No. 48 Recommendations on Loading Instruments

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1. INTRODUCTION

1.1 These Recommendations may be used by IACS Member Societies in conjunction with their requirements and procedures when approving loading instruments for ships not yet fitted with an approved loading instrument.

1.2 These recommendations are applicable to a loading instrument which is a computer based system consisting of a calculation program and the computer hardware on which it runs. Recommendations pertaining to the calculation program's system and functional specifications are contained in sections 3.1 and 4, respectively. Recommendations pertaining to the computer hardware specification for type approval are contained in section 3.2, see also section 1.8.

1.3 The loading instrument is not a substitute for the approved loading manual.

1.4 The loading instrument is ship specific onboard equipment and the results of the calculations are only applicable to the ship for which it has been approved.

1.5 Ships having undertaken major alterations or conversions affecting longitudinal strength, such as lengthening or removal of decks, should be treated as new ships for the purpose of these Recommendations.

1.6 The loading instrument approval process includes the following procedures for each ship;

1. Data verification which results in Endorsed Test Conditions
2. Approval of computer hardware, where necessary
3. Installation Testing which results in a Program Installation Test Certificate

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1.7 The loading instrument's calculation program may receive general approval from the Society and be issued with a Certificate of Approval. In such cases, some stages of the data verification procedure may be waived for each specific ship as specified in 2.1.7.

1.8 Hardware approval is intended to ensure that either a single computer is type approved in accordance with section 3.2 or that there are two nominated computers available in case of failure of one. If two nominated computers are available, type approval may be waived but both should be subject to installation testing. In addition, computers which are to be a part of a ship's network should be approved in accordance with the Society's relevant requirements.

1.9 The calculation program may be issued with a Program Installation Test Certificate after a satisfactory installation test of the loading instrument has been carried out onboard the ship in accordance with the recommendations in section 2.3.

2. APPROVAL PROCESS

2.1 Data Verification Approval - Endorsed Test Conditions

2.1.1 The Society should verify the computational results and actual ship data used by the calculation program for the particular ship on which the program will be installed.

2.1.2 Upon application to the Society for data verification, the Society should advise the applicant of a minimum of four loading conditions, taken from the ship's approved loading manual, which are to be used as the test conditions. Within the range of these test conditions each compartment should be loaded at least once. These test conditions normally cover the range of load draughts from the deepest envisaged loaded condition to the light ballast condition.

2.1.3 Read-out points should usually be selected at the position of the transverse bulkheads or other obvious boundaries. Additional read-out points may be required between bulkheads of long holds or tanks or between container stacks.

2.1.4 Where the still water torsion moments are required to be calculated, one test condition should demonstrate such a calculation.

2.1.5 It is important that the data contained in the loading program is consistent with the data specified in the approved loading manual. Particular attention is drawn to the final lightship weight and centres of gravity derived from the inclining experiment or lightweight check.

2.1.6 The Society should verify that the following data, submitted by the applicant, is consistent with the as-built ship:

1. Identification of the calculation program including version number.
2. Main dimensions, hydrostatic particulars and, if applicable, the ship profile.
3. 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.
4. Ship lightweight and lightweight distribution along the ship's length.
5. Lines plans and/or offset tables, or bonjean data at 21 stations in the length between perpendiculars.
6. Compartment definitions, including frame spacing, and centres of volume, together with capacity tables(sounding/ullage tables), if appropriate.

7. Deadweight definitions for each loading condition.

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2.1.7 The data verification procedure should be considered complete when:

1. The loading program's system specification is found to be satisfactory. See section 3.1.
2. The functionality of the program has been clearly described and the calculation methods and principles are to the satisfaction of the Society.
3. The loading program's functional specification is found to be satisfactory. See section 4.
4. The computational accuracy of the loading program is within acceptable tolerances. See section 2.5 for recommended tolerances.
5. The actual ship's data as described in 2.1.5 is satisfactory.
6. A clear and concise operation manual in accordance with 2.4 has been reviewed and found satisfactory.
7. Details of the minimum hardware specification have been stated.
8. Submitted test conditions have been endorsed.

2.1.8 Member Societies have the option to issue Approval Certification for the calculation program in accordance with section 2.2. When a calculation program has such an approval, the data verification procedure should be considered complete when:

1. It has been ascertained that the General Approval is applicable for the ship considered.
2. The details specified on the valid Certificate of Approval correspond to the calculation program's identification and version number.
3. The computational accuracy of the calculation program is within acceptable tolerances. See section 2.5.
4. The actual ship's data as described in 2.1.5 is satisfactory.
5. A clear and concise operation manual in accordance with 2.4 has been reviewed and found satisfactory.
6. Details of the minimum hardware specification and operating system software have been stated.
7. Submitted test conditions have been endorsed.

2.1.9 The Society should send the endorsed test conditions to the local surveyor with instructions to carry out an installation test. Where the ship is in service, the endorsed test conditions should be sent to the ship's owner who should arrange for the test conditions to be placed onboard and arrangements for an installation test, witnessed by a Society surveyor, should be made.

2.2 General Approval - Certificate of Approval of the Calculation Program

2.2.1 The loading instrument's calculation program may be generally approved in accordance with the Recommendations of this section. Upon satisfactory completion, the calculation program may be issued with a Certificate of Approval.

2.2.2 A Certificate of Approval is only valid for the identified, specified version of the calculation program.

2.2.3 Upon application to the Society for general approval of the calculation program, the Society should provide the applicant with test data from at least two different ship types. For calculation programs based on the input of hull form data, test data should be provided for three different ship types. This data should be used by the applicant to run the calculation

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program for the test ships. The results obtained (together with the hydrostatic data and cross-curve data developed by the program, if appropriate) should be submitted to the Society for the assessment of the program's computational accuracy. The Society should perform parallel calculations using the same input data and a comparison of these results will be made against the submitted program's results.

2.2.4 A Certificate of Approval may be issued if:

1. The loading program's system specification is found to be satisfactory. See section 3.1.
2. The functionality of the loading program has been clearly described and the calculation methods and principles are to the satisfaction of the Society.
3. The loading program's functional specification is found to be satisfactory. See section 4.
4. The computational accuracy of the loading program is within acceptable tolerances. See section 2.5.
5. A clear and concise operation manual is submitted for review.
6. Details of the minimum hardware specification have been stated.

2.2.5 The certificate of approval should specify, in detail, what calculations the program is approved for as well as important limitations.

2.2.6 The Certificate of Approval should remain valid for a period not exceeding five years. The Certificate of Approval would be revalidated upon confirmation from the manufacturers of the calculation program that the calculation algorithms remain unchanged.

2.2.7 The Certificate of Approval held for any specified calculation program should become invalid if the calculation algorithms have been modified by the manufacturer without the agreement of the issuing Society. In such cases, the revised calculation program should be treated as a new calculation program.

2.3 Installation Testing - Program Installation Test Certificate

2.3.1 Installation tests should be performed soon after the loading instrument has been installed onboard the ship.

2.3.2 During the installation test one of the ship's senior officers should operate the loading instrument and calculate the test conditions. This operation should be witnessed by a Society surveyor. The results obtained from the loading instrument should be identical to the results stated in the endorsed test conditions. Should the numerical output from the loading instrument be at variance with the endorsed test conditions, no certification should be issued.

2.3.3 An installation test should also be carried out on the second nominated computer, which would be used in the event of failure of the first computer. The results obtained from the loading instrument should be identical to the results stated in the endorsed test conditions. Should the numerical output from the loading instrument be at variance with the endorsed test conditions, no certification should be issued. Where the installation test is carried out on a Type Approved computer, a second nominated computer and test are not required.

2.3.4 Where the hardware is not Type Approved, it should be demonstrated that the Program Installation Test is acceptable on both the first and second nominated computers prior to the issue of a Program Installation Test Certificate.

2.3.5 After completion of satisfactory installation tests, the Society surveyor should attach

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the endorsed test conditions to the previously reviewed operations manual. The Society should then issue the Program Installation Test Certificate.

2.4 Operation Manual

2.4.1 A uniquely identified ship specific operation manual should be submitted to the Society for review.

2.4.2 The operation manual should be written in a concise and unambiguous manner. The use of illustrations and flowcharts is recommended.

2.4.3 The operation manual should contain;

1. A general description of the program denoting identification of the program and its version number stated.
2. Where applicable, a copy of the Certificate of Approval, or equivalent, signifying approval of the calculation program;
3. Details of the hardware specification needed to run the loading program;
4. A description of error messages and warnings likely to be encountered and unambiguous instructions for subsequent actions to be taken by the user in each case;
5. Light shipweight and co-ordinates of its centre of gravity;
6. Full deadweight description of each test condition;
7. A list of the permissible still water shear forces and still water bending moments assigned by the Society in addition to the permissible cargo torque, where applicable;
8. Where applicable, the shear force correction factors;
9. Where applicable, local permissible limits for single and two adjacent hold loading as a function of the appropriate draught and the maximum weight for each hold.
10. An example of a calculation procedure supported by illustrations and sample computer output;
11. Example computer output of each screen display, complete with explanatory text.

2.5 Acceptable Tolerances

2.5.1 The computational accuracy of the calculation program should be within the acceptable tolerance band, specified in Table 1, of the results at each read-out point obtained by the Society using an independent program or the approved loading manual with identical input.

Table 1 : Tolerance Band for the Comparison of Computational Accuracy

Computation	Tolerance (Percentage of the approved value)
Still Water Shear Force	± 5%
Still Water Bending Moment	± 5%
Still Water Torsion Moment	± 5%

2.6 Hardware Approval

2.6.1 Where the loading instrument's hardware is to be type approved, the hardware specification should be in accordance with section 3.2, also see paragraph 1.8.

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3. SYSTEM SPECIFICATION

3.1 Calculation Program

3.1.1 It is recommended that the design and production of the calculation program should be in accordance with appropriate international quality standards, for example ISO 90003: 2018 or equivalent.

3.1.2 The software should be written to ensure the user can not alter the critical ship data files containing the following information:

1. Light shipweight and lightship weight distribution and associated centres of gravity;
2. The Society's imposed structural limitations;
3. Geometric hull form data;
4. Hydrostatic data;
5. Compartment definitions including frame spacing, and centres of volume, together with capacity tables (sounding/ullage tables), if appropriate.

3.1.3 Any changes made to the software, which may affect the longitudinal strength aspects, should be made by the manufacturer or his appointed representative and the Society should be informed immediately of any changes. Failure to advise of any modifications to the calculation program may invalidate the certification issued. In cases where the certification is considered invalid by the Society, the modified calculation program should be re-assessed in accordance with the approval procedure.

3.2 Stand-alone Computer Hardware

3.2.1 The Society may issue a Certificate of Type Approval for the shipboard hardware, used by the calculation program, when the hardware has been deemed to satisfy the recommendations specified in 3.2.2. Individual IACS Member Societies may stipulate additional requirements.

3.2.2 The manufacturer should submit details of the hardware to be installed onboard. The following information should be submitted for review and if found satisfactory, the manufacturer will be advised accordingly:

1. The hardware specification;
2. Relevant design drawings with materials specified, catalogues, data sheets, calculations and functional descriptions;
3. Proposed test programme to demonstrate that the performance provisions of the specified standards maybe fulfilled;
4. Certificates and reports for relevant tests previously obtained for the product.

3.2.3 When considering the information described in 3.2.2 the Society may recognise valid certificates or reports issued by another certification body or accredited laboratory.

3.2.4 Performance and environmental testing should be carried out in the presence of the Society Surveyor according to the type testing conditions for type approval detailed in IACS Unified Requirements (UR) E10 Testing Procedure for Electrical, Control and Instrumentation Equipment, Computers and Peripherals covered by Classification. The following tests should be successfully completed;

1. Visual inspection,

2. Performance test,
3. Electric power supply variations,
4. Dry heat,
5. Damp heat,
6. Vibration,
7. Inclination,
8. Insulation resistance,
9. Cold temperatures,
10. Electromagnetic compatibility tests.

3.2.5 The Society should be advised of any alterations in the hardware specifications.

4 FUNCTIONAL SPECIFICATION

4.1 General

4.1.1 The computational functions to be encompassed by the calculation program depend upon the specific requirements which are given in the Society's Rules and Regulations.

4.1.2 The calculation program should be user-friendly and designed such that it limits possible input errors by the user.

4.1.3 The forward, midship and after draughts, at the respective perpendiculars, should be calculated and presented as screen and hardcopy output to the user in a clear and unambiguous manner.

4.1.4 It is recommended that the forward, midship and after draughts, at the actual position of the ship's draught marks should be calculated and presented as screen and hard copy output to the user in a clear and unambiguous manner. Provision should be made available for the introduction of a longitudinal deflection.

4.1.5 The displacement should be calculated for the specified load condition and corresponding draught readings and presented as screen and hardcopy output to the user.

4.1.6 The loading instrument should be capable of producing print-outs of the results in both numerical and graphical form. The numeric values should be in both absolute values and as the percentage of the allowable value. This print-out should include a description of the corresponding load condition.

4.1.7 All screen and hardcopy output data should be presented in a clear and unambiguous manner with an identification of the calculation program (version number should be stated).

4.2 Hull Girder Forces and Moments

4.2.1 The loading program should be capable of calculating the following hull girder forces and moments in accordance with IACS Unified Requirements and, where applicable, the Society Rules and Regulations:

1. Still Water Shear Force (SWSF) including the shear force correction, where applicable.
2. Still Water Bending Moment (SWBM).
3. Still Water Torsion Moment (SWTM), where applicable.
4. For ships with relatively large deck openings, additional considerations such as

torsional loads should be considered.

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4.2.2 The data which should be provided to or accepted by the Society is specified in Table 2.

Table 2: Data to be Provided to/or Accepted by the Society

Calculation	Data to be Provided to or Accepted by the Society
Still Water Shear Force (SWSF)	1. The read-out points (frame locations) for the SWSF calculations. These points are normally selected at the position of the transverse bulkhead or other obvious boundaries. Additional read-out points may be specified between the bulkheads of long holds or tanks or between container stacks. 2. Shear force correction factors and method of application. 3. The permissible seagoing and harbour SWSF limits at the read-out points specified in (1). Where appropriate, additional sets of permissible SWSF values may be specified.
Still Water Bending Moment (SWBM)	1. The read-out points (frame locations) for the SWBM calculations. These points are normally selected at the position of the transverse bulkhead, mid-hold or other obvious boundaries. 2. The permissible seagoing and harbour SWBM limits at the read-out points specified in (1). Where appropriate, additional sets of permissible SWBM values may be specified.
Still Water Torsion Moment (SWTM), where applicable	1. The read-out points (frame locations) for the SWTM calculations. 2. The permissible limits at the read-out points specified in (1).

4.2.3 The calculated forces and moments should be displayed in both graphical and tabular format, including the percentage of permissible values. The screen and hardcopy output should display the calculated forces or moments, and the corresponding permissible limit, at each specified read-out point.

Alternative limits, e.g. vertical still water bending and torsion may be considered in accordance with the Society's Rules.

4.3 Permissible Limits

4.3.1 The user should be able to view the following Society imposed structural limitations in a clear and unambiguous manner;

1. All permissible still water shear forces and still water bending moments:
2. Where applicable, the permissible still water torsion moments:
3. Where applicable, all local loading limits for both one hold and adjacent hold loading:

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4. Cargo hold weight;
5. Ballast tank/hold capacities:
6. Filling restrictions.

4.3.2 It should be readily apparent to the user when any of the imposed structural limits have been exceeded.

5 IN SERVICE VERIFICATION

5.1 General

5.1.1 Where an installed shipboard loading instrument is required and has no Program Installation Test Certificate or record of having previously been examined by a Society, the attending Society surveyor should advise the Society accordingly.

5.2 Scope of Survey

5.2.1 When testing the loading instrument, the results obtained from the calculation program should be identical to the results stated in the endorsed test conditions. Should the numerical output from the loading instrument be at variance with the endorsed test conditions, a condition of class should be imposed on the ship and the owners advised accordingly. The calculation program should be tested on all specified computers (type approved or nominated).

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