



CLASSIFICATION NOTES

No. 20.1

STABILITY DOCUMENTATION FOR APPROVAL

MAY 2011

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FOREWORD

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Classification Notes are publications that give practical information on classification of ships and other objects. Examples of design solutions, calculation methods, specifications of test procedures, as well as acceptable repair methods for some components are given as interpretations of the more general rule requirements.

All publications may be downloaded from the Society's Web site <http://www.dnv.com/>.

The Society reserves the exclusive right to interpret, decide equivalence or make exemptions to this Classification Note.

This issue of CN 20.1 replaces the April 2010 issue and is valid until superseded by a new revision or withdrawn.

Main changes

— References to DNV e-Form 44.70a 'Attendance Checklist' have been removed.

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CONTENTS

1. Introduction.....	4
1.1 Scope.....	4
1.2 General.....	4
1.3 Documents submitted in electronic form.....	4
2. Stability Documentation.....	4
2.1 B050 - Preliminary stability manual (PSM).....	4
2.2 B100 - Inclining test and lightweight survey procedure (ITP).....	10
2.3 B110 - Inclining test and lightweight survey report (ITR, LWS).....	11
2.4 B120 - Final stability manual (FSM).....	11
2.5 B070 - Preliminary damage stability calculation (PDS).....	11
2.6 B130 - Final damage stability calculation (FDS).....	12
2.7 B060 - Floodable lengths and subdivision calculations of passenger ships (FSC).....	12
2.8 Damage control information.....	13
2.9 B150 - Damage control plan (DCP).....	13
2.10 B160 - Damage control manual (DCM).....	14
2.11 Z010 - General arrangement plan (GAP).....	14
2.12 B010 - Lines plan and offset tables (LPO).....	14
2.13 B020 - External watertight integrity plan or freeboard plan (EWP).....	15
2.14 B030 - Internal watertight integrity plan (IWP).....	15
3. Additional Documentation for Certain Ships.....	16
3.1 Sea-going ships of 65 m in length and above required to carry a loading manual.....	16
3.2 New tankers designed as combination carriers.....	17
3.3 Bulk carriers.....	17
3.4 Ships intended for the carriage of grain in bulk.....	18
3.5 Ships designed to carry timber deck cargoes.....	21
3.6 High speed crafts - B170 Stability in the non-displacement mode.....	22
Appendix A.	
NOTIFICATION ON LIGHTWEIGHT SURVEY AND INCLINING TEST.....	23

1. Introduction

1.1 Scope

1.1.1 The purpose of this Classification Note (CN) is to provide DNV's clients with specification on minimum contents of the stability documentation required in connection with stability approval.

The codes given for each of the document type (e.g. B050) refers to the DNV document code according to Rules for Ships Pt.0 Ch.3 and the documentation requirement list for newbuildings and conversions.

1.1.2 The information in this CN is made to suit various DNV stability rules and common IMO and IACS standards in those cases where DNV is authorised to conduct statutory stability approvals. This CN is not intended to cover statutory documentation requirements that may be in excess of those standards. One should therefore refer to the rules and regulations in question to verify the applicable information for the ship in question.

1.1.3 While this Classification Note has been written with application to newbuildings in mind it should also be used as far as practicable whenever all or parts of stability documentation for existing ships is to be replaced.

1.1.4 This CN is not a substitute for the rules or regulations, but a means to help implementing them.

1.1.5 DNV stability rules allow that the class requirements may be considered complied with in some cases where a national authority has carried out the approval. In these cases it is nevertheless recommended that the contents of this CN be implemented in that documentation as far as practicable.

1.1.6 DNV may accept layouts of stability documentation other than those presented in this CN, provided the basic contents are included.

1.1.7 According to the Society's rules, approved loading computer systems (LCS) are accepted as supplementary to printed stability documentation. The documentation requirements for such systems are not within the scope of this CN. For information on approval and certification of LCS software please see CN 21.1.

1.2 General

1.2.1 General requirements for all documentation are outlined in DNV's Rules for Classification of Ships, Pt.0 Ch.3 Sec.1 E100.

All documentation must include evidence of verification.

1.2.2 The stability documents should be legible, clear and easy to use onboard.

1.2.3 The units in all stability documentation should be consistent.

1.2.4 Approval of preliminary stability documentation means preliminary stability approval. Short-term certificates require preliminary stability approval.

1.2.5 Approval of final stability documentation means final stability approval. Full-term certificates require final stability approval.

1.2.6 IMO has adopted certain mandatory documentation requirements for tankers and bulk carriers. An excerpt from these requirements has been included in this CN.

1.3 Documents submitted in electronic form

Unless otherwise agreed in accordance with Pt.1 Ch.1 Sec.3 A of DNV Rules (eApproval), electronic versions of single drawings and booklets should be avoided, but may be accepted for time critical approvals upon prior agreement.

2. Stability Documentation

2.1 B050 - Preliminary stability manual (PSM)

2.1.1 The PSM should be submitted for approval as early as possible to ensure valid approval at vessel

delivery. The PSM covers all vessels in a series and is to be submitted once.

2.1.2 For compliance with the intact stability criteria of the 2008 IS Code (IMO Res.MSC.267(85)) only, the format of IMO MSC/Circ.920 may be accepted for the stability manual.

2.1.3 The following are the general contents of the stability manual. The manual should contain sufficient information to enable the master to operate the ship in compliance with the stability requirements applicable to the vessel. These contents are to be adjusted in accordance with the applicable regulations. The stability manual should also include information on longitudinal strength, if applicable for the relevant ship type.

Guidance note:

Sea-going ships of 65 m in length and above which are contracted for construction on or after 1998-07-01 are to be provided with an approved loading manual based on the final light ship particulars of the ship and which includes strength considerations (IACS UR S1). There are also additional requirements for bulk carriers, ore carriers and combination carriers of 150 m in length and above (IACS UR S1A). The loading manual required for these ships may be submitted for approval as the FSM provided that it also contains the information set out below. See also section 3 of this CN for details.

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Table of contents

Table of contents and index for each booklet forming part of the stability documentation.

Main particulars

The vessel's identification, including the IMO number, main dimensions, maximum draught, maximum trim and service information.

Guidance note:

According to IMO MSC/Circ.1142 "all plans, manuals and other documents required by the various IMO conventions to be carried on board ships constructed on or after 1 July 2005 should be marked with the IMO ship identification number in a clearly legible and unambiguous manner". For consistency it is recommended that new versions of such documents for older ships be marked with the IMO number as well.

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Applicable regulations

Reference to the statutory regulations and class notations that are basis for the approval and a brief list of the corresponding stability requirements.

Stability model

Sketch of volumes contributing to buoyancy in intact and damage stability calculations.

Reference system and baseline

These are to be clearly defined and are to be used consistently throughout the stability documentation.

Preliminary lightship particulars

Based on an estimate or sister vessel.

Deadweight data

Masses and positions of centre of gravity of typical deadweight groups/items to facilitate simplified calculation of loading conditions such as "consumables departure", "consumables arrival" or standard cargo loads and so forth. Information on the transverse centre of gravity TCG should be provided in order to enable upright loading if it is expected that this value will not be 0 due to the ship's design or load distribution.

Tank data

Tank plan and capacity tables with following information on each tank:

- tank name/number
- type
- volume
- centre of gravity
- maximum free surface effect.

Sounding or ullage tables may be included for this purpose.

Stowage plan

Applicable for carriage of containers or vehicles.

Draught marks

A sketch showing longitudinal position of draught marks, position relative to the hydrostatic reference system and baseline. Information on the correlation between the draught marks and appendages such as azimuth thrusters is to be particularly emphasised. Instructions on how to calculate from draught readings the corresponding draught to be used in tables for hydrostatic data, cross curves and minimum required GM_T or maximum allowable VCG curves, assuming no deflection of hull girder are to be included.

Hydrostatic data

The hydrostatic data are to be presented on extreme draught basis in tabular form, from lightship draught to above maximum draught with steps not exceeding 0.10 m.

In cases where the vessel is expected to operate with trim, the hydrostatic data should cover the intended trim range. Alternatively, trim correction tables are to be included.

As a minimum, the following hydrostatic should be presented:

- displacement moulded (m^3)
- displacement extreme (tonnes)
- tonnes per centimetre immersion
- moment to change trim one centimetre
- vertical centre of buoyancy
- longitudinal centre of buoyancy
- longitudinal centre of flotation
- transverse metacentre
- longitudinal metacentre.

Cross curves

The cross curves should be presented on an extreme draught or displacement basis in tabular form, from lightship draught to above maximum draught for at least the following angles of heel: 5, 10, 15, 20, 30 and 40 degrees. If the same curves are also intended for use in connection with grain stability, the curve for 12 degrees is to be included.

In cases where the vessel is expected to operate with trim, the cross curves should cover the intended trim range and the trim values should correspond with those presented for the hydrostatic particulars.

The cross curves are to be calculated on a “free to trim” basis.

Guidance note:

See also Sec.3 in the case of ships designed for carriage of timber deck cargoes.

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Water- and weathertight integrity

Position of critical unprotected and weathertight openings considered flooding points in intact- and damage stability calculations as applicable.

Instructions on closing appliances and location of signboards.

Flooding angle curve

Flooding angle curve representing the angle of flooding of critical unprotected openings as a function of extreme draught or displacement from lightship draught to above maximum draught.

In cases where the vessel is expected to operate with trim, multiple flooding angle curves covering the intended trim range is to be developed. The trim values are to correspond with those presented for hydrostatic particulars and cross curves.

Minimum required GM_T or maximum allowable VCG curves

The draught reference point is to be same as for hydrostatic data.

The *minimum required GM_T* or maximum allowable VCG curves may be presented on an extreme draught or displacement basis in tabular or curves form from lightship draught to maximum draught.

In cases where the vessel is intended to operate with trim, the minimum required GM_T or maximum allowable VCG curves are to cover the intended trim range. The trim values are to correspond with those presented for hydrostatic particulars and cross curves.

The minimum required GM_T or maximum allowable VCG curves are to satisfy all intact and damage stability requirements of the regulations applicable to the ship. The curves are to be presented as resulting curves. Separate curves for intact and damage stability are not to be included in the documentation intended for use on

board unless justified by multiple modes of operation.

Any limitations or conditions such as specific modes of operation related to the application of the minimum required GM_T or maximum allowable VCG curves are to be clearly stated on the curves.

If no minimum required GM_T or maximum allowable VCG curves have been calculated, the validity of the stability approval will be limited to the presented loading conditions.

Guidance note:

See also Sec.3 in the case of ships designed for carriage of timber deck cargoes.

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Special loads/moments

Special loads and external heeling moments are to be presented as required by the applicable rules, regulations and additional class notations, such as:

- high speed turning
- wind heeling moment
- passenger heeling moment
- davit launching moment
- towing heeling moment
- crane heeling moment
- entrapped water in pipes on deck, included in the loading conditions
- entrapped water on deck or other spaces included in the loading conditions
- water monitors heeling moment
- ice beaching moment
- ice accretion, included in the loading conditions.

Loading conditions

The loading conditions should be preceded by a summary of all loading cases in a tabular form giving a brief overview of the loading conditions included in the document. This overview should consist of:

- total capacity of cargo, tanks and other items included in each loading condition
- total displacement and corrected centre of gravity (VCG)
- extreme draughts and total trim
- corrected transverse metacentric height (GM_T).

Except as otherwise specified by this CN or required by the regulations applicable for the ship, for the purpose of assessing in general whether the stability criteria are met, stability curves using the assumptions given by the applicable regulations should be drawn for the loading conditions intended by the owner in respect of the ship's operations.

If the owner of the ship does not supply sufficiently detailed information regarding such loading conditions, calculations should be made for the standard loading conditions, as follows:

- full load condition, departure (100% consumables)
- full load condition, arrival (10% consumables)
- ballast condition, departure (100% consumables)
- ballast condition, arrival (10% consumables).

Guidance note:

Standard loading conditions for certain types of ships are listed in the 2008 IS Code Part C Part 3.4.1.

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If the loading conditions are based on the assumption that the reduction in stability due to consumption of fuel oil and fresh water is to be compensated by intake of water ballast during the voyage the calculations should be supplemented with additional loading conditions demonstrating at what stage(s) of the voyage water ballast is to be added. The free surface effects should be calculated to take account of the most onerous transitory stage relating to such operations. Please note 2008 IS Code Part B Par. 3.1.5 in this respect.

Special loads and external heeling moments such as ice load, crane load and entrapped water are to be applied to the presented loading conditions as may be required by the regulations applicable to the ship.

Guidance note:

Some regulations require that the special loads or heeling moments be applied to supplementary loading conditions assuming maximum allowable VCG.

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In addition to the regulatory conditions above loading conditions covering the intended range of service modes including those most unfavourable are to be presented.

Guidance note:

See also Sec.3 for more specific guidance on loading conditions for certain types of ships.

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The presented loading conditions are to be within the limit curves or satisfy the applicable requirements.

As a minimum, the following information is to be presented for each loading condition:

- individual masses with centre of gravity
- free surface moments of slack tanks
- total displacement and corrected centre of gravity
- extreme draughts and total trim
- propeller immersion, if applicable
- corrected transverse metacentric height (GM_T)
- maximum allowable VCG or minimum required GM_T
- tabulated GZ - values and GZ - curves
- values of applicable stability criteria if maximum allowable VCG curves have not been calculated.

Notes on stability

- general precautions against capsizing
- instructions on checking the stability
- use of free surface correction
- use of cross curves
- use of maximum allowable VCG curves.
- stability limitations regarding loading of the vessel including draught to prevent slamming, if applicable
- instructions on emergency situations (storm/damage)
- use of onboard computer in assessing the stability.

Worked example on stability

A complete worked example on calculating and checking the stability of a loading condition.

Blank stability forms

Blank forms for calculating and checking the stability for actual loading conditions.

Deadweight scale

Conversion tables

For vessels to which the DNV Offshore Standard applies, a Preliminary Stability Manual (B051, PSM) shall be prepared. The contents are to be the same as for B050, with the following adjustments, as applicable. For self-elevating units and column-stabilized units required to have an Operation Manual, the below information should be included therein.

Limit curves or maximum allowable VCG curves, general:

- The details of the calculations are to be documented in a separate document, B040 Stability analysis.
- The draught reference point is to be same as for hydrostatic data.
- The limit curves may be presented on an extreme draught or displacement basis in tabular or curves form from lightweight draught to maximum draught.
- In cases where the vessel is intended to operate with trim, the limit curves are to cover the trim range.
- The limit curves are to satisfy all stability requirements of the rules and regulations.
- Any limitation or conditions related to the application of the limit curves should be clearly stated on the curves.

Limit curves or maximum allowable VCG-curves, column-stabilised units

Table 2-1 Limit curves or maximum allowable VCG-curves, column-stabilised units		
<i>Curve</i>	<i>Conditions</i>	<i>Values</i>
I	Operation and transit conditions	Maximum VCG-values according to the intact stability criteria with 70 knots wind and damage stability criteria with 50 knots wind. The curve should at least cover the operation and transit draughts.
II	Survival conditions	Maximum VCG-values according to the intact stability criteria with 100 knots wind. The curve should at least cover the range from maximum operation draught to minimum storm draught.
III	Temporary conditions, column stabilised units	Maximum VCG-values according to the intact stability criteria with 70 knots wind ex-kept that the minimum GM-requirement is 0.3 m. The curve should cover the whole range of draughts

The allowable VCG-curve should reflect the lowest VCG-values obtained for the most critical heeling axis at each draught. The vessel should be assumed free to trim when heeled.

In cases where a change in draught is necessary to reach the survival draught, ballasting and deballasting curves should be worked out and included in the stability manual as follows:

Curve A: Ballasting from transit draught to survival draught

Curve B: De-ballasting from operating draught to survival draught.

For column stabilised units, these curves should be based on ballasted or de-ballasted water at half the pontoon height and possible transfer of mud. Curves A and B should be regarded as the final maximum allowable VCG-curves for checking the actual loading conditions. The ballast curve A and B may be derived by taking into account the actual changes in loading conditions brought about by the change in the operating mode such as change in mooring loads, removal of hook load, disconnection of marine riser, etc., provided that such underlying assumptions are clearly stated.

Maximum allowable VCG-curves, self-elevating units:

For self-elevating units, it is normally only relevant to draw curve I and curve II, as described above. Curve I covers the field move conditions, while Curve II together with the curve developed from damage stability requirements covers the ocean tow conditions.

Special loads and moments:

Special loads such as ice loads and crane loads, should be presented as required by the rules and regulations.

Loading conditions:

The presented loading conditions should include the standard loading conditions required by the rules and regulations. For a column stabilised unit the following conditions should be presented:

- transit condition with maximum deck load and anchors onboard
- severe storm condition from transit, same distribution of loads except ballast water
- operational condition with maximum deck load and equipment in the most unfavourable position
- severe storm condition from operational condition (same distribution of loads except ballast water, the marine riser disconnected and a reasonable amount of drill pipes stored in the derrick)
- same as above with ice load.

Self-elevating unit:

- maximum loaded for ocean tows
- maximum loaded for field moves
- same as above with ice loads.

Drill ship:

- departure fully loaded with maximum deck load (100% consumables)
- arrival fully loaded with maximum deck load (10% consumables)
- moored at the field, alternatively dynamically positioned
- same as above with ice load.

Oil storage vessel:

- recommended loading and offloading sequences
- same as above with ice load.

Any other kind of vessel:

- loading conditions reflecting the most onerous loading of the vessel consistent with the intended operational practice.

The presented loading conditions should cover the intended range of service modes including the most unfavourable loading conditions.

The presented loading conditions should be within the limit curves.

The following minimum information should be given for each loading condition:

- individual weights, centre of gravity and free surface moment for slack tanks
- total weight and corrected centre of gravity
- extreme draughts and total trim
- corrected GM
- maximum allowable VCG or minimum required GM. GZ curves should be plotted.

A summary of the loading conditions should be presented in a tabular form giving information above except individual weights and GZ curves.

Lightweight definition and forms for lightweight recording:

- The estimated lightweight data and definition should be included together with blank forms and instructions for continuous follow up on lightweight alteration.

General procedures for deballasting or counter-flooding in case of damage:

- General procedures in case of damage should be indicated. These may be simple guidelines such as advice on emptying loaded tanks in the vicinity of the damage, closing of doors, etc.

Guidance in determining the cause of unexpected list:

- General procedures should be given in order to avoid that corrective measures are taken before the consequences are properly considered.

2.2 B100 - Inclining test and lightweight survey procedure (ITP)

2.2.1 For the purpose of procedures and reporting a lightweight survey is the same as the inclining test disregarding inclining weights, shifts, pendulums and so forth.

2.2.2 To carry out an inclining test or a lightweight survey, an ITP developed in accordance with the principles in IACS Rec. No.31 should be available in approved order at the time of the conduct. As an alternative, Appendix A “Notification on lightweight survey and inclining test” may be filled in and handed over to the DNV surveyor (ref. list in the form of cases for which this is accepted) before the conduct.

2.2.3 If the yard/owner wishes to determine the lightship particulars based on a satisfactory lightweight survey and the inclining test of a sister vessel, a lightweight survey procedure is to be submitted as the ITP instead.

2.2.4 Subject to statutory regulations and DNV Rules for Ships, a lightweight survey may be accepted in lieu of an inclining test for a series of sister vessels. This will also depend on:

- the type of vessel
- the time span of building the series
- whether the vessels are built for the same owner
- if there are dissimilarities between the vessels
- if the inclining test of the first vessel is approved.

Guidance note:

SOLAS 2009 Reg.II-1/5.2 states that: “A weight survey shall be carried out upon completion and the ship shall be inclined whenever in comparison with the data derived from the sister ship, a deviation from the lightship displacement exceeding 1% for ships of 160 m or more in length and 2% for ships of 50 m or less in length and as determined by linear interpolation for intermediate lengths or a deviation from the lightship longitudinal centre of gravity exceeding 0.5% of L_s is found”.

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2.2.5 The contents of the procedure are to be in accordance with IACS Rec.No.31 or, as an alternative, Annex 1 of IMO 2008 IS Code part B.

2.3 B110 - Inclining test and lightweight survey report (ITR, LWS)

2.3.1 An ITR/LWS prepared in accordance with IACS Rec.31 should be submitted for approval as soon as possible after the inclining test or lightweight survey, to ensure approval before vessel delivery. It is to be forwarded to the attending surveyor for endorsement before being submitted for approval.

2.4 B120 - Final stability manual (FSM)

2.4.1 The FSM is basically the revision of the loading conditions from the PSM according to the approved lightship particulars in the ITR, and any other comments as may have been given in connection with the preliminary approval.

2.4.2 The date and place of the inclining test or lightweight survey upon which the FSM is based is to be entered under lightship particulars and also the name of the organisation responsible for the approval. Alternatively a stamped copy of the ITR could be included, if available.

2.4.3 The mass and location of any permanent ballast or other fixed weights not included in the results from the ITR/LWS is to be clearly specified in the FSM.

2.4.4 If the differences between lightship particulars for sister vessels are sufficiently small and within the accuracy and tolerances of inclining tests and lightweight surveys, the lightship particulars of the first vessels in a series may be used for the sister vessel. Identical final stability documentation to that of the first vessel may then be accepted for the sister vessel. This will normally be accepted if the difference in lightship mass is within 0.5% and the difference in LCG is within 0.5% of LBP. In such cases it is recommended that the lightweight data approval letter is included in the FSM.

2.4.5 Upon approval of the FSM, the approval letter should be physically attached to the FSM before taken onboard the vessel. That is to ensure that any limitations to the approval are clearly communicated to the Master.

2.5 B070 - Preliminary damage stability calculation (PDS)

2.5.1 Subject to appropriate class and statutory regulations a damage stability approval can be either general, based on approval of minimum required GM_T or maximum allowable VCG curves, specific, based on approval of specific loading conditions representing the intended service of the vessel, or a combination.

2.5.2 The PDS should be submitted for approval as early as possible, since such calculations often decide the limit curves that are to be used further in the PSM.

2.5.3 If the PDS is intended to provide maximum allowable VCG curves only, that is, they are independent of the lightship particulars, they may also be considered as the final damage stability calculations (FDC).

2.5.4 The presentation of the calculations depends on the calculation method, that is, whether the applicable regulations are based on deterministic or probabilistic principles or a combination of both.

Information common for both methods

- reference to the applicable damage stability requirements
- description and location of openings assumed watertight, weathertight or unprotected in the calculations
- description of the margin line or other immersion limits as may be applicable
- a list and sketches of cross-flooding systems, downflooding openings and other devices assumed to correct list due to flooding.

Deterministic method

The following are the minimum contents of the PDS in the case of deterministic calculations, such as for supply vessels, oil tankers under regulation 28 of MARPOL 73/78 Annex I (2006 Edition) and the deterministic IMO 2000 HSC Code:

- a list of initial intact conditions is to be given if it is the intention to obtain an approval of specific loading conditions only
- initial intact conditions covering the intended range of draughts and trims if only minimum required GM_T or maximum allowable VCG curves are to be calculated
- assumed extent of damage and number of damaged compartments

- a list and sketches of the calculated damage cases. the calculated damage cases are to be the most severe damage cases according to the applicable requirements
- a specification of the initial contents of damaged tanks, if applicable
- details on the damage stability calculations and the results for each damage case:
 - i) equilibrium position (draught, trim and heel) after damage;
 - ii) the metacentric height (GM_T);
 - iii) particulars of the GZ curve in intermediate and final stages of flooding, including maximum righting arm and the corresponding heel angle, positive range, freeboard to critical flooding points and the margin line, if applicable
 - iv) time required for equalisation, if applicable
 - v) other critical factors, such as crowding of passengers on one side, launching of lifeboats, effect of wind and so forth, if required by the regulations.
- minimum required GM_T or maximum allowable VCG curves if applicable.

Probabilistic method

The following are the minimum contents of the PDS in the case of probabilistic calculations; such as for cargo ships under part B-1, chapter II-1 of SOLAS-74 and passenger ships under IMO resolution A.265(VIII):

- calculation of the required subdivision index R
- initial intact conditions. (Deepest subdivision load line, partial load line(s), light service draught, assumed trims, VCG)
- a list and sketches of the calculated damage cases
- tables showing, for each damage case:
 - i) the indices 'p', 'b', 'h', 'v' and 's'
 - ii) particulars of the GZ curve in intermediate and final stages of flooding, including maximum righting arm and the corresponding heel angle, positive range, freeboard to critical flooding points and the margin line, if applicable
 - iii) time required for equalisation, if applicable
- minimum required GM_T or maximum allowable VCG curves.

Guidance note:

For guidance on calculation of subdivision indices and minimum required GM_T under part B-1 in chapter II-1 of SOLAS-2009 refer to "Explanatory notes to the SOLAS Ch.II-1 subdivision and damage stability regulations", IMO Res. MSC.281(85). For guidance on calculation of subdivision indices under IMO Res. A.265(VIII) refer to "Explanatory notes to the regulations on subdivision and stability of passenger ships as an equivalent to part B of Chapter II of the International Convention for the safety of Life at Sea, 1960" as adopted by IMO in connection with IMO Res. A.265(VIII).

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2.6 B130 - Final damage stability calculation (FDS)

2.6.1 The FDS is the revised PDS according to the approved lightship particulars after the inclining test or lightweight survey, and any comments in connection with the preliminary approval.

2.6.2 If the approved PDS is based on loading conditions only it may be considered as the final damage stability calculations if the approved lightship particulars are not less favourable than the estimates used in those calculations.

2.6.3 If the approved PDS is based on the probabilistic method, a preliminary approved partial index A_i may be considered to remain valid as final provided that, 1) differences in lightship particulars result in minor deviations from the assumed draught and trim in the light service conditions, and 2) the assumed watertight subdivision and watertight integrity has been confirmed unchanged.

2.7 B060 - Floodable lengths and subdivision calculations of passenger ships (FSC)

This document contains calculations according to SOLAS-74 Ch.II-1 Part B Reg.4-7, and only applies to passenger vessels constructed before 1. January 2009. The FSC should be submitted for approval together with the PDS.

FSC for passenger ships should contain:

- calculations of permeability, criterion of service and factor of subdivision

— floodable- and permissible length curves.

Guidance note:

SOLAS-74 and common interpretations permit certain alternatives for detailed calculation of permeability etc. The use of such alternative calculation methods is to be clarified with DNV in advance of the submission.

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2.8 Damage control information

2.8.1 The damage control information is intended to provide the ship's officers with clear information on the ship's watertight subdivision and equipment related to maintaining the integrity of the watertight boundaries so that in the event of damage to the ship causing flooding proper precautions can be taken to prevent progressive flooding through openings therein and effective action can be taken quickly to mitigate and, where possible, recover the ship's loss of stability.

Guidance note:

Damage control information should be prepared according to IMO MSC/Circ.919 (pre. 1. January 2009) or MSC/Circ.1245 (after 1. January 2009).

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2.8.2 The damage control information should consist of:

- damage control Plan (DCP)
- damage control Manual (DCM).

2.8.3 The DCP and DCM should be clear and easy to understand. They should not include information that is not directly relevant to damage control, and should be provided in the working language of the ship. If the languages used in the preparation of the plan and booklet is not one of the official languages of the SOLAS Convention, a translation into one of the official languages should be included.

2.8.4 DCP and DCM are to be provided in printed form. The use of on-board computers with damage stability software developed for the specific ship and familiar to properly trained ship's officers can provide a rapid means to supplement the information in the planned booklet for effective damage control but can not be approved in lieu of the DCP and DCM.

2.9 B150 - Damage control plan (DCP)

2.9.1 The DCP should be of a scale adequate to show clearly the required contents of the plan.

2.9.2 The DCP should include inboard profile, plan views of each deck and transverse sections to the extent necessary to show the following:

- a) The watertight boundaries of the ship.
- b) The locations and arrangements of all cross-flooding systems, blow-out plugs and any mechanical means to correct list due to flooding, together with the locations of their valves and remote controls, if any.
- c) The locations of all internal watertight closing appliances, including internal ramps or doors acting as extension of the collision bulkhead on 'Ro-Ro ships', their controls and the locations of their local and remote controls, position indicators and alarms.
- d) The locations of those watertight closing appliances which are not allowed to be opened during navigation, and of those watertight closing appliances which are allowed to be opened during navigation.
- e) Watertight doors in passenger ships that are allowed to remain open during navigation in accordance with SOLAS 2009 regulation II-1/13.
- f) The location of all doors in the shell of the ship, position indicators, leakage detection and surveillance devices.
- g) The locations of all weathertight closing appliances in local subdivision boundaries above the bulkhead deck and on the lowest exposed weather decks, together with locations of controls and position indicators, if applicable.
- h) The location of all bilge and ballast pumps, their control positions and associated valves.
- i) Any pipes, ducts or tunnels through which limited progressive flooding has been accepted by the Administration.

- j) Reference to where to find detailed information for each damage case. This information is to be given in the DCM. Each damage case should therefore refer to the corresponding page number in the DCM.

Guidance note:

In the case of large passenger ships using a GAP as the basis for a DCP is not advisable as information tends to get lost in the large amount of detail on such drawings.

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2.10 B160 - Damage control manual (DCM)

2.10.1 The information listed in paragraph 2.9.2 should be repeated in the damage control booklet. In addition the DCM should include general instructions for controlling the effects of damage, such as:

- immediately closing all watertight and weathertight closing appliances
- establishing the locations and safety of persons on board, sounding tanks and compartments to ascertain the extent of damage and repeated soundings to determine rates of flooding
- cautionary advice regarding the cause of any list and of liquid transfer operations to lessen list or trim, and the resulting effects of creating additional free surfaces and of initiating pumping operations to control the ingress of water.

2.10.2 The booklet should contain additional details to the information shown on the DCP, such as the locations of all sounding devices, tank vents and overflows which do not extend above the weather deck, pump capacities, piping diagrams, instructions for operating cross-flooding systems, means of accessing and escaping from watertight compartments below the bulkhead deck for use by damage control parties, and alerting ship management and other organisations to stand by and to co-ordinate assistance, if required.

2.10.3 If applicable to the ship, locations of non-watertight openings with non-automatic closing devices through which progressive flooding might occur should be indicated as well as guidance on the possibility of non-structural bulkheads and doors or other obstructions retarding the flow of entering seawater to cause at least temporary conditions of unsymmetrical flooding.

2.10.4 An easily assimilated summary of the damage stability calculations is to be presented for the required draughts at even keel, assuming the corresponding maximum allowable VCG as initial intact conditions. Additional guidance should be provided to ensure that the ship's officers referring to that information are aware that the results are included only to assist them in estimating the ship's relative survivability.

2.10.5 The guidance should identify criteria on which the analyses were based and clearly indicate that the initial conditions of the ship's loading extents and locations of damage, permeability, assumed for the analyses may have no correlation with the actual damaged condition of the ship.

2.10.6 Simple, clear and concise guidance, such as damage consequence diagrams, can provide the master with a rapid means to evaluate the consequence of damage to the ship and may be attached to the DCM.

2.11 Z010 - General arrangement plan (GAP)

2.11.1 The GAP is to be submitted with the PSM or PDS and includes names of compartments, frame numbers, frame spacing and so forth.

2.12 B010 - Lines plan and offset tables (LPO)

2.12.1 LPO is to be submitted with the PSM or PDS.

2.12.2 The following drawings are to be included:

- offset tables
- body plan
- profile (elevation)
- lines plan (waterlines)
- appendages, both positive and negative.

2.12.3 The following information is to be indicated:

- definition of base line and reference system
- stations/frame spacing.

2.13 B020 - External watertight integrity plan or freeboard plan (EWP)

2.13.1 A EWP is to be submitted with the PSM or PDS. The plan is to contain information on all external openings (air pipes, ventilators, hatches, doors and so forth.) of volumes affecting stability calculations.

2.13.2 The following information is to be shown on the plan:

- superstructures and deckhouses contributing to buoyancy in intact or damage stability calculations
- position of each opening (longitudinal, transverse and vertical)
- type of closing appliance (watertight, weathertight or unprotected)
- alarms, indicators, remote controls and signboards fitted for each opening/closing appliance
- spaces that each opening leads to.

If the above information is shown on the freeboard plan or on the Damage Control Plan, one of those drawings can be submitted as the external watertight integrity plan.

2.13.3 *B021 External watertight integrity plan for vessels*, to which the DNV Offshore Codes apply, should contain the following information:

- position of opening (longitudinal, transverse and vertical)
- type of closing appliance (watertight, weathertight or unprotected)
- alarms, indicators, remote controls and signboards fitted for each opening or closing appliance
- spaces that each opening leads to beach lines showing the extent of the weathertight zone according to intact stability requirements and the water- and weathertight zones according to damage stability requirements should be indicated.

If the above information is shown on the freeboard plan, that drawing can be submitted as the external watertight integrity plan.

2.14 B030 - Internal watertight integrity plan (IWP)

2.14.1 The IWP is only required in connection with approval of damage stability calculations and is to be submitted with PDS.

2.14.2 The plan is to contain items affecting damage stability calculations, such as internal subdivision, possibility of progressive flooding from one compartment to another through internal openings, pipes/tunnels or ventilation ducts and pipes, ducts, tunnels in the damage penetration zone specified in the applicable damage assumptions.

2.14.3 The following information is to be shown on the plan:

- internal watertight boundaries (bulkheads, decks and tunnels)
- internal openings in these boundaries such as: doors, hatches, stairways, ventilation ducts and so forth
- spaces each opening leads to (for ventilation ducts)
- type of closing appliance (doors, hatches, valves and so forth).
- alarms, indicators, remote controls and signboards fitted for each opening/closing appliance
- marking of the damage penetration zone, as specified in the applicable damage assumptions, on various waterlines/decks and cross sections
- pipes, ducts and tunnels in the marked damage penetration zone and spaces where these lead
- design pressure heads for watertight bulkheads and decks
- information on materials in piping if it is intended to use heat sensitive materials.

2.14.4 For ships to which chapter II-1, part B-1, of SOLAS-74 or SOLAS 2009 applies the damage penetration zone is to be consistent with the depth of penetration 'b' and position of horizontal subdivision (factor 'v') used in the attained subdivision index calculations.

2.14.5 For ships where the watertight integrity is complex (e.g. passenger ships), the yard/approval unit should agree on a list of drawings showing all piping systems, including valves, with their exact location and with the

subdivision limits included, according to the table below:

<i>Ventilation ducts</i>	<i>Position and dimensions, closing valves if any</i>
Ballast lines	A (deck-plan) drawing showing location of pipes and valves.
Fuel lines and overflow line	Transfer lines, valves normally closed opened only when the transfer takes place. Overflow lines have to be open and the piping has to be arranged in such a way that the progressive flooding can not take place, i.e. are to be above the most severe waterline, residual stability.
Bilge lines	Normally non-return valves at the end of the pipe.
Drainage	Applicable from ro-ro decks, tender and bunker stations.
Grey water/ black water	A drawing (deck plan and side projection as found necessary) showing the actual position of the pipes. Emergency shut-off valves to be included.
Air pipes	Longitudinal projection and transverse sections
Fresh water	Positions of pipes and location of valves
Sprinkler/drencher	Sprinkler systems may be considered as closed while drencher systems are open.

In addition, basic drawings should present the transverse projection showing fore and abaft of each section of the ship where there are either transverse watertight bulkheads or steps in the longitudinal subdivision limits. The deepest equilibrium waterline for which contribution to the attained index A is obtained as well as the waterline corresponding to the calculated residual stability (GZ-range) should be indicated. The co-ordinates of the waterlines should be included. It is to be noted that the zone between the equilibrium/intermediate waterline and the residual stability waterline may correspond to any angle between 1 to 16 degrees depending on the calculations. This residual zone is intended to account for wave action.

2.14.6 For ships with less complex arrangements (such as crude oil tankers), the Damage control plan (DCP) may be accepted as the IWP provided that:

- the DCP includes the information required for the IWP;
- the drawing is submitted together with the preliminary damage stability calculations; and
- the drawing is available for the internal watertight integrity survey.

3. Additional Documentation for Certain Ships

The following is an overview of documentation requirements for some mandatory ship type notations. They are also to be applied in the case of statutory approvals of the same ship types.

3.1 Sea-going ships of 65 m in length and above required to carry a loading manual

For compliance with IACS UR S1 all DNV-classed sea-going ships of 65 m in length or more contracted for construction on or after 1998-07-01 are to carry an approved loading manual containing the design loading and ballast conditions upon which the approval of the hull scantlings is based, subdivided into departure and arrival conditions and ballast exchange at sea conditions, where applicable. In particular the following loading conditions should be included.

3.1.1 General cargo ships, container ships, roll-on/roll-off and refrigerated carriers, ore carriers and bulk carriers:

- homogeneous loading conditions at maximum draught
- ballast conditions
- special loading conditions, e.g. container or light load conditions at less than the maximum draught, heavy cargo, empty holds or non-homogeneous cargo conditions deck cargo conditions, etc., where applicable
- short voyage or harbour conditions, where applicable
- docking condition afloat
- loading and unloading transitory conditions, where applicable.

3.1.2 Oil tankers:

- homogeneous loading conditions (excluding dry and clean ballast tanks) and ballast or part loaded conditions for both departure and arrival
- any specified non-uniform distribution of loading
- mid-voyage conditions relating to tank cleaning or other operations where these differ significantly from the ballast conditions
- docking condition afloat
- loading and unloading transitory conditions.

3.1.3 Chemical tankers:

- conditions as specified for oil tankers
- conditions for high density or heated cargo and segregated cargo where these are included in the approved cargo list.

3.1.4 Liquefied gas carriers:

- homogeneous loading conditions for all approved cargoes for both arrival and departure
- ballast conditions for both arrival and departure
- cargo condition where one or more tanks are empty or partially filled or where more than one type of cargo having significantly different densities is carried, for both arrival and departure
- harbour condition for which an increased vapour pressure has been approved
- docking condition afloat.

3.1.5 Combination carriers:

- conditions as specified in 3.3.1 and 3.3.2 above.

Details related to the presentation of strength calculations are not within the scope of this CN. Please refer to the structural requirements for the ship in question and IACS UR S1 and S1A as may be applicable.

3.2 New tankers designed as combination carriers

3.2.1 This sub-section is intended for documentation required for oil carriers with additional notation Bulk Carrier or Tanker for Oil and its equivalents.

3.2.2 For oil tankers regulation 27 of MARPOL-73/78 Annex I (2006 edition) requires that certain intact stability requirements included in that regulation be met through design measures alone. However, for combination carriers simple supplementary operational procedures may be allowed. Such supplementary operational procedures for liquid transfer means written procedures made available to the master. To comply with the MARPOL Convention these procedures are to:

- be approved by or on behalf of the Flag State
- indicate those cargo and ballast tanks which may, under any specific condition of liquid transfer and possible range of cargo densities, be slack and still allow the stability criteria to be met. The slack tanks may vary during the liquid transfer operations and be of any combination provided they satisfy the criteria
- be readily understandable to the officer in charge of liquid transfer operations
- provide for planned sequences of cargo and ballast transfer operations
- allow comparisons of attained and required stability using stability performance criteria in graphical or tabular form;
- require no extensive mathematical calculations by the officer-in-charge
- provide for corrective actions to be taken by the officer in charge in case of departure from recommended values and in case of emergency situations
- be prominently displayed in the approved trim and stability booklet and at the cargo/ballast transfer control station and in any computer software by which stability calculations are performed.

3.3 Bulk carriers

3.3.1 This sub-section is intended for documentation required for mandatory ship type notation Bulk Carrier

3.3.2 Chapters VI and XII of SOLAS-74, as amended, contain certain additional requirements for information to be presented in conjunction with the stability documentation. The purpose of these requirements is to enable the master to prevent excessive stresses in the ship's structure. Information on statutory application to new and existing bulk carriers will be found in that Convention.

3.3.3 The ship is to be provided with a booklet, which should be written in a language with which the ship's officers responsible for cargo operations are familiar. If this language is not English, the ship should be provided with a booklet written also in the English language.

3.3.4 The booklet should, as a minimum, include:

- stability data, as required by SOLAS 2009 regulation II-1/5, effectively the PSM and FSM
- ballasting and de-ballasting rates and capacities
- maximum allowable load per unit surface area of the tank top plating
- maximum allowable load per hold

- general loading and unloading instructions with regard to the strength of the ship's structure including any limitations on the most adverse operating conditions during loading, unloading, ballasting operations and the voyage
- any special restrictions such as limitations on the most adverse operating conditions imposed by the Administration or organisation recognised by it, if applicable; and
- where strength calculations are required, maximum permissible forces and moments on the ship's hull during loading, unloading and the voyage
- identification of any restrictions imposed on the carriage of solid bulk cargoes having a density of 1,780 kg/m³ and above in accordance with the requirements of regulation XII/8 of SOLAS-74, as amended.

For convenience it is recommended that the above information be included in the PSM and FSM

Guidance note:

See also IMO Res. A.862(20), “Code of practice for the safe loading and unloading of bulk carriers” (BLU Code).

Regulation 10 of chapter XII of SOLAS-74 requires that all bulk carriers of 150 m in length and upwards, regardless of their date of construction, shall be fitted with a loading instrument capable of providing information on hull girder shear forces and bending moments. For information on DNV approval procedures for such instruments refer to CN 21.1

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3.4 Ships intended for the carriage of grain in bulk

3.4.1 This sub-section is intended for documentation required in those cases where DNV is authorised to carry out the statutory approval of grain stability.

3.4.2 The final grain loading manual (B090, FGM) is basically the revision of the loading conditions from the preliminary grain loading manual (PGM, B040) according to the approved lightship particulars in the ITR, and any other comments given in connection with the preliminary approval.

Guidance note:

The date and place of the inclining test or lightweight survey is to be entered under lightship particulars and also the name of the organisation responsible for the approval.

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3.4.3 The following is the general contents of the grain loading manual. These contents are to be adjusted in accordance with the applicable regulations.

Table of contents

A table of contents and index for each booklet forming part of the grain stability documentation is to be included.

References to associated drawings

A list of references to associated drawings not included in the PGM such as grain fittings, hydrostatic tables and cross curves.

Main particulars

The vessel's identification, including the IMO number, main dimensions, maximum draught, maximum trim and relevant service information.

Applicable regulations

Reference to the regulations which are basis for the approval and a brief list of the corresponding grain stability requirements. It is to be clearly stated if calculations for “cargo holds filled, untrimmed” are included.

Stability model

Sketch of volumes contributing to buoyancy in the stability calculations.

Reference system and baseline

These are to be clearly defined and maintained throughout the manual.

Preliminary lightship particulars

Based on an estimate or a sister vessel.

Deadweight data

Masses and position of gravity centre of typical deadweight groups or items in order to facilitate simplified calculation of loading conditions such as “consumables departure”, “consumables arrival” or standard cargo

loads and so forth.

Tank data

Tank plan and capacity tables with following information on each tank:

- tank name/number
- type
- volume
- centre of gravity
- maximum free surface effect.

Sounding or ullage tables may be included for this purpose.

Draught marks

A sketch showing longitudinal position of draught marks, position relative to the hydrostatic reference system and baseline. Information on the correlation between the draught marks and appendages such as azimuth thrusters is to be particularly emphasised. Instructions on how to calculate from draught readings the corresponding draught to be used in tables for hydrostatic data, cross curves and maximum allowable VCG curves, assuming no deflection of hull girder are to be included.

Hydrostatic data

The hydrostatic particulars are to be presented on extreme draught basis in tabular form, from lightship draught to above maximum draught with steps not exceeding 0.10 m.

In cases where the vessel is expected to operate with trim, the hydrostatic data are to cover the intended trim range. Alternatively, trim correction tables are to be included.

As a minimum, the following hydrostatic data are to be presented:

- displacement moulded (m³)
- displacement extreme (tonnes)
- tonnes per centimetre immersion
- moment to change trim one centimetre
- vertical centre of buoyancy
- longitudinal centre of buoyancy
- longitudinal centre of flotation
- transverse metacentre
- longitudinal metacentre.

Cross curves

The cross curves should be presented on an extreme draught or displacement basis in tabular form, from lightship draught to above maximum draught for at least the following angles of heel: 5, 10, 15, 20, 30 and 40 degrees. If the same curves are also intended for use in connection with grain stability, the curve for 12 degrees is also to be included.

In cases where the vessel is expected to operate with trim, the cross curves are to cover the intended trim range and the trim values are to correspond with those presented for the hydrostatic particulars.

The cross curves are to be calculated on a “free to trim” basis.

Guidance note:

The values for heeling angles 12 and 40 degrees are an explicit SOLAS/International grain code requirement.

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Watertight integrity

Position of critical unprotected openings considered down-flooding points for grain stability calculations.

Flooding angle curve

Flooding angle curve representing the angle of flooding of critical unprotected openings as a function of extreme draught or displacement from lightship draught to above maximum draught.

In cases where the vessel is expected to operate with trim, multiple flooding angle curves covering the intended trim range are to be developed.

Minimum required GM_T or maximum allowable VCG curves

The draught reference point is to be the same as for hydrostatic data.

The curves may be presented on an extreme draught or displacement basis in tabular or curves form from

lightship draught to maximum draught.

In cases where the vessel is intended to operate with trim, the curves are to cover the trim range.

The curves are to satisfy all stability requirements of the applicable regulations.

Any limitations or conditions related to the application of the minimum required GM_T or maximum allowable VCG curves are to be clearly stated on the curves.

Grain loading information

This should include:

- curves or tables of volumes, vertical centres of volumes and volumetric heeling moments for every compartment, filled or partly filled, or combination thereof, including the effects of temporary fittings
- tables of volumetric heeling moments for holds “filled, ends untrimmed”, if applicable
- curves or tables of maximum allowable heeling moments or other information sufficient to allow the master to demonstrate compliance with the applicable requirements
- details of the scantlings of any temporary grain fittings, feeders, feeder holes and so forth, if assumed in the calculations.

Guidance note:

It is a requirement of the International Grain Code that the heeling moment data for each cargo compartment is to be provided as volumetric heeling moments in the grain loading information rather than as actual grain heeling moments. Instructions on how to accomplish the required conversion are to be provided.

The uppermost point on a curve of volumetric heeling moment versus either depth or grain ullage in a partly filled compartment should be based on the void in the filled condition shifted 25°. In other words, the curve of volumetric heeling moments for the partly filled condition should not be terminated at the point, at zero ullage, which represents the volumetric heeling moment based on a 150 shift as that moment applies only to the filled condition. (IMO MSC/Circ.488)

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Grain loading conditions

The presented loading conditions are to include the standard loading conditions required by the applicable regulations such as:

- full load conditions, departure (100% consumables) and arrival (10% consumables) with at least the following stowage factors 1.25, 1.53 and 1.81 m³/t (45, 55 and 65 ft³/t).

If, for reasons of carrying capacity, it is not practicable to carry cargoes with stowage factors less than a certain value this limitation is to be included in the “Grain loading instructions” below.

Worst intermediate loading conditions are to be presented, if necessary.

As a minimum, the following information is to be presented for each loading condition:

- individual masses with centre of gravity
- free surface moments for slack tanks
- total displacement and corrected centre of gravity
- extreme draughts and total trim
- corrected metacentric height (GM_T)
- maximum allowable VCG or minimum required GM_T
- actual grain heeling moment
- maximum allowable grain heeling moment
- plotted GZ and grain heeling lever curves
- values of applicable stability criteria.

A summary of the loading conditions is to be presented in a tabular form giving information above except individual masses, GZ values and grain heeling lever curves.

Grain loading instructions

These should include:

- general precautions against capsizing
- instructions on how to verify compliance with the grain loading requirements
- use of free surface correction
- use of cross curves
- use of limit curves
- stability limitations regarding loading of the vessel, including draught to prevent slamming, if applicable
- instructions on emergency situations (storm/damage)
- use of onboard computer in assessing the stability.

Worked example on grain stability

A complete worked example on calculating and checking the stability of a grain loading condition.

Blank grain stability forms

Blank forms for calculating and checking the stability for actual grain loading conditions.

*Deadweight scale**Conversion tables**Grain heeling moment calculation (B080)*

Underlying data related to calculation of grain heeling moments such as:

- capacity plan giving general dimensions and size of compartments.
- details of hatch covers and hatch coamings, dimensions of deck girders, hatch girders and hatch end beams
- copy of input and output from computer calculations in addition to the drawings used in connection with the input data and any supporting calculation carried out.

The above information may be submitted separately, and need not be included in the FGM.

3.5 Ships designed to carry timber deck cargoes

3.5.1 Supplementary stability information for ships designed to carry timber deck cargoes may be inserted in the PSM/FSM. If the buoyancy of the timber deck cargo is taken into consideration when calculating the ship's stability all related calculations should be kept in a separate section of the manual and should be clearly marked to avoid confusion with other information.

3.5.2 The presentation in general is to be as for the PSM/FGM and PDC/FDC, but the following supplementary information is to be included:

Stowage plan

Drawing showing the location and dimensions of the deck cargo assumed in the calculations.

Guidance note:

See also IMO Res. A.715(17), "Code of safe practice for ships carrying timber deck cargoes" for general advice on stowing and securing of cargo.

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Cross curves

Account may be taken of the buoyancy of the timber deck cargo assuming that such cargo has a permeability of 25% of the volume of the cargo. However, the buoyancy of only one standard superstructure height of timber deck cargo is to be considered.

Minimum required GM_T or maximum allowable VCG curves

If the buoyancy of the timber deck cargo has been taken into account a second limiting curve based on this assumption is to be included.

Loading conditions

Loading conditions indicating the maximum amount of deck cargo having regard to the lightest stowage rate likely to be met in service are to be included. They should at least include:

- full load condition, departure (100% consumables), with the ship loaded to its timber load line, if assigned
- full load condition, arrival (10% consumables).

In arrival conditions it is to be assumed that the mass of the deck cargo has increased by 10% due to water absorption.

Damage stability

For dry cargo ships to which damage stability requirements apply separate PDC/FDC may be submitted covering the conditions with timber deck cargo. The calculation principles and the presentation are basically as for ordinary dry cargo ships, but the buoyancy of the timber deck cargo may be taken into account.

Guidance note:

See also IMO MSC/Circ.998 on IACS unified interpretation “Timber deck cargo in the context of damage stability requirements” (UI SC161).

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3.6 High speed crafts - B170 Stability in the non-displacement mode

For high speed crafts using foils, air cushions or other means as the main hydrodynamic lift force at speed, the stability in the non-displacement and transient mode should be documented according to the IMO 2000 HSC Code Ch.2. Details should be agreed on in each separate case and may involve simulations and/or model tests.

Appendix A

NOTIFICATION ON LIGHTWEIGHT SURVEY AND INCLINING TEST

(Download an active pdf-form)



DET NORSKE VERITAS

Yard, Y/N or ship name	DNV Id No.
Location	Expected date and time for test
Person responsible for conduct	Contact details (Telephone, email etc.)
DNV station	Surveyor
This notification concerns (tick one)	
<input type="checkbox"/> Inclining test and lightweight survey	<input type="checkbox"/> Lightweight survey only

This form and the enclosed checklist shall be completed by the person responsible for the execution and forwarded to the DNV station not later than a week prior to the conduct as notification that an inclining test/lightweight survey is planned. The checklist is not subject to formal approval.

In the following cases DNV approval of a detailed inclining test procedure is mandatory, and such a procedure shall be forwarded to the DNV station in reasonable time before the conduct (minimum one week):

- inclining tests carried out by water transfer
- inclining tests for mobile offshore units
- use of alternative arrangements not covered by IACS Rec. No.31, if required by the Flag Administration.

In general the standard procedures and quantitative recommendations set out in IACS Recommendation No. 31, 'Inclining test unified procedure' and chapter 7 of IMO resolution A.749(18)/chapter 8 of Res. MSC.267(85) shall be applied as the minimum standard for ships classed with DNV. The purpose of this document is to assist in achieving a satisfactory accuracy in the determination of the lightship weight and of the coordinates of its centre of gravity by assigning resources for the different tasks to be carried out.

Guidance notes

Any inclining test includes a lightweight survey. The section 'Lightweight survey and general actions' in this form is always to be completed while the section 'Inclining test actions' is only completed if an inclining test is to be carried out. The expression 'test' in this document refers to lightweight surveys and inclining tests alike. The column Ref refers to the specific standards in IACS Rec. No.31. The person(s) or institution(s) responsible for preparation and execution of each item is entered in the column **Responsible for...** The column **OK** is intended for checking out completed items. N/A should be entered for items not relevant for the particular test in question.

Where the lightweight survey and inclining test is performed to satisfy a statutory requirement, such equivalents may also be subject to acceptance of the Flag Administration.

The responsibility of the DNV surveyor attending a lightweight survey/inclining test is to verify that the test is conducted according to the above standards and that all basic measurements and data are correctly taken and recorded. Upon completion of the test a test report and analysis including calculation of the light ship particulars is to be submitted to the attending surveyor for verification and endorsement. The attending surveyor will then forward the endorsed report to the relevant DNV approval centre for review and approval.

Reports sent directly to an approval centre will normally not be reviewed until an endorsed copy is available.

Place	Date	Completed by (Signature)

Annex

YARD'S CHECKLIST FOR PLANNING AND EXECUTION OF LIGHTWEIGHT SURVEY AND INCLINING TEST

LIGHTWEIGHT SURVEYS AND GENERAL ACTIONS

(Download an active pdf-form)

Estimated floating position and transverse metacentric height at time of survey			
Draught [m]	Trim [m]	Heel [deg]	GMt [m]
Weight estimates			
	Weight [tonnes]	LCG [m]	VCG [m]
Sum tanks to go off			
Sum weights to go off (max 4% of lightweight)			
Sum weights to go on (max 2% of lightweight)			
Sum weights to relocate			

Ref	Action	Responsible for preparation/execution	OK
2.1 2.7.2	Drawings and hydrostatic particulars valid (tolerance +/- 1% of LBP) for the anticipated trim will be available or will be provided by direct calculations		
2.2.3	The ship will be as near to completion as possible and cleared of cargo residues, tools, scaffolding and garbage. (Surplus weights excluding tanks maximum 4% of lightweight and missing weights within 2% of lightweight)		
2.7.3	Adequate, positive stability and acceptable stress levels will be ensured. (Initial metacentric height should be at least 0.20 m.)		
2.2.3	Accumulations of ice, snow or rain water on inner and outer surfaces, including the underwater hull, will be removed		
2.2.4	All bilge water and other extraneous standing liquids will be removed		
2.2.5	All service tanks and machinery plant piping will be filled to operating levels		
2.2.6	The number of people not participating in the test will be reduced to a minimum		
2.2.7	Spaces and tanks that will be entered will be made gas-free and safe for inspection		
2.3.1	The number of tanks containing liquids will be kept to a minimum		
2.3.2	Tape measures and sounding tables for manual sounding of tanks will be available.		
2.3.2	Measurements of densities of liquids in tanks will be taken		
	Manholes on tanks assumed empty will be opened for visual inspection		
2.4.1	Mooring arrangement will ensure that the draft readings and inclining test results will not be affected		

2.4.6	The ship's gangway will be in the stowed position and any shore gangway will be removed during the draught readings and the inclining test		
2.4.6	As few cables, hoses, etc. as possible will be connected to shore		
2.4.2	It will be ensured that the depth of water under the hull will be sufficient to keep the hull entirely free of the bottom		
2.4.5	The scheduled time of day or location will ensure that tidal currents will not affect the results		
2.4.7	The weather forecast will be checked to ensure that adverse wind, waves or other ambient conditions will not affect the results		
3.5.2	Weather conditions, i.e., wind speed and direction relative to the vessel, sea state, air and water temperatures, etc., during the test will be recorded		
3.3.1	Draught and/or freeboard will be measured immediately before and verified after the test (Forward/amidships/aft on both sides)		
3.3.2	Draught marks and freeboard measurement locations are documented or will be verified		
3.3.5	Hydrometer will be available and will be checked for accuracy		
3.3.5	Seawater density will be measured at suitable locations and depths (Average of forward/amidships/aft at two depths)		
3.3.3 3.3.4	Boat and equipment for measuring draughts will be available		
	Communication equipment will be available		
2.2.1	Lists ready for inventory of tank contents, weights to go off, weights to go on and weights to be relocated will be available		
5.2	Test report will be forwarded to the attending DNV surveyor for verification of recorded data		
5.3	Endorsed test report will be forwarded to responsible DNV approval centre for approval.	To be carried out by the attending DNV surveyor	

INCLINING TEST ACTIONS

This section is only completed if an inclining experiment is to be carried out

Ref	Action	Responsible for preparation /execution	OK
2.7.2	It will be assured that abrupt changes in the water-plane will be avoided as the ship heels in the intended draught and trim		
2.7.3	It will be verified that hull stress levels, including structure under heeling weights will be acceptable		
2.2.2	All weights which may swing or shift will be secured in a known position		
2.3.1	Nearly empty tanks and spaces that may generate large free surfaces will be drained (no free surface correction)		
2.3.3	Measures will be taken to avoid air pockets in tanks assumed completely full.		
2.3.3	Measures will be taken to prevent any unintended passage of water between tanks, including cross-flooding connections. Closed valves will be suitably marked		
	Consumption/production of fuel, freshwater etc. will be kept at a minimum and will be monitored		
2.5.3	An estimate of necessary heeling moments to obtain minimum angles will be prepared (+/- 1-4 degrees past upright for conventional ships)		
2.5.5	If not certified earlier weighing of the inclining weights with verified scales will be arranged (Minimum 4 solid weights, marked with identification)		
2.7.1	It will be assured that the initial position is close to upright (+/- 0.5 degree) and that the ship will be heeled past upright in both directions		
3.4.1 3.4.2	Planned movement pattern will be in accordance with the standards (Minimum 8 shifts, 0.5 degrees between each, 4th shift to verify initial position). Changes in longitudinal or vertical position when shifting weights shall be avoided.		
2.6.1 3.4.4	At least two pendulums with recording battens and oil trays to dampen pendulum oscillations will be provided.		
2.6.1 3.4.3	Pendulums or U-tubes will be of sufficient length to obtained minimum nominal deflection readings (minimum 4 meters and minimum 150 mm deflection past upright at maximum moment to both sides)		
2.6.1	Pendulums will be placed in a protected location		
2.6.1 2.6.2	Use of other measurement devices than pendulums has been accepted by the Society in advance if other devices will be used (Minimum 1 pendulum)		
	U-tubes, if used, will be checked for air pockets and resonance in the water column		
3.4.6	Readings will be plotted independently as heeling moments against tangents or angles of heel for each measuring device to verify consistency of results during the test		
	Transverse metacentric height for ship as inclined will be calculated independently for each measuring device using linear regression		

3.4.7	Personnel will be instructed to remain on their assigned positions while inclination readings are being taken		
3.4.7	Personnel will be assigned to check that all mooring lines, etc., remain slack following each weight shift		
	The final GM value will be calculated based on accumulated inclining moments and angles using the least square method (linear regression) separately for each pendulum.		
	The report will include information on particular weight items considered part of the light ship. Amount and location of included or excluded permanent ballast to be clearly specified		