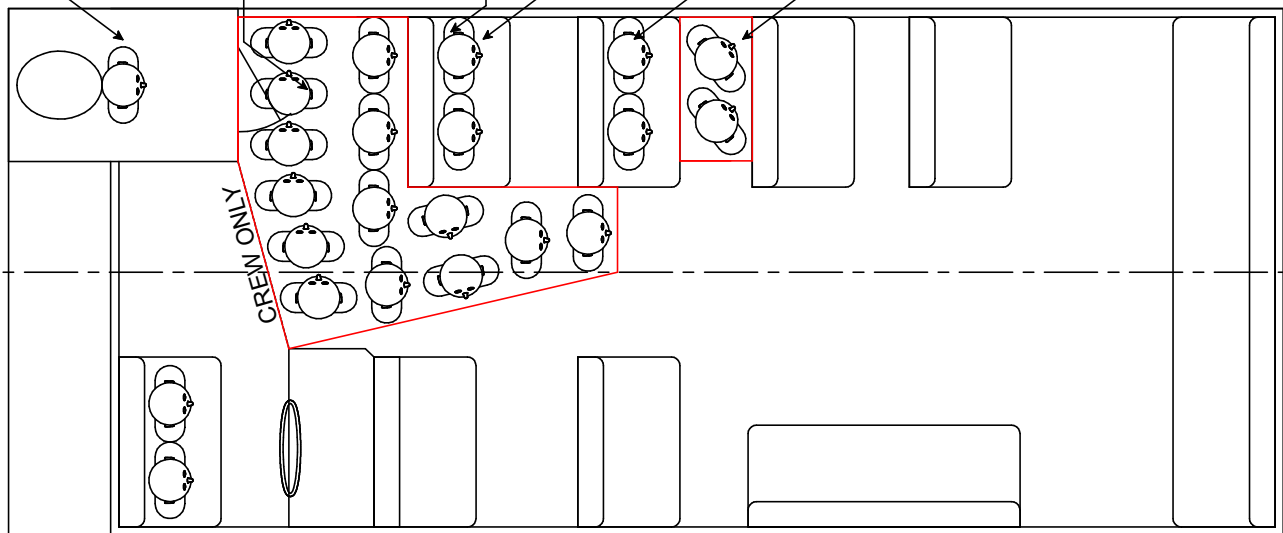
The distance between the front of this bench and the back of the next bench is 16 inches. As there is no toe / kickspace under the next bench, crowding between these benches is not required.

Example of corner crowding with 28 square feet = 14 passengers with center of gravity at center of area

Assume 1 passenger in the center of the head compartment

Distance between these benches is 17 inches and there is no toe / kickspace under the next bench. Therefore, crowding between these benches is required. 4 square feet = 2 passengers

2 passengers on these benches, crowded to the rail

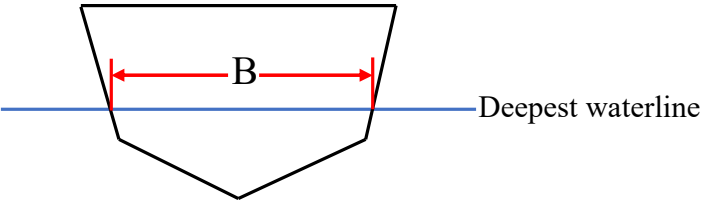


### Port Quarter Crowding, 2 Square Feet / Person

21 Passengers  
2 Crew

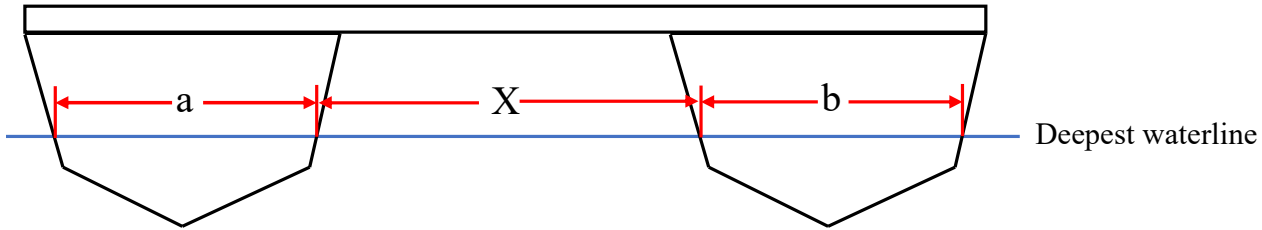
## Damage Stability and Subdivision Penetration Extents - Monohulls

- Position of collision bulkhead to be positioned in accordance with 46 CFR 179.210.
- See 46 CFR 179.212 for applicability of subdivision and damage stability analyses.
- Table below in accordance with Type II subdivision and damage stability requirements of 46 CFR 171.070 and 171.080, respectively.
- For damage stability, and in accordance with 46 CFR 171.080(b)(2), the penetrations should be as described below, except that if the most disabling penetration would be less, the smaller penetration must be assumed.

Item	Subdivision	Damage Stability
Vertical Penetration	Upward without limit (entire subdivision)	Upward without limit
Transverse Penetration	Shell to shell (entire subdivision)	B/5
Longitudinal Penetration	For LBP < 143 and no international voyages: greater of 10 % of LBP or 6 feet  For LBP > 143 or international voyages: 10 feet + 3% of LBP, or 35 feet (whichever is greater)	
B	 <p>The diagram shows a cross-section of a ship's hull. A blue horizontal line represents the 'Deepest waterline'. A red double-headed arrow labeled 'B' indicates the horizontal distance between two vertical red lines (perpendiculars) drawn at the forwardmost and aftermost points where the hull intersects the deepest waterline.</p>	Note: For ferries that operate on inland waters, see the modified definition for B in accordance with note 3 under Table 171.080(a).
LBP	The horizontal distance measured between perpendiculars taken at the forwardmost and aftermost points on the waterline corresponding to the deepest draft.	
Standard of Flooding	Damage forward of the collision bulkhead, and then aft of the collision bulkhead using the extents in this table.	

## Damage Stability and Subdivision Penetration Extents - Catamarans / Pontoon Vessels

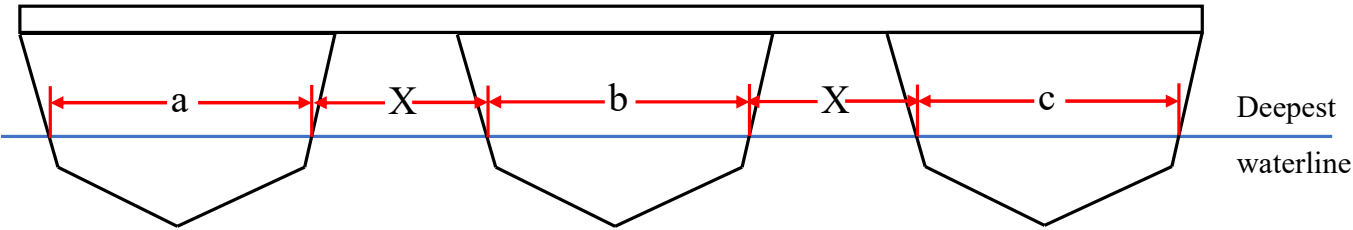
- Position of collision bulkheads required for each hull, and to be positioned in accordance with 46 CFR 179.210.
- See 46 CFR 179.212 for applicability of subdivision and damage stability analyses.
- Table below in accordance with Type II subdivision and damage stability requirements of 46 CFR 171.070 and 171.080, respectively, and policy per G-MTH-3 letter from Commandant to the Marine Safety Center dated February 2, 1988.
- For damage stability, and in accordance with 46 CFR 171.080(b)(2), the penetrations should be as described below, except that if the most disabling penetration would be less, the smaller penetration must be assumed.

Item	Subdivision	Damage Stability
Vertical Penetration	Greater of B/15 or 30 inches	Upward without limit
Transverse Penetration	B/3	B/5
Longitudinal Penetration	For LBP < 143 and no international voyages: greater of 10 % of LBP or 6 feet For LBP > 143 or international voyages: 10 feet + 3% of LBP, or 35 feet (whichever is greater)	
B = a + b		
X	For $X > 1/2 * B$ : Damage aft of the collision bulkheads to be asymmetric (down one hull only). For $X \leq 1/2 * B$ : Damage aft of the collision bulkheads to be symmetric.	
LBP	The horizontal distance measured between perpendiculars taken at the forward most and aftermost points on the waterline corresponding to the deepest draft.	
Standard of Flooding	Damage forward of the collision bulkheads both symmetrically and asymmetrically, and then aft of the collision bulkhead using the extents in this table. Damage should be in the direction of any pre-damage vessel list.	



## Damage Stability and Subdivision Penetration Extents - Trimarans / Tritoon Vessels

- Position of collision bulkheads required for each hull, and to be positioned in accordance with 46 CFR 179.210.
- See 46 CFR 179.212 for applicability of subdivision and damage stability analyses.
- Table below in accordance with Type II subdivision and damage stability requirements of 46 CFR 171.070 and 171.080, respectively, and policy per G-MTH-3 letter from Commandant to the Marine Safety Center dated February 2, 1988.
- For damage stability, and in accordance with 46 CFR 171.080(b)(2), the penetrations should be as described below, except that if the most disabling penetration would be less, the smaller penetration must be assumed.

Item	Subdivision	Damage Stability
Vertical Penetration	Greater of B/15 or 30 inches	Upward without limit
Transverse Penetration	B/3	B/5
Longitudinal Penetration	For LBP < 143 and no international voyages: greater of 10 % of LBP or 6 feet For LBP > 143 or international voyages: 10 feet + 3% of LBP, or 35 feet (whichever is greater)	
B = a + b + c		
X	For $X > 1/3 * B$ : Damage aft of the collision bulkheads to be asymmetric (down outboard hull only). For $X \leq 1/3 * B$ : Damage aft of the collision bulkheads to include both centerline and outboard hull.	
LBP	The horizontal distance measured between perpendiculars taken at the forward most and aftermost points on the waterline corresponding to the deepest draft.	
Standard of Flooding	Damage forward of the collision bulkheads both symmetrically and asymmetrically, and then aft of the collision bulkhead using the extents in this table. Damage should be in the direction of any pre-damage vessel list.	