

U.S. COAST GUARD MARINE SAFETY CENTER PLAN REVIEW GUIDELINE



SUBMISSION OF STABILITY TEST RESULTS: DEADWEIGHT SURVEY OR INCLINING EXPERIMENT

Procedure Number: GEN-02

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J. B. Bybee, LCDR, Chief, Hull Division

Purpose

This Plan Review Guideline provides information regarding the submission of results for stability tests which will be reviewed by the Marine Safety Center.

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 GEN-02.

E-mail: msc@uscg.mil

Phone: 202-795-6729

Website: www.dco.uscg.mil/msc

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1. Applicability

This Plan Review Guideline is applicable to each vessel for which the lightweight displacement and centers of gravity must be determined in order to prepare stability calculations which are to be reviewed by the Marine Safety Center.

2. References

- a. 46 CFR 170, Subpart F *Determination of Lightweight Displacement and Centers of Gravity*
- b. NVIC 17-91 "Guidelines for Conducting Stability Tests"
- c. ASTM F1321(Series) - 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
- d. Marine Safety Manual (MSM) Vol. IV, Chapter 6
- e. Military Specification MIL-P-21929B, "Plastic Material, Cellular Polyurethane, Foam in Place, Rigid," 1970.
- f. MSC Plan Review Guideline GEN-05, "Review of Stability Test Procedures"

3. Guidance Applicable to Both Deadweight Survey and Inclining Results

- a. Ensure that the following items are either included in the current submittal or have already been submitted:
 - (1) Approved stability test procedure
 - (2) Lines plan or offsets suitable for digitizing (an electronic hull model may also be submitted but lines or offsets are required to validate the model)
 - (3) Hydrostatics Curves or tabulated data
 - (4) Test field notes signed by Coast Guard witness and including:
 - (i) Vessel dimensions including length overall (LOA), length between perpendicular (LBP) and location of forward perpendicular, aft perpendicular and amidships
 - (ii) Specific gravity of water at time of test
 - (iii) Measured freeboard readings
 - (iv) List of Weights to Add (lightship items not on board the vessel during the test)
 - (v) List of Weights to Deduct (non-lightship items on board during the test)
 - (vi) List of Weights to Relocate (lightship items on board the vessel during the test but not in their proper location)
 - (vii) Verification that recorded weights to add, deduct or relocate include the vertical center of gravity (VCG), longitudinal center of gravity (LCG), and transverse center of gravity (TCG) (if required) for each item
 - (viii) Down flooding point locations (longitudinal, transverse and vertical)
 - (5) Capacity plans showing capacities and vertical, longitudinal, and transverse centers of gravity of stowage spaces and tanks
 - (6) Tank sounding tables (if applicable)
 - (7) Draft mark plan (if applicable). Draft mark locations shall be verified.
 - (8) General arrangement plan of decks, holds, and inner bottoms

- (9) Permanent Ballast plan (if fitted)
 - (10) Foam Flotation Material plan (if fitted) including foam material properties in accordance with reference (e) for new installations
 - (11) Calculation of as-surveyed and lightship values from stability test data
 - (12) Profile pictures of the vessel if taken during the test
- b. Review the approved stability test procedure required by 46 CFR 170.085. Any significant deviations from the approved procedure should be explained and/or reasonably accounted for.
 - c. Verify that the lines plan clearly indicates if it references the molded depth or if it accounts for the skin thickness of the vessel.
 - d. Verify that the locations of the baseline and vertical, transverse, and longitudinal origins are clearly indicated and consistent.
 - e. Ensure that the hydrostatics submitted capture a range of displacements to verify the accuracy of electronic hull model.
 - f. Verify freeboard recordings taken at the time of survey. Ensure that a minimum of 5 freeboards were recorded both port and starboard, that the readings were reasonably distributed along the length of the vessel, and that the position (longitudinal, transverse and vertical) of each freeboard location is explicitly referenced. If the vessel has draft marks, additional freeboards may be taken at their location and draft mark readings should be taken to assist in determining the waterline defined by the freeboard reading and to verify the vertical location of the draft marks. Drafts should be calculated from freeboard readings and account for deck thickness and bulwark height. The freeboards shall be plotted to indicate any measurement errors or hogging / sagging of the vessel.
 - g. To evaluate the displacement and LCG values for the vessel at the surveyed condition, follow the steps below:
 - (1) Convert the freeboard reading to draft as indicated in reference (c).
 - (2) Calculate the mean draft (average port and starboard reading) for each of the locations where the freeboard/draft readings are taken.
 - (3) Plot the mean draft values on the vessel's lines drawing or outboard profile.
 - (4) Define the waterline by linear and second degree (polynomial) curve fitting through the draft points. Should a draft value produce an anomalous result, provide sufficient justification for omitting the value from the final displacement calculation.
 - (5) Evaluate the displacement and LCG values from a linear or polynomial curve waterline as appropriate for the data.

Note: Any hogging or sagging of the vessel identified during the deadweight survey shall be addressed. For smaller vessels, the freeboards shall not be taken while on board the vessel as the movement of the individual taking the freeboards may impact the trim and heel of the vessel and invalidate the deadweight survey.

- h. For Fiberglass Reinforced Plastic (FRP) and composite vessels that have a deck/hull joint, ensure the lines plan accurately indicates the actual vessel depth and accounts for any buoyancy or depth provided by the deck. Verify trim of vessel during test. Generally, when using hydrostatic tables, trim should be restricted to less than 1% of LBP to ensure sufficient accuracy.

- i. Verify that personnel and stores present during test were properly accounted for. For smaller vessels, personnel on board the vessel shall remain in the same location during both the freeboard recording and the inclining. Check that any stores or trash that should have been removed was actually removed. Excess amounts of stores and trash are indicative of a vessel inadequately prepared and the test results may be disallowed.
- j. Verify the aggregate weight (sum of additions, deductions, and relocations, neglecting tankage, incline weights, and inclining equipment) to correct the as-surveyed displacement to the lightship displacement is less than 2% of the vessel's lightship displacement. Excess weights to add or delete are indicative of a vessel which was not adequately complete and the stability test results may be disallowed.
- k. Verify liquid loadings present during test. Slack tankage in excess of the limits prescribed in reference (c) or expressly permitted in the approved stability test procedure is indicative of a vessel inadequately prepared and the test results may be disallowed.

4. Additional Guidance Applicable only to Deadweight Survey Results

- a. Deadweight Survey Only – Ensure that the calculation of lightship characteristics from the as-surveyed condition of the vessel adequately assesses the height of the lightship VCG. Lightship VCG height may be conservatively assumed or estimated. The margin applied to the estimated VCG height should be commensurate with the level of detail presented in weight estimates, when the weight estimate is presented, and how well the deadweight survey results correlate with the estimate.
- b. If the results of the deadweight survey indicated inaccuracies with the weight estimates, a complete inclining may be required.

Note: Typically, a deadweight survey is required for determining the lightship characteristics of any type of barge (deck cargo, derrick, open hopper or tank barge) operating in inland or ocean routes. Displacement, LCG and VCG can be determined by a detailed shipyard weight estimate, with a confirming deadweight survey, to check the accuracy of the weight estimate. If the measured displacement and LCG agree with the predictions of the detailed weight estimate, then the estimated lightship VCG will be accepted as valid. However, MSC may require a stability test on any barge when the size or complexity of the barge warrants it, or when there are large unknown quantities (e.g., a derrick barge with a derrick that does not have a detailed manufacturer's information as to weight and center of gravity).

- c. Inland tank barges inspected under Subchapter D do not have specific stability requirements [MSM Volume IV Chapter 6.e.5] if the barge;
 - (1) is of conventional type,
 - (2) carries all cargo below the main deck,
 - (3) has an oil-tight or watertight centerline bulkhead in way of cargo compartments,
 - (4) carries no more than 1/3 of tank pairs slack, and
 - (5) has a load line draft-to-depth ratio no greater than 0.85.

Therefore, a stability test (deadweight survey) is not required for these barges.

5. Additional Guidance Applicable only to Inclining Results

- a. Ensure the following additional items are included in the submittal for inclining experiments:
 - (1) Test field notes signed by the Coast Guard witness indicating:
 - (i) Incline weight certifications or validation
 - (ii) Pendulum locations and lengths
 - (iii) Pendulum deflection readings
 - (iv) Incline weight locations and movements
 - (2) Details of any alternate heel measurement methods, as approved in the stability test procedure, which were employed during the inclining
 - (3) Tangent-moment plot
 - (4) Calculation of as-surveyed metacentric height (GM) and VCG from the incline tangent-moment plot.
- b. Verify plotting of data points. Ensure deviations from a straight moment-tangent line are addressed. They may indicate that other moments were acting on the vessel during the inclining and should be assessed. Provided there is good agreement among the three pendulums, the graph may include the average pendulum reading instead of the individual readings.
- c. Verify that the vessel was in the same loading condition (incline weights, personnel, pendulums, liquid loading, etc.) during the both the deadweight survey and inclining.
- d. Verify incline angles obtained during the test. The maximum inclination should be between 1 and 4 degrees, with 2 to 3 degrees preferred. Angles exceeding 4 degrees could result in movement of the metacenter, invalidating the test.
- e. Verify adequate pendulum deflection. A minimum of 6 inches of deflection to each side of the zero point is required to ensure accuracy. If alternate measurement methods were employed, ensure appropriate accuracies and deflections were achieved. The alternate methods accepted to date include:
 - (1) U-tube manometers. When employed as a substitute for up to 2 of the 3 required pendulums, u-tube manometers must be readable to 1/16th of an inch and a minimum of 6 inches of deflection must be attained above and below the zero point on each side of the vessel. Details of the u-tube test configuration including tube diameter and location/routing must be also be submitted.
 - (2) Digital Inclinator. When employed as a substitute for up to 2 of the required 3 pendulums, digital inclinometers must have a precision and accuracy at least equivalent to the remaining pendulum(s). Typically a precision of at least +/- 0.01 degrees with an accuracy of +/- 0.05 degrees is adequate. Manufacturer's data or certification for the inclinometer must also be submitted.
 - (3) Laser levels. When employed as a substitute for up to 2 of the 3 required pendulums, laser levels must be readable to 1/16th of an inch and a minimum of 6 inches of deflection must be attained above and below the zero point. Details of the laser level test configuration must be submitted.
- f. Verify acceptability of any free surface corrections used in the calculation of VCG. Generally, free surface corrections will not be allowed for slack tanks in excess of those allowed by 46 CFR 170.185. At no time will a free surface correction be allowed for loose water (i.e. bilge water).

6. Additional Information

Additional information on stability test related topics that may assist you preparing your stability test results can be found in references (a) through (f).

7. 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.