

**DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD**

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COMDTPUB 16700.4
NVIC 3-89
7 SEP 1989

NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 3-89

Electronic Version for Distribution via the WWW.

Subj: Guidelines for the Presentation of Stability Information for Operating Personnel

Ref: (a) 46 CFR 170 Subpart D, Stability Instructions for Operating Personnel

1. **PURPOSE**. The purpose of this Circular is to provide the marine industry with guidelines for the preparation of stability information that is provided for ensuring the safe operation of vessels, as defined by compliance with Coast Guard stability standards.
2. **APPLICATION** This guidance is for use by those required to submit stability information to the Coast Guard for inspected vessels and other vessels assigned load lines by or on behalf of the Commandant. The guidance is generally applicable to vessels of all sizes and in all services, from vessels that need only a sentence of guidance to vessels whose stability must be ascertained by detailed calculations performed on board. This guidance is not provided specifically with mobile offshore drilling units in mind, but portions of this guidance are appropriate for the operating manual required by 46 CFR 109.121. This guidance may be used by the Coast Guard during stability review, or by an organization performing stability review on behalf of the Coast Guard.
3. **BACKGROUND**
 - a. Reference (a) requires stability instructions for operating personnel of certain inspected vessels. Similarly, 46 CFR 42.15-1(b) requires that stability information approved by the Commandant be provided to operating personnel of new vessels which have load lines issued by the United States. The intent of the regulatory requirements is to provide information to the operator of a vessel that will enable the operator to readily ascertain the stability of the vessel under varying loading conditions and to operate the vessel in compliance with applicable stability criteria.
 - b. The Coast Guard reviews calculations which demonstrate compliance with applicable stability criteria. As part of that review, the operating guidance is reviewed for technical detail, sufficiency, clarity, and ease of use. The review is normally performed by the Marine Safety Center, the cognizant Officer in Charge of Marine Inspection (OCMI), or the American Bureau of Shipping (ABS) on behalf of the Coast Guard.
 - c. Use of vessels in services for which they were not originally designed has led to confusion and inconsistency in developing suitable stability guidance. Unfamiliarity with Coast Guard practices has affected many deliveries as the industry relies more on the support of individuals with little or no experience with Coast Guard review.

- d. A series of tugboat capsizings in the mid 1980s indicated that the operators of some vessels were not familiar with what is assumed to be good marine practice related to stability. Consequently, the Coast Guard now ensures stability information is provided for most vessels receiving a Load Line Certificate or a Certificate of Inspection. The information may be in the form of a stability letter or placed on the Certificate of Inspection or the Load Line Certificate. In many cases, the information is simply a short list of good marine practices upon which stability calculations have been based.

4. DISCUSSION

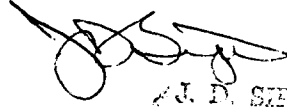
- a. The format of the required stability information, exclusive of the Coast Guard issued stability letter, is intentionally left to the discretion of the owner. The Coast Guard prefers to have the owner propose the format and content of the stability information, since vessel arrangements, operations, and the capabilities of operating personnel vary significantly. However, the Coast Guard must determine that the format and content are appropriate for the vessel and suitable for use by the vessel's operators.
- b. Stability information should be simple to use, appropriate for any operator of the vessel, and free from unnecessary or confusing information. Generally, the stability information becomes 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. The Coast Guard encourages the use of the simplest guidance for vessels; however, restricting operating flexibility for the purpose of simplifying stability information is not intended by the Coast Guard.
- c. Enclosure (1) contains the recommendations of the Commandant in regard to the format and detail of required stability information for operating personnel.
- d. Enclosure (2) provides guidance suitable for use in the preparation of the type of stability information that is typically used on large vessels.
- e. Enclosure (3) is a sample stability letter that the Marine Safety Center uses in tailoring individual stability letters for vessels. The instructions, in general, are suitable for most vessels.

5. IMPLEMENTATION

- a. The Coast Guard encourages owners to work with vessel designers when stability guidance is being prepared. The designer must know the constraints of the vessel's operations and the capabilities of its operating personnel. The owner must ensure that vessel operators are capable of readily and safely using the supplied stability guidance.

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- b. Designers and owners should consult enclosure (1) when developing stability information for operating personnel. Early discussion with the cognizant reviewing office is encouraged, to ensure that the form of the guidance provided to operating personnel will be acceptable to the Coast Guard.



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- End: (1) Guidelines for Presenting Stability Information to Operating Personnel
(2) IMO MSC Circular 456, Guidelines for the Preparation of Intact Stability Information
(3) Sample simplified stability letter for small vessels

NON-STANDARD DISTRIBUTION:

- C:e New Orleans (90); Baltimore (45); San Francisco (40); Port Arthur, Honolulu, Puget Sound (35); Miami, Mobile, Long Beach, Morgan City (25); Hampton Roads, Jacksonville Portland OR (20); Boston, Portland ME, Charleston, Anchorage (15); Cleveland (12); Louisville, Memphis, Paducah, Pittsburgh, St. Louis, Savannah, San Juan, Tampa, Galveston, Buffalo, Chicago, Detroit, Duluth, Milwaukee, San Diego, Juneau, Valdez (10); Providence, Huntington, Wilmington, Corpus Christi, Toledo (5).
- C:m New York (70); Philadelphia (35); Houston (25); St Ignace (5); Sturgeon Bay (4).
- D:1 CG Liaison Officer MILSEALIFTCOMD M-65 STRAT MOB,
CG Liaison Officer JUSMAGPHIL (1).

GUIDELINES FOR THE PRESENTATION OF STABILITY INFORMATION TO OPERATING PERSONNEL

1. SIMPLIFIED INFORMATION vs. TRIM AND STABILITY BOOKLET

All vessels which obtain a Certificate of Inspection and/or a U.S. Load Line Certificate must be provided with stability information for operating personnel. The information should be clear and concise. For a few uncomplicated vessels such as some tank barges, and some passenger vessels less than 65 feet in length, the guidance may be reduced to a few sentences on the Load Line Certificate or the Certificate of Inspection. All other vessels are issued a stability letter that either contains all of the necessary stability information or refers to a more complete Trim and Stability (T&S) booklet.

The major difference between the two methods of presenting stability information is that a "simplified stability letter" contains all necessary instructions in the letter itself and may refer to a limited number of attached loading diagrams. Use of an attached loading diagram should require no more calculation than simple addition. A T&S booklet usually requires operating personnel to calculate moments for the determination of the vertical location of the effective center of gravity of the loaded vessel.

The desired wording for a simplified stability letter may be proposed by the owner. However, the Coast Guard will issue a stability letter which includes standard phrases to provide consistency among vessels and ensure that underlying assumptions are stated. This is routinely done with small passenger vessels. It is recommended that proposed wording be submitted for an industrial vessel to ensure that any restrictions assumed in the stability calculations are stated on the stability letter, in a suitable manner intended by the owner.

In those cases where a complete T&S booklet is not desirable but a number of graphs are needed to make use of the vessel's capabilities, a booklet is preferred. It need not require operating personnel to perform detailed stability calculations to be called a T&S booklet.

In some cases a blend of the two formats is needed to account for desired loading that necessitates calculations and for operators who have licenses which do not require mathematical aptitude. The guidance suitable for the license required should precede a section that allows detailed calculations. When the Coast Guard requires simple guidance but the owner desires the capabilities afforded by detailed calculations, the owner should present the reviewing office with a letter confirming that the owner will operate the vessel with personnel capable of using the detailed calculation section when the loading so requires. When that is the case, a statement should be made in the general operating instructions of the manual stating such intentions. In special cases, such as dynamically supported craft and submersibles, the Coast Guard may require specific training and detailed operating manuals to ensure safe operation.

2. NON-ESSENTIAL INFORMATION/SUPPORTING CALCULATIONS

The T&S booklet should contain only that information necessary to ensure the vessel has adequate stability for the route and service intended. It should not contain extraneous information or information that might confuse operating personnel. Stability test calculations and stability criteria calculations ~~should~~ appear in the information presented to operating personnel as the necessary stability guidance. If an owner wishes to present background information to operating personnel, it should be clearly separate from the required guidance.

The stability information should describe the conditions for which supporting calculations are valid. For example, the center of gravity of deck cargo, the doors which must remain closed when the vessel

is underway, and slack tank assumptions from the supporting calculations are some items of information which should be addressed to ensure compliance with the applicable stability criteria.

Inclusion of righting arm (or energy) calculations in the stability information to be used by operating personnel is not appropriate. Operating personnel do not have the time to perform such calculations and can not be expected to be familiar with the criteria. As a matter of reference only, righting arm curves for specific sample loading conditions might be included in a detailed T&S booklet for an ocean-going vessel. Generally, presentation of the criteria can be expected to lead to mis-application of the criteria or even to confuse operating personnel. Supporting information might best be collated in a single "stability supporting data booklet," separate from the required T&S booklet.

Tank sounding tables should normally be included in the T&S booklet in those cases where their use is necessary to perform the required calculations. However, the tables need not be a part of the T&S booklet when they are bulky.

3. STANDARD SIMPLE INSTRUCTIONS FOR ALL VESSELS

A list of general instructions will be included in stability letters unless they are included in T&S booklets. These can normally be single sentences addressing "good marine" practices. Such practices are often not addressed in stability calculations. They should include:

- a. keeping bilges pumped to minimum content
- b. maintaining freeing ports operable and unobstructed
- c. securing cargo to prevent shifting
- d. keeping weather doors and hatches closed
- e. keeping the number of slack tanks to a minimum
- f. keeping cross-connections between tanks closed
- g. determining the cause of list prior to taking actions to correct it
- h. stating the standard of subdivision and the location of watertight (WT) bulkheads
- i. keeping doors in watertight bulkheads closed
- j. minimizing trim
- k. stating that it is the responsibility of operating personnel to ensure a satisfactory stability condition at all times

4. SIMPLE INSTRUCTIONS FOR SPECIFIC VESSELS

Especially in the case of simplified stability letters, the operating limitations for which stability criteria have been shown satisfactory are reflected in a list of simple instructions. These might form part of the general instructions in a T&S book and include items such as:

- a. route restrictions
- b. maximum draft(s) (and any trim limitations from stability criteria)
- c. maximum weight of deck cargo and its VCG and height
- d. location of internal watertight doors and other fittings to be kept closed
- e. limitations on slack tanks for each type of liquid
- f. restrictions on the use of liquid ballast
- g. fixed/required ballast and foam flotation descriptions and locations with warnings not to change the installations without Coast Guard approval
- h. number of passengers allowed
- i. restrictions on the number of passengers allowed on upper decks

- j. description of watertight bulkheads on vessels subject to damage stability requirements

5. SAMPLE LOADING CONDITIONS

Sample stability loading conditions serve two purposes. First, when used to support a simplified stability letter, they demonstrate compliance with applicable stability criteria for the requested loading. In this case, operating personnel do not need the calculations. Second, when used in a T&S booklet, they serve as a reference from which to understand instructions for calculating specific conditions and as specific voyage guidelines. If a reasonable number of sample loading conditions are presented to describe a complete voyage, they may serve as the calculations for that voyage. This is often possible for tank vessels and passenger vessels, especially when tanks that carry consumable liquids are located on a single deck level.

Sample loading conditions in a T&S booklet should be worked out fully so that operating personnel can follow through them if necessary. A minimum of three sample conditions is recommended. They should normally include conditions at the maximum (load line) draft, conditions with 100, 50, and 10 percent of consumable liquids and stores, and any other important or typical conditions. All sample conditions should be accurate and shown to comply with the applicable stability criteria.

6. SIMPLIFYING ASSUMPTIONS

Simplified assumptions that ensure a margin of safety in supporting calculations permit the use of simple instructions and therefore their use is encouraged. Such assumptions can help avoid mathematical complexities and overcome time constraints placed on operating personnel. At one end of the spectrum, small passenger vessel operators may not have to perform any calculations. Consequently, few conditions are approved, and they must "bracket" the conditions which are to be allowed. For example, the maximum possible free surface effect for all liquid loads may be applied in all loading conditions regardless of actual soundings. Normally, this would require examining only departure and arrival loading conditions. At the other end of the spectrum, operating personnel of an integrated tug-barge carrying grain, chemicals and/or oil might use the vertical center of gravity (VCG) of a full tank in the calculations for a tank which is actually slack.

In some cases, a T&S booklet is necessary for a vessel because simplifying assumptions would be too restrictive. In such cases, consideration should be given to including a "quick and dirty" section in the booklet which would be sufficient for many voyages. Such a section would save operating personnel considerable time and effort yet allow checking compliance with the applicable stability criteria for unusual or more complex loading conditions.

Specific simplifying assumptions which are often used include:

- a. Free surface is limited to a single P/S pair (or centerline) of slack tanks for each liquid. This is often done for consumables on large vessels. On small passenger vessels, the assumption that a single P/S pair of tanks is slack should be made for any tanks which are fitted, including nonconsumables such as ballast since the operator may use them but will not be performing calculations. If more than a single centerline or pair of tanks for a specific liquid are to be carried slack, then all of the tanks carried slack should be used in the calculations.

- b. The vertical center of gravity (VCG) of individual tanks is assumed to be at the location for a full tank, regardless of the actual sounding. This shortens the time to perform calculations and reduces possible errors when using tank data.
- c. The VCG of deck cargo is assumed to be at some maximum level (3 feet above the deck of an offshore supply vessel for example). This may eliminate the need to calculate moments for each parcel of cargo. For deck cargo barges, the height of deck cargo as a function of draft may be the only specific instruction necessary.
- d. The VCG of solid cargo is assumed to be at its mid-height unless contradictory information exists. This is usually a safe assumption for containers, pipe, grain, etc. When carrying stacked containers (break bulk cargo), the operator should be advised to ensure that the weight of each tier is less than the weight of the next lower tier to ensure the validity of this assumption.

7. METHODS TO SIMPLIFY CALCULATIONS IN A TRIM AND STABILITY BOOKLET

- a. Simplifying assumptions such as those in 6.a. through 6.d. above may be used to reduce the number of required calculations by operating personnel.
- b. Vessel KG (height of VCG above the baseline) can be used in lieu of ~~GM~~ metacentric height) for the curve demonstrating compliance with the applicable stability criteria. This precludes the need to calculate GM and affords the opportunity to relate to a geometric parameter that operating personnel can understand.
- c. The free surface correction described in 6.a. above (if used) may be included in a KG allowable curve. This would eliminate all free surface calculations by operating personnel. This can be done with different slack tank scenarios such as one or two pairs of slack liquid mud tanks on offshore supply vessels.
- d. Interpolation and the use of curves can be eliminated by presenting data in tables. Care must be taken to have the most limiting criteria apply. This works well when the allowable KG is a constantly increasing or a constantly decreasing value, as is normally the case for broad shallow-draft vessels. Tables can be quite helpful when using hydrostatic data.
- e. Vertical moment may be used in lieu of KG. This can eliminate some calculations, especially when tank tables include moments, but it may not readily provide a comparison of KG to physical arrangements.
- f. A longitudinal center of gravity (LCG) allowable may be used to control trim. When the applicable criteria impose trim limitations, an LCG allowable range at each displacement may be used. The need to calculate trim or LCG is not as critical as calculating KG. Trim on small vessels on short voyages may be checked by reading draft marks on the hull. In such cases, operating personnel need not calculate trim or LCG. Most small passenger vessels and offshore supply vessels can use hull markings to monitor trim. Limiting aft trim can readily be checked by painting marks at the stern. Painted marks are preferred to having operating personnel measure freeboards.

8. RECOMMENDED PRESENTATION DETAILS FOR A TRIM AND STABILITY BOOKLET

International standards and recommendations are developed by the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO). Circular 456, "Guidelines for the Preparation of Intact Stability Information", was published in 1986 and is a good guide for drafting T&S booklets. Much of the information resembles the requirements of 46 CFR 170.110. MSC

Numerous published works address stability information for operating personnel, especially with regard to T&S booklets. In 1980, E. C Frankel, Inc. studied and documented practices in writing T&S booklets. The 372 page final report may be obtained from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161 as report number AD A098157. A recommended T&S booklet is proposed in the report, together with graphic standards and guidelines. Many of the following recommendations are made in the report:

- a. KG allowable in lieu of GM required
- b. tabular data at small increments of draft or displacement in lieu of curves
- c. instructions for the use of graphs located on the graphs
- d. large grid graph paper in lieu of background grid
- e. label safe and unsafe sides of curves (text to explain that safe means in compliance with applicable stability criteria)
- f. type numbers in lieu of handwriting them
- g. all pages oriented in the same direction
- h. all pages labeled and numbered
- i. index or table of contents included
- j. reference specific stability criteria only for information
- k. units of measure consistent throughout
- l. vessel particulars section to include at least:
 - (1) builder and hull number
 - (2) year and location of build
 - (3) current and original name
 - (4) official number
 - (5) length, breadth, depth, and maximum draft
 - (6) service and route

Photocopied versions of information to be presented in T&S booklets tend to become illegible after repeated reproduction. Since the stability information must last a vessel's lifetime, care should be taken to ensure that reproduced information is legible.

9. GUIDELINES FOR SPECIFIC TYPES OF VESSELS

- a. A complete description concerning the stability review of tugboats was presented by McGowan and Meyer in "Has Stability Delayed the Delivery of Your Tug?" Marine Technology, January 1980, Society of Naval Architects and Marine Engineers (SNAME). The simplified assumptions used in the suggested stability evaluation procedure will normally ensure the simplest of stability information for operating personnel, a list of good marine practices and the maximum draft. Copies of Marine Technology can be obtained from SNAME, 601 Pavonia Avenue, Jersey City, NJ 07306.
- b. A complete description concerning the stability review of offshore supply vessels was presented by Meyer and Feeney in "A Simplified Stability Letter for Offshore Supply Vessels", Marine Technology January 1981. The simplified assumptions used in the

suggested stability evaluation procedure will normally ensure the simplest of stability information for operating personnel, a list of good marine practices and a loading diagram that merely requires the addition of deck cargo weights and the addition of below-deck cargo weights. This procedure can readily be used with single deck vessels in other services.

- c. NVIC 5-86, Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels, was published as part of a voluntary safety initiative. The section on presenting stability information demonstrates the use of some simplified methods, including a pictorial format, a tabular condition format, a simple letter format, and a simplified trim and stability booklet format. The stability material in the NVIC 5-86 contains considerable information that is also appropriate for other types of vessels.
- d. Stability calculations for each voyage are not necessary for some vessels if they are always loaded in the same manner. Most tankships have a T&S booklet with multiple sample conditions that encompass all normal loading conditions. Similarly, small passenger vessels have loading limitations in their stability letters for worst case sample loading conditions. Conversely, container vessels and product carriers are examples of vessel types that often require calculations by operating personnel for specific loading conditions due to the variability of the loading.

10. COMPUTER APPLICATIONS

Computers are used in varying degrees as a tool to help the ship operator evaluate stability. They vary from hand held calculators for simple addition to computer systems dedicated to calculating stability, with output ranging from KG to graphic analysis of righting arm curves after damage. In any case, an approved T&S booklet should be carried on board as a back-up in the event the computer becomes inoperative. The following features are recommended for any computerized system used for stability:

- a. A printed record of all inputs which can then be verified against the actual loading. The input form used should be similar to that in the T&S booklet so that the operators gain familiarity with the T&S booklet in the event of a computer system failure.
- b. A test program to check the results against known pre-calculated conditions in the T&S booklet.
- c. A decision point in the program for the operator to make the determination that the stability is satisfactory and to record agreement with the stability evaluation.
- d. A process that is as simple and straightforward as possible for entering the data needed by the computer to perform the required calculations.

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Ref. T4/1.03

MSC/Circ .456
13 October 1986

GUIDELINES FOR THE PREPARATION OF INTACT STABILITY INFORMATION

- 1 The Maritime Safety Committee at its fifty-third session, adopted Guidelines for the preparation of intact stability information for the master which are set out in the annex.
- 2 Member Governments are invited to ensure their widespread circulation and in particular to:
 - .1 utilize these guidelines to decide the extent of intact stability information necessary and appropriate to the type of ship and mode of operation;
 - .2 encourage designers and owners to use these guidelines in the preparation of all necessary documentation for the proper operation of the ship;
 - .3 encourage designers to provide a simplified but meaningful summary of the intact stability information, derived from data collected under the preceding paragraph to assist the master in the routine operation of his ship and to provide him with the means of evaluating the stability of his ship in other conditions;
 - .4 acknowledge the availability of electronic aids and their use in the more complicated operating conditions as a supplement to the information otherwise provided.

ANNEX

GUIDELINES FOR THE PREPARATION OF INTACT STABILITY INFORMATION

1 INTRODUCTION

Intact stability information covering the general operation of the ship is required for most ships by regulation 11-1/22 of the International Convention for the Safety of Life at Sea, 1974, as amended, and by regulation 10 of the International Convention on Load Lines, 1966.

Additional specific intact stability information is recommended by other international instruments.

The following guidelines are offered to assist Administrations, ship designers, ship owners, masters and all others concerned with the proper design, construction and operation of ships to decide the proper extent of stability information required and necessary.

2 CATEGORIES OF INFORMATION

Information included in a stability document should be classified as follows:

2.1 Category IA

Information which includes all basic data necessary to obtain the trim and stability characteristics of the ship.

It may be necessary however to supplement this information to meet current requirements of the Administration concerned.

2.2 Category 1B

Optional information which is deemed by owners to be useful material appropriate to the operation of the ship.

2.3 Category 2

Information which provides the master with ready means of ensuring that the ship's stability parameters for a given service and condition of loading lie within the limits dictated by the Administration. Included also in this category is information which will enable the master by using data provided under category 1 to obtain further information as may be required by the

Administration or by himself for the proper working of the ship. Information within this category may be simplified if in the opinion of the Administration, or government recognized organization, the ship is not critical in terms of the required stability criteria within the range and type of loading conditions and for the service intended.

3 GENERAL

- 3.1 An index of contents should precede all information in the document.
- 3.2 The pages of the stability document should be numbered to facilitate access to data in association with the index of contents and appropriate references.
- 3.3 Units of measurement should be consistent throughout the stability document. The main units of measurement may however be transposed to other units for reference purposes provided this does not conflict with consistent use of the data provided. All units of measurement should be clearly and unambiguously stated.
- 3.4 Computations which support the data included under categories I and 2 should not be included in the stability document.
- 3.5 The accuracy and correctness of the information included in the document under category 1B should be the responsibility of the owners.
- 3.6 Information provided under different categories need not be physically separated within the document) however, any information provided under category 1B should be clearly identified.

3.7 Longitudinal, vertical and transverse centers of mass) volume, buoyancy and floatation should be given relative to common reference planes.

3.8 A description of each category should be included in the document. (see section 2)

4 CATEGORY 1A

Information under this category should include the following:

4.1 General information

- .1 ship's name;
- .2 type of ship (e.g. general cargo ship, container ship, oil tanker etc.);
- .3 name of builders and yard number;
- .4 date of build/conversion;
- .5 particulars of classification;
- .6 nationality, port of registry and official number;
- .7 principal dimensions (length, breadth and depth);
- .8 maximum mean permissible draught corresponding to the summer freeboard assigned;
- .9 maximum mean permissible draught corresponding to the summer timber freeboard (if appropriate);
- .10 displacement in salt water (at stated density) corresponding to .8 and .9 at the designed trim;
- .11 the minimum recommended draught at the forward perpendicular for any sailing condition.

4.2 Arrangement drawing

A scaled drawing showing clearly the use and distribution of the various cargo compartments, tanks, stores as well as machinery, crew and passenger accommodation spaces.

Names of compartments used in the text of the document should be clearly indicated.

4.3 Weights and centers of mass

Estimated total weight and center of mass of items such as:

- .1 passengers and their effects;

- .2 crew and their effects;
- .3 vehicles in the case of car ferries;
- .4 deck cargoes;
- .5 hanging loads;
- .6 container cargoes.

In the case of ships intended for the carriage of containers, a container stowage plan should be included using a numbering system to enable the weight and center of every container on board to be obtained. The maximum and minimum (unladen) weight of all containers should be given.

Where necessary, guidance should be given as to the methods used in assessing weights and centers of mass.

4.4 Volumes and centers of volume

A table of capacities with centers of volume (longitudinal, vertical and transverse) for every compartment available for the carriage of cargo, fuel, stores, feed water, domestic water and water ballast.

Where applicable, tables or curves giving capacity and center of volume as functions of compartment depth onullage should be included. When ullage is used, the ullage reference point should be stated.

4.5 Free surface effects

Tables and/or curves for every tank as a function of volume showing the effect on the stability of the ship of liquids in partially filled tanks.

These tables/curves should give the free surface moments necessary to correct the initial metacentric height and those to correct the righting lever values when the ship is inclined.

- 4.5.1 In the case of tanks containing liquids which may be consumed, discharged or transferred to and from other compartments whilst the ship is at sea, including anti-rolling tanks and/or heeling tanks, the maximum free surface moments which may be developed should be given.

For the purpose of correcting the initial metacentric height, the data provided for such tanks should be a function of the maximum attainable second moment of liquid surface area about the principal axis of rotation parallel to the centerline of the ship when not inclined.

Corresponding data for correcting the righting lever values may be computed using the method described in section 3 of appendix I to resolution A.167(ES.IV). This method provides a means for calculating the maximum free surface moments of tanks which are approximately trapezoidal in cross-section. In the case of

irregularly shaped tanks such free surface moments should be obtained independently by direct calculation.

- 4.5.2 When holds or deep tanks containing liquids are maintained partially filled whilst the ship is at sea, the free surface moments used may be based upon the actual quantity of fluid contained.

If due to the service of the ship different amounts of liquids are carried, the free surface moments for such a space may be calibrated against volume and depth of filling.

- 4.5.3 Where it can be shown that by using methods which do not correctly obtain the free surface moments for a particular space but which nevertheless show the ship's critical stability parameters to be more onerous than they are in practice, such methods may be used subject to agreement by the Administration.

4.6 Lightship particulars and rolling coefficient

Details resulting from the inclining experiment as follows:

- .1 lightship weight;
- .2 longitudinal center of gravity of lightship;
- .3 vertical center of gravity of lightship;
- .4 transverse center of gravity of lightship if necessary;
- .5 place at and date on which inclining experiment was conducted;
- .6 name of organization responsible for the approval of results obtained during the inclining experiment.

The position of the reference planes should be stated for items specified in .2, .3 and .4.

If dispensation from carrying out an inclining experiment has been given, the name of the authority and the reasons should be stated. If details of the lightship have been based on a sister ship, the builder and builders number of the sister ship should be stated together with items specified in .1 to .6. In such a case details corresponding to .1, .2, .4, .5 and .6 which apply to the lightship check should be given.

If differences in values of items specified in .1 to .4 from the sister ship have been used and there are known reasons, these should be stated together with a summary showing how the adopted values have arisen.

If permanent ballast is included in the lightship particulars, a description of such ballast should be included giving the material, its mass and distribution relative to the common reference planes.

A sketch showing the distribution of such ballast should be included.

If a rolling period test is required by the Administration, details of the result should be given.

4.7 Hydrostatic particulars

Hydrostatic particulars of the ship at the designed trim drawn in curves or tabulated to a base of mean draught measured to the bottom of the keel over a range covering the lightship and maximum draughts.

When tabulated, these should correspond to evenly-spaced rounded units of draught at intervals appropriate to the size and type of ship.

If the hydrostatic particulars are presented in the form of curves their scales and accuracy should be to the satisfaction of the Administration or government recognized organization. The particulars should include:

- .1 extreme displacement in salt water at stated density;
- .2 immersion (displacement per unit interval of draught);
- .3 moment to change trim one unit;
- .4 transverse metacentric height;
- .5 longitudinal metacentric height;
- .6 vertical center of buoyancy;
- .7 longitudinal center of floatation;
- .8 longitudinal center of buoyancy.

Position of reference planes should be stated in the case of items specified in .4 to .8.

Where operation of the ship results in loading conditions having significant trim, additional hydrostatic particulars should be included for a suitable range of trim.

4.8 Deadweight particulars and details of draught marks

If required by the Administration a diagram or tabular presentation giving the relationships between:

- .1 mean draught;
- .2 extreme displacement;
- .3 immersion (displacement per unit interval of draught);
- .4 deadweight.

If desired, in lieu of the above, the deadweight information may be included in the hydrostatic particulars.

If required, the positions of the draught marks should be defined in relation to the ship's perpendiculars.

4.9 Form stability particulars

Form stability data at the designed trim showing the relationship between righting lever, angle of heel and displacement drawn in curves or tabulated.

The data should cover the full range of displacement extending from light to maximum draughts with a range of inclination appropriate to the type of ship and stability criteria adopted.

If the data is given in the form of curves, the scale and accuracy should be to the satisfaction of the Administration or government recognized organization. Intervals of displacement and righting lever when tabulated and angles of inclination should be sufficient to meet the accuracy demanded by the stability criteria. Below 500 the intervals of inclination should not exceed 100, however, closer spacing may be required according to the ship form and proportions, also to the stability criteria adopted.

A statement should be appended to the data indicating the erections and/or timber deck loads which are included.

Where the operating trim or the form and arrangement of the ship are such that change in trim has an appreciable effect on righting arms, additional form stability data should be included for a suitable range of trim.

5 CATEGORY 2

Information under this category should include the following:

5.1 Stability criteria

Full details of the stability criteria appropriate to the ship under all anticipated conditions of service should be clearly stated in text supplemented, as necessary, by diagrams using the nomenclature adopted for the data given in category I.

Where requirements for wind and/or wave forces and ice accretion as specified by the Administration, full details should be given.

5.2 Details relating to the assigned load line

- .1 a statement giving the type of load line assigned (type A, B etc);
- .2 the displacement of the ship on the summer load waterline at the designed trim in water at a density of 1.025 metric tons per cubic meter;
- .3 the maximum permissible draught at the forward perpendicular if necessary for bow height consideration;

- .4 the minimum permissible freeboard at the stern if required by the Administration;
- .5 a diagram of the load line marks showing:
 - .5.1 the position of the deck line relative to the ship;
 - .5.2 the draught to the summer load waterline;
 - .5.3 the draught to the summer timber load waterline (if appropriate);
 - .5.4 the corresponding freeboards.

5.3 Critical stability data

A pre-calculated table and/or diagram from which the master can determine if the stability of the ship is acceptable for a given loading condition under the governing stability criteria.

This information should show, for example, the maximum allowable height of the loaded ship's center of gravity or the maximum allowable static (displacement or deadweight) moment about the bottom of keel as a function of draught or displacement.

The form of the data and the parameters used should be to the satisfaction of the Administration taking into account the stability criteria adopted, the ship type and the service intended.

The data should extend from the lightest anticipated sea-going draught to the minimum freeboard assigned.

If two or more independent governing stability parameters or conditions of service are included in the stability criteria the information should provide for any combination.

Where the operating trim or the form and arrangement of the ship are such that a change in trim has an appreciable effect on righting arms additional pre-calculated tables/diagrams should be included for a suitable range of trim.

5.4 Conditions of loading

Conditions of loading appropriate to the operation of the ship should be included showing the practical limits of service for which the ship is intended and to demonstrate the stability characteristics in relation to the specified stability criteria.

The following conditions of loading should also be included unless they are clearly inappropriate:

- .1 light condition;
- .2 docking condition;
- .3 the conditions of loading stipulated in section 1 of appendix II to resolution A. 167 (ES.IV);

- .4 departure and arrival conditions of loading for which the ship has been specially designed (e.g. alternate hold loading, timber deck cargoes, containers on deck etc.).

Where icing is likely to occur the loading conditions should take this into account.

5.4.1 Each condition of loading should include:

- .1 a sketch of the ship indicating, pictorially, the main items of deadweight included in the displacement.
- .2 a table showing the lightship particulars, the distribution of all components of the deadweight, the positions of their centers relative to the defined reference planes, corresponding static moments and a summation giving the result. The result should show the full weight of displacement and the position of its center.
- .3 a table listing the free surface effects of liquids in all compartments which may be partly filled.
- .4 a diagram showing the curve of righting levers (GZ) plotted against angle of inclination. The righting levers are to be corrected for free surface effects (see .3).

Wind and/or other heeling lever curves are to be superimposed on the diagram as appropriate and it should be demonstrated that all the stability criteria have been met.

The scales used in this diagram should be the same for each loading condition.

- .5 a summary of the appropriate condition giving:
 - .5.1 displacement;
 - .5.2 corresponding designed trim draught at longitudinal center of floatation;
 - .5.3 moment to change trim one unit;
 - .5.4 longitudinal position of center of buoyancy;
 - .5.5 longitudinal position of center of gravity;
 - .5.6 trimming lever;
 - .5.7 total trim over perpendiculars;
 - .5.8 longitudinal position of center of floatation;
 - .5.9 trim at forward perpendicular;

- .5.10 trim at after perpendicular;
- .5.11 draught at forward perpendicular;
- .5.12 draught at after perpendicular;
- .5.13 draught at the forward draught mark (if required);
- .5.14 draught at the after draught mark (if required);
- .5.15 mean draught amidships;
- .5.16 the total free surface moment for initial stability;
- .5.17 the vertical position of the transverse metacentre;
- .5.18 the vertical position of the ship's center of gravity uncorrected and corrected for free surface effects;
- .5.19 the transverse metacentric height (GM) uncorrected and corrected for free surface effects;
- .5.20 a statement giving the limiting value or values of stability parameters taken from the data provided under 5.1 together with corresponding values achieved.

5.5 Master's instructions

Instructions to the master in the use of the data provided under category 1 to obtain the draught, trim and stability characteristics appropriate to a loading condition meeting the requirements of 5.1 and the draught limitations in 5.2.

These instructions should refer to numerical examples which may be drawn-up specifically for the purpose or to conditions of loading provided under 5.4.

The instructions are to be precise and unambiguous. Sources of data within the document and other information should be clearly identified.

Specific instructions should be given with regard to the following items:

- .1 calculations of displacement and centers of gravity;
- .2 calculation of draughts and trim;
- .3 correct use of the data provided under 4.5 in obtaining free surface moment data for a given loading condition;
- .4 lifting of form stability data from the information provided under 4.9 and correction to that data to account for the position of the ship's vertical center of gravity (see .1) and for free surface effects (see .3);

- .5 calculation of initial stability parameter (GM) corrected for the initial free surface effect (see .3);
- .6 calculation of the ship's vertical center of gravity corrected for the initial free surface effect (see .3);
- .7 construction of righting lever (GZ) curves;
- .8 construction of a heeling lever curve (as appropriate) relative to and on the same diagram as the righting lever (GZ) curve;
- .9 evaluation of the GZ curve (also the heeling lever curve if appropriate) in relation to the specified stability criteria;
- .10 evaluation of stability parameters) if appropriate, in relation to assumed wind and/or wave forces;
- .11 where ballasting during a voyage is necessary the master should be provided with guidance to ensure the stability of the ship;
- .12 the correct operation of anti-rolling devices and/or heeling tanks and limitations on their use;
- .13 use of the data provided under 5.3;
- .14 use of any other data provided under category A which is required by the Administration to be included as necessary information in evaluating the stability of the ship;
- .15 if information is provided under category B, instructions should be given as to its use if appropriate.

6 ADDENDUM

Use of computers in assessing the stability of a loading condition

If a computer is provided for calculating stability parameters it should be regarded) unless deemed otherwise by the Administration, as an aid to the master.

It should not replace approved documentation.

G-MSC-1
(202) 366-6481

16710/(vessel name or O.N.)
Ser H_ - _____
_____ 1989

Master, _____

Subj: _____ (EX: _____), O.N. _____
Small Passenger Vessel (T-L)
(Temporary) Stability Letter

Dear Master:

You are responsible for maintaining this vessel in a satisfactory stability condition at all times and for following the instructions and precautions listed below.

A stability test witnessed by the U. S. Coast Guard was conducted on the _____
(Ex: _____), O.N. _____ Hull _____, sistership of the subject vessel, at
_____ on _____. On the basis of this test and a deadweight survey
performed on the subject vessel at _____ on _____
stability calculations have been performed. Results indicate that the stability of the _____ as
presently outfitted and equipped is satisfactory (on a temporary basis) for operation (only in the offshore oil
industry trade) on exposed/protected/partially protected waters, provided that the following restrictions are
strictly observed.

SUBDIVISION

When operated as indicated below, calculations indicate this vessel will remain afloat with any one major compartment flooded (one-compartment subdivision). A major compartment is the total space between any two adjacent Main Transverse watertight Bulkheads (MTWB). For this vessel, the MTWBs are located at frames ___, ___, ___, ___, ___, and ___/ feet forward of the transom at the side. Calculations further indicate this vessel will remain afloat with any two adjacent major compartments flooded forward of frame _____. This standard of safety is described as Type I/II subdivision and is detailed in Title 46 Code of Federal Regulations (CFR), Chapter I, Part 171.

DAMAGE SURVIVAL

Calculations indicate this vessel will stay upright (no more than ___ degrees of list under ideal conditions) after side damage when the side damage is limited to any one major compartment and not more than ___ feet inboard from the side of the hull. Calculations further indicate this vessel will stay upright when side damage is limited to any two adjacent major compartments forward of frame _____ and not more than ___ feet inboard from the side of the hull.

To maintain the vessel upright after flooding (damage), the heeling forces imposed by wind, wave and passenger movements must be minimized. The calculations do not specifically account for high winds, heavy seas or the movement of many passengers to one side.

16710/ _____
 Ser H - _____
 _____ 1989

Subj: _____

OPERATING RESTRICTIONS

1. ROUTE: Operation on Exposed Waters/Protected Waters/Partially Protected Waters not more than 20 nautical miles from a harbor of safe refuge may be permitted. Since the vessel's route is based on other considerations in addition to stability, you are cautioned that the route may be further limited to that specified on the Certificate of Inspection.

2. PERSONNEL: A maximum of _____ persons may be carried (on this _____ deck vessel) of which _____ may be passengers. A maximum of _____ persons may be carried on the upper passenger deck. Since the personnel capacity is based upon other considerations in addition to stability, you are cautioned that the number of persons carried may be further limited to that specified on the Certificate of Inspection.

3. FREEBOARD AND DRAFT A freeboard of at least _____ feet _____ inches from the main deck measured at _____ must be maintained. A maximum draft of _____ feet _____ inches forward (draft marks), _____ feet _____ inches aft (draft marks) is permitted. Trim should be minimized. A load line is not authorized. (Stability is satisfactory for issuance of a load line.)

4. SAILS: The sails which may be set shall be limited to the _____, _____, _____, _____, and _____ as shown on the sail plan bearing U. S. Coast Guard approval stamp dated _____.

5. WATERTIGHT DOORS AND BULKHEADS
 - a. The quick acting Class 1 watertight doors in MTWBs located at (frames) _____, _____, _____, _____, and _____ (feet forward of the transom at the side) shall be closed and properly dogged at all times when underway, except when actually used for transit under safe conditions. (There are no watertight doors in any MTWBs.)

 - b. No watertight bulkheads shall be removed or altered without the authorization and supervision of the cognizant Officer in Charge, Marine Inspection (OCMI).

6. HULL OPENINGS Any openings that could allow water to enter into the hull or deckhouse should be kept closed when rough weather or sea conditions exist or are anticipated. The _____ (and _____) located at _____ (and _____) was (were) assumed to be closed tight in the stability analysis.

7. TANKS: No more than one centerline or P/S pair of the following tanks may be partially filled at any one time: fuel oil, lube oil, ballast/cargo water, potable water, fuel oil day tanks. Any cross-connections between port and starboard tank pairs shall be kept closed at all times when underway.

16710/ _____
Ser H - _____
_____ 1989

Subj: _____

8. DECK CARGO: A maximum of _____ long tons having a maximum vertical center of gravity _____ feet above the main deck may be carried. Additionally, the height of the deck cargo shall not exceed _____ feet above the main deck. Cargo must be positively secured against shifting before leaving protected waters.
9. WEIGHT CHANGES: No fixed ballast or other such weights shall be added, removed, altered and/or relocated without the authorization and supervision of the cognizant OCMI. The vessel is (not) fitted with (_____) permanent ballast (located in _____)
10. BILGES: The vessel's bilges and voids shall be kept pumped to minimum content at all times consistent with pollution prevention requirements.
11. FREEING PORTS: Deck freeing ports shall be maintained operable and completely unobstructed at all times.
12. LIST: You should make every effort to determine the cause of any list of the vessel before taking corrective action.

This (temporary) stability letter shall be posted under glass or other suitable transparent material in the pilothouse of the vessel so that all pages are visible. It shall expire on _____ or upon replacement by a permanent letter, whichever occurs first. It supersedes any stability information previously issued to the vessel.

Sincerely,

R. S. TWEEDIE
Captain, U. S. Coast Guard
Commanding Officer