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Onboard Computers for Stability Calculations

Application

The use of onboard computers for stability calculations is not a requirement of class.

However, a stability software installed onboard shall cover all stability requirements applicable to the ship. This UR, which requires only software approval, applies to onboard computers which are provided with software capable of performing stability calculations for the vessel.

Active and passive systems are defined in paragraph 2. This UR covers passive systems and the off-line operation mode of active systems only.

The requirements in this UR apply to stability software on ships contracted for construction on or after 1 July 2005.

1.   General

-       The scope of a stability calculation software shall be in accordance with the stability information as approved by the administration and shall at least include all information and perform all calculations or checks as necessary to ensure compliance with the applicable stability requirements.

-       Approved stability software is not a substitute for the approved stability information, and is used as a supplement to the approved stability information to facilitate stability calculations.

-       The input/output information should be easily comparable with approved stability information so as to avoid confusion and possible misinterpretation by the operator relative to the approved stability information.

-       An operation manual is to be provided for the onboard computer stability software.

-       The language in which the stability information is displayed and printed out as well as the operation manual is written should be the same as used in the ship's approved stability information. The society may require a translation into a language considered appropriate.

Note:
1. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of "contracted for construction", refer to IACS Procedural Requirement (PR) No.29.

2. Changes introduced in Rev.2 of this UR are to be uniformly applied by IACS Societies on ships contracted for construction on or after 1 January 2007.

L5
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- The onboard computer software for stability calculations is ship specific and the results of the calculations are only applicable to the ship for which it has been approved.

- In case of modifications implying changes in the main data or internal arrangement of the ship, the specific approval of any original stability calculation software is no longer valid. The software is to be modified accordingly and re-approved.

2.   Calculation Systems

A passive system requires manual data entry,

an active system replaces the manual entry with sensors reading and entering the contents of tanks, etc., and

a third system, an integrated system, controls or initiates actions based on the sensor-supplied inputs and is not within the scope of this UR.

3.   Types of Stability Software

Three types of calculations performed by stability software are acceptable depending upon a vessel's stability requirements:

Type 1

Software calculating intact stability only (for vessels not required to meet a damage stability criterion)

Type 2

Software calculating intact stability and checking damage stability on basis of a limit curve (e.g. for vessels applicable to SOLAS Part B-1 damage stability calculations, etc.) or previously approved loading conditions and

Type 3

Software calculating intact stability and damage stability by direct application of pre-programmed damage cases for each loading condition (for some tankers etc.)

L5
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4.   Functional requirements:

4.1   The calculation program shall present relevant parameters of each loading condition in order to assist the Master in his judgement on whether the ship is loaded within the approval limits. The following parameters shall be presented for a given loading condition:

- deadweight data;

- lightship data;

- trim;

- draft at the draft marks and perpendiculars;

- summary of loading condition displacement, VCG, LCG and, if applicable, TCG;

- downflooding angle and corresponding downflooding opening;

- compliance with stability criteria: Listing of all calculated stability criteria, the limit values, the obtained values and the conclusions (criteria fulfilled or not fulfilled).

4.2   If direct damage stability calculations are performed, the relevant damage cases according to the applicable rules shall be pre-defined for automatic check of a given loading condition.

4.3   A clear warning shall be given on screen and in hard copy printout if any of the loading limitations are not complied with.

4.4   The data are to be presented on screen and in hard copy printout in a clear unambiguous manner.

4.5   The date and time of a saved calculation shall be part of the screen display and hard copy printout.

4.6   Each hard copy printout shall contain identification of the calculation program including version number.

4.7   Units of measurement are to be clearly identified and used consistently within a loading calculation.

L5
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5.   Acceptable Tolerances

Depending on the type and scope of programs, the acceptable tolerances are to be determined differently, according to 5.1 or 5.2. Deviation from these tolerances shall not be accepted unless the Society considers that there is a satisfactory explanation for the difference and that there will be no adverse effect on the safety of the ship.

Examples of pre-programmed input data include the following:

Hydrostatic data: Displacement, LCB, LCF, VCB, KM_t and MCT versus draught.

Stability data: KN or MS values at appropriate heel/ trim angles versus displacement, stability limits.

Compartment data: Volume, LCG, VCG, TCG and FSM/ Grain heeling moments vs level of the compartment's contents.

Examples of output data include the following:

Hydrostatic data: Displacement, LCB, LCF, VCB, KM_t and MCT versus draught as well as actual draughts, trim.

Stability data: FSC (free surface correction), GZ-values, KG, GM, KG/GM limits, allowable grain heeling moments, derived stability criteria, e.g. areas under the GZ curve, weather criteria.

Compartment data: Calculated Volume, LCG, VCG, TCG and FSM/ Grain heeling moments vs level of the compartment's contents.

The computational accuracy of the calculation program results shall be within the acceptable tolerances specified in 5.1 or 5.2, of the results using an independent program or the approved stability information with identical input.

5.1   Programs which use only pre-programmed data from the approved stability information as the basis for stability calculations, shall have zero tolerances for the printouts of input data.

Output data tolerances are to be close to zero, however, small differences associated with calculation rounding or abridged input data are acceptable. Additionally differences associated with the use of hydrostatic and stability data for trims that differ from those in the approved stability information, are acceptable subject to review by the individual Society.

5.2   Programs which use hull form models as their basis for stability calculations, shall have tolerances for the printouts of basic calculated data established against either data from the approved stability information or data obtained using the approval authority's model. Acceptable tolerances shall be in accordance with Table 1.

L5
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Table 1

Hull Form Dependent	
Displacement	2%
Longitudinal center of buoyancy, from AP	1% / 50 cm max
Vertical center of buoyancy	1% / 5 cm max
Transverse center of buoyancy	0.5% of B / 5 cm max
Longitudinal center of flotation, from AP	1% / 50 cm max
Moment to trim 1 cm	2%
Transverse metacentric height	1% / 5 cm max
Longitudinal metacentric height	1% / 50 cm max
Cross curves of stability	5 cm
Compartment dependent	
Volume or deadweight	2%
Longitudinal center of gravity, from AP	1% / 50 cm max
Vertical centre of gravity	1% / 5 cm max
Transverse center of gravity	0.5% of B / 5 cm max
Free surface moment	2%
Shifting moment	5%
Level of contents	2%
Trim and stability	
Draughts (forward, aft, mean)	1% / 5 cm max
GMt	1% / 5 cm max
GZ values	5% / 5 cm max
FS correction	2%
Downflooding angle	2^0
Equilibrium angles	1^0
Distance to unprotected openings or margin line from WL, if applicable	+/- 5% / 5 cm max
Areas under righting arm curve	5% or 0,0012mrad

Deviation in % = {(base value-applicant's value)/base value} *100

Where the "base value" may be from the approved stability information or the society's computer model.

L5
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6.   Approval Procedure

Conditions of approval of the onboard software for stability calculations

The onboard software used for stability calculations is subject to approval, which is to include;

-    verification of type approval, if any;

-    verification that the data used is consistent with the current condition of the ship. (Refer to paragraph 6.2);

-    verification and approval of the test conditions;

-    verification that the software is appropriate for the type of ship and stability calculations required.

The satisfactory operation of the software with the onboard computer(s) for stability calculations is to be verified by testing upon installation. (Refer to paragraph 8). A copy of the approved test conditions and the operation manual for the computer/ software are to be available on board.

6.1   General Approval (optional):

Upon application to the Society for general approval of the calculation program, the Society may provide the applicant with test data consisting of two or more design data sets, each of which is to include a ship's hull form data, compartmentation data, lightship characteristics and deadweight data, in sufficient detail to accurately define the ship and it's loading condition. Acceptable hull form and compartmentation data may be in the form of surface coordinates for modeling the hull form and compartment boundaries, e.g: a table of offsets, or in the form of pre-calculated tabular data, e.g: hydrostatic tables, capacity tables, etc., depending upon the form of data used by the software being submitted for approval. Alternatively, the general approval may be given based on at least two test ships agreed upon between the society and the applicant.

In general, the software is to be tested for two types of ships for which approval is requested, with at least one design data set for each of the two types. Where approval is requested for only one type of ship, a minimum of two data sets for different hull forms of that type of ship are required to be tested. For calculation software which is bases on the input of hull form data, design data sets shall be provided for three types of ships for which the software is to be approved, or a minimum of three data sets for different hull forms if approval is requested for only one type of ship. Representative ship types which require different design data sets due to their hull forms, typical arrangements, and nature of cargo include: tanker, bulk carrier, container ship, and other dry cargo and passenger ships. The test data sets shall be used by the applicant to run the calculation program for the test ships. The results obtained (together with the hydrostatic data and cross-curve data developed by the program, if appropriate) shall be submitted to the Society for the assessment of the program's computational accuracy. The Society shall perform parallel calculations using the same data sets and a comparison of these results will be made against the applicant's submitted program's results.

L5
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6.2   Specific Approval:

- The Society shall verify the accuracy of the computational results and actual ship data used by the calculation program for the particular ship on which the program will be installed.

- Upon application to the Society for data verification, the Society and the applicant shall agree on a minimum of four loading conditions, taken from the ship's approved stability information, which are to be used as the test conditions. For ships carrying liquids in bulk, at least one of the conditions shall include partially filled tanks. For ships carrying grain in bulk, one of the grain loading conditions shall include a partially filled grain compartment. Within the test conditions each compartment shall be loaded at least once. The test conditions normally are to cover the range of load draughts from the deepest envisaged loaded condition to the light ballast condition and shall include at least one departure and one arrival condition.

- The Society is to verify that the following data, submitted by the applicant, is consistent with arrangements and most recently approved lightship characteristics of the ship according to current plans and documentation on file with the Society, subject to possible further verification on board:

- Identification of the calculation program including version number.

- Main dimensions, hydrostatic particulars and, if applicable, the ship profile.

- The position of the forward and after perpendiculars, and if appropriate, the calculation method to derive the forward and after draughts at the actual position of the ship's draught marks.

- Ship lightweight and centre of gravity derived from the most recently approved inclining experiment or light weight check.

- Lines plan, offset tables or other suitable presentation of hull form data if necessary for the Society to model the ship.

- Compartment definitions, including frame spacing, and centres of volume, together with capacity tables (sounding/ullage tables), free surface corrections, if appropriate.

- Cargo and Consumables distribution for each loading condition.

Verification by the Society does not absolve the applicant and shipowner of responsibility for ensuring that the information programmed into the onboard computer software is consistent with the current condition of the ship.

L5

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7. Operation Manual

A simple and straightforward operation manual is to be provided, containing descriptions and instructions, as appropriate, for at least the following:

- installation

- function keys

- menu displays

- input and output data

- required minimum hardware to operate the software

- use of the test loading conditions

- computer-guided dialogue steps

- list of warnings

8. Installation Testing

To ensure correct working of the computer after the final or updated software has been installed, it is the responsibility of the ship's Master to have test calculations carried out according to the following pattern in the presence of a Society surveyor:

From the approved test conditions at least one load case (other than light ship) shall be calculated. Note: Actual loading condition results are not suitable for checking the correct working of the computer.

Normally, the test conditions are permanently stored in the computer.

Steps to be performed:

- Retrieve the test load case and start a calculation run; compare the stability results with those in the documentation.

- Change several items of deadweight (tank weights and the cargo weight) sufficiently to change the draught or displacement by at least 10%. The results are to be reviewed to ensure that they differ in a logical way from those of the approved test condition.

- Revise the above modified load condition to restore the initial test condition and compare the results. The relevant input and output data of the approved test condition are to been replicated.

- Alternatively, one or more test conditions shall be selected and the test calculation performed by entering all deadweight data for each selected test condition into the program as if it were a proposed loading. The results shall be verified as identical to the results in the approved copy of the test conditions.

L5
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9.   Periodical Testing

It is the responsibility of the ship's master to check the accuracy of the onboard computer for stability calculations at each Annual Survey by applying at least one approved test condition. If a Society surveyor is not present for the computer check, a copy of the test condition results obtained by the computer check is to be retained on board as documentation of satisfactory testing for the surveyor's verification.

At each Special Survey this checking for all approved test loading conditions is to be done in presence of the surveyor.

The testing procedure shall be carried out in accordance with paragraph 8.

10.   Other Requirements

Protection against unintentional or unauthorised modification of programs and data shall be provided.

The program shall monitor operation and activate an alarm when the program is incorrectly or abnormally used.

The program and any data stored in the system shall be protected from corruption by loss of power.

Error messages with regard to limitations such as filling a compartment beyond capacity, or exceeding the assigned load line, etc. shall be included.

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