

# U.S. COAST GUARD MARINE SAFETY CENTER DESIGN VERIFICATION GUIDELINE



## REVIEW OF STABILITY FOR TOWING VESSELS (M)

Procedure Number: H1-04

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### **Purpose**

This Design Verification Guideline (DVG) provides guidance and information to the marine industry regarding verification of stability compliance for towing vessels certificated under 46 Subchapter M.

### **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 DVG-H1-04.

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## **1. Applicability**

This Design Verification Guideline is applicable to stability calculations reviewed by MSC for towing vessels with a keel laid on or after July 20, 2017; or underwent a major conversion on or after July 20, 2017. Stability review for a towing vessel under Subchapter M does not need to be completed by MSC. In accordance with 46 CFR 144.140, the owner of the vessel may use any of the following authorized individuals or entities to conduct design verification:

- a. A registered professional engineer (P.E.) licensed by one of the states of the United States or the District of Columbia
- b. An authorized classification society that has been delegated the authority to issue the SOLAS Cargo Ship Safety Construction Certificate under 46 CFR 8.320
- c. The Coast Guard

## **2. References**

- (a) [46 CFR Subchapter M, Part 144](#)
- (b) [46 CFR Subchapter S, Parts 170, 173](#)
- (c) [Navigation and Vessel Circular No. 17-91, CH-1, "Guidelines for Conducting Stability Tests," dated November 4, 1991](#)
- (d) 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
- (e) [USCG MSC Plan Review Guide H2-06, "MSC Guidelines for Preparation of Trim & Stability \(T&S\) Booklets"](#)
- (f) [COMDTINST M16000.9, Marine Safety Manual, Vol. IV](#)
- (g) [MTN 01-01, CH-1, "Towline Pull Criteria for Vessels Equipped with Azimuth Thrusters \(Z-Drives\)," dated February 22, 2011](#)
- (h) [MTN 1-17, CH-1, "Guidance on Design Verification for Subchapter M Towing Vessels," dated December 1, 2021](#)
- (i) [Navigation and Vessel Circular No. 3-89, "Guidelines for the Presentation of Stability Information for Operating Personnel," dated September 7, 1989](#)



### **3. Definitions:**

- a. **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.
- b. **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.

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.

- c. **Weathertight:** Water will not penetrate into the vessel in any sea condition. This also means being able to resist boarding seas. Windows are not accepted as weathertight closures and, without the provision of deadlight covers, must be considered as potential downflooding points. Ball check valves used in tank vent lines are generally accepted as weathertight closures.
- d. **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.

### **4. Submittal Checklist**

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

- a. Letter of intent identifying what is included in the submittal and requested actions to be taken by the Marine Safety Center;
- b. Copy of Application for Inspection submitted to the Officer in Charge, Marine Inspection (OCMI);
- c. Description of vessel operating envelope including route designation and classification, number of persons carried, and any operating limits and/or restrictions (such as maximum draft, trim, wave height, speed or geographical boundaries);
- d. Vessel loading conditions;
- e. Lines plan of the hull to at least the bulkhead deck;
- f. Computerized hull model (recommended, but not required);



- g. Hydrostatics or Curves of Form and Righting Arm Curves (tabulated data may be accepted);
- h. Tank capacity data including liquid volume or weight, center of gravity location, and free surface factor for relevant tank filling levels;
- i. General Arrangement and relevant plans showing:
  - (1) Outboard Profile;
  - (2) Compartmentation (at least plan and profile views);
  - (3) Location and extent of bulkhead deck;
  - (4) Watertight and weathertight doors, hatches, scuttles and similar closures;
  - (5) Weather deck freeing port and/or scupper sizes and locations (as applicable);
  - (6) Downflooding points and other openings into the hull such as vents or windows;
  - (7) Locations and reference points of any draft of loading marks;
- j. Fixed Ballast Plan or Listing (if applicable): Ensure that fixed ballast shown on ballast plan or listing matches the fixed ballast used in lightship calculation;
- k. Approved lightship values or stability test lightship calculations;
- l. Intact Stability Calculations;
- m. Proposed Stability Instructions (if applicable);
- n. Trim and Stability (T&S) booklet (if applicable).

### **5. Lightship Verification**

Ensure that lightship characteristics were (or are to be) determined using one of the following methods:

- a. Acceptance as a sister to a vessel with known characteristics (46 CFR 144.155);
- b. Deadweight survey combined with a conservatively assumed vertical center of gravity (VCG) height (references (c) or (d));
- c. Inclining (full stability test) (references (c) or (d)).

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In accordance with 46 CFR 170.085, a written stability test procedure must be submitted to the Coast Guard Marine Safety Center at least two weeks before the stability test. Reference (d) provides guidance on the required elements for the stability test procedure. The procedure shall be approved by the MSC prior conducting the test or survey.

In accordance with 46 CFR 170.175(b), arrangements shall be made with the OCMI for an acceptable Coast Guard representative to witness the stability test.

### **6. Hull Model**

MSC will generate a hull model in GHS from the lines plans, table of offsets, or a provided computer model to verify the stability of the vessel.

### **7. Passenger/Crew Guidance**

The assumed average weight per person (AAWP) must not be less than 185 pounds in accordance with 46 CFR 170.090(d)(1).

### **8. Loading Conditions**

Realistic loading conditions must be developed that allow for clear, simple tank loading instructions for placement in the stability instructions.

a. Load conditions shall include conditions for all consumable tanks full and all consumable tanks empty. Ensure that the vessel's loading conditions cover the entire range of operation. This includes, but is not limited to the following conditions:

(1) Departure (Full Load) with 100% consumables;

(2) Mid Voyage with 50% consumables;

(3) Arrival (Burned Out) with 10% consumables.

b. Additional load conditions should be added to account for the realistic extents of both list and trim.

c. If the loading conditions are too varied for inclusion in the stability instructions for the Master, a Trim and Stability (T&S) booklet shall be submitted. See reference (e) for guidance on the preparation of T&S booklets.

d. If the developed loading conditions do not pass applicable stability criteria, you may contact MSC to discuss alternate load conditions.

e. Ensure that loading conditions incorporate liquid free surface in accordance with 46 CFR 170.285 for intact stability.

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- (1) For each type of consumable liquid, the maximum free surface effect of at least one transverse pair of wing tanks or a single centerline tank.
- (2) The maximum free surface effect of each partially filled tank containing non-consumable liquids.
- (3) For the purpose of part (1) above, the tank or combination of tanks selected must be those having the greatest free surface effect.

**9. Intact Stability**

Vessels shall demonstrate compliance with the criteria below, regardless of route, if applicable to the vessel:

a. Towline Pull Criteria, 46 CFR 173.095:

- (1) Applicable if the vessel engages in towing operations by the stern.
- (2) For the purpose of this section, 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.
- (3) Reference (f), Section 6.E.2 is to be used in the evaluation of Voith-Schneider type propulsion units.
- (4) Reference (g) is to be used in the evaluation of Azimuth thruster (Z-drive) type propulsion units.

b. Lifting Criteria, 46 CFR Part 173, Subpart B:

- (1) Determine applicability in accordance with 46 CFR 173.005: If the vessel is equipped to lift cargo or other objects, submit calculations comparing maximum heeling moment due to hook load to  $(0.67)(W)(GM)(F/B)$ . In accordance with 46 CFR 173.007, the hook load must be considered to be located at the head of the crane.
- (2) If the crane heeling moment is greater than  $(0.67)(W)(GM)(F/B)$ , submit additional calculations for lifting: 46 CFR 173.020, and .025.

Vessels shall demonstrate compliance for each condition of loading based on the applicable route the vessel is seeking operations for:

Protected Waters	46CFR170.173(e)(2)
Partially Protected Waters	46CFR170.170 46CFR170.173(e)(1)
Exposed waters or if assigned a load line	46CFR170.170 46CFR174.145



- c. Weather Criteria, 46 CFR 170.170:
  - (1) Ensure correct use of weather criterion variables for intended route.
  - (2) Ensure upright GM meets or exceeds the minimum acceptable value.
- d. Righting Energy Criteria, 46 CFR 170.173:
  - (1) Ensure stability characteristics meet the minimum requirements for intended route and that all criteria are addressed:
    - (i) Partially Protected Route: 46 CFR 170.173(e)(1)
    - (ii) Protected Route: 46 CFR 170.173(e)(2)
  - (2) Ensure these calculations correctly reflect submergence of any potential downflooding points.
- e. Special Rules Pertaining to Tugboats and Towboats, Righting Energy Criteria, 46 CFR 174.145:
  - (1) Determine applicability in accordance with 46 CFR 144.305 and 46 CFR 174.140.
  - (2) Ensure these calculations correctly reflect submergence of any potential down flooding points.
- f. Ensure compliance with the watertight integrity requirements of 46 CFR 144.320 and 144.330.

## **10. Stability Instructions**

As discussed in reference (h), vessel owners, or managing operators of towing vessels NOT requesting a load line assignment, must propose to the MSC a set of stability instructions outlining the operating restrictions necessary to maintain the safe operation of their vessels. The format of the stability instructions is left to the discretion of the owner. The MSC will verify that the format and content are appropriate for the vessel and suitable for use by the vessel's operators. If the loading conditions are too varied for inclusion in the stability instructions for the Master, a Trim and Stability (T&S) booklet shall be submitted. At a minimum the general instructions listed in paragraphs 3 and 4 in enclosure (1) of reference (i), if applicable, must be addressed in the proposed stability instructions:



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## a. Good marine practices:

- (1) Bilges pumped to minimum content.
- (2) Maintain freeing ports operable and unobstructed.
- (3) Secure cargo to prevent shifting.
- (4) Keep weather doors and hatches closed.
- (5) Keep the number of slack tanks to a minimum.
- (6) Keep cross-connections between tanks closed.
- (7) Determine the cause of list prior to taking actions to correct it.
- (8) State the location of watertight (WT) bulkheads.
- (9) Keep doors in watertight bulkheads closed.
- (10) Minimize trim.
- (11) State that it is the responsibility of operating personnel to ensure satisfactory stability condition at all times.

## b. Operating limitations:

- (1) Route restrictions.
- (2) Maximum draft(s) (and any trim limitations).
- (3) Maximum weight of deck cargo and its VCG and/or height.
- (4) Location of internal watertight doors and other fittings to be kept closed.
- (5) Limitations on slack tanks for each type of liquid.
- (6) Restrictions on the use of liquid ballast.
- (7) Fixed/required ballast descriptions and locations.
- (8) Number of persons allowed.
- (9) Restrictions on the number of persons allowed on upper decks.

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Stability instructions should be simple to use, appropriate for any operator of the vessel, and free from unnecessary or confusing information. Generally, the stability instructions become more complex as the vessel size increases, due to the owner's desire to provide maximum flexibility in the vessel's use. In most cases, such complexity is accommodated by improved understanding of stability by the operating personnel.

### **11. Lightship Changes**

In accordance with 46 CFR 144.315, changes in weight to a vessel with approved Lightweight Characteristics must be documented and new Lightweight Characteristics calculated following each weight change. The aggregate weight change (absolute total of all additions, removals, and relocations) since the last stability test must be tracked. Submissions to document changes in a vessel's Lightship Characteristic should be made to the authorized entity who verified the lightship values and stability instructions. The determination for when a new Stability Test is required shall be in accordance with Table 144.315.

### **12. Disclaimer**

This guidance is not a substitute for applicable legal requirements, nor is it itself a rule. It is not intended to nor does it impose legally-binding requirements on any party. It represents the Coast Guard's current thinking on this topic and may assist industry, mariners, the general public, and the Coast Guard, as well as other federal and state regulators, in applying statutory and regulatory requirements. You can use an alternative approach for complying with these requirements if the approach satisfies the requirements of the applicable statutes and regulations. If you want to discuss an alternative, you may contact MSC, the unit responsible for implementing this guidance.