

# Marine Safety Center Guidelines for Review of Computerized Trim and Stability Books

Procedure Number: T1-2

Revision Date: 12/02/99

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## References

- a. 46 CFR, Subchapter S
  - b. Guidelines for the On-Board Use and Application of Computers. IMO MSC Circular 891.21 of December, 1998.
  - c. ASTM F1166-95a, Standard Practice for Human Engineering Design for Marine Systems, Equipment and Facilities
  - d. Navigation and Vessel Inspection Circular (NVIC) No. 3-89, Guidelines for the Presentation of Stability Information for Operating Personnel
  - e. Navigation and Vessel Inspection Circular No. 4-89, Introduction to Human Engineering Factors
  - f. MIL-STD 1472-E, Human Engineering Design Criteria for Military Systems, Equipment and Facilities
  - g. Guidance Notes on the Application of Ergonomics to Marine Systems. The American Bureau of Shipping, January 1998
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## Disclaimer

These guidelines were developed by the Marine Safety Center staff as an aid in the preparation and review of vessel plans and submissions. They were developed to supplement existing guidance. They are not intended to substitute or replace laws, regulations, or other official Coast Guard policy guidance. The responsibility to demonstrate compliance with all applicable laws and regulations still rests with the plan submitter. The Coast Guard and the U. S. Department of Transportation expressly disclaim liability resulting from the use of this document.

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## Contact Information

If you have any questions or comments concerning this document, please contact the Marine Safety Center by e-mail or phone. Please refer to the Procedure Number: T1-2

E-mail: [customerservicemsc@msc.uscg.mil](mailto:customerservicemsc@msc.uscg.mil)

Phone: 202-366-6480.

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## Discussion

The review of stability software and approval of software installations involves two main areas of concern: (1) validity of calculations/computer output, and (2) adequate human factors engineering in the design, layout, functioning, and use of the software. Vessel stability instructions and tools must demonstrate valid, accurate calculations that comply with regulatory requirements. In addition, as with many other shipboard systems, the reliability and effectiveness of these instructions and tools are highly dependent on characteristics and design features that adequately address the human element and the potential for human error. At a minimum, software designers and personnel conducting regulatory approvals for the software installations should become very familiar with reference (b) and its Appendix, "Guidelines for Shipboard Loading and Stability Computer Programs", as well as reference (d), and sections 52 through 56 of reference (c).

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## General Review Guidance

Note: The Coast Guard's MSC does not approve the software itself in general terms, but rather validates the use and output of the software for a given vessel, and approves the installation of the software on a vessel specific basis.

- ❑ Has the general software package been previously approved on this vessel or any other vessel? If not, it is a "pilot" installation of unproven software and must complete detailed operational testing is a prerequisite for its installation. The operational testing should be oriented toward the intended users of the software, the human/computer interface, and software reliability. A summary report of the operational testing should be submitted as part of the regular approval process for this type of software installation.

## Verification of Manual T&S Book

- ❑ Verify the adequacy of the stability guidance and light ship parameters for the vessel's manual T&S Book. In all cases, a manual T&S Book is required in order to provide the Master with the capability to manually calculate the vessel's stability.
- ❑ Compare the output hydrostatics, tank capacities, and lightship characteristics of the computer to those provided in the T&S book. The values should be nearly identical.

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## Validity of Software Calculations and Output

- Analyze a limited number of representative loading conditions, which cover the range of vessel operations. The calculated results for these conditions should be included in a separate section of the manual T&S Book, and/or the software user manual, tabulated in a consistent format.
- Compare results of the manual T&S Book and computer software output for the representative loading cases -- they should closely match. Any discrepancies between the results must be clearly accounted for and validated (i.e. the software utilizes variable VCG values while the manual T&S book uses fixed VCG values, etc).
- As a “reasonableness” check, vary the loading to achieve one or more “failure” cases, such that the vessel does not meet required GM, loadline, and stress limitations, as applicable. The program should never indicate a loading condition as acceptable, if any of these required parameters are not achieved.
- Verify that the software has adequate file protection features. A software installation should have the ability to protect the integrity of its basic data files which uniquely describe the vessel’s form and characteristics (tank capacities, hydrostatics, lightship parameters, etc). The basic file protection features should be described in the software user manual, and any attempt to alter these files by the software user should prove unsuccessful.

## Human Factors Engineering

- General
  - The design and layout of the user interface and displays, input procedures, and output displays, should always address the human element and the potential for human error. As much as is possible, the software and the user interface must be designed to prevent the misuse of the software and/or misinterpretation of results. Proper attention must be paid to the design of input and output displays, including the scaling of results. Detailed guidance for design and review criteria are contained in references (c) and (f). Key areas of concern including the user interface, display formatting, and display content, are itemized below.
  - Hands-on use is the only effective way to evaluate the human factors adequacy of the software. In this regard, the software should essentially be

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used as if conducting “beta testing” of the product. The functions and capabilities of the program should be explored, paying attention to potentially confusing or otherwise difficult aspects of the program from the user’s perspective (input procedures, output displays, etc).

- Detailed software metrics are not of principle concern as a matter of plan review (the master can use the manual T&S book as backup, if computer hardware/software is inoperable). However, a program that frequently crashes or “locks up” is not acceptable for installation.
- User interface
  - Home screen: the program should have the ability to easily return to a familiar “home” screen from any other displays.
  - Help functions: the program should provide users with on-line assistance in navigating the software, using the program, and completing data entry procedures. Definitions of allowable options, system capabilities, procedures, and ranges of values should be available.
  - Screen alerts: alerts should be incorporated to clearly indicate critical/unacceptable loading conditions (e.g. required GM is not achieved), and input entries which are out of typical parametric ranges. These alerts should be clearly identifiable: using spatial separation, color-coding, and/or other accentuation techniques to distinguish from other information. Screen alerts should be accompanied by an audio alert in most cases.
  - Default loading: a default loading condition should reflect any special loading or operating requirements imposed by the ship’s stability booklet (such as fixed ballast requirements).
  - Units: Different unit measurements and conversions between these units may be desirable to make the program more convenient and flexible for the user (Ltons, Mtons, short tons, TEUs, barrels, soundings/ullages, etc). Proper/consistent labeling is imperative to avoid confusion. Where possible, weight conversions should be calculated by the computer. Screen displays

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and printouts should present both the entered value and the computational weight value side-by-side.

- Data entry: data entry functions should establish consistency of data entry transactions, minimize input actions and memory load on the user, ensure compatibility of data entry with data display, and provide flexibility of user control of data entry. The user should not be required to enter data already available to the program, especially in long or redundant data tables.
- Input screening: the program should check data entered by the user for reasonableness in order to screen out possible input errors, such as a cargo tank entry which exceeds the capacity of the tank, or cargo densities vastly differing from typical values for a given cargo type (fuel oil, water, etc). Allowance for such variations may be acceptable, but only if the user is clearly alerted that the specific input parameters are out of range of typical values.
- Display formatting
  - As much as possible, display layout of screens and input forms should be similar between the stability software and the manual T&S book.
  - Data should be displayed in a readily usable form. The user should not be required to transpose, convert, or mentally translate displayed data.
  - Where feasible, data should be grouped according to importance, function, and frequency.
    - Recurring data fields should have consistent labeling and relative positions within displays.
    - Basic output parameters such as drafts, GM, maximum bending moment, or other important and/or frequently used information may be effectively separated and grouped from other information (e.g. at the top or margin of the screen).

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- Labels and titles:
  - Each display screen should be labeled with a title that is unique within the system. Each field or column heading should be labeled to make the display as meaningful as possible and to reduce user memory requirements.
  - Group labels should be consistently located, and present an unambiguous relationship to the group, field, or message they describe.
  - Labels should be highlighted or otherwise accentuated to facilitate operator scanning and recognition.
- Display content
  - Standardization: the content of displays within a system should be presented in a consistent, standardized manner. Data entry and displays should be consistent in word choice, format, and style.
  - Information density: high information density and crowded displays should be avoided. Sufficient space and grouping layouts should be used to assist the user's ability to identify and differentiate information.
  - Colors: color coding to differentiate acceptable/unacceptable primary output parameters and input values may be effective to aid in user identification and differentiation of the information (e.g. black for input values, green for acceptable GM value output, red for unacceptable GM). However, color-coding must be consistent and should keep the total number of colors to a minimum. Information cannot be coded solely by color if the data must be accessed from monochromatic as well as color video terminals.
- Other Items
  - Documentation: the software should be accompanied by a user's manual and a programmer's manual.

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- The user's manual should include the following:
  - An identification number that matches an on-screen ID number in the program, unique to the subject vessel. The corresponding stability booklet and lightship data used by the program should also be clearly identified.
  - System requirements for hardware and software such as compatible computers, operating system, memory requirements, and any other special requirements for use.
  - File management aspects of the program, including a list of all relevant software files, giving name, size, date and a brief description of each. The manual should explain how any user-generated files, such as saved loading conditions, are named. These measures should allow the user to review the disk directory and verify that the correct current files are present.
  - User-friendly instructions that give a clear explanation of how to install, use, and troubleshoot the program.
  - A comprehensive list of all ship-specific plans, drawings, tables, and any other documents or information sources that provided information for development/use of the program.
- The programmer's manual should not be furnished to the ship, nor is it necessary to review this document before approving a software installation. However, its existence should be verified, as it provides necessary information to programmers conducting future revisions of the program. See reference (b) for further details.
- Assuming a satisfactory review of the program is completed, the stability letter issued to the vessel should include a comment referencing the software, and authorizing its installation and use. This statement should also include statements regarding software updates, training, and periodic inspections of the software.

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- Example comment on the stability letter:

Stability Software. The installation and use of the computer stability program SafeLoad (version 6.02, ID# 152) is authorized onboard the subject vessel. This software must be revised, and submitted for review and installation approval, for any lightship change, vessel alteration, or other change in service that requires a new stability letter and/or T&S book approval. Periodic inspections to verify the good working order of the software should be conducted on a regular basis, and as part of inspections for vessel re-certification. The owner is responsible for ensuring that only adequately trained and competent personnel may use the stability software.

- Comment note regarding periodic inspections: Ideally, upon start-up the program should conduct a self-diagnostic report on program functioning. At a minimum, however, inspection of the software functioning should be performed as part of the vessel's regular periodic inspections for re-certification. This may be accomplished by comparing the computer output at the time of inspection to the baseline outputs documented in the T&S Book, and/or software user manual as the representative loading conditions. If the software is in good working order, the two outputs should be identical.
  - As an added measure, evaluate the software to the standards provided in sections 52, and 54 through 56 of reference (c)
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Attachments

None