Rules for Classification and Construction

VI  Additional Rules and Guidelines

11  Other Operations and Systems

7  Guidelines for Loading Computer Systems
The following Guidelines come into force on 1 July 2013.

Alterations to the preceding Edition are marked by beams at the text margin.

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<tr>
<td>A</td>
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<td>C-1</td>
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</tbody>
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Section 1 Loading Computer Systems

A  General, Definitions

A.1 A loading instrument is an instrument, which is either analogue or digital, by means of which it can be easily and quickly ascertained that, at specified read-out points, the still water bending moments, shear forces, and the still water torsional moments and lateral loads, where applicable, in any load or ballast condition will not exceed the specified permissible values. A loading instrument comprises hardware and software.

An operational manual is always to be provided for the loading instrument.

Single point loading instruments are not acceptable.

(IACS UR S1.1.2)

In addition to an approved loading manual, an approved loading instrument is to be supplied for all ships of Category I of 100 m in length and above.

(IACS UR S1.2.1)

Ship categories are defined for all classed seagoing ships of 65 m in length and above which were contracted for construction on or after 1st July 1998 as follows:

- Category I Ships:
  - Ships with large deck openings where, according to GL Rules for Hull Structures (I-1-1), Section 5, E.8, combined stresses due to vertical and horizontal hull girder bending and torsional and lateral loads have to be considered.
  - Chemical tankers and gas carriers.
  - Ships liable to carry non-homogeneous loadings, where the cargo and/or ballast may be unevenly distributed. Ships less than 120 m in length, when their design takes into account uneven distribution of cargo or ballast, belong to Category II.

- Category II Ships:
  - Ships with arrangement giving small possibilities for variation in the distribution of cargo and ballast (e.g. passenger vessels).
  - Ships on regular and fixed trading patterns where the loading manual gives sufficient guidance.
  - The exception given under Category I.

(IACS UR S1.1.2)

In special cases, e.g. extreme loading conditions or unusual structural configurations, GL may also require an approved loading instrument for ships of Category I less than 100 m in length.
In addition to an approved loading manual, an approved loading instrument is to be supplied for all bulk carriers built according to the Common Structural Rules for Bulk Carriers, which apply to the hull structures of single side skin and double side skin bulk carriers with unrestricted worldwide navigation, having length $L$ of 90 m or above.

(CSR Chapter 1, Section 1 and Chapter 4, Section 8)

A.2 An onboard stability computer is an instrument installed on board by means of which it can be ascertained that stability requirements specified for the ship in Stability Booklet are met in any load or ballast condition. An onboard stability computer comprises hardware and software.

A.3 A Loading Computer System is a computer based system consisting of a loading computer (hardware) and a calculation program (software), by means of which it can be easily and quickly ascertained that in any ballast or loading condition
- the longitudinal and local strength will not exceed the permissible values, and
- the stability complies with the stability requirements applicable to the ship.

A.4 A loading manual is a document which describes:
- the loading conditions on which the design of the ship has been based, including permissible limits of still water bending moment and shear force and shear force correction values and, where applicable, permissible limits related to still water torsional moment and lateral loads
- the results of calculations of still water bending moments, shear forces and still water torsional moments if unsymmetrical loading conditions with respect to the ships centreline
- the allowable local loadings for the structure (hatch covers, decks, double bottom, etc.)

(IACS UR S1.1.2).

A.5 A stability booklet is a document approved by the Administration which contains sufficient information to enable the master to operate the ship in compliance with the applicable stability requirements. The stability booklet may include information on longitudinal strength.

B Introduction

B.1 The requirements in these Guidelines concerning stability apply to stability software onboard ships contracted for construction on or after 1st July 2005.

B.2 The use of onboard stability computers as defined by IACS Unified Requirement L5 is not required by Class. However, a stability program installed on board shall cover all stability requirements applicable to the ship and be approved by GL.

B.3 These Guidelines cover passive systems and the off-line operation mode of active systems only (see D).

B.4 Unless otherwise noted, the requirements to loading computer systems given in these Guidelines concern to loading instruments and onboard stability computers as well.

B.5 If the loading computer system installed on board of a ship contracted for construction prior to 1st July 2005 does not check all applicable stability requirements to this ship, the users are to be informed accordingly. The requirements not checked are to be displayed on the screen for the actual loading condition and included in the printouts.

B.6 These Guidelines are valid for the seagoing vessels. They shall be used for inland vessels, if no other specific guidelines exist for inland vessels. Specific stability and longitudinal strength requirements for inland vessels shall be observed.
Fig. 1.1 Definition of loading computer system (LCS)

C Remarks

C.1 An approved loading computer system is not a substitute for the approved loading manual respective the approved stability booklet and it is used as a supplement to these approved documents to facilitate strength and stability calculations.

C.2 The scope of the stability calculations carried out by the onboard stability program 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.

(IACS UR L5.1)

C.3 The loading computer system is a ship specific onboard equipment and the results of the calculations are applicable only to the ship for which it has been approved.

C.4 In case of modifications implying changes in the used main data or the internal arrangement of the ship, the ship specific approval of any original loading or stability program is no longer valid. The software is to be modified and re-approved, see K.

C.5 The replacement of the loading computer on board shall be notified to GL as well. Failure to advise of any modifications to the loading computer may invalidate the certification, see K.

C.6 It is strictly recommended that no other than ship specific, technical or organisational software will be used on the loading computer. Data protection shall include virus protection in any case.

C.7 An operation manual is always to be provided for the loading computer system installed on board and shall be submitted to GL for review, see I.
The language in which the stability and strength information is displayed and printed out should be same as used in the operation manual. If this language is not English, a translation into English is to be included.

(IACS UR S1.2.3)

C.8 The input/output information of the loading computer system shall be easily comparable with the approved stability information and the loading manual so as to avoid confusion and possible misinterpretation by the operator relative to the stability information and loading manual.

D Calculation Systems and Software Types

D.1 Calculation systems

Generally, three different calculation systems are specified:

- A passive system requiring manual data input,
- an active system replacing the manual input by sensors reading and entering the contents of tanks, etc. and
- an integrated system, which controls or initiates actions based on the sensor-supplied inputs.

These Guidelines cover passive systems and the off-line operation mode of active systems only.

(IACS UR L5.2)

D.2 Types of stability calculation software

Three types of calculation performed by the stability module are acceptable depending upon a vessel's stability requirements:

- Type 1
  Stability program calculating intact stability only (for vessels not required to meet a damage stability criterion)

- Type 2
  Stability program calculating intact stability and checking damage stability on the basis of a limit curve (e.g. vessels applicable to SOLAS Part B-1 damage stability calculations etc.) or previously approved loading conditions

- Type 3
  Stability program calculating intact stability and damage stability by direct application of pre-programmed damage cases for each loading condition (for some tankers etc.)

(IACS UR L5.3)

Note

For an oil tanker, chemical tanker or gas carrier, if damage stability limit curves are not available in the approved stability documentation, Type 3 Stability Software shall be installed and used for the onboard Computer. If damage stability limit curves are available in the approved stability documentation, Type 2 Stability Software may be installed and used for the onboard Computer. Regardless of the Type of Stability Software installed and used for the onboard Computer, the stability Software shall be subject to the examination and ship specific acceptance by GL.

(IACS Interpretation)

E Functional Requirements

E.1 The loading computer system 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:
E.1.1 With regard to strength

- Calculation of actual still water shear forces $SF$ and bending moments $BM$ at the predefined read-out points obtained by GL and comparison with the permissible values in tabular and graphical format.
- Actual and allowable static torsional moments $TM$ along the ship's length or at the relevant read-out point in tabular and graphical format, if applicable.
- Ship weight and buoyancy distribution
- Local loads in the holds and in the double bottom
- Shear force corrections, if applicable, shall be shown in graphical and tabular form.
- Check of the allowable mass of cargo and double bottom contents in way of each cargo hold and in any two adjacent holds as a function of the ship's draught at mid-hold positions, if applicable.
- Calculations of still water shear forces and bending moments in the hold flooded conditions, if applicable.

E.1.1.1 Output

The loading program should be capable of producing printouts of the results in both numerical and graphical form. For the calculation of still water shear forces, bending moments and static torsional moments the numeric values shall be shown in both, absolute values and as the percentage of the allowable value (see E.1.1.3.).

(IACS Rec 48 4.1.6)

E.1.1.2 Sign convention

For the calculation of still water shear forces and bending moments downward loads are assumed to be taken as positive values, and are to be integrated in the forward direction from aft end of the ship's length.

![Sign Convention](https://example.com/sign_convention.png)

(IACS UR S11 2.1.1)

E.1.1.3 Calculation of percentage values

For the case where the hogging limit is positive and the sagging limit is negative, the bending moment percentage value is as presented as:

$$\frac{\text{actual value}}{\text{actual limit}} \cdot 100$$

When both bending moment limits carry the same sign the bending moment percentage value is presented as:

$$\frac{\text{actual value} - \text{low limit}}{\text{high limit} - \text{low limit}} \cdot 100$$, if the actual value is above the midpoint between high and low limits

or

$$\frac{\text{high limit} - \text{actual value}}{\text{high limit} - \text{low limit}} \cdot 100$$, if the actual value is below the midpoint between high and low limits.
E.1.2 With regard to stability

- deadweight data
- light ship data
- trim
- heel
- draft at the perpendiculars
- draft at the marks
- summary of the loading condition Displacement, VCG, LCG and TCG, if applicable
- downflooding angle and corresponding downflooding openings
- transversal metacentric height KMT
- initial metacentre above centre of gravity GM
- free surface correction on the initial metacentre above centre of gravity
- corrected metacentre above centre of gravity GM'
- free surface moments from tanks, listed for each tank and in total for the vessel
- free surface correction on the righting lever arm (GZ)
- where applicable, effect of external heeling moments
- compliance with the stability criteria: Listing of all calculated stability criteria, the limit values, the obtained values and the conclusions (criteria fulfilled or not fulfilled).

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

(IACS UR L5 4.2)

E.2 A clear warning shall be given on screen and in the hardcopy printout if any of the loading limitations is not complied with.

(IACS UR L5 4.3)

E.3 The data are to be presented on the screen and in the hard copy printout in a clear unambiguous manner.

(IACS UR L5 4.4)

E.4 The date and the time of a saved calculation shall be a part of the screen display and the hard copy printout.

(IACS UR L5 4.5)

E.5 Each hard copy printout shall contain the identification of the calculation program including the version number, the ship’s name and a description of the corresponding loading condition.

(IACS UR L5 4.6)

E.6 Units of measurement are to be clearly identified and used consistently within the loading conditions.

(IACS UR L5 4.7)

E.7 Protection against unintentional or unauthorized modification of the programs and data shall be provided.

(IACS UR L5 10)
E.8 The loading computer system shall monitor operation and activate an alarm when the program is incorrectly or abnormally used.

(IACS UR L5 10)

E.9 The programs and any data stored in the system shall be protected from corruption by loss of power.

(IACS UR L5 10)

E.10 Error messages with regard to limitations such as filling a compartment beyond capacity, or exceeding the assigned load line, etc. shall be included.

(IACS UR L5 10)

E.11 The calculation of the navigation bridge visibility shall be carried out according to SOLAS Chapter V Reg. 22.

F Additional Guidance Notes

F.1 With regard to strength

F.1.1 Torsional moments

The calculation of the static torsional moments applies to all ships with large deck opening as defined in GL Rules for Hull Structures (I-1-1), Section 5, E.8, if applicable.

The actual static torsional moment shall not exceed the permissible values that are calculated by GL. The actual torsional moment is to be zero at both ship ends. Typical curves for the transverse and the buoyancy moments are given in Fig. 1.3. and 1.4.

![Fig. 1.3 Static torsional moments with anti-heeling tank](image-url)
F.1.2 Cargo hold mass diagrams (HMD)

The loading program shall be capable of carrying out a check of the cargo hold masses, if such diagrams approved by Class are available for the respective ship as following:

- Check of allowable mass of cargo and double bottom contents in way of each cargo hold as a function of the ship’s draught at mid-hold position for sea-going condition as well for harbour condition.
- Check of allowable mass of cargo and double bottom contents in any two adjacent cargo holds as a function of the mean draught in way of these holds for sea-going condition as well for harbour condition. The mean draught may be calculated by averaging the draught of the two mid-hold positions.

(IACS UR S1A.2)

The results may be listed in a tabular overview. However, a graphical format may be helpful as well.

It should be noted that the double bottom content could be considered by the yards in different ways:

- The double bottom contents are to be added to the actual cargo load before comparison with permissible limits, or
- the double bottom contents have already been considered during the calculation of the HMD.

F.1.3 Cargo hold flooded condition

For all bulk carriers with the Notation BC-A or BC-B built according to the GL Rules for Hull Structures (I-1-1) or to the Common Structural Rules for Bulk Carriers the loading instrument shall ascertain that the still water bending moment and shear forces in the hold flooded conditions do not exceed the permissible values.

- The permissible still water shear forces and bending moments for flooded conditions are calculated by GL. These limits shall be included into the loading program.
- The still water shear forces and bending moments under flooded conditions should be shown on screen and in printed format in a clear format (tables, diagrams).
- The actual values are to be compared to with the limit values. Percentage values shall be listed as well.
• The loading program shall allow selecting or entering the appropriate permeability for the cargo density. Please observe the notes given within the GL Rules for Hull Structures (I-1-1), Section 23, C.2.2.2 or Common Structural Rules for Bulk Carriers, Chapter 4, Section 2.4.2.

F.1.4 Shear force correction

Shear force correction apply only to those bulk carriers, ore carries or combination carriers for which a Class Notation BC-A has been assigned for alternate loading, e.g. \{holds a, b, ... may be empty\}.

• The loading program shall be capable to calculate shear force corrections, where applicable. The respective shear force correction factors are to be confirmed by GL.

• The user shall be able to select manually between "alternate" loading and "normal" loading.

• The corrected still water shear forces and relative shear force correction coefficients shall be listed in tabular form and the uncorrected and corrected still water shear forces shall be displayed in graphical form (stress curves).

• The shear force corrections apply to the read out points at the cargo hold bulkheads only. The shear forces at the foremost and the machinery front bulkhead must not to be corrected.

• The actual shear force may be corrected whenever the hold cargo masses in two adjoined holds are different, e.g. hold 1 filled with 50 % and hold 2 filled with 20 %. That means the SF correction may not be only used in case of alternate loading (e.g. hold 1 full, hold 2 empty, hold 3 full etc.).

• The supporting forces of the bottom grillage at the transverse bulkheads may be determined by approximation, according to GL Rules for Hull Structures (I-1-1), Section 5, E.6.2.2 for vessels built according to the GL Rules or according to Common Structural Rules for Bulk Carriers, Chapter 5, Section 1, 2.2.2 for CSR bulk carriers.

![Fig. 1.5 Correction of shear force curve](image)

F.2 With regard to stability

F.2.1 Calculation of free surface correction

For the pre-calculation of arrival or intermediate loading conditions the stability program shall allow the user a manual selection of the free surface moments (FSM) as follows:

• The maximum FSM, independently of the degree of tank filling, for each tank or pair of tanks, (taken from the approved stability information), or

• The actual FSM value corresponding to the degree of filling of the respective tank or pair of tanks (taken from the pre-programmed tank tables and/or tank geometric description).

However, the program should not allow the user to manually input any FSM value that is lower than the maximum FSM.
G Acceptable Tolerances

G.1 With regard to longitudinal strength

The computational accuracy of the loading program should be within the acceptable tolerance band, specified in the following, of the results at each read-out point obtained by GL using an independent program or the approved loading manual with identical input:

- still water shear force: ± 5 %
- still water bending moment: ± 5 %
- still water torsion moment: ± 5 %

(As percentage of the permissible value)

(IACS Rec. 48)

G.2 With regard to stability

Depending on the type and the scope of the stability program, the acceptable tolerances are to be determined differently (see G.2.1 and G.2.2). Deviations from these tolerances shall not be accepted unless GL considers that there is a satisfactory explanation for the differences and that there will be no adverse effect on the safety of the ship.

Examples for pre-programmed input data include the following:

- Hydrostatic data:
  Displacement, LCG, LCF, VCB, KMT, 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 versus level of the compartment's contents.

Examples for output data include the following:

- Hydrostatic data:
  Displacement, LCG, LCF, VCB, KMT, and MCT versus draught as well as actual draughts, trim.

- Stability data:
  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 versus level of the compartment's contents.

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

G.2.1 Stability programs which use only pre-programmed data from the approved stability booklet as the basis for the 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 the 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 booklet, are acceptable subject to review by GL.

G.2.2 Stability programs which use hull form models as their basis for the stability calculations, shall have tolerances for their printouts of basic calculated data established against either data from the approved stability booklet or data obtained using the approval GL model. Acceptable tolerances shall be in accordance with Table 1.1.
### Table 1.1 Acceptable tolerances

#### Hull Form Dependent

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>2 %</td>
</tr>
<tr>
<td>Longitudinal centre of buoyancy, from AP</td>
<td>1 % / 50 cm max.</td>
</tr>
<tr>
<td>Vertical centre of buoyancy</td>
<td>1 % / 5 cm max.</td>
</tr>
<tr>
<td>Transverse centre of buoyancy</td>
<td>0.5 % of B / 5 cm max.</td>
</tr>
<tr>
<td>Longitudinal centre of flotation, from AP</td>
<td>1 % / 50 cm max.</td>
</tr>
<tr>
<td>Moment to trim 1 cm</td>
<td>2 %</td>
</tr>
<tr>
<td>Transverse metacentric height</td>
<td>1 % / 5 cm max.</td>
</tr>
<tr>
<td>Longitudinal metacentric height</td>
<td>1 % / 50 cm max.</td>
</tr>
<tr>
<td>Cross curves of stability</td>
<td>5 cm</td>
</tr>
</tbody>
</table>

#### Compartment Dependent

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume or deadweight</td>
<td>2 %</td>
</tr>
<tr>
<td>Longitudinal centre of gravity, from AP</td>
<td>1 % / 50 cm max.</td>
</tr>
<tr>
<td>Vertical centre of gravity</td>
<td>1 % / 5 cm max.</td>
</tr>
<tr>
<td>Transverse centre of gravity</td>
<td>0.5 % of B / 5 cm max.</td>
</tr>
<tr>
<td>Free surface moment</td>
<td>2 %</td>
</tr>
<tr>
<td>Shifting moment</td>
<td>5 %</td>
</tr>
<tr>
<td>Level of contents</td>
<td>2 %</td>
</tr>
</tbody>
</table>

#### Trim and Stability

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draughts (forward, aft, mean)</td>
<td>1 % / 5 cm max.</td>
</tr>
<tr>
<td>GMt</td>
<td>1 % / 5 cm max.</td>
</tr>
<tr>
<td>GZ values</td>
<td>5 % / 5 cm max.</td>
</tr>
<tr>
<td>FS correction</td>
<td>2 %</td>
</tr>
<tr>
<td>Downflooding angle</td>
<td>2 %</td>
</tr>
<tr>
<td>Equilibrium angles</td>
<td>1 %</td>
</tr>
<tr>
<td>Distance to unprotected openings or margin line from WL, if applicable</td>
<td>± 5 % / 5 cm</td>
</tr>
<tr>
<td>Areas under righting arm curve</td>
<td>5% or 0.0012 mrad</td>
</tr>
</tbody>
</table>

\[
\text{Deviation} = \left( \frac{\text{base values} - \text{applicant’s value}}{\text{base value}} \right) \times 100 \quad [\%]
\]

Where the "base value" may be from the approved stability information or the GL computer model.

(IACS UR L5 5)
H Approval Procedure

H.1 Approval conditions of loading computer systems

H.1.1 The loading computer system is subject to an approval process which includes the following steps:
- verification that the data used is consistent with the current condition of the ship (refer to H.2.1.3. Ship’s Specific Approval)
- verification and approval of the test conditions
- verification that the software is appropriate for the type of ship and strength/stability calculations required
- verification of type approval of computer hardware, if applicable
- checking of a proper installation and operation of the instrument on board in accordance with agreed test conditions
- issuance of the test certificate of the program installation

H.1.2 The satisfactory operation of the loading computer system is to be verified by testing upon installation, see Annex C.

A copy of the approved test conditions and the operation manuals (see J) for the computer/software are to be available on board.

H.2 Ship specific approval

H.2.1 With regard to loading programs and stability programs

H.2.1.1 General
GL will verify the accuracy of the computational results and actual ship data used by the programs for the particular ship on which the programs will be installed. Concerning preliminary approval of loading computer system see H.2.2.

Note
It is strongly recommended that the programs are developed in accordance with international quality standards as ISO 9000-3 or equivalent.

H.2.1.2 Test loading conditions

As a minimum, the following four test loading conditions taken from the ship’s approved stability booklet and loading manual, are to be submitted to GL:
- Light ship condition
- Ballast condition (departure or arrival)
- Fully loaded condition
- Partly loaded condition

Where applicable:
- For ships carrying liquids in bulk, at least one of the test conditions shall include partially filled tanks.
- If applicable, for bulkers one homogeneous and one alternate loading condition shall be included, both with intact loading and corresponding flooding conditions, if applicable.
- A grain loading condition
- A loading condition with timber deck cargo.

Within the test conditions each compartment shall be loaded at least once. The test conditions normally are to cover the range of the load draughts from the deepest envisaged loaded condition to the light ship condition and shall include at least one departure and one arrival condition.
In special cases, e.g. extreme or unusual loading patterns, GL may require additional test loading conditions.

If onboard damage stability computations are requested, the loading conditions shall be taken from the approved stability booklet after consultation with GL.

Data to be submitted by the applicant are outlined in Annex A.

H.2.1.3 Data verification

It is important that the data contained in the programs are consistent with the data specified in the approved stability booklet and loading manual. Particular attention is drawn to the final lightship weight and centres of gravity.

GL is to verify that the following data, submitted by the applicant, are consistent with the arrangements of the ship according to the current plans and documentations on file with GL:

- Identification of the loading program including the version number
- Main dimensions, hydrostatic particulars and predefined stability limiting values and, if applicable, the ship profile
- The position of the forward and aft perpendiculars, and if appropriate, the calculation method to derive the forward and the aft draughts at the actual position of the ship's draught marks
- Final light ship data and centre of gravity including light ship distribution along the ship's length
- Lines plan, offset tables or other suitable presentation of hull form data if necessary for GL 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
- Deadweight definitions (cargo and consumables distribution) of each loading condition
- Acceptance of the number and position of predefined read-out points for still water shear forces, bending moments and static torsional moments and shear force correction factors, if applicable
- Acceptance of relevant strength limits for all read out points
- Acceptance of local strength limits (allowable cargo hold masses etc.), if applicable.

In case the strength limit values are not available in the Classification documents submitted to GL, additional costs will be charged by GL for their calculation.

The verification by GL does not absolve the applicant and the ship owner of their responsibility to ensure that the information programmed into the onboard computer software is consistent with the current condition of the ship.

H.2.1.4 Certification

After the data verification has been completed an approval certificate for acceptance of the loading computer system will be issued by GL. The following information is specified:

- Type and name of software
- Register No., IMO No., Hull No. and Yard
- Specification of the range of approval (applicable Rules etc.) and additional approval remarks to the specific loading computer system
- Approval date and certification number.

This certificate becomes valid provided that the installation test on board of the vessel has been carried out satisfactorily in the presence of a GL surveyor and the system is running without any problem.

H.2.1.5 Installation test

An extensive plausibility check will be performed on a computer in the GL Office provided that the program can be installed on computers using common operation systems.

Finally, the loading instrument is to be tested in accordance to the test procedure outlined in Annex C on board of the ship. This shall be done in the presence of a GL Surveyor. Where the ship is in service, the endorsed test loading conditions, approval letter and certificate should be sent to the ship’s owner who
should arrange for the documents to be placed onboard and arrangements for an installation test, witnessed by a Society surveyor, should be made.

H.2.1.6 Periodical testing

It is the responsibility of the ship’s master to check the accuracy of the loading computer system at each Annual survey by applying at least one approved test loading condition (other than light ship). If a Surveyor is not present for the computer check, a copy of the test conditions results obtained by the computer check is to be retained on board as documentation of satisfactory testing for the surveyor’s verification.

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

(IACS UR L5 9)

H.2.1.7 Documents on board

The following documents shall be filed on board:

- the approved test loading conditions, stamped and signed by GL
- the approval certificate for acceptance of the loading computer system
- the approval letter
- at least one hardcopy of the operation manual (see I.)

H.2.2 Preliminary Approval Loading Program

H.2.2.1 General

In order to ensure the ship’s safety, GL requires the preliminary approval of the loading computer system before the delivery of the ship.

This preliminary approval will cover all longitudinal strength and stability calculations carried out by the loading program as applicable.

The final approval of the loading program will be carried out after the final data are implemented in the loading program and after the final stability booklet/loading manual has been approved, see H.3.

H.2.2.2 Test loading conditions

The same test loading conditions as defined under H.2.1.2 are to be used but taken from the preliminary loading manual and stability booklet:

H.2.2.3 Data verification

The same data as defined under H.2.1.3 will be verified by GL but taken from the preliminary loading manual and stability booklet.

H.2.2.4 Approval of the documents

GL will check the test cases from longitudinal strength and stability points of view. The preliminary approved test cases and the preliminary Certificate for acceptance of the loading computer system will be sent to GL’s local site office in charge.

H.2.2.5 Onboard test by Surveyors

In order to ensure the correct working of the loading instrument on board after the software has been installed, an onboard test will be carried out in the presence of the local Surveyor (see Annex C). After this test has been carried out to satisfaction, the Surveyor will hand over the approved test cases and the preliminary Certificate to the ship’s management.

H.2.2.6 Approval costs

In general GL will not charge additional costs for the preliminary approval of the loading program provided that the above procedure can be carried out step by step without any revisions of the preliminary loading program. Otherwise additional costs calculated on a time spent basis will be taken into account.
H.3 General Approval (optional)

Upon application to GL for general approval of the calculation program, GL 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, lightskip characteristics and deadweight data, in sufficient detail to accurately define the ship and its 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 GL 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 based 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 GL for the assessment of the program's computational accuracy. GL 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.

(IACS UR L.5).

Upon satisfactory completion, a respective certificate of acceptance will be issued which is valid only for the identified, specified version of the software and has a period of validity of 5 years.

I 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 keys
- input and output data
- required minimum hardware to operate the software
- use of the test loading conditions
- computer-guided dialogue steps
- list of warnings.

(IACS UR L5 7)

The operation manual should be devised in a concise and unambiguous manner and must be prepared in a language understood by the users. If this language is not English, a translation into English is to be included.

(IACS UR S1.2.2)
J Loading computer (Hardware)

J.1 General

The loading computer must be type tested and certified. The type approval may be waived, if redundancy is ensured by an installation of a certified second loading computer system. The type approval is required if:

- the computers are installed on the bridge or in adjacent spaces (acc. SOLAS Chapter V, Regulation 17)
- interfaces to other systems of the ship operation are provided

J.2 Hardware type approval

The hardware type approval shall be carried out in accordance with GL Guidelines Procedure (VI-7-1) and Test Requirements for Electrical / Electronic Equipment and Systems (VI-7-2)

The certificate, issued by GL after type approval, will be valid for 5 years and will be entered in the electronic list of type tested and approved products on GL's home page, accessible via:

http://www.gl-group.com/newbuilding/approvals/index.html (choose “Type of approvals of electrical systems and components” under “Kind of Approval” and “I--- Computers” under “Group”)

J.2.1 In case the type approval has been already carried out by another IACS Classification Society or a recognised independent laboratory, some of the type approval tests already successfully performed may be accepted by GL, provided that all relevant GL requirements have been considered. This has to be documented.

J.2.2 For loading computers, which are generally installed in dry control rooms outside of machinery spaces, Environmental Category E may be accepted in accordance with GL Guidelines Test Requirements for Electrical / Electronic Equipment and Systems (VI-7-2), Section 3.

In addition, computers which are intended to be a part of ship's network shall be approved in accordance with the Rules of GL.

K Modifications

GL is to be informed about any modifications which may affect the approved loading computer system installed on board of the ship. GL will decide about a re-approval case by case. If the modifications have an effect on:

- the ship's main/basic data (e.g. lengthening of the ship, increasing of the draught, (de-) installation of cranes etc.), or
- the calculation of the longitudinal strength, the local strength or the lashing, or
- the intact and damage stability calculations, or
- the loading computer (hardware)

the re-examination of the loading instrument is required by GL in any case. The former approval certificate becomes invalid.

Normally, the costs for re-approval of the loading instrument will be charged on a time spent basis.
Abbreviations

ETM: moment to change of trim
FSM: free surface moment
GM: metacentre above centre of gravity
GM': corrected metacentre above centre of gravity
GZ_max: maximum righting lever arm
GZ: righting lever arm
KG: vertical centre of gravity
KMT: transversal metacentric height
KN: stability cross curves
LCB: longitudinal centre of buoyancy
LCF: longitudinal centre of flotation
LCG: longitudinal centre of gravity
L_pp: length between perpendiculars
MCT: see ETM
MS: mid ship
TA: draught at aft perpendicular
TF: draught at forward perpendicular
TCG: transverse centre of gravity
VCB: vertical centre of buoyancy
VCG: vertical centre of gravity
VCG': corrected vertical centre of gravity
Annex A  Documentation Required

A Documentation Required for Ship Specific Approval of Loading and Stability Programs

The following documentation shall be submitted to GL for the ship specific approval.

A.1 Intact stability and longitudinal strength:

- printouts of the calculated test loading conditions including the input data for the respective cases, stability results, longitudinal strength results and combined trim and forward visibility range results, if applicable
- program copy with the respective data and the test loading conditions
- operation manual including an installation instruction
- printouts of the ship data base:
  - The ship's lightweight distribution
  - The position of the forward and aft perpendiculars
  - The position of the forward and aft draught marks
  - Bonjean data at a sufficient number of stations in the length between perpendiculars
  - Positions of the read-out points
  - Permissible still water bending moments, shear forces, and the still water torsional moments, as applicable for seagoing, harbour and flooded conditions
  - Allowable mass of cargo and double bottom contents in way of each cargo hold and in any two adjacent holds as a function of the ship's draught at mid-hold positions, as applicable
  - Hydrostatic-/cross curve tables
  - the hold, store, and tank data (Volume, LCG, VCG, TCG, aft and forward limits of the weight distribution)
  - Grain data: tables of volumetric heeling moments for partly filled holds, tables for cargo holds filled with ends trimmed and untrimmed, tables of maximum permissible grain heeling moments
  - the relevant stability limiting curves (KG GM)
  - List of unprotected openings / margin line / flooding angle.
  - Other data as container stowage data, car stowage data, timber loading data (cross curves), data for calculation of severe wind and rolling criteria.

A.2 Damage Stability

General (in addition to the particulars listed in A.1.):

- loading case/damage case description
- list of all tank data, including the assumed permeability
- Co-ordinates of immersion points. In the definition of the immersion points their level of tightness has to be defined, separated in watertight, weathertight and unprotected.

Damage stability results:

- specification of damaged rooms (incl. permeability, mass/lost buoyancy, centres of gravity)
- $T_A$, $T_F$, $GZ_{\text{max}}$, range, heel, distance of the immersion points to the waterline
- required and attained value of all relevant criteria
- damage lever arm curve (numerically or graphically).
Annex B  Documentation Required for General Approval

A  Documentation Required for General Approval

A.1  For the purpose of checking the software of intact and damaged stability programs GL has developed a so-called "test-ship" enabling requirements for special programs to be tested by means of reference calculations.

In this connection the principal dimensions of the test-ship, as well as the arrangement of cargo and ballast water tanks and additional points of immersion were fixed in accordance with a realistic design; however, in order to confine the input to a minimum, some simplifications were made. These input data are to be used for calculating a given number of loading conditions under aspects of intact and damaged stability.

A.2  For this purpose the following particulars will be submitted by GL to the software provider:

- lines plan, scale 1 : 50, with principal dimensions
- subdivision plan
- light ship data and principal dimensions
- table of side contour; the vessel has neither sheer nor beam
- table of immersion points with relevant tank numbers
- table showing co-ordinates of deck at side
- description of cargo tanks
- table of tanks with details for each tank
- weight distributions of test loading conditions

A.3  Apart from this, the following information is to be used by the software provider:

1. Intact stability criteria:
   as per IMO Resolution A.749, Chapter 3
2. Damage assumptions:
   The sub-compartments of the respective test-ship are to be assumed as being damaged
3. Damage stability:
   as per the valid damage stability requirements (IGC Code, IBC Code etc...)

A.4  After calculation, the following particulars are to be submitted by the software provider:

- hydrostatic curves (in steps of 0.02 m)
- cross-curves of stability (fixed trim, $\varphi = 10^\circ$ to $70^\circ$ in steps of $10^\circ$)
- table of all tanks and sub-compartments offering the same information as that contained in the GL table
- printed intact and damage stability results of 12 test loading conditions containing the following data:
  - intact stability:
    displacement, VCG, LCG, mean draught, trim TA, TF, LCB, LCF, ETM, KM, VCG', GM', uprighting levers at $0^\circ$, $10^\circ$, $20^\circ$, $30^\circ$, $40^\circ$, $50^\circ$ and $60^\circ$, range of stability, area under lever arm curve up to $30^\circ$, up to $40^\circ$ and between $30^\circ$ and $40^\circ$
damaged stability:

displacement, VCG, LCG, TCG, draught forward, centre aft, GM', at $\phi = 0^\circ$, lever arm in damaged condition at $0^\circ$, $10^\circ$, $20^\circ$, $30^\circ$, $40^\circ$, and $50^\circ$, points of immersion with minimum freeboard and pertinent x-co-ordinate, minimum freeboard of margin line with x-co-ordinate; angle of position of equilibrium, lever at angle of position of equilibrium $+ 20^\circ$, area within this range and maximum lever within this range

All particulars are to be submitted on DIN-A4 size sheets.
Annex C  Test Procedure

A  Test Procedure for Loading Computer Systems

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:

A.1  Retrieve the test load case and start a calculation run; compare the stability and strength results with those in the documentation.

A.2  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.

A.3  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 be replicated.

A.4  Alternatively, one or more test conditions shall be selected and the test calculations 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.