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Ships and marine technology — Computer applications — Shipboard loading instruments

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 16155 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 10, *Computer applications*.

Introduction

A computer tool to assess technical operational properties of a ship, such as stability or longitudinal strength, has become more or less standard equipment on board vessels and other floating objects. There is a great variety of such instruments available, in terms of both calculation method and appearance. This International Standard was developed to guide both producers and shipowners in determining the suitability of a particular instrument. In order to guarantee a minimum quality level, this International Standard specifies certain minimum requirements for loading instruments; however, it leaves sufficient freedom for producers to apply innovative solutions.

Ships and marine technology — Computer applications — Shipboard loading instruments

1 Scope

This International Standard is applicable where computer equipment is used to perform functions related to loading and associated ship safety issues, such as, but not limited to, intact and damaged stability and longitudinal strength.

This International Standard defines requirements on a shipboard loading instrument that are supplementary to IMO MSC/Circ. 836, IMO MSC/Circ. 854, IMO MSC/Circ. 891 and IACS Recommendation No. 48.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IACS Recommendation No. 48, *Recommendations on Loading Instruments*

IEC 61996:2000, *Maritime navigation and radiocommunication equipment and systems — Shipborne voyage data recorder (VDR) — Performance requirements — Methods of testing and required test results*

IMO Resolution A.739(18), *Guidelines for the authorization of organizations acting on behalf of the Administration*

IMO Resolution A.789(19), *Specifications on the survey and certification functions of recognized organizations acting on behalf of the Administration*

IMO MSC/Circ. 836, *Recommendation on loading instruments*

IMO MSC/Circ. 854, *Guidelines for shipboard loading and stability computer programs*

IMO MSC/Circ. 891, *Guidelines for the on-board use and application of computers*

IMO MSC/Circ. 920, *Model loading and stability manual*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
direct calculation
first-principles calculation
physics-based calculation which involves only primary entities of the ship, such as loading, hull geometry, internal geometry (e.g. holds and compartments) and the shape of sounding pipes

3.2
loading instrument
instrument consisting of loading software, hardware and probably also an operating system, which in their combination can determine characteristics and properties related to a particular loading of a particular vessel or other floating object

3.3
loading software
software consisting of a combination of computer instructions and preprogrammed static data of a particular vessel or object in question

3.4
hardware
at least a central processing unit, means for permanent storage and means for input and output

NOTE Hardware can be stand-alone, or form part of a computer network.

4 Abbreviated terms

COG	centre of gravity
FSM	free surface moment
KM_T	transverse metacentre above base line
KG or VCG	vertical centre of gravity above base line
KG′ or VCG′	virtual vertical centre of gravity above base line (corrected for free surface effects)
$G'M_T$	transverse metacentric height (corrected for free surface effects)
Lpp	length between perpendiculars
LCG	longitudinal centre of gravity
TCG	transverse centre of gravity
TEU	twenty foot equivalent unit

5 Categories of loading instrument

5.1 Categories of functions

This International Standard should be applicable for all types of instrument, which will be suitable for a variety of purposes; therefore, segregation into categories of functions, each for different purposes, is made.

5.1.1 *Category **A** functions* are designed and intended for basic calculations and analysis. Its information generating capacities are comparable with information and calculations which can be made with a traditional Loading and Stability Manual.

Examples of functions are

— upright hydrostatics;

— draft and trim;

— verify transverse metacentric height $G'M_T$ against the minimum required $G'M_T$ (or the KG′ against the maximum allowable KG′), based on intact stability requirements;

— verify transverse metacentric height $G'M_T$ against one or more enveloped minimum required $G'M_T$ values (or the KG′ against one or more enveloped maximum allowable KG′ values), based on damage stability criteria;

— intact stability;

— tank soundings/volumes.

5.1.2 *Category **B** functions* are designed and intended for calculations and analysis which extend beyond calculations or information which can be made with standard Loading and Stability Manuals.

Examples of functions are

— intact or damaged longitudinal strength;

— intact stability for extreme conditions (e.g. draft, trim, or list outside the range of the tables as included in the Loading and Stability Manual);

— damage stability calculations, to verify whether an actual loading condition complies with statutory requirements;

— damage stability calculations, in order to assess sinkage, heel, trim and residual stability for an actual loading and damage case;

— exact determination of tank contents, taking into account effects of list and trim;

— advise on countermeasures for actual damage situations, intended to improve residual stability, bending moments, etc.

5.1.3 *Category **C** functions* fulfil auxiliary roles, within the framework of a loading instrument. Examples are

— container loading utilities;

— grain loading utilities;

— utilities to create voyage-/cargo-specific loading plans for chemical parcel tankers, taking into account chemical compatibility data;

— tank-/cargo-expansion effects, due to temperature variations, for oil and oil product tankers;

— roll-on roll-off (RoRo) loading utilities.

5.2 Categories of instrument

Loading instruments may contain combinations of function categories.

EXAMPLE An instrument might contain an intact stability function (which is comparable with the function of the Loading and Stability Manual, and hence of Category A), a longitudinal strength function (which is by its nature beyond Loading and Stability Manual level, and hence of Category B) and a container loading module (which is auxiliary, of Category C).

The instruments shall be categorized by the combinations of categories of functions it can perform. In the above example, it would be A/B/C.

5.3 Marking of categories

The documentation of a loading instrument shall clearly state

— which functions it performs;

— the category standard to which those functions are performed.

6 Minimum requirements for Category A functions

6.1 Minimum calculations required

Category A instruments shall, as a minimum, perform the following functions:

— determination of displacement, deadweight, centre of gravity and free surface moments;

— calculation of draft, list and trim;

— calculation of an intact stability curve (including free surface effects), for a range of angles of inclination which is sufficient for the appropriate stability regulation for the specific vessel;

— verify the intact stability against the appropriate stability regulation for the specific vessel by at least one of the following methods:

  1) verify transverse metacentric height (corrected for free surface effects) $G'M_T$ against the minimum required $G'M_T$ (or the KG' against the maximum allowable KG'), based on all intact stability criteria;

  2) calculate all stability parameters which are relevant for all intact stability criteria (so, including a possible wind/weather criterion), and check those parameters against the critical values;

— deliver a conclusion about compliance with the intact and damage stability criteria.

6.2 Protection of predefined tables

When Category A functions are performed on the basis of precalculated and predefined tables, provisions shall be made which protect those tables from deliberate or involuntary modifications.

6.3 Interpolation and extrapolation

When Category A functions are performed on the basis of precalculated and predefined tables, provisions shall be made which prevent the software from being used outside the validity region of those tables. In order to ensure sufficient accuracy, the intervals in precalculated tables of hydrostatic and stability particulars shall be as small as possible. A draft interval of 0,02 m at maximum and a maximum trim interval of 0,5 % of Lpp should be used, but in no case shall the intervals be larger than those used in the available Loading and Stability Manual or the available tables of hydrostatic data. In any case, the draft interval shall not exceed 0,05 m.

6.4 Documentation

One copy of ship-specific data shall be supplied with the instrument, which contains, at least,

— an explanation of abbreviations, list of units used, the coordinate system and orientation;

— main particulars;

— all precalculated tables used;

— definition of openings (open and weather tight) which are taken into account;

— light ship weight and centre of gravity, the light ship weight distribution should also be provided;

— preferably some typical loading conditions;

— relevant stability criteria;

— overview of tanks, compartments, holds and other spaces;

— other particulars which are relevant for a particular type of ship, such as the margin line for passenger vessels.

7 Minimum requirements for Category B functions

7.1 Calculation methodology

Functions of Category B shall be based on direct calculations. Furthermore, it is encouraged that the software takes into account as many realistic effects as possible (e.g. the actual initial trim, the actual heel, the free to trim effect and the actual shift of COG of liquid due to list and trim).

7.2 Accuracy and certification of calculations

Loading software of Category B shall comply with at least one of the following requirements.

— The calculation results of loading instruments shall be in agreement with results of calculations with specific ship design software, which is certified by a flag state Administration or a recognized organization that meets the minimum requirements and specifications of IMO Resolutions A.739(18) and A.789(19).

— The calculation part of the software itself shall be certified by a flag state Administration or a recognized organization that meets the minimum requirements and specifications of IMO Resolutions A.739(18) and A.789(19).

7.3 Documentation

One copy of ship-specific data shall be supplied with the instrument, which contains, at least,

— an explanation of abbreviations, list of units used, the coordinate system and orientation;

— main particulars;

— definition of openings (open and weather tight) which are taken into account;

— light ship weight and centre of gravity;

— maximum allowable bending moments and shear forces, for both seagoing and harbour conditions (if applicable).

It should also contain

— definition of hull and appendages;

— definition of tanks, sounding pipes, compartments, holds and other spaces;

— wind contour of the longitudinal projected area;

— light ship weight distribution;

— other particulars which are relevant for a particular type of ship, such as the margin line for passenger vessels.

8 General loading software requirements

8.1 Protection of software and static data

In order to maintain software integrity, it shall be compiled, or protected by other means to prevent voluntary modification attempts. Furthermore, static data shall be stored encrypted or in binary, or protected by other means against modification attempts. In both cases, it is not sufficient to rely on a “read-only” mechanism of an operating system.

8.2 Units

The basic system of units shall be metric. Where weights are used, typically metric tons (1 000 kg) shall be employed.

However, some cargoes are more commonly measured in, for example, ft^3/ton, long tons, short tons, TEUs, or barrels. The program developer may wish to make its program more convenient for the user to enter data in these alternate units. If so, the program shall minimize opportunities for unit confusion and, wherever possible, unit conversions shall be calculated by the computer. However, screen displays and print-outs shall be available in at least metric units.

8.3 Back-up of data

Copies of all necessary data residing in computer files, such as loading software, ship geometry or tables, shall be available on independent storage units, such as CD or floppy disks. The number of such copies shall not be less than two.

8.4 Update facilities

The supplier shall have the facility to receive reports on errors in program logic or static data, to manufacture an improved version within reasonable time and to distribute that update. It is recommended to implement a structure which enables ship owners to acquire the latest update of the software.

9 Hardware requirements

The loading instrument hardware configuration shall be one of the following.

— Redundant. In this case at least two complete sets of hardware shall be available, with the loading software installed on both sets.

— Not redundant. In this case, the hardware shall be suitably designed to withstand supply voltage variations and transients, ambient temperature changes, vibration, humidity, electromagnetic interference and corrosion normally encountered in ships. In order to encourage continuous operation, the hardware shall be approved by a recognized organization according to IMO Resolutions A.739(18) and A.789(19) or a flag state Administration, based on physical tests, such as electric power supply variations, dry heat, damp heat, vibration, inclination, insulation resistance, cold temperature and electromagnetic compatibility.

Each replaceable part shall be simple to replace and shall be constructed for easy and safe handling. All replaceable parts shall be so arranged that it is not possible to connect them incorrectly or to use incorrect replacements. Where this is not practicable, the replaceable parts, including their means of electrical connection, shall be clearly marked.

10 Documentation and training requirements

10.1 User manual

The user manual shall be written for the direct user (ship's officers) and shall include the following elements.

— *Identification*: a unique identification name or number, which is also displayed by the software.

— *System requirements*: identification of computer system hardware and software requirements such as compatible computers, operating system, memory requirements and other special requirements (video graphics, mouse, printer, etc.).

— *Functions*: an enumeration of all functions the instrument performs, including the category for each function.

— *Warning*: a note which states clearly that only properly educated and trained people can safely use the instrument, and judge the results.

EXAMPLE "This loading instrument is an aid in determining intact stability, longitudinal strength and damage stability. Its use, and the interpretation of its results, are reserved for people with sufficient professional training and with a background in these subjects."

— *Abbreviations and units*: an enumeration of all abbreviations which are used by the program during input and on the output, and a list of units used.

— *Instructions*: a clear explanation of how to install and use the program. The instructions shall be user-friendly, recognizing that the user is a ship's officer.

— *Verification check*: instructions and tables for verification checks, according to 13.3.

— *Information sources*: a list summarizing all ship-specific plans, drawings, tables, other documents, etc. which provided information used in the program. In most cases, this information will probably come from the ship's approved Loading and Stability Manual; however, other sources shall be clearly identified. Ideally, all such information sources shall themselves be annotated to the effect that they were used in developing the program (so that future revisions to the drawing will also prompt a review of the program).

The manual shall only be used to describe the background and generic functions of the software; the manual is not a proper location for ship-specific limitations, which shall be incorporated in the software integrally.

At least three copies of the user manual shall be supplied.

10.2 Static ship data

At least one copy of a booklet which contains static ship data used in the instrument shall be provided. The data shall include, but are not limited to, items mentioned in 6.4 and 7.3.

10.3 User training

Training/tutorial material shall be provided, as appropriate, for the sophistication of the program. This can range from individual instruction or formal classroom sessions to tutorial videotapes and/or self-study lesson plans. The training/tutorial material shall contain an example of a calculation procedure supported by illustrations and sample computer output, together with examples of computer output of each screen display, complete with explanatory text.

10.4 Supplier copy

The supplier of the software shall keep a working copy of the software and manual available, ready to be transferred in case of emergencies.

11 Elements in user interface design

11.1 “Home” screen

The program shall have a simple command that returns the user directly to a familiar “home” screen from any of the loading screens. This allows a “lost” user (who may have become disoriented among various loading screens) to quickly re-establish their orientation.

11.2 “Help” functions

The program shall have easily-accessible “help” functions such as designated function keys, or an on-screen menu bar.

11.3 Predefined loading conditions

Predefined loading conditions shall reflect any special loading or operating requirements imposed by the ship’s stability requirements (such as locked-in ballast requirements).

11.4 Input and output data screening

The program shall check data entered by the user in order to screen out possible input errors; for example, a cargo tank entry which exceeds the capacity of the tank. The program clearly indicates to the user that the entry is out of expected bounds.

11.5 Loading entry lines

Wherever appropriate, loading entry lines of the following nature shall be used.

— Tanks for ballast, consumables or liquid cargo. At these lines a user preferably only enters weight, filling percentage, volume, specific weight, sounding or ullage, after which the software updates all other particulars, including COGs and FSMs.

— Specific loading items, such as containers or RoRo trailers, or a link to functions of Category C, which can be used for those kinds of cargo.

— Other load entries will be of the fixed-location type where LCGs, VCGs, etc. are predisplayed and the user only needs to enter a weight value.

— Extra blank lines to allow additional non-fixed load entries (e.g. an unusual deck cargo) where the user can enter VCG, LCG, TCG, etc.

11.6 Print-outs

Each loading condition print-out shall automatically contain the software and version, name of the ship and the date of print-out; in addition, the user shall be prompted to enter a title for the condition. This information shall be repeated on each page of the print-out.

11.7 Selection of options or functions

All options or functions shall be accessible by at least text-oriented menus, toolbars, pop-up windows, tab controls, list boxes, etc. Also, symbolic icons may be used only as a primary selection mechanism, and only if they have a clear, unambiguous meaning.

11.8 Output format

It is desirable that the input/output form in the computer and screen presentation be similar to the one in the Loading and Stability Manual, so that the operators will easily gain familiarity with the use of the Loading and Stability Manual. In order to stimulate this similarity, the output format shall be in line with IMO MSC/Circ. 920. In any case, all screen and hard-copy output data shall be presented in a clear and unambiguous manner.

The forward, (midship) and aft drafts at the perpendiculars shall be calculated and presented as screen and as hard-copy output. Furthermore, the navigational draft (often the draft to the underside of the keel) at forward, midship and aft, at the actual position corresponding to the ship's draft marks, should be calculated and presented on screen as well as in hard copy.

12 Interfaces with other shipboard systems

12.1 Disabling interfaces

If interfaces with shipboard systems are available, the loading software shall allow any interface with those systems to be switched off, and yet, permit the systems to remain operational. Manual input of data which is normally imported from such systems shall be possible.

12.2 Voyage data recorder

If a voyage data recorder (VDR) is installed, the last known loading condition should be stored in the VDR in accordance with IEC 61996:2000.

13 Standards for accuracy of calculations and verification checks required

13.1 Category A functions

Functions of Category A shall provide results identical to those printed in the Loading and Stability Manual. However, minor deviations, e.g. in the fraction, are allowable.

13.2 Category B functions

Functions of Category B should give results identical to those printed in the Loading and Stability Manual. However, because of different calculation strategies deviations might occur. These should be small but in no case shall exceed the following limits:

— displacement — 0,35 % (at a fixed draft and trim);

— transverse metacentre KM_T — 0,20 %;

— longitudinal centre of buoyancy — 0,2 % of Lpp;

— waterplane area — 0,2 % to 0,5 %;

— cross curves — 0,00 m to 0,05 m, depending on the heeling angle;

— maximum allowable intact VCG — 0,4 % to 1,7 %;

— shear forces, bending moments and torsion moments — 5 % of the maximum allowable value.

These maximum limits shall be verified, at least, for the standard loading conditions in the Loading and Stability Manual.

13.3 Verification check

A loading instrument shall be supplied with a hard copy of two or three predefined loading conditions, including printed output of calculations based upon those conditions. At regular intervals, the user shall perform calculations with those loading conditions, and check the results against the output as supplied. If the results do not agree, the loading instrument is considered to be defective, and shall no longer be used. The loading conditions which are used for this purpose may be, but need not be, the same as loading conditions from the Loading and Stability Manual.

Those hard copies shall either be included in the user manual, or be supplied as a separate booklet. Alternatively, reference could be made to a specific loading condition from the Loading and Stability Manual.

14 Integration of a loading instrument within the ship owner's organization

14.1 Office back-up of data

One copy of back-up data, as required by 5.3, shall be kept in the ship owner's office, together with at least one copy of the user manual.

14.2 The ship owner's office as operational back-up station

The ship owner's office, or offices, should be ready to function as an operational back-up resource for the fleet. In particular, the following measures are recommended:

— keep the loading software installed and operational in the ship owner's office;

— ensure that at least one qualified person, who is trained to install and use the software, is present in the office.

14.3 Support

In order to ensure support from within the ship owner's organization, at least two persons from the ship owner's office should be skilled in the use of the loading software.

14.4 Reporting errors and acquiring updates

Users of the software should have clear instructions on how to report bugs or erroneous static data to the supplier, and how to obtain software updates, all in accordance with 8.4.

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