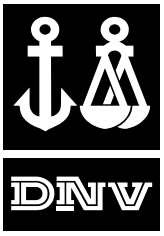

CLASSIFICATION NOTES

No. 8

CONVERSION OF SHIPS

FEBRUARY 2004

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FOREWORD

DET NORSKE VERITAS is an autonomous and independent Foundation with the objective of safeguarding life, property and the environment at sea and ashore.

DET NORSKE VERITAS AS is a fully owned subsidiary Society of the Foundation. It undertakes classification and certification of ships, mobile offshore units, fixed offshore structures, facilities and systems for shipping and other industries. The Society also carries out research and development associated with these functions.

DET NORSKE VERITAS operates a worldwide network of survey stations and is authorised by more than 130 national administrations to carry out surveys and, in most cases, issue certificates on their behalf.

Classification Notes

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.

A list of Classification Notes is found in the latest edition of Pt.0 Ch.1 of the ”Rules for Classification of Ships” and the ”Rules for Classification of High Speed, Light Craft and Naval Surface Craft”.

The list of Classification Notes is also included in the current “Classification Services – Publications” issued by the Society, which is available on request. All publications may be ordered from the Society’s Web site http://exchange.dnv.com.

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1. Introduction

1.1 Application

This Classification Note only covers conversion of ships. Conversion of offshore installations or converting ships to offshore installations is not covered.

1.2 Retention of class

See the Rules for Classification of Ships Pt.1 Ch.1 Sec.3 B600.

1.3 Definition of a conversion

From a structural point of view, any modification to the ship structure is regarded as a conversion; from alteration of the main dimensions (such as length, breadth, depth) to installing thrusters, generators, cranes, winches, or similar.

Note that the following aspects are also treated as conversions:

1) Increasing the maximum allowable draught.
2) Modifications reported by surveyors that have not been approved by DNV in advance.
3) Change of flag, provided the new flag state has additional requirements. This will be a case for the new flag State.
4) Adding new class notations normally implies new requirements.
5) Class transfer from a classification society that is not a member of IACS (International Association of Classification Societies).

1.4 Major conversions

A major conversion is defined in the Rules for Classification of Ships Pt.1 Ch.1 Sec.3 B605 as follows:

By modifications of a major character it is to be understood that major conversions are defined as a conversion of an existing ship:

i) which substantially alters the dimensions or carrying capacity of the ship; or

ii) which changes the type of ship; or

iii) the intent of which in the opinion of the Society substantially prolongs the life of the ship.

(MARPOL 73/78, Annex I, Regulation 1(8)(a))

1.5 Application of the rules

1.5.1 Generally

Normally, the current rules provide the basis for approval of major conversions. However, in some cases the basis of the current rules and the rules applied at the newbuilding stage will be considerably different. One possible approach will be to follow the rules applied at the newbuilding stage. Moreover, the current rules may be significantly stricter, which is often a result of practical experiences e.g. damage to ships in operation. Applying earlier rules should therefore be done with some precaution. Application of earlier rules will be decided on a case by case basis.

1.5.2 Increased draught

Increased draught is normally not regarded as a major conversion despite the phrase *carrying capacity* in 1.4. However, precaution should be taken if the increase in draught is major. See further information in chapter 2.1.

1.5.3 Structural strength

New structure is to have scantlings according to prevailing rules. When modifying existing structure, the scantlings of the modified structure and other affected structure must be assessed such that the stress level is within the rules' limits also after the conversion.

1.5.4 Vibrations

Extensive conversions may have adverse effects on the natural frequencies of parts of the vessel. The plan approval does not include consideration of vibrations in the hull structural elements in relation to the requirements for scantling given in the rules.

1.5.5 Stability

Stability is a very important aspect to clarify when planning a conversion. In particular, it should be noted that for a dry cargo ship over 80 m in length where no damage stability requirements have previously been in force, it may be necessary to submit damage stability index calculations demonstrating that the level of subdivision is not less than before the conversion.

1.5.6 Class notations

Upon assignment of class notations, the current rules are to be complied with.

Deletion of additional class notations or imposed service restrictions may be accepted where rule requirements cannot otherwise be complied with.

1.5.7 Statutory

SOLAS, MARPOL, IBC/BCH codes and IGC code are not covered be this Classification Note. Reference is given to the applicable rules and regulations.

Conversions which change the tonnage particulars of the ship may imply that the ship has to comply with new additional requirements.

1.5.8 Flag States

It is important to note that the flag States may have additional requirements.

1.6 Structural testing

Testing of new tanks and new equipment will be required as for a newbuilding. Refer to the rules for details.

1.7 Structural continuity

Connections between new and existing structure are to be arranged with good continuity in order to avoid stress concentrations.

1.8 Documentation required by class

See Annex I for documentation requirements with respect to conversions.

For major conversions, the following information shall in general be included on the new main drawings submitted for approval:

- Main particulars L, B, D, T, speed and block coefficient
- Class notation and register notations after the conversion
- Flag authority after the conversion.

1.9 Relevant references for conversion

The Rules for Classification of Ships and all Guidelines are applicable, as appropriate.

2. Structural Strength

2.1 Increased draught

2.1.1 General

Some items may have vital influence on the feasibility of the project and the amount of work required, such as:

1) What is the current scantling draught of the vessel and what draughts have been approved earlier?
2) Has the question regarding increased draught been raised before for this ship or for sister ships?
3) Will there be any redefinition of the freeboard deck? If yes, may vertical extent of watertight bulkheads interrupt the project (ro-ro ships, trawlers, general cargo ships)?
4) The freeboard has to be approved according to the load line regulations. Extensive calculations may be wasted if the questioned draught has to be reduced because it is not according to the load line regulations.
5) The global strength.
6) Bow height requirement.
7) Stern or bow doors and doors in the ship's side.
8) Position of side scuttles.
9) Position of valves and discharges.
10) Bottom of net bin for fishing vessels.

2.1.2 Application of the rules

Increased draught is normally not regarded as a major conversion. This may however depend on the background for the deeper draught. A major change in load capacity or load type for a bulk carrier or a tanker could for instance be regarded as a major conversion. This will be evaluated on a case by case basis.

The current rules are normally to be applied but previous rules may be accepted, based on special considerations.

2.1.3 Global strength

The distribution of still water bending moment (Msw) and shear forces (Qsw) are a function of distribution of buoyancy, lightweight and cargo (dwt) over the ship's length. The type of vessel and the cargo distribution will therefore have an important impact on how an increase in a ship’s draught will affect the longitudinal strength.

Wave bending moment and shear forces are very little influenced by the ship's draught. The block-coefficient Cb, increases with increasing draught, but this can in most cases be ignored, and design wave bending moments and shear forces are consequently unchanged.

Still water bending moment (Msw) and shear force (Qsw) for loading conditions with increased draught are often within values for existing loading conditions. However, Msw and Qsw can be critical, depending on the type of vessel, e.g. sagging moment amidships and shear force at the collision and forward engine room bulkheads for vessels with a large block coefficient, such as tankers for chemicals and bulk carriers.

The actual distribution of Msw and Qsw is seldom known at the time when an increased draught is requested. The evaluation is therefore normally based on previous approved loading conditions, or previous approved maximum still water bending moment and shear forces. In cases where the existing loading conditions are irrelevant, e.g. due to a major conversion of the vessel, rule design values or design limits are to be applied.

The loading manual is to be updated and submitted for approval when applicable.

The cargo or loading instrument is to be adjusted, if found necessary.

2.1.4 Local strength

2.1.4.1 Ship's sides and deck

Scantlings of structural elements are to be checked based on the new design sea-pressure.

1) Frames, stringers and longitudinals, especially at the ends of the ship.
2) Forecastle structure.
3) Transverse strength of deck and ship side in way of cargo holds for open vessels (e.g. general cargo vessel with one large cargo hold opening).

4) Main frames for bulk carriers. Frames in empty holds.
5) Transverse strength of deck between cargo holds for bulk carriers. Buckling capacity is to be appraised.

2.1.4.2 Girder system in bottom and sides

The girder system is to be checked based on the increased design sea pressure and increased cargo weight in tanks, holds or on deck, if relevant.

1) Bottom structure in tankers (floors and longitudinal girders). A limitation on net pressure on the bottom may be given.
2) Double bottom and bulkheads strength for bulk carriers. Double bottom analysis may be required.

2.1.4.3 Deck houses

Change of freeboard deck may lead to a substantial increase in the design pressure for the front bulkhead. E.g. old 2nd tier becomes 1st tier if a new shelter deck is fitted.

Plating and stiffeners on front bulkhead are to be checked for strength.

Side and end bulkheads are to be checked for strength if the freeboard deck is changed or if the draught increase is substantial.

2.1.4.4 Bulkheads and decks acting as top/bottom of tanks

Watertight bulkheads are to be dimensioned for increased static pressure, due to new damage waterline or new freeboard deck (bulkhead deck).

Checking of bulkhead scantlings is normally only required if the freeboard deck is changed, since the increase in damaged water line must be considerable before it has any consequence for the bulkhead strength.

Tank bulkheads, bottom and top are to be checked if the height of the air pipes is increased, e.g. relevant when a vessel's depth is increased. In this case DNV is to be informed.

Cargo hold and tank bulkheads are to be checked if the total weight in hold or tank is increased beyond the previously approved limits (increased cargo density). In this case drawings showing the modification are to be submitted for approval.

2.1.4.5 The ice belt

The ice belt is to be especially considered. See 2.8.

2.1.4.6 Bow impact

Bow impact is only necessary to check for vessels with large flare, when the increase in draught is substantial.

2.1.5 Structural arrangement when the freeboard deck is redefined

2.1.5.1 Collision bulkhead

No openings are accepted below the freeboard deck.

The requirement for the longitudinal position of the bulkhead is normally not influenced. It should however be checked when the freeboard deck is redefined.

The vertical height of the collision bulkhead is to extend to the next deck above the freeboard deck for ships having complete or long forward superstructure. Openings or doors in the existing upper part are to be closed.

Note that steps in the collision bulkhead can be accepted if all parts of the bulkhead are within the rule limits.

2.1.5.2 Fore engine room bulkhead

The bulkhead is to extend watertight to the freeboard deck. Doors in bulkheads acting as fore engine room bulkhead above the 'tween deck are to be watertight and fitted with signboards stating that the doors are to be kept closed at sea. Sill height is to be to the waterline or maximum 600 mm. Scuttles in tween deck bulkheads may be kept if fitted with deadlights.

2.1.5.3 After peak bulkhead

Three alternatives are normally accepted, see Figure 2-1:

a) Ships already fitted with a complete bulkhead from side to side between the aft perpendicular and the fore engine room bulkhead may use this as the after peak bulkhead. Strength is to be checked. The bulkhead is to extend to first watertight deck above the waterline.
   If the accommodation deck acts as a part of the bulkhead, the height of the deck from the bottom is to be at least equal to the height of the bottom floors. Inclined decks are acceptable.
b) A bulkhead is fitted between old and first watertight deck above the waterline. Doors are to be watertight with a sill height to the waterline or maximum 600 mm.
c) Entrance down to the aft accommodation below 'tween deck is closed by a steel casing with weathertight steel door and with a sill height to the waterline or maximum 600 mm. This arrangement is normally applied only for older vessels.

Note that the net bin bottom on fishing vessels is not to be below the new waterline.

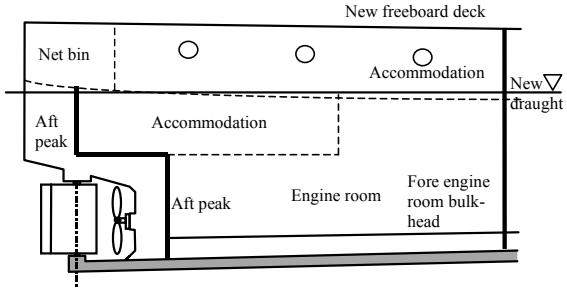

Figure 2-1 a)

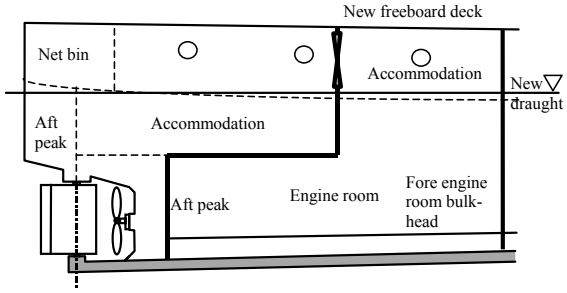

Figure 2-1 b)

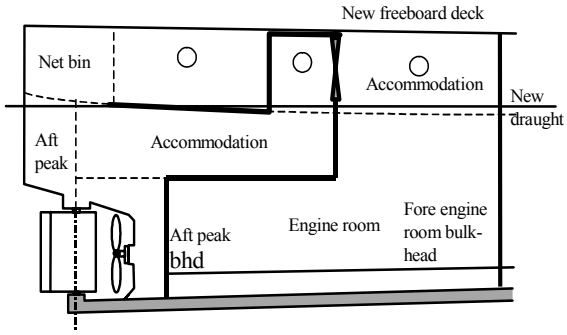

Figure 2-1 c)

Figure 2-1 Three different arrangements of the aft peak bulkhead for a fishing vessel (old type)

Approval of the above mentioned alternatives is based on that the entrance down to the engine room from 'tween deck below water line is closed by steel casing with weathertight steel doors with a sill to the waterline or maximum 600 mm.

Where parts of a deck form a part of the watertight bulkhead, the deck is to be dimensioned accordingly.

The rules state no requirement with respect to position of the afterpeak or fore engine room bulkheads, but:

- one may not define a bulkhead both as an after peak and a fore engine bulkhead
- the entrance down to the engine room is to be located between the bulkheads.

2.1.5.4 Doors and hatches

Coaming heights should be checked for possible redefinition from Position 2 to Position 1. In general the minimum required heights of coamings in way of hatches in the freeboard deck should be complied with. Due to the operational aspects of some vessels reduced coaming heights are often preferred. In such cases written acceptance of dispensation from the National Authorities will be required.

2.1.5.5 Bow height

The minimum bow height is calculated according to the load line regulations. Note the minimum longitudinal extension of the forecastle.

Acceptable solutions to obtain acceptable bow height, see Figure 2-2:

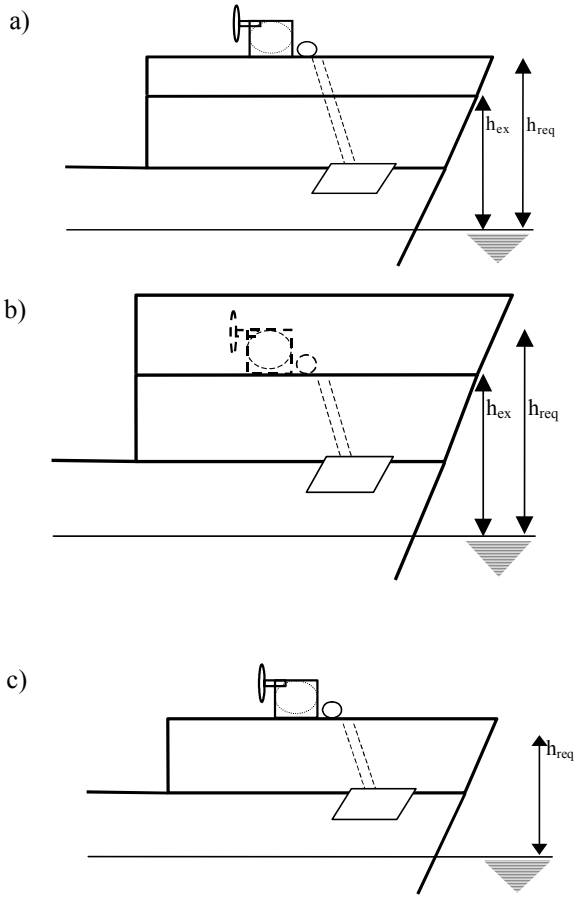

Figure 2-2 Examples of ways to increase the bow height

a) A new forecastle deck is built above the existing. Note that the space between the old and the new deck is to be arranged with access using a manhole or similar. This alternative may require that deck equipment (anchoring winches etc.) are removed and refitted on the new deck.
b) A new forecastle deck is built enclosing existing forecastle and the deck equipment. The new part is to be made watertight and the anchor chain pipes are to be arranged with closing arrangements at the upper end.
c) New forecastle (fulfilling the minimum criteria).

2.1.5.6 Ventilators, air pipes, scuppers and discharges

If the height of the air pipes is increased then the tanks are to be checked for the new design loads. DNV is to be informed.

2.1.5.7 Openings when freeboard deck is redefined

Old freeboard deck drains are to be closed. The minimum height between the waterline and the light valves is 500 mm.

If the rudder carrier is flooded, an additional sealing box is to be fitted.

2.1.6 Checklist for increased draught

1) watertight bulkheads
   - vertical extent
   - strength
   - position of collision bulkhead
2) minimum bow height
3) position of overboard discharges
4) position of side scuttles
5) doors in the ship's side
6) position of rudder carrier
7) hatchway coamings and covers
8) ice belt:
   - strength and vertical extent
   - min. required engine power for ice class
9) longitudinal strength (if applicable)
10) local strength:
    - weather deck
    - forecastle deck
    - ship's sides
    - bottom
    - deckhouse front and sides.

2.2 Lengthening of vessels

2.2.1 Application of the rules

Reference is made to the introduction, for general information.

Lengthening of a vessel is always regarded as a major conversion with regard to strength. This means that the current rules apply with respect to local and global strength.

The design process to determinate the required scantlings for the new section should be similar as for a new building. Scantlings of the new hull section must be in accordance with current rules i.e. the rule requirements for minimum thickness and minimum section modulus are to be complied with.

With respect to existing parts of the vessel, the minimum thickness requirements are normally not complied with if the vessel is lengthened. Usually, this can be dealt with as follows:

- If the minimum thickness complies with the newbuilding stage rules, no further considerations are necessary, in this aspect.
- Deletion of class notations, e.g. **Fishing Vessel** or **Supply Vessel**, may reduce the minimum requirements.
- Minor discrepancies are, in general, acceptable, provided the strength is acceptable.

The design still water bending moments and design loads (sea pressure, bow impact, slamming, accelerations) are directly dependent on the length. This means that the complete vessel has to be reassessed for strength.

It should be noted that minor strength discrepancies may be accepted as reduced corrosion margins if requested by the owner. Memo for owner or surveyor will normally be given in such cases.

2.2.2 Documentation requirements

The following drawings and documentation are required to be submitted for approval or information, in connection with lengthening of a vessel, see also Appendix I:

1) general arrangement
2) tank plan
3) midship section with material properties (new Cb, speed and design draught to be stated on the drawing)
4) shell expansion
5) profile and deck plan
6) new section
7) design loading conditions or loading manual, see the rules
8) reinforcement of existing structure
9) docking plan (L > 100 m)
10) new equipment number calculation and proposal of upgraded anchoring equipment as far as relevant
11) intended class notations.

2.2.3 Longitudinal strength

The coherence between a vessel's length and required longitudinal hull girder scantlings, with respect to bending moments and shear forces is discussed here. Lengthening of a vessel will have an influence on both still water and wave induced hull girder loads. Global design loads, and acceptance criteria for the hull girder, are given in the Rules for Classification of Ships.

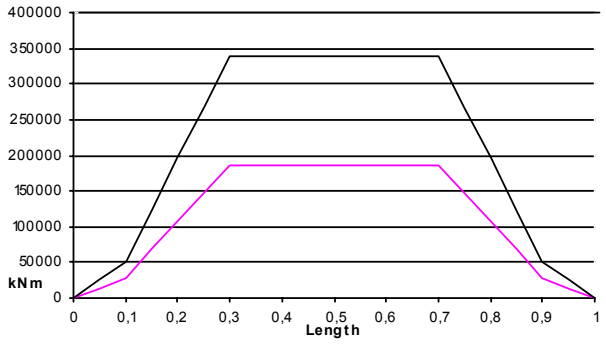

Figure 2.3 Stillwater bending moments along the vessel length for L=100 m and L=130 m

The actual still water bending moments and shear forces on a hull girder is dependent on both the vessel's length and type (hull shape and buoyancy, lightweight distribution and cargo distribution). The design still water bending moments, given by the rules, is a function of L^3, i.e. an increase in the length will lead to a rapid increase in the design bending moment, see Figure 2-3.

Still water bending moment less than the rule design still water bending moment can be used provided relevant and realistic loading conditions are submitted for approval. For some types of vessel e.g. cruise vessels, which often are pure hogging vessels, zero (0) or the minimum hogging condition as design "sagging condition" can be accepted.

Wave induced loads on the hull girder are also a function of the ship length. The rule design wave bending moments is a function of L^3 i.e. increasing the length will imply a rapid increase in the wave bending moment, see Figure 2-4.

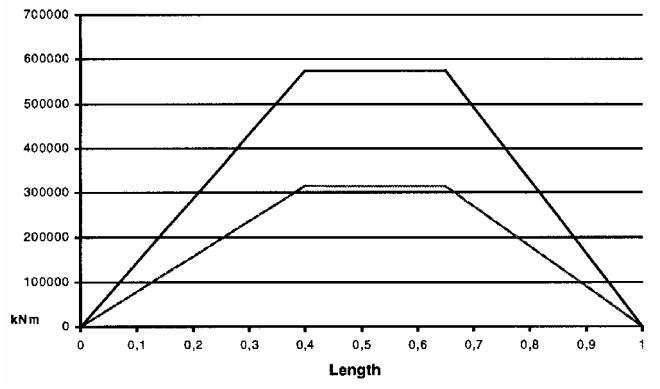

Figure 2-4 Wave bending moment along the vessel length for L=100 m and L=130 m

From Figures 2-3 and 2-4, it may be seen that a 30% increase in length will lead to approximately 90% increase in both the rule still water and wave bending moment. In other words, the requirement to section modulus will increase with 90% for a lengthening of 30%. The minimum requirement to the section modulus about the horizontal neutral axis, which must be fulfilled for all vessels irrespective of loading conditions, will increase similarly.

2.2.3.1 Longitudinal strength evaluation

Scantlings of the new hull section must be in accordance with the current rules.

The existing vessel must be reassessed according to the current rules, based on the new length, and hence the new design bending and shear forces. Such evaluation should include checking of the relevant cross sections, with respect to fulfilment of the rule requirements for section modulus, buckling control of longitudinal structural elements and shear strength control. In addition, it is to be checked that the plate thickness is according to the rule minimum.

Minimum requirements for thickness are a function of the ship's length, see Table 2-1.

Minor deficiencies can be accepted as a reduction due to corrosion, where corrosion addition is applied (if requested by the owner). However, a Memo for Owner (MO) will be given if this alternative is applied.

Acceptance of deficiencies in scantlings must be based on performed calculations proving that both the longitudinal and local strength of the vessel is satisfactory with the actual deficiencies, e.g. buckling control of longitudinal strength element such as bottom and strength deck plating. Corrosion allowance, according to the rules, is to be deducted from the plate thickness when carrying out the buckling check.

Length, L (m)	*Bottom and sides*	*Keel*	*Strength Deck*	*Shell,* **ICE-C**	*Bottom decks*
50	7	9.5	6.5	11.5	7
75	8	10.8	7	14.25	7.5
100	9	12	7.5	17	8
150	11	14.5	8.5	22.5	9
200	12	17	9.5	25	10

Table 2-1 Typical minimum thickness requirements for some plates, corrosion addition tk is not included (mm)

The allowable stress in longitudinal strength members, when checking for lateral loads, is dependent on the longitudinal hull girder stress. Members, which were acceptable before the lengthening, may fail to fulfil the rule requirements after the lengthening, due to reduced allowable stresses.

2.2.3.2 Shear strength

The rule design wave shear forces will increase when a ship's length is increased, see Figure 2-5.

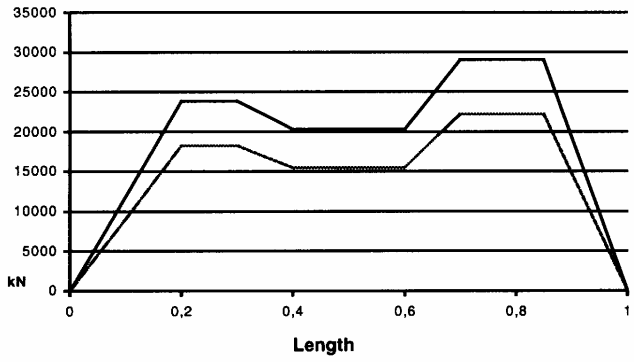

Figure 2-5 Wave shear force distribution along the vessel length for L=180 m and L=210 m

Evaluation of global shear strength is especially important for vessels with large or many openings in the side shell, in way of the quarter length fore and aft. It is important to check both vertical and horizontal shear for passenger and cruise vessels, which have many windows with a small distance between them. The allowable shear stress, shear buckling and secondary bending of shell plating between the windows is to be controlled.

For vessels with a relatively simple longitudinal structure (single skin vessel or vessel with continuous longitudinal bulkhead(s)), rule values or the Nauticus Section Scantling shear stream analysis may be used. For more complex vessels, it may be required to carry out FEM analysis in order to achieve a satisfactory shear stress level.

2.2.3.3 Racking analysis

For vessels with large deck areas over several decks, without any transverse bulkhead in the cargo area, such as ro-ro vessels, racking analyses may be required. How the lengthening effects the vessel's racking capacity has to be considered before racking analysis is required and the extension of such.

2.2.3.4 Torsion

For ships with large deck openings (total width of hatch openings in one transverse section exceeding 65% of the ship breadth or length of hatch opening exceeding 75% of hold length) the longitudinal strength including torsion may be required to be considered. This is normally only applicable for bulk carriers and container carriers.

See the following references:

- Rules for Classification of Ships Pt.5 Ch.2 Sec.6: Container Carriers
- Classification Note 31.1: Strength Analysis for Hull Strength in Bulk Carriers.

2.2.3.5 Reinforcement of existing structure

For a newbuilding or a new section, it is normally not a problem e.g. to increase the plate thickness or the size of the longitudinals in order to achieve satisfactory section modulus or buckling capacity. Such proposals will in most cases be unrealistic for existing parts of a ship, due to the cost involved in first removing the old structure and then inserting a new structure, with the required scantlings.

Reinforcement of existing ships must therefore be based on what is possible to achieve bearing in mind the conversion cost involved. However, proposed reinforcement shall always comply with the rule requirement.

Problems, which frequently occur for the existing structure, are:

1) Section modulus for the existing structure does not fulfil the rule minimum or the required section modulus based on the new design bending moments and shear forces.
2) Buckling of longitudinal strength elements, such as bottom plating, strength deck plating, side shell plating etc. Transversely stiffened plating is to be especially considered.
3) The rule minimum thickness is not fulfilled for all structural elements.
4) Torsion strength of vessel with large deck openings, i.e. a general cargo vessel with one large hatch opening, open hatch container vessel. The longitudinal strength, including torsion may be required to be considered.
5) Shear strength in way of quarter length from AP and FP for vessel with many or large openings in the side shell, e.g. cruise vessels.

The following reinforcements can be applied:

1) Fitting of doubler plates on bottom, strength deck or at shear strake in order to increase the section modulus, and hence reduce the longitudinal hull girder stress.
2) Increase breadth by fitting of sponsons, in order to increase the section modulus.
3) Fitting intermediate stiffeners or longitudinals in order to increase both section modulus and buckling capacity.
4) Fitting buckling stiffeners.
5) Doublers on side shell in order to increase shear capacity or closing of windows or openings.

Acceptable ways to increase the section modulus by fitting doublers, are described in 2.10.

2.2.4 Local strength general

The following areas are to be considered with respect to strength:

- ship's side, especially fore and aft ship
- bow impact affected area
- slamming affected area
- bottom
- ice belt
- weather decks, especially fore and aft ship
- hatches
- superstructures, especially front bulkhead.

2.2.5 Local strength - New section

The new section is to be checked with respect to requirements stated in the current rules.

2.2.6 Local strength - Existing parts of the ship

2.2.6.1 Structures exposed to sea loads

The ship length is included in both the minimum sea pressure and the rule sea pressure. Increased length will however not result in a major change in the sea pressure.

E.g. given a ship with the particulars:

L = 50 m, B = 12 m, D = 10 m, T = 6 m, Cb = 0.6, V = 15,

an increase of the length of 40 % will only lead to a sea pressure increase of approximately 15 % in way of FP at the base line. The pressure alteration will increase if the draught is less than given above.

Larger ships will generally experience a smaller pressure increase than smaller ships when the length is altered. Considering that Cb increases with the length, one may experience that the sea pressure will remain unchanged when the ship is lengthened.

The percentage increase of sea pressure should be checked before detailed calculations are carried out. If the sea pressure increases by less than:

- 5%, then frames need not be checked
- 10%, then plating need not be checked.

For increased draughts of less than 10% above the scantling draught, frames and plating need normally only be checked in the fore and the aft ship.

It is however important to take rule changes into consideration. Old ships may have to be checked even for small sea pressure alterations, as the current rules are applied for major conversions.

2.2.6.2 Superstructures

The front bulkhead is to be checked as the length of the vessel has major influence on the design pressure.

The superstructure sides should also be checked on the lower tiers, especially if the draught is increased.

2.2.6.3 Ship sides for bulk carriers or general cargo carriers with large hatch openings in deck

The ship side is carried by deep web frames or stringers or deck strips. If the latter carries the side and the cargo space is altered, these stringers or deck strips are to be checked according to the new span and sea pressure. The most conservative load case is to be applied i.e. empty hold and maximum sea pressure (if applicable).

When applying a beam element model one should note that the hatch coaming will be the upper deck strip flange.

2.2.6.4 Hatches

Hatches that previously were located within Position 2 may after the ship lengthening be located within Position 1. Thus the requirement for hatch coaming height and strength increases. It is also to be noted that the minimum load on the hatches according to the loadline convention rules increases with the ship length.

2.2.6.5 Slamming

The area affected by slamming is always to be checked when the length is increased. The rule slamming pressure increases rapidly (over proportional) and almost linear with the ship length. The extension of the area affected by slamming will also increase, see Figure 2-6.

E.g. for a ship which is lengthened from 80 to 100 m (25 %) with a forward minimum ballast draught of 3 m, the slamming pressure will increase by approximately 75 %.

Discrepancies may be handled in the following ways:

a) Plating: Intermediate stiffeners are fitted or plating is renewed.
b) Stiffeners: Intermediate stiffeners are fitted or existing stiffeners are strengthened with brackets, additional flanges or struts.
c) Shear area of bottom floors or girders: Manholes are closed, floors or girders are fitted with doublers, additional floors or girders are fitted.
d) Weight of ballast may be deducted. New load conditions apply.

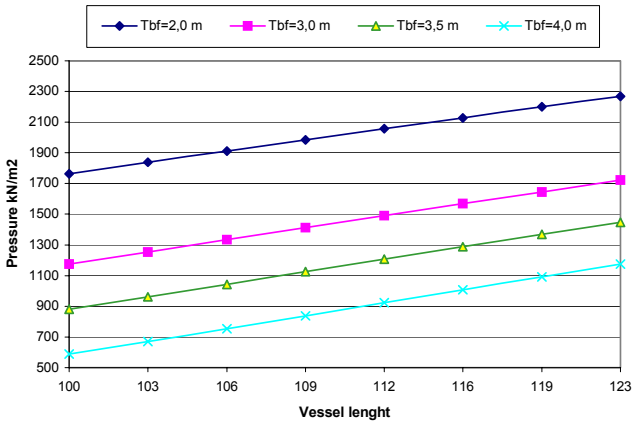

Figure 2-6 Slamming pressure for different ballast conditions as a function of the vessel length

In ships with large holds in the foreship, one may often find a shear area deficiency in bottom floors or girders according to the rule formula. As additional steel in the bottom may become costly for the shipowner, it is important to know that it is possible to carry out a direct stress analysis of the bottom structure based on the slamming pressure.

The shear area summation formula is based on the fact that the slamming pressure is very local. The mean allowable shear stress is set to 100 N/mm^2 and the slamming pressure is reduced as a function of the affected area.

- for an area (l x b) ≥ (L x B / 20) a minimum pressure of $p = p_{sl}/4$ is applied
- (L x B / 60) ≤ (l x b) ≤ (L x B / 80) => $p = p_{sl} / 2$

High bending stresses according to this model may be neglected as the slamming pressure is assumed to be peaky.

2.2.6.6 Bow impact

The foreship need only be checked according to the bow impact pressure for ships with well-rounded bow lines and/or flare. The bow impact pressure increases significantly less (in %) than the slamming pressure when the ship length is increased.

For direct calculations of girder or frame arrangements, the following parameters may be used:

- as the bow impact pressure is peaky, $p_{sl} / 2$ is applied on the model
- allowable shear stress: τ = 110 N/mm^2
- allowable bending stress: σ = 235 N/mm^2
- the girders are assumed simply supported at both ends.

2.2.6.7 Ice belt

The ice belt is to be especially considered. See 2.8.

2.2.7 Checklist for lengthening – strength

1) Documentation requirements (See Appendix A)
2) Watertight bulkheads
   - number
   - position
   - collision bulkhead
3) Minimum bow height
4) Anchoring equipment
   - new equipment number
   - upgrading
5) Longitudinal strength (if applicable)
   - new midship section, Z_0
   - new midship section, buckling
   - existing parts amidship, Z_0
   - existing parts, buckling
   - shear strength
   - shear strength existing parts
6) Local Strength
   - new midship section
   - existing ship sides
   - ice belt
   - existing bottom
   - forecastle deck
   - slamming
   - bow impact
   - hatchway coamings and covers
   - deckhouse front and sides.
7) Minimum engine power requirements for ice class if applicable.

2.3 Increased breadth

2.3.1 General

Increasing a vessel's breadth is performed by fitting sponsons to the ship's side. It may be carried out to reduce draught or to increase deadweight.

2.3.2 Documentation requirements

The following documentation is to be submitted for approval, see also Appendix A:

1) new shell expansion and framing plan
2) steel structural details and welding details
3) proposal for new equipment number and updated anchoring equipment
4) new loading manual, if applicable.

For information:

1) general arrangement
2) tank plan.

2.3.3 The following is to be considered

1) Minimum thickness requirement for sponsons sides will be as for side shell. Similar for frames.
2) It is of outmost importance that the sponson framing is aligned with the existing frames, see Figure 2-7.
3) When the sponsons are tapered at the ends, slot welding of the shell plating to the frames will be accepted where access is not possible, unless the vessel has assigned ice class notation, see below.
   The slot weld throat thickness is normally to be 0,6 t, see Figure 2-8 and 2-9. See the rules with regard to the required arrangement of the slots in the plating.
   Closed spaces are to be conserved.
4) Ice belt and minimum engine power requirement.
   Sponsons in the ice belt are to be strengthened according to the assigned ice class notation and the minimum requirements to engine power is to be checked accordingly. See 2.8.
5) The equipment number may change due to the increased displacement and wind area (factors of the rules' requirement to equipment number), and hence proposal for new number is to be submitted for approval. See 2.5.

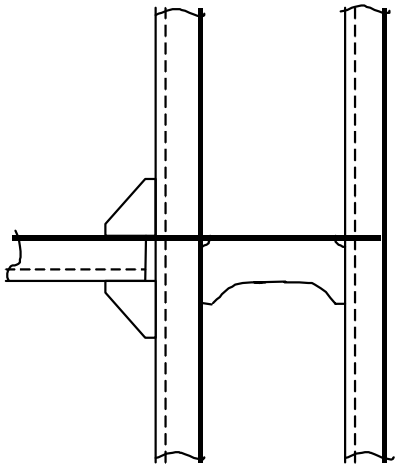

Figure 2-7 Alignment of sponson framing

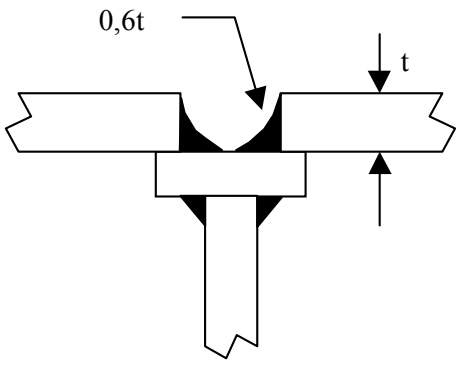

Figure 2-8 Slot welding of shell plate

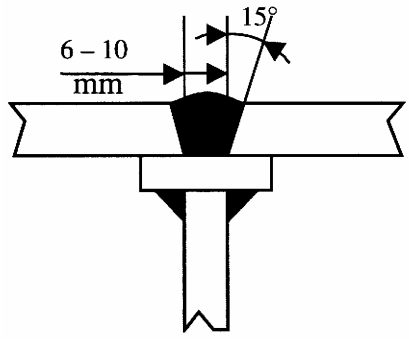

Figure 2-9 Slots through plating subject to large in-plane tensile stresses

2.4 Increased depth

2.4.1 General

Increasing the depth of a vessel is normally done by fitting of a new shelter deck, e.g. in connection with an increased draught where freeboard deck is redefined. The most important structural consequences may be that the new deck will be a strength deck (and freeboard deck) and that the equipment number increases due to the increased wind area. In addition the minimum power requirements with regard to ice class will change and must be considered accordingly.

2.4.2 Documentation requirements

The following documentation is to be submitted for approval, see also Appendix A:

1) deck plan with applicable deck load
2) shell expansion or framing plan of new part
3) new loading manual if applicable
4) proposal for new equipment number and updated anchoring equipment.

For information:

1) general arrangement
2) updated tank plan if air pipe heights are increased.

2.4.3 The following is to be considered

1) If the new deck is to be regarded as a strength deck, then all scantlings (minimum, allowable stress level, sheer strake) are to be considered consequently. If not, scantlings may be as for superstructure weather decks.
2) If the distance between effective transverse bulkheads is large, racking analysis should be considered.
3) The enclosed deck is to be fitted with drainage arrangement according to the rules.
4) If the old weather deck (main deck) is to be used as cargo deck after conversion, new load (t/m^2) and possible strengthening thereof is to be submitted for approval.
5) Extension of collision bulkhead.
6) The equipment number may change due to the increased wind area and hence a proposal for a new number is to be submitted for approval. See 2.5.
7) Tank bulkheads to be checked for new design pressure if air pipe heights of tanks are increased.
8) Fishing vessels: The minimum requirement for hatch coaming heights on freeboard decks, within L/4 from F.P. is 600 mm. Upon application, DNV or the flag State may accept a coaming height of hatches or door sill of 300 mm, on doors or hatches leading below this deck. The minimum freeboard is presupposed to be increased to the same level as the hatch coaming is reduced, or 50 % of the reduced door sill height.
   The minimum requirement for hatch coaming heights on Position 2 decks, within L/4 from F.P. is 450 mm. Upon application as described in 5), 225 mm may be accepted.

2.5 Anchoring equipment

2.5.1 General

Being a function of the vessel's displacement and the area of vessel profile above the waterline, the equipment number and letter will normally increase in connection with a major conversion. Deficiencies with regard to anchoring equipment may however be accepted upon special considerations.

2.5.2 Documentation requirements

New equipment number calculations is always to be submitted for approval when considering;

– increased length L, breadth B or depth D
– additional superstructures or other new structures that considerably increase the wind exposed area

Note that an increased draught does not normally alter the vessel's equipment number as the decreased wind exposed area compensates for the increased displacement. DNV, therefore, does not normally require calculations in these cases.

See also the rule guidance in regard to mooring and towing lines.

2.5.3 Acceptance criteria for equipment deficiency

A principle of equivalence with the rules is normally used. After conversion of the vessel, the anchoring equipment shall have the required holding power and the required level of safety according to the new letter.

1) *Chain diameter:* A reduction of 12 % according to new letter for wear and corrosion is allowed.
2) *Chain length:* No reduction is accepted.
3) *Anchor weight:* A deficiency of 25 % is accepted. The deficiency is to be compensated with additional lengths of chain of same weight as the anchor weight deficiency + 50 %. The last 50 % shall compensate for reduced holding power of smaller anchors. Minimum compensation will always be one additional length.

Equipment deficiency, compensated for by additional lengths of chain, is to be according to the new equipment letter at times of possible renewal after the conversion. Wear and tear limits shall be calculated according to the new equipment letter. A reference to this will be noted as a Memo for Owner and in the Appendix to the Classification Certificate.

Letter increment 1 or 2 steps	*Letter increment 3 steps:*	*Letter increment 4 steps or more:*
Anchor weight and chain length deficiency according to the new letter can be compensated with adding additional lengths of chain.	New anchors are required when new letter is ≤ x. New chain is required when: – new letter ≤ t and existing chain is of K1 quality – new letter ≤ w and existing chain is of K2 quality – new letter ≤ A and existing chain is of K3 quality.	New anchors and new chain according to new letter are required.

Table 2-2 Equipment compensation requirements

2.5.4 Important consequences

1) Chain lockers may have to be converted.
2) Anchor pockets may have to be converted. Note the possibility to change to high holding power anchors, allowing a weight reduction of 25 %.
3) Cable lifters may have to be renewed according to new chain diameter. Note that increased chain material quality will reduce upgrading requirement.
4) Hoisting speed of windlass shall maintain 9 m/min after upgrading of equipment.
5) Upgrading of windlass,chain stoppers and chain securing may have to be considered for increased breaking strength of chain.

2.5.5 Example 1

Existing equipment onboard according to letter 'j' i.e. 2 x 900 kg anchors + 357,5 m 30 mm NV K1 chain.

New required equipment according to letter 'l': 2 x 1140 kg anchors + 385,0 m 34 mm NV K1 chain.

Existing chain may be kept: 34 mm – 12 % = 29,9 mm.

Equipment deficiency will be as follows:

Chain length deficiency	*Weight deficiency of anchors*
385 m – 357,5 m = 27.5 m	*(2 x 900 kg – 2 x 1140 kg) x 1,5 = 720 kg* *Weight compensation:* *720 kg : 25,1 kg/m = 29 m*
⇒ Required: 27,5 m + 29 m = 2 additional lengths of 27.5 m 34 mm NV K1 chain; one on each side. Existing anchors remain.	

A Memo for Owner will be issued e.g.: "Due to lengthening of the vessel, the equipment number has been increased corresponding to letter 'l'. To compensate the shortage in weight of anchor and length of chain cable, one length of chain cable has been added on each side. Wear and tear limits will be calculated according to the new equipment letter. Renewals are as far as practicable to be in accordance with letter 'l'."

A similar reference will be given in the Appendix to the classification certificate.

2.5.6 Example 2

Existing equipment onboard according to letter 'A' i.e. 2 x 4050 kg anchors + 522,5 m 56 mm NV K2 chain.

New required equipment according to letter 'D': 2 x 4890 kg anchors + 550 m 62 mm NV K2 chain.

Existing chain may be kept: 62 mm – 12 % = 54,6 mm. The owner wishes however to renew the chain in order to increase the corrosion margin. Cable lifters cannot take 62 mm chain and the owner therefore decides to use NV K3 chain.

Equipment after conversion will be as follows:

Chain	*Anchors*
Requirement according to letter: *550 m, 54 mm NV K3*	*Weight deficiency: (2 x 4890 kg – 2 x 4050 kg) x 1,50 = 2621 kg* *Weight compensation:* *2621 kg : 63 kg/m = 42 m*
⇒ Required: 550 m + 42 m = 22 lengths of 54 mm NV K3 chain; 11 lengths on each side. Existing anchors remain.	

A Memo for Owner will be issued similar as in example 1.

2.5.7 Example 3

Similar as example 2 but owner wishes to change to high holding power anchors due to lack of space in the anchor pockets. Equipment after conversion will be as follows:

Chain	*Anchors*
Requirement according to letter: *550 m, 54 mm NV K3*	*HHP anchors – weight requirement:* *4890 kg – 25 % = 3668 kg*
⇒ Required: 550 m = 20 lengths of 54 mm NV K3 chain; 10 lengths on each side and 2 x 3668 HHP anchors.	

No Memo for Owner will be issued.

2.6 Steering arrangement

Any change in the ship's main parameters, such as the rudder, propulsion or power supply systems, may have impact on the steering capability of the ship. The rules state no requirements with regard to rudder area only a guidance note in the rules for Stern frames, Rudders and Steering gears. The owners will have to decide whether the steering capabilities are considered adequate for the vessel after conversion. If, however, the rudder has been altered, or if an alteration of the ship could otherwise affect the ship's steering capability, then a new sea trial for testing of the rudder and the steering gear, including documenting the steering capability of the ship, is to be carried out.

If the rule requirement to the rudder stock in way of the tiller exceeds 230 mm after the conversion, then an alternative power supply to the steering gear will be required, assuming that the new rules apply.

Any modification to the rudder, increased vessel speed, repositioning of the rudder or modification of and or the steering gear will be subject to approval and survey. Azimuth thrusters are subject to approval, survey and testing to the same degree as conventional propulsion and steering arrangements.

Increased vessel speed and or the installation of propeller nozzles will give greater requirements for the rudder, rudder stock, sole piece and steering gear.

Note that a repositioning of the rudder stock will affect the ships length. DNV Approval Centre and the Flag state is to be informed accordingly to determine new correct freeboard values.

The following documentation is to be submitted for approval:

1) Updated or new arrangement drawings of rudder, steering gear and steering compartment.
2) Drawings and particulars of all changes to azimuth thrusters, rudder, stock, bearing and steering gear inclusive all relevant piping, control and monitoring. systems. Material data and ratings shall be specified.
3) Updated operating instructions (posters in wheel house and in steering gear compartment).

All new parts and relevant components are to be delivered with a DNV certificate.

The sea trial of the rudder and steering gear is to be carried out at full speed, i.e. the same conditions that are required for a new ship.

2.7 Mounting of hydro acoustic bottom equipment, retractable thrusters and side thrusters

2.7.1 Documentation requirements

An arrangement drawing showing the system shall be submitted for information. Structural drawings showing the foundations and the watertight compartment are to be submitted for approval. Relevant forces and bending moments are to be stated on the submitted drawings.

2.7.2 Mounting of hydro acoustic bottom equiment

Hydro acoustic bottom equipment, or similar equipment which is lowered through the vessel's bottom on e.g. a shaft, should be fitted in a separate watertight compartment of limited space.

The foundation for the shaft is to be efficiently supported in the transverse and longitudinal directions.

The supporting structure is to be able to withstand a bending moment equal to that causing yield stress in the lowered shaft. Acceptable stress level in this condition is:

σ = 160 N/mm2

τ = 90 N/mm2.

There are to be operating instructions onboard the vessel stating how the instrument is to be operated. The instructions are to emphasis the correct use, in order to maintain watertight integrity.

2.7.3 Mounting of retractable thrusters

Retractable thrusters are to be fitted in a separate watertight compartment. Welds on plating forming hull boundaries are to be carried out with full penetration. Special consideration with respect to arrangement must be made on tankers with low flash-point cargo in order to comply with relevant rule requirements for this type of vessel.

For an ice classed ship, ice class requirements may be applicable if the thruster is used in ice and dependent on the type of thruster.

2.7.4 Mounting of side thrusters

Resiliently mounted thrusters are to be fitted in a separate watertight compartment, unless the sealing arrangement is especially approved for that purpose. Welds on plating forming hull boundaries are to be carried out with full penetration.

Special consideration, with respect to the arrangement of the exhaust pipe outlet from a diesel engine, must be made on tankers and other vessels with similar restrictions with respect to fire safety.

2.8 Ice belt

2.8.1 Generally

Longitudinal extension of forward, midship and aft ice region is dependent upon the vessel's length, its breadth and the given ice class notation. The vertical extension is dependent upon the ice class notation. The extension and strength of the ice belt is very often utilised with regard to the initial draught. This means that the ice strengthening often fails to meet the requirement given by a possible new draught or a major conversion, e.g. typical lengthening. Changes in displacement or in main dimensions L, B or T will require appraisal of machinery power, shafting, propeller, etc. in addition to structural strength, shafting, propeller, etc. Attention is to be paid to the extension of the ice belt, in both directions.

DNV accepts that the class notation **ICE-C** is valid to a maximum specified draught, which is less than the new draught. If such an arrangement is chosen, a reference to this will be given in the Appendix to the classification certificate and as a Memo for Owner. This procedure is *not* acceptable for the Baltic ice class notations.

2.8.2 ICE-C

1) Plating: The plating rule thickness formula is dependent on the vessel length L.
2) Frames: Dependent on L and the draught T.
3) Engine output: Dependent on displacement.

A deviation of 250 mm with respect to the extension of stiffeners may be accepted if the stiffeners are connected to a deck or stringer in way of the upper end.

It is important to note that the rule requirements according to **ICE-C** need not be taken higher than for **ICE-1C**. This is important to check, if the plate thickness is too low or existing frames are under-dimensioned but have short spans (**ICE-C** framing requirement are not dependent on the frame span).

2.8.3 Baltic ice class notations

The ice pressure is dependent on the vessel's displacement and its propulsion power. It is important to find the total ice pressure increase and consider the amount of checkpoints according to this.

- Ordinary and intermediate frames are generally to be checked if the ice pressure increases more than 5 %.
- The ice belt plating is generally to be checked if the ice pressure increases with more than 10 %.

Design ice-pressure, increase with increasing displacement. In most cases this can be ignored. Only a considerable increase in draught will require the adjustment of the ice-pressure.

2.8.4 Strengthening in the ice belt

If the owner does not intend to carry out the required strengthening, the ice class notation will be deleted.

2.8.4.1 Shell plating

Doublers are normally accepted in connection with conversions or increased draught of vessels, in order to fulfil the ice class requirements with respect to shell thickness. Where doublers are to be used for increasing the shell thickness, the guidance below should be followed:

1) Minimum thickness of doublers is 10.0 mm.
2) The breadth of doublers should not exceed 250 mm in the foreship and 325 mm elsewhere. Where slot welds are accepted, the vertical distance should not exceed 325 mm.
3) Adjacent doublers are to be connected with full penetration welding, see Figure 2-11.
4) Welds along the doublers sides are to be at least: $a = 0{,}5\ t_{db}$, see Figure 2-11.
   Slot welds shall not be used in the foreship for **ICE-1B** and **ICE-1C** and shall not be used in the fore- and amidship for ice class **ICE-1A*F, ICE-1A***, and **ICE-1A.** Where accepted, slot welds are to be completely filled with welding in the ice belt.
5) Thickness of doublers is to be determined by the following formulae:

Required doubler plate thickness for transverse and longitudinal framing:

$$t_{db} = \sqrt[3]{\frac{445\ P_{PL}\ t_{ex}\ s^2}{\sigma_f} - t_{ex}^{\ 3}} + t_c \qquad t_{db} \le t_{ex}$$

$$t_{db} = \sqrt[3]{t_{ice}^{\ 3} - t_{ex}^{\ 3}} \qquad t_{db} \ge t_{ex}$$

t_{ice} = required shell thickness for the given ice class (without *tc*)

t_{ex} = existing shell thickness

t_{db} = required thickness of doubler

P_{PL} = 0.75 P, where P = the design ice pressure

σ_f = yield stress of the material (N/mm²)

s = stiffener spacing in m measured along the plating between ordinary and/or intermediate stiffeners

t_c = increment for abrasion and corrosion (mm), normally 2 mm

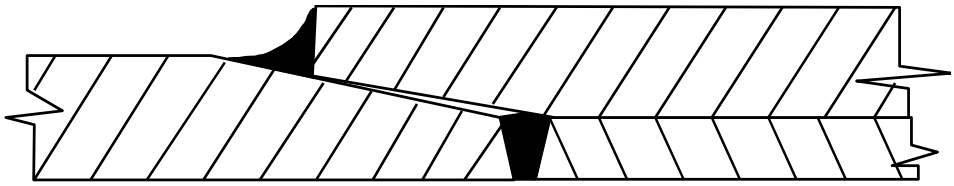

Figure 2-10 Section A-A: Extending the ice belt vertical with doublers. Welding detail

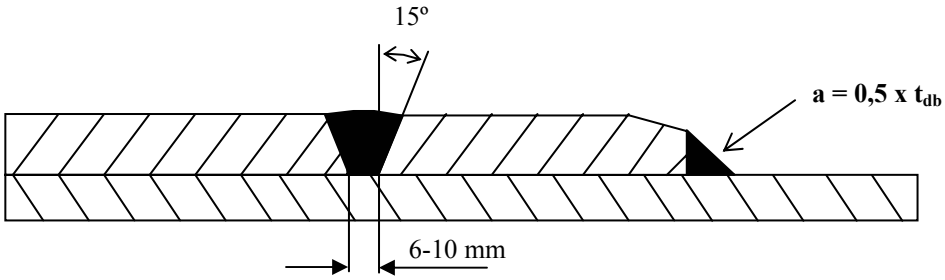

Figure 2.11 Section B-B: Welding of doublers to the shell

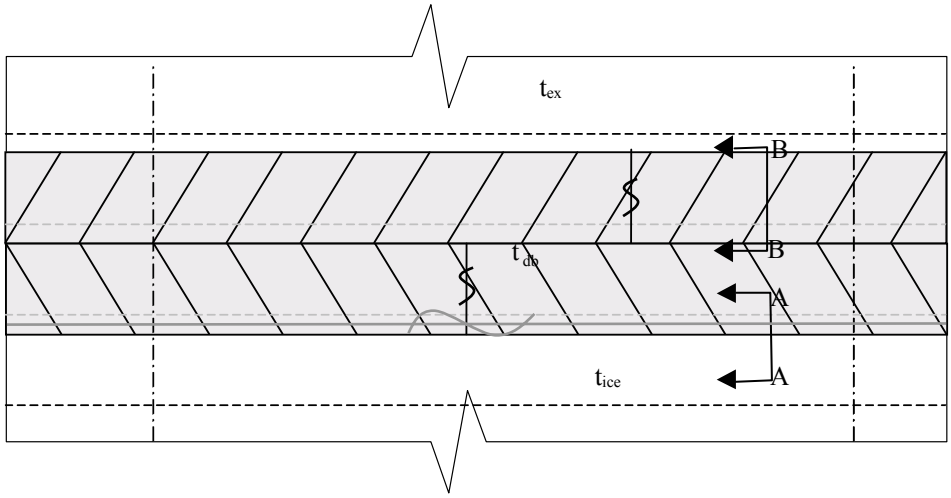

Figure 2-12 Fitting of doublers

2.8.4.2 Side frames in the ice belt

Ice frames may be strengthened with additional flanges, new intermediate stiffeners, fitting of brackets or supported by stringers (must be specially considered). Intermediate framing may have to be extended.

2.9 Strengthening for local overloading

When increased environmental loading due to increased main dimensions or increased draught necessitates strengthening of the existing steel structure, some arrangements must be approved which are usually not approved during a newbuilding phase.

2.9.1 Strengthening of plating

Increased sea pressure will seldom necessitate strengthening of plating. Such are usually required due to increased:

1) slamming pressure
2) bow impact pressure
3) design load for decks
4) tank loading
5) ice belt extension or pressure
6) longitudinal stress level.

In the four first cases, fitting of intermediate stiffening is often used. Refitting of plating may be necessary in extreme cases or when increased local loading is combined with increased longitudinal stresses. It may be necessary to strengthen existing stiffeners as well as adding intermediate. In regard to the ice belt, see 2.8. With respect to the increased longitudinal stress level, this is usually handled by fitting doublers, see 2.11.

2.9.2 Strengthening of stiffeners

The strengthening of stiffeners due to increased environmental loads or loads from new equipment is usually handled in one of the three following ways:

1) The stiffeners' end brackets are increased or new larger brackets are fitted. The alignment of supporting structures is to be especially considered.
2) The stiffeners' sections are increased by fitting of doublers or additional sections. The thickness of doublers should not be less than 6.5 mm. The additional flanges are to extend beyond the existing end brackets. Where the sections are considerably increased, new brackets should be fitted.
3) The stiffeners are supported by girders, stringers or struts. Note that when girders are fitted on the outside of a bulkhead, typical strengthening on the superstructure front connection area is to be applied, with brackets.

See also Figures 2-13 and 2-14.

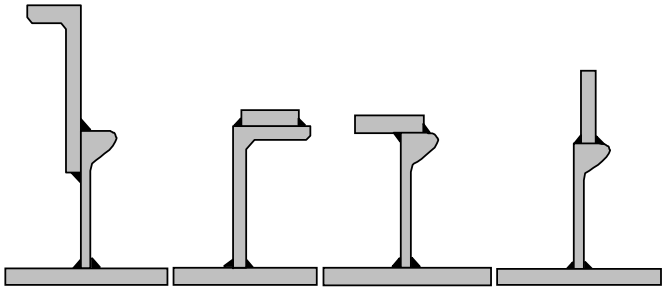

Figure 2-13 Increasing sections of stiffeners

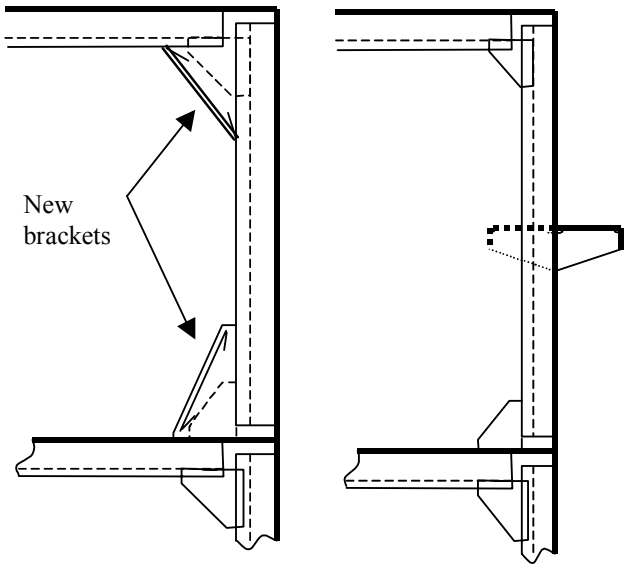

Figure 2-14 Reducing stiffener spans

2.9.3 Strengthening of girders

Girders may be strengthened with regard to bending strength and shear strength, see Figures 2-15 to 2-17.

1) When strengthening girders in order to reduce bending stresses, the sections are to be increased in the same way as for stiffeners. Doublers are to be extended beyond brackets. This may be done by slotting the doubler in way of the bracket or by making the section unsymmetrical. The latter will require additional tripping brackets.

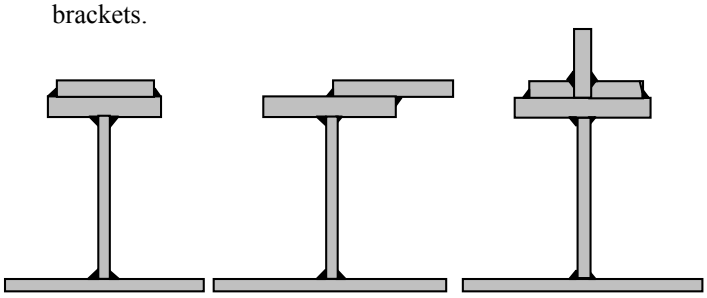

Figure 2-15 Strengthening of girders for bending strength

2) To reduce shear stresses in girders, two solutions are normally acceptable:
   a) Increase girder height.
   b) Increase shear area by fitting a doubler. The doubler is to be located in way of the shear centre of the girder. Doublers outside the shear centre will not be accepted.

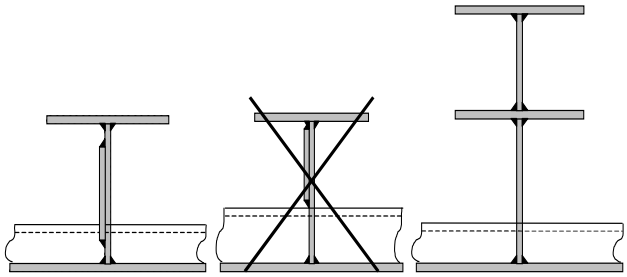

Figure 2-16 Strengthening of girders for shear strength

Doublers for shear are to extend fully to the girders ends and are to be tapered inboard. When the doubler height is equal to the girder height, the doubler is to be welded with full penetration welds.

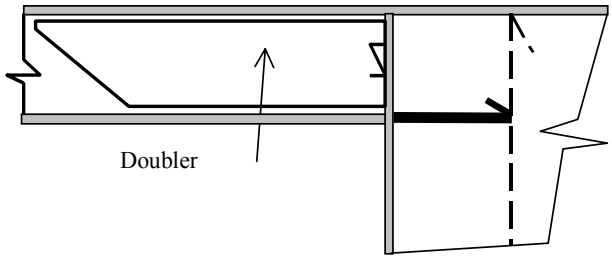

Figure 2-17 Fitting of shear doubler

2.10 Application of doublers for longitudinal strength

Where the stress level in existing structures is increased above the maximum allowable, either according to buckling criteria or according to longitudinal strength criteria, fitting of doublers may be an acceptable solution. Doublers may be fitted at deck or bottom for insufficient bending strength or at sides for insufficient shear strength.

Increased area in deck and/or bottom due to longitudinal strength, may be obtained from the formula:

$$\Delta A \geq \frac{\Delta Z}{\frac{Z}{A} + Y_T}$$

ΔA = required increase in deck/bottom area (cm^2)

ΔZ = required increase in deck/bottom section modulus (cm^3)

Z = actual section modulus (cm^3)

A = actual total area in the cross section (cm^2)

Y_T = distance from deck or bottom to neutral axis (cm)

It is assumed that the doubler material is of the same quality as the existing deck or bottom plating.

Minimum thickness of the doublers are to be as follows:

- Deck plating:
  t_{min} = 6,5 mm or $t_{existing\ deck\ plate}$
- Sides and bottom:
  t_{min} = 10,0 mm or $t_{existing\ side\ /\ bottom\ plate}$
  whichever is less.

2.10.1 Welding of doublers

Doublers are to be welded to plating contributing to longitudinal strength with continuous welding along the edges. The thickness of doublers should not be less than 6.5mm.

Throat thickness of the welds to the deck or bottom plating for tapered terminations is normally to be:

$$a_t \geq 0{,}4\ t\ (mm) > \text{(at tapered terminations)}$$

and

$$a_t \geq 3 + 0{,}1\ t\ (mm)\ \text{(in general)},$$

assuming the breadth of the doublers b < 100 + 30 t , where t is the thickness of the doubler (mm).

Where doubler plates are tapered within 0,2 L and 0,25 L, fore and aft of amidships, the weld area surrounding the taper of each doubler should not be less than 1,75 x the doubler area. Where several doublers are terminated in the same region, the sectional area A* of the strengthened part, see Figure 2-18, should not be less than:

$A^* > 1.75\left(\sum_{i=1}^{n} A_i + A_0\right)$ where A_0 is original shell plate area in way of doublers.

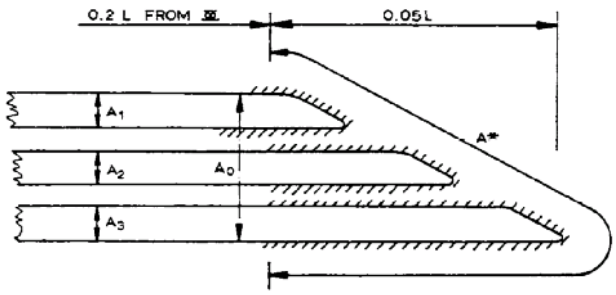

Figure 2-18 Weld area in doubler ends

For doublers plates with breadth, b, exceeding:

$$b = 100 + 30\ t, \text{ maximum } 850\ mm$$

welding through evenly distributed slots will be required.

2.11 Ladder access by means of cut-outs in ships side

Occasionally, but mainly on fishing vessels, access ladders are arranged by cutting holes in the ships side. Even though longitudinal stresses may be relatively low cracks may arise unless adequate reinforcing is arranged. A suitable and acceptable method is shown in Figure 2-19.

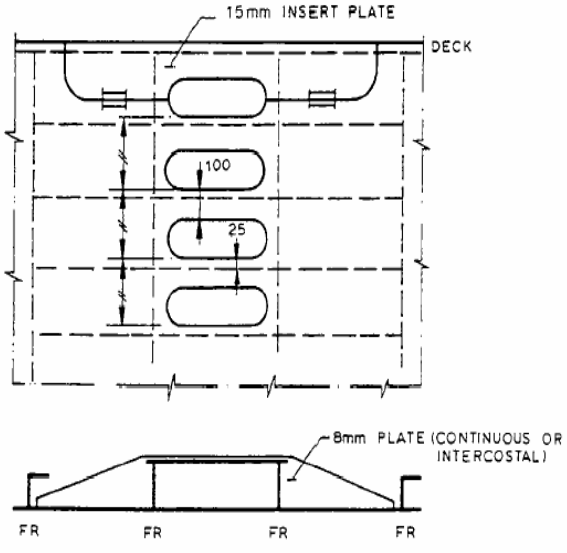

Figure 2-19: Shell insert in way of ladder holes

It is, however, strongly recommended that such openings are positioned outside 0.4L amidships, if possible.

2.12 Ballast keels made from slabs

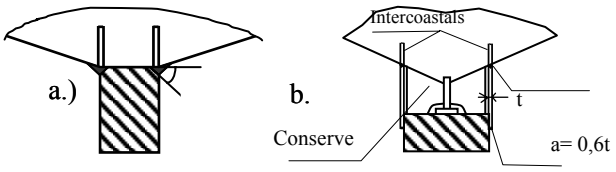

Figure 2-20 Ballast keels made of slabs

Fitting of new a new keel is subject to class approval. To achieve required stability, a ballast keel built up by slabs is often used for ships with L<100 m. The following requirements must be satisfied:

1) Ballast keel built up by slabs is not accepted as an integral part of the bottom structure, and is not to be included in the calculation of section modulus, Z_B
2) Internal stiffening must be provided to ensure the load distribution between the ballast keel and the bottom structure with respect to docking. Internal brackets or intercostals in line with the longitudinal welding seam are to be fitted.
3) The keel plate thickness for connections of the ballast keel is not to be less than twice the normal rule thickness. Steel grades in accordance with class III are to be provided.
4) The slab material is to have good weldability with carbon content normally not exceeding 0.18 %. Preheating to 75-100 ^oC is recommended. Special attention should be paid to weather conditions and air temperature.
5) Butt welded joints of the slabs are not accepted within sections which may be subjected to local tensile stress, such as just below or near to transverse bulkheads.
6) Butt welded joints and the seams along the keel plate are to be built up after 45 degrees edge preparation with depth minimum 20-25 mm.
7) The welds are to be carefully checked with respect to cracks by MPI or equivalent methods.
8) For Z_B/Z_R less than 2, ballast keel built up by slabs will normally not be accepted. (Z_B/Z_R will normally be less than 2 for ships exceeding 90 m).
9) The slabs are to be delivered in normalised condition if:
   a) The ballast keel serve as a sole piece, or in any other way is subject to higher local tensile stresses.
   b) If Z_B/Z_R is less than 3. (Z_B/Z_R is normally to be checked for all vessels with length exceeding 60 m).
10) For vessels with length less than 50 m and with docking weight less than 30 t/m, the stress concentration in the supporting structures found to be low (120 – 160 N/mm^2). Brackets or intercostals in line with the welded seam between frames may therefore normally be omitted.
11) The strength of the supporting structure of the keel will be subject to special consideration.

Z_R = Rule section modulus requirement.
Z_B = Section modulus of ship as built.

2.13 Reefer Ships

2.13.1 General

This applies for vessels which are going to convert existing cargo hold into cargo hold intended for refrigerated cargo.

It also applies for existing vessel having cargo holds intended for refrigerating cargo and which shall undertake conversion of the existing refrigerating arrangement.

The content of this chapter only covers the requirements for conversion of the hull structure and is based on DNV Rules for Classification of Ships Pt.5 Ch.10. For rule requirements for other disciplines than hull structure, see Pt.5 Ch.10.

2.13.2 Class Notation

Ships designed, built, equipped and tested under the supervision of the Society in compliance with the requirements of Pt.5 Ch.10 may be given one of the relevant additional class notations:

Reefer (...ºC/...ºC sea)

RM (...ºC/...ºC sea)

2.13.3 Documentation requirements for hull structure

The following plans and particulars related to hull structure are to be submitted for approval:

1) Profile and Plan
2) Midship section
3) Framing plan/typical cross section for the freezing chambers
4) Structural details such as welding, material grade etc.

Reference is made to the DNV rules for documentation requirements with respect to the refrigeration plant.

2.13.4 Strength evaluation

2.13.4.1 Material quality

The material grade is normally to comply with the rule requirements specified in Pt.5 Ch.10 Sec.2 Table A1.

2.13.4.2 Deck Plating

The existing grade of material of deck plating will normally be accepted except in local areas where the total tensile stress level is high. This is typical in way of hatch corners, where deck girders are supported by pillars or where deck girders tie into rigid structures such as bulkheads or deep web frames (Figure 2-21). In such areas new plating with material grades complying with Pt.5 Ch.10 Sec.2 is to be inserted.

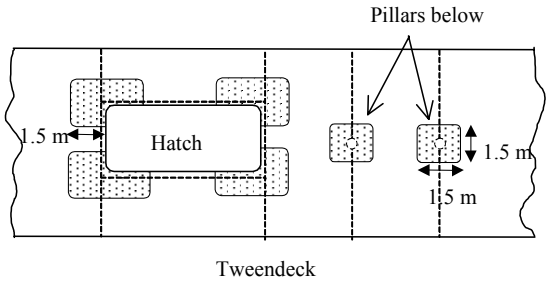

Figure 2-21 Strengthening of deck plating exposed to tensile stresses

2.13.4.3 Strengthening of girders

Material quality of flanges of deck and side girders exposed to tensile stresses are to be upgraded to comply with the rule requirements. Alternatively doublers on the girder flanges with correct material grade could be accepted (Figure 2-22). When calculating the section modulus of the doubler strengthened girders, the material not complying the quality requirements is to be deducted from the calculations. Hence, only the shaded area shown in Figure 2-22/23 can be included in the section modulus of the girder.

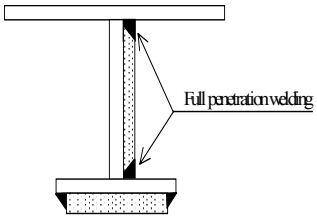

Figure 2-22 Strengthening of girders

If webs of deck and side girders are exposed to shear stress levels higher than 60 N/mm^2, the material grade is to be upgraded. Doubler plates with correct material grade will be accepted provided it is welded with full penetration, see Figure 2-25.

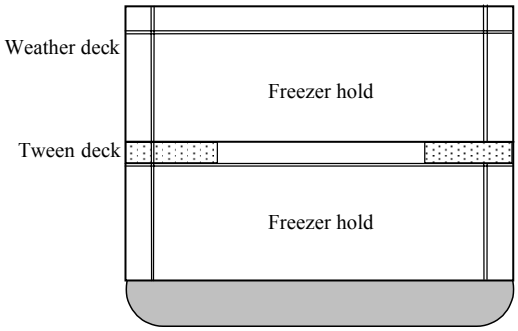

Figure 2-23 Shear strengthening of girders

2.14 Installation of special fixed ballast materials

2.14.1 General

The following is based on USCG's Circular from 1982:

NAVIGATION AND VESSEL INSPECTION CIRCULAR No. 5-82

When fixed ballast is installed, the following Memo to Owners is to be given:

"Tank(s)..... have been filled with ..... tons (m^3) of fixed ballast of the type ....., with a specific gravity of ..... t/m^3.

The ballast is to be removed for the survey of the tanks on request from the Society."

2.14.2 Fixed ballast, general

Fixed ballast may be installed to increase stability on new or existing vessels. If fixed ballast is to be used aboard vessels requiring stability tests, it should be installed prior to conducting the test. On existing vessels, addition or removal of fixed ballast may require that a new stability test is performed on the vessel. The mass and location of fixed ballast on such vessels should be included in the stability calculations.
The use of high density materials for fixed ballast installations may cause excessive structural loading on a vessel. Therefore, the following plans and calculations may be required to be submitted for approval:

1) An arrangement plan showing proposed types, locations and quantities of fixed ballast.
2) A capacity plan showing the original capacity of each space in which fixed ballast will be installed.
3) A structural evaluation of each fixed ballast compartment for the mass and location of the proposed ballast installation.

Special arrangements may be necessary to provide proper ventilation and to facilitate the installation and inspection of the ballast material. The following guidance applies to all fixed ballast installations:

1) Each ballast tank should be fitted with vents to the weather deck. Flame screens should be installed if organic decay is possible.
2) Fixed ballast should not be installed in tanks containing piping systems that require inspection. If fixed ballast must be installed in such tanks, a pipe tunnel or other suitable arrangement should be made to permit inspection of the piping.
3) The ballast material should be properly secured to prevent shifting in severe weather.
4) Inspection openings should be provided in each corner of the ballast space for detection of shifting or settling of the material or seepage of water into the ballast space. Manholes may be provided for this purpose in double bottom tanks. If concrete caps are used to secure the ballast, ullage pipes at least 200 mm in diameter should

be fitted in the concrete to permit inspection of the ballast material.
5) An expansion trunk should be provided which is adequate for the maximum volumetric expansion of liquid ballast.
6) Plans showing ventilation of the fixed ballast space, the securing arrangement of the ballast material, and all closure plate installations for openings cut in the vessel structure may be required to be submitted for approval.

Fixed ballast is often installed in compartments or tanks that would normally be examined for deterioration during periodic inspections. The following procedures may be followed in lieu of emptying fixed ballast tanks at each inspection period:

1) The atmosphere in each tank should be sampled and analysed by a certified marine chemist who should follow the provisions of NFPA 306 to determine if gas evolution is present.
2) All fixed ballast installations should be accessed through the ullage openings provided. The ballast material should be inspected for shifting, settling and excessive moisture. Visible change to the ballast material may be cause for removal and additional inspection.
3) If a bacteriostatic agent is required, a sample of ballast fluid from the mid-depth of each tank should be removed for analysis to determine the bacteriostatic agent residual and the presence of any methane gas or gas producing bacterin. If there is evidence that the bacteriostatic agent residual is inadequate to prevent bacterin growth, the fluid should be pumped out and supplied with a bacteriostatic agent.
4) If installed, the tank material test pieces should be examined to determine the apparent type and rate of corrosion. If there is indication that extensive or accelerated corrosion is taking place the ballast material should be pumped out and the tank cleaned for internal examination.

Plans, calculations and procedures for approval of fixed ballast installations should be submitted in one co-ordinated package. DNV's approval of the package should be obtained prior to installation of the ballast material.

2.14.3 Fixed mud ballast

Special drilling mud type fluids (Baryte) may be used as fixed ballast, under the following provisions:

1) *Bacteriostatic agent*. A bacteriostatic agent effective against aerobic as well as anaerobic bacteria should be thoroughly mixed with the fluid in accordance with the manufacturer's specifications.
2) *Anticorrosivity*. The pH factor of the fluid should be adjusted to a value which minimise corrosion for the particular metals involved. Corrosion inhibitors may be added to the fluid, but they should not interfere with the action of the bacteriostatic agent or affect the physical properties of the fluid such as suspension, viscosity, etc.
3) *Settling*. Fluids should have sufficient viscosity and gel strength to minimise settling of solids.
4) *Thermal expansion*. Volumetric expansion should not be greater than four tenths of one percent (0.4%) over a temperature range from -2°C to 30°C.
5) *Freezing*. The fluid should withstand a low temperature ambient of -2°C without freezing. Unless adjacent to high temperature spaces, the expected maximum temperature of the ballast should be taken as 30°C.
6) *Proposed ballast*. A sample of proposed ballast fluid should be prepared by the manufacturer and subjected to at least a thirty day test to insure that all of the above requirements are fulfilled. A report of the test should be made available to the surveyor prior to installation of the fluid.
7) *Corrosion test plates*. Corrosion test specimens, in the form of two 100 x 500 mm plates 10 mm thick and of the same material as the internal structure of the ballast tanks and welded together to form a plate 200 mm wide, should be attached to the underside of the manhole cover on each expansion trunk for the ballast tanks in such a way that the corrosion test specimens hang down to the mid-depth of the ballast tanks. A permanent record of the date of installation, thickness and weight of each corrosion test specimen should be kept on aboard the vessel. Specimen thickness, weight and date of inspection should be placed in this record after each inspection.
8) *Air pockets*. When pumping the fluid into the ballast tanks, care should be taken to eliminate all air pockets. Permanently installed ship's pumps or piping should not be used for handling the fluid.

3. Stability

3.1 DNV involvement

DNV handles stability as a statutory matter when authorised by the flag Administration. In these cases decisions handled by the Administration are handled by the class.

DNV handles stability as a class matter for vessels:

- built after 1992-07-01
- having undergone a major conversion after 1992-07-01.

When stability is a class matter, but DNV is not authorised by the flag State, DNV will base the class approval on the approval of the Administration, if possible. The final stability documentation carrying the approval stamp of the Administration is then to be submitted for approval and for class file, together with the Administration’s approval letter. Preliminary documentation need not be submitted, nor will it be necessary to submit inclining test procedure or report or attend at the test.

Note that some class notations such as **Tug, Supply Vessel, SF, Crane Vessel** and **Crane** contain stability requirements not necessarily covered by the statutory approval (see also Table A1 in the Rules for Classification of Ships Pt.3 Ch.4 Sec.3). In these cases it will be necessary for DNV to be involved from the preliminary stage.

3.2 Increased draught

3.2.1 General

This is normally not regarded as a major conversion, see 2.1.2. Thus, the converted ship must continue complying with the same intact and damage stability requirements, but now up to the new summer load line draught (and timber draught, if relevant). Note, however, that for a dry cargo ship over 80 m in length where no damage stability requirements have previously been in force, it may be necessary to submit damage stability index calculations demonstrating that the level of subdivision is not less than before the conversion. This is to be decided by the flag Administration.

3.2.2 Documentation requirements

The following documentation will be required for all ships:

- stability booklet or loading manual including loading conditions, hydrostatic data, cross curves and limiting stability data covering the new maximum draught.

Where damage stability requirements are applicable:

- damage stability calculations covering the loading conditions in the stability booklet or loading manual or damage KG/GM limiting curves for the full draught range.

For passenger ships:

- floodable length calculations.

For ro-ro passenger ships not yet upgraded to current SOLAS standard:

- calculation of A/Amax at the new maximum draught.

For dry cargo ships over 80 m in length where no damage stability requirements have previously been in force, when required by the flag Administration:

- calculation of A/R ratio for the ship before and after the conversion as required by MSC/Circ.650.

For ships carrying grain cargo:

- grain stability booklet including loading conditions and maximum allowable heeling moments covering the new maximum draught.

For ships with a loading instrument approved with respect to stability:

- test loading condition at new maximum draught
- stored characteristic data for the increased draught range.

When strengthening and/or other conversion work changes the light ship particulars (see also 3.5):

- inclining test procedure
- inclining test report.

In the latter case, preliminary versions of the stability booklet or loading manual and damage stability calculations will also be required.

3.2.3 Survey points

To meet damage stability requirements at the increased draught, it may be necessary to increase air pipe heights, install weathertight or watertight doors, etc. In these cases it is very important that the position of openings with type of closing appliances assumed in the damage stability calculations, are verified by the surveyor.

3.3 Major conversions

3.3.1 General

This covers change in main dimensions (see also 1.4). The ship is to comply with the rules and statutory requirements currently in force for new ships. The exception is existing dry cargo ships over 80 m in length where no damage stability requirements have previously been in force, where it may be sufficient to prove that the level of subdivision is not less than before the conversion. This is to be accepted by the flag Administration.

Change of ship type is also regarded as a major conversion. The ship is to comply with the rules and statutory requirements currently in force for new ships (no exceptions). As an example, a cargo ship converted to a passenger ship shall comply with the regulations in force for new passenger ships regardless of the date of construction.

3.3.2 Documentation requirements

The following will be required for all ships:

- preliminary and final stability booklet or loading manual
- inclining test procedure
- inclining test report.

Where damage stability requirements are applicable:

- preliminary and final damage stability calculations
- internal watertight integrity plan.

For passenger ships:

- floodable length calculations.

For dry cargo ships built after 1992-02-01 and for passenger ships:

- damage control plan
- damage control manual.

For change in main dimensions of a dry cargo ship over 80 m in length where no damage stability requirements have previously been in force:

- calculation of A/R ratio for the ship before and after the conversion as required by MSC/Circ.650.

For ships carrying grain cargo:

– preliminary and final grain stability booklet
– grain loading plan.

For ships with a loading instrument approved with respect to stability:

– test loading conditions
– stored characteristic data.

3.3.3 Survey points

1) Verification onboard of internal watertight integrity plan or damage control plan will be required.
2) Existing cross-flooding valves, spindle extensions and cross-flooding pipes in older ships are susceptible to corrosion and should be examined and tested in connection with the verification of the damage control plan.

3.4 Internal modifications

3.4.1 General

The converted ship must continue to comply with the same intact and damage stability requirements, at least to the same extent as before the modification. Modifications to tanks and cargo spaces may make it necessary to revise loading conditions and tank or hold data. Similarly, the damage stability may be influenced by internal modifications and therefore need revision.

Note that for a dry cargo ship over 80 m in length where no damage stability requirements have previously been in force, it may be necessary to submit damage stability index calculations demonstrating that the level of subdivision is not less than before the conversion.

3.4.2 Documentation requirements

The following will be required for all ships:

– stability booklet or loading manual including updated loading conditions and tank or cargo space data.

Where damage stability requirements are applicable:

– damage stability calculations covering the loading conditions in the stability booklet or loading manual or damage KG/GM limiting curves.

For passenger ships:

– revised floodable length calculations.

For dry cargo ships over 80 m in length where no damage stability requirements have previously been in force:

– calculation of A/R ratio for the ship before and after the conversion as required by MSC/Circ.650.

For ships carrying grain cargo:

– grain stability booklet including updated loading conditions and cargo hold volumetric heeling moments
– revised grain loading plan.

For ships with a loading instrument approved with respect to stability:

– new test loading conditions
– revised stored characteristic data.

When the conversion changes the lightship particulars (see also 3.5):

– inclining test procedure
– inclining test report.

In the latter case, preliminary versions of the stability booklet or loading manual and damage stability calculations will also be required.

3.4.3 Survey points

1) Even a minor modification of a bulkhead between two dry compartments could have an effect on the damage stability. In such cases DNV should be contacted to determine if new stability documentation would be required.
2) Modifications to existing cross-flooding arrangements will usually have significant effect on the damage stability. Any modification or discrepancies found in comparison with the damage control plan must be reported to DNV.

3.5 Change in lightship particulars, additional comments

3.5.1 General

The effect of the conversion on the lightship particulars must always be considered. This is not only the case for extensive conversion work such as a lengthening, but also minor changes such as strengthening of deck structure or installation or replacement of equipment (cranes, winches, etc.).

3.5.2 Inclining test

As a general guideline, the new lightship particulars are to be found by an inclining test if the estimated change in lightship mass is more than 2%.

3.5.3 Lightship particulars found by calculation

Subject to acceptance by DNV, lightship particulars may be found by calculations, provided that the estimated mass change is less than 2% and that the surveyor is able to verify the mass and position of the changes. Following survey onboard the calculations listing the mass changes are to be endorsed by the surveyor and submitted for approval. (See also 3.7.2.) Note that the 2% guideline is not the net change; the total of added and removed masses as well as their positions are to be considered.

In the case where the lightship particulars have originally been based on the inclining test results of a sister ship, the modification may invalidate previous dispensation from an inclining test.

3.5.4 Documentation requirements

This will vary depending on the conversion and must be clarified with DNV (although it is assumed that 3.2 to 3.4 cover most cases).

3.6 Conversions that may have an effect on stability

3.6.1 Change of tank contents

When the types of liquid in tanks are changed, it will normally be necessary to revise the loading conditions as well as the tank plan or tables and submit an updated stability booklet or loading manual. Typical examples are an increase in fuel capacity by converting fresh water or ballast tanks, conversion of combined fuel or ballast tanks to exclusive fuel tanks, and conversion of tanks in supply vessels to high density cargo tanks.

Where the damage stability calculations are direct calculations based on actual loading conditions, or otherwise assume a specified tank content in intact condition, revised damage stability calculations may also be necessary.

3.6.2 Increase of load on deck

Additional loading conditions covering the new maximum deck load are to be calculated and submitted as part of a revised stability booklet or loading manual.

3.6.3 Increase in windage areas

New loading conditions including weather criteria calculations may have to be submitted as part of a revised stability booklet or loading manual. A typical example is increase of stack height on container ships.

3.6.4 Tugs and supply vessels, increase of bollard pull

For vessels with the class notations **Tug** or **Supply Vessel** (in the latter case: only if engaged in towing), where the bollard pull is increased, calculations according to the Rules for Classification of Ships Pt.5 Ch.7 Sec.2 E or Pt.5 Ch.7 Sec.3 D302 are to be submitted for approval.

3.6.5 Fire fighters, increase in monitor heeling moment

For vessels with the class notation **Fire Fighter** where the monitor heeling moment is increased, calculations according to the Rules for Classification of Ships Pt.5 Ch.7 Sec.5 I are to be submitted for approval.

3.6.6 Crane vessels, modification of crane arrangement

For vessels with the class notation **Crane Vessel** or **Crane**, where the maximum hook load is increased or other changes are made to the crane arrangement that could adversely effect the stability, calculations according to the Rules for Classification of Ships Pt.5 Ch.7 Sec.8 D200 are to be submitted for approval.

3.6.7 Upgrade of ice class

Upgrade from class notation **ICE-xx** to **POLAR** or **Icebreaker** will require damage stability calculations in accordance with the Rules for Classification of Ships Pt.5 Ch.1 Sec.4 L.

3.6.8 Increase of number of passengers

For passenger vessels where the number of passengers is increased, it may be necessary to require new floodable length calculations, new damage stability calculations and a revised stability booklet or loading manual.

3.7 Stability documentation and other formal matters

3.7.1 Preliminary stability documentation

Preliminary documentation must be submitted for approval at least 6 weeks prior to the completion of the conversion.

3.7.2 Dispensation from an inclining test

In order to allow time for preparations in case a dispensation from an inclining test cannot be granted, the application for a dispensation together with lightship particulars found by calculations (see 3.5.3), must be submitted together with the preliminary stability documentation.

3.7.3 Inclining test procedure

This is to be received for approval at least 1 week prior to the test.

3.7.4 Inclining test report

The inclining test report is to be endorsed by the surveyor and submitted for approval.

3.7.5 Departure of converted and inclined ship

In general, preliminary documentation is to be onboard in approved order and the inclining test is to be approved before the ship departs.

4. Load Line

4.1 Increased draught – freeboard deck not redefined

4.1.1 Important aspects with respect to load line conditions of assignment

a) *Sanitary discharges*
The requirements for number of, type and position of

closing of valves are determined by the height of the lowest inboard opening for each system above the new summer water line.
See the Rules for Classification of Ships Pt.3 Ch.1 or Ch.2 Sec.11 K.

b) *Side scuttles in the ship's sides and windows*
For side scuttles in the ship's sides, the distance from lowest sill of the lowest scuttle to the new summer water line is not to less than the largest of either 0.025 B or 500 mm.
Increased glass thickness for side scuttles and windows may be required.
See Rules for Classification of Ships Pt.3 Ch.1 or Ch.2 Sec.11 L.

c) *Minimum bow height*
See Rules for Classification of Ships Pt.3 Ch.5 Sec.3 M.

d) *Exemption from the load line convention*
Possible previous exemption with respect to load line may have been granted for a specific draught.

4.1.2 Required load line documentation

Form No. 44.401a, "Record of Conditions of Assignment" and Freeboard plan is to be updated for possible changes made.

4.2 Increased draught – freeboard deck redefined

4.2.1 Important aspects with respect to load line conditions of assignment

1) Requirements listed under 4.1.1.
2) Stricter Position 1 requirements, according to ICLL 66, may be required for closing appliances with respect to sills, coamings, scantlings of hatch covers, freeing arrangement etc.

4.2.2 Required load line documentation

1) updated Form No. 44.401a, "Record of Conditions of Assignment"
2) updated freeboard plan
3) new Form No. 44.402a, "Report on Measurements for Load Line".

4.3 Alteration of main dimensions

Existing ships with one or more conversions affecting one or more of the main dimensions are to be in accordance with prevailing load line convention regulations.

4.3.1 Important aspects with respect to load line conditions of assignment and freeboard assignment

1) New freeboard calculation to be carried out based on new Form No. 44.402a, "Report on Measurements for Load Line".
Note:
   – Lesser draught may be expected for lengthening of vessels that was previously assigned maximum geometrical draught.
   – Minimum bow height requirement increases with increase of L.
   – Length of forecastle, from F.P., is required to minimum cover 7% of the new L after lengthening in order to be included in the available bow height.
2) Requirements listed under 4.1.1.

4.3.2 Required load line documentation

1) Updated Form No. 44.401a, "Record of Conditions of Assignment".
2) Updated Freeboard plan.
3) New Form No. 44.402a, "Report on Measurements for Load Line".

4.4 Alteration of - or new superstructure

4.4.1 Important aspects with respect to load line conditions of assignment and freeboard assignment

1) New freeboard calculation is to be carried out.
Note:
   – Lesser draught may be expected for reduction of superstructure.
   – For modification of forecastle the mean covered length, from F.P., is required to be minimum 7% of the new L in order to be included in the available bow height.

4.4.2 Required load line documentation

1) Updated Form No. 44.401a, "Record of Conditions of Assignment".
2) Updated Freeboard plan.
3) Updated or new Form No. 44.402a, "Report on Measurements for Load Line".

5. Life-saving Appliances and COLREG and ILO Crew Accommodation

5.1 Life-saving appliances

If the life-saving appliances or arrangements are changed due to the conversion, alteration or modification, then drawings showing the new arrangement are to be submitted to DNV for approval. The following should be noted in this respect:

When life-saving appliances or arrangements of the ship is replaced or the ship undergo repairs, alterations or modifications of a major character which involve replacement of, or any addition to, their existing life-saving appliances or arrangements, such life-saving appliances or arrangements, in so far as is reasonable and practicable, is to comply with the requirements which are applicable under chapter III of the SOLAS convention in force.

However, if a survival craft other than an inflatable liferaft is replaced without replacing its launching appliance, or vice versa, the survival craft or launching appliances may be of the same type as that replaced.

5.2 COLREG

(Convention on the International Regulations for Preventing Collision at Sea)

If the conversion, alteration or modification involves that the navigation light arrangements and/or sound signal appliances are changed, then drawings showing the new arrangement is to be submitted to DNV for approval.

5.3 ILO Crew accommodation

If the superstructure (crew accommodation) is replaced or modified, then drawings showing the new arrangement is to be submitted to DNV for approval.

6. Electrical Components

6.1 Documentation

6.1.1 General

All changes in the electrical system are to be specified. This applies to changes to the already existing system, new electrical installations and changes or additions of a class notation. For changes in rudder stock size from below to above 230 mm, see 2.6 for further details.

6.1.2 Documentation requirements

For changes in the electrical equipment the following documentation should be submitted to DNV:

For changes in the electrical system:

- single line diagram.

For changes in installed power (e.g. changes in motor load or installed generator power):

- power consumption balance covering the following operational modes: normal at sea, manoeuvring, special operations and emergency
- discrimination analysis
- short circuit calculations (if the short circuit current changes).

For changes in the switchboard or installation of new switchboard:

- drawings of the switchboard.

For changes in bus-bar- or circuit-breaker size or type:

- discrimination analysis (only if the change of breakers affects the selectivity in the system).

For generators powered by the main propulsion system, e.g. power take off (PTO):

- section of shaft generators with bearing arrangement and details of lubrication.

6.2 New class notations

New rules will apply to the vessel if the following changes are done:

1) If the size of the vessel is changed from below 500 gross tonnage to above 500 gross tonnage there will be a requirement to installation of emergency power according to the Rules for Classification of Ships Pt.4 Ch.4.
2) Conversion from a **HSLC Passenger A** to a **HSLC Passenger B** vessel, stricter regulations regarding emergency installations will apply according to the Rules for Classification of High Speed, Light Craft and Naval Surface Craft.

6.3 Certification

New electrical equipment is to be certified according to the Rules for Classification of Ships Pt.4 Ch.4.

6.4 Testing

New electrical equipment is to be tested according to the Rules for Classification of Ships Pt.4 Ch.4.

7. Fire Safety

7.1 General

The Rules for Classification of Ships Pt.4 Ch.10 will apply to all ships assigned main class. Note that new Fire and Safety Plans are to be submitted for major conversions in the form of change of ship type. For vessels changing class notation or obtaining additional class notations after the conversion, special requirements will be applicable as referred to in Pt.4 Ch.6 Sec.1 B200 and for vessels with the following additional class notations:

- **OILREC,** see also Pt.5 Ch.7 Sec.12 B200
- **LFL**, see also Pt.5 Ch.7 Sec.11 F100 to F300
- **DSV-I SF,-II SF,-III SF**, see also Pt.6 Ch.1 Sec.4 E100
- **DYNPOS-AUTRO,** see also Pt.6 Ch.7 Sec.1 to Sec.5
- **Drilling Vessel**, see also Pt.5 Ch.7 Sec.6
- **Oil Production and Storage Vessel**, (FPSO), see also Pt.5 Ch.9 Sec.6
- **HELDK-S** and **HELDK-SH** see also Pt.6 Ch.1 Sec.2.

7.2 Documentation requirements

Required drawings are given in Appendix A. See also Rules for Classification of Ships Pt.4 Ch.6 Sec.1 D.

The drawings submitted should show all fire safety details as for newbuildings. Equipment used should be type approved when required by the rules. Special attention should be made to equipment placed onboard an EU and EFTA vessel, where equipment mentioned in the Marine Equipment Directive is required to be CE marked (wheel marking).

MSC/Circ.847 “Interpretations of vague expressions and other vague wording in SOLAS Chapter II-2” will apply.

7.3 Special arrangement

For vessels fitted with an helicopter deck the following should be noted:

All helicopter decks are to comply with the Rules for Classification of Ships Pt.4 Ch.6 Sec.13. When additional class notations **HELDK-S** or **HELDK-SH**, is given, Pt.6 Ch.1 Sec.2 will apply.

For vessels with the class notation **Cable Laying Vessel** spaces containing cables are regarded as cargo spaces, and should be fitted with a fixed fire extinguishing system approved by DNV.

8. Machinery

8.1 Documentation

8.1.1 General

All changes in the machinery systems, or components, which are covered by the scope of class are subject to approval and survey. Installation of new equipment, which becomes under ditto scope, e.g. a side thruster, is subject to approval with respect to equipment design and installation on board and shall be delivered with a certificate.

All changes in the machinery systems are to be specified. This applies to changes to the already existing system, new installations and change or addition of class notations.

8.1.2 Documentation requirements

For changes in the machinery systems and/or components the following documentation shall be submitted:

For changes in the propulsion system:

- updated or new arrangement drawing(s)
- drawings and particulars of all changes in shafting system inclusive propeller and gear, main engine and all relevant piping, control and monitoring systems. Material data and power rating shall be specified
- torsional vibration calculations if the mass-elastic system is effected by changes (e.g. new propeller, new type elastic coupling, new engine type, etc.) and P > 200 kW
- calculation of natural frequencies of resiliently mounted engines
- shaft alignment calculations, axial vibration calculations upon request.

For changes in installed power, or class notations (e.g. new or higher ice class):

- new power rating and/or class notation.

For change and/or installation of generator set:

- updated or new arrangement drawing
- torsional vibration calculations if P > 200 kW
- calculation of natural frequencies of resiliently mounted engines
- relevant piping, control and monitoring system diagrams.

For change and/or installation of thruster:

- arrangement drawings in thruster room and thruster itself
- drawings of connections to the ship's hull
- torsional vibration calculations if P > 200 kW
- engine mounting (fixing to foundation) arrangement (note that resilient mounting of diesel engine requires that vibration calculations are to be submitted)
- piping systems: lubrication oil, hydraulic oil, cooling, fuel, starting air and exhaust (insulation)
- control and monitoring systems.

8.2 Certification

New machinery equipment is to be certified according to the Rules for Classification of Ships Pt.4 Ch.2.

8.3 Testing

Function and load testing of machinery including verification of any running or load restrictions and setting safety valves, etc. is to be carried out. Proper function and performance of the propulsion system after any modification shall be verified at sea trial. Quay test may be accepted for minor changes, provided that function testing can be properly carried out. If the alteration may effect the ship's manoeuvrability, a new sea trial for testing and documenting stopping time and manoeuvrability shall be carried out.

9. Piping Systems

9.1 Documentation

9.1.1 General

All changes in machinery and ship piping systems or components, which are covered by the scope of class, are subject to approval and survey. All changes in machinery and ship piping systems are to be specified. This applies to changes to the already existing system, new installations and change or addition of class notations.

9.1.2 Documentation requirements

For changes in the machinery and ship piping systems and/or components the following documentation shall be submitted:

- updated engine room arrangement (if applicable)
- schematic drawings of piping systems with clear identification of modifications. In case of lengthening, schematic drawings simply showing extension of piping systems need not be submitted for approval, but the modifications are to be reflected in as carried out drawings
- if a new class notation is assigned, document requirements as specified in the rules are to be submitted.

9.2 Application of rules

9.2.1 General

In case of a new class notation being assigned, the latest edition of the relevant rules is to be applied.

The latest edition of the rules is to be applied on the part of the piping system subject to modification. New components in a piping system are to be certified in accordance with the requirements in the latest edition of the rules.

9.3 Testing

For new and modified piping systems the requirements for manufacture, workmanship, inspection and testing as specified in the latest edition of the rules apply.

Appendix A Conversion documentation requirements

	General	Alteration of main dimensions, increased L, B or D	New tank contents, heightened air pipes	New super-structure	Machinery and ship piping systems
Hull and Equipment Drawings Strengthening of existing structures is always to be considered and submitted for approval	– Updated general arrangement – Updated tank plan with air pipe heights – Deck equipment foundations with applicable loads – Bottom equipment foundations with applicable loads – Engine and generator foundations – Propeller nozzles with supports – Hatch covers – Doors in ship sides and ends – Openings and closing appliances – Welding dimensions – Rudder and steering gear	– New profile and deck plans – New midship section with material properties – New shell expansion – Proposal for new equipment number – Proposal for upgraded anchoring equipment – New loading manual or loading conditions – Reinforcement of existing structures	– Air pipe heights – Proposal for strengthening of tank structures	– General arrangement – New deckhouse steel drawings	– New engine room arrangement
Stability and load line	– Updated freeboard plan – Updated record of conditions of assignment	– Stability documentation or copy of such if approved by Authorities – Inclining test procedure and report – Report on measurement for load line – Updated freeboard plan – Updated record of conditions of assignment	– Updated freeboard plan – Updated record of conditions of assignment	– Updated freeboard plan – Updated record of conditions of assignment – Updated or new report on measurements for load line	
Life-saving and fire safety	Life saving: Updated fire and safety plan Fire safety for altered sections: – Fire integrity plan – Structural fire protection – Fire detection and alarm system – Fire extinguishing system – Ventilation system	Life-saving and COLREG: – Updated lifeboat or rescue boat arrangement drawing if changed – Updated navigation lights arrangement drawing if changed – Pilot ladder arrangement if changed		Life saving and COLREG: – Updated lifeboat or rescue boat arrangement drawing if changed – Updated navigation lights arrangement drawing if changed – Pilot ladder arrangement if changed – ILO Crew accommodation arrangement drawings	
Electrical installations and instrumenta-tion	– Updated single line diagram – New load balance – New selectivity analysis – New short circuit calculations – New switchboard drawings – Updated switchboard drawings				
Machinery and piping	Updated drawings for: – Machinery arrangement – Shafting arrangement – Torsional vibration calculations (P > 200 kW) – Chocking calculations – Other calculations (upon request) – Foundation plan for propulsion – Plans and calculations for resiliently mounted engines – Thrusters including driving engine and torsional vibrations calculations if P > 200 kW – Boilers – Pressure vessels – Incinerator – Piping and system diagrams – Engine room arrangement				Schematic piping diagrams with alterations clearly marked. In case of lengthening only, schematic diagrams of extended piping systems need only be submitted through as carried out drawings. Schematic diagrams of bilge, air, sounding and overflow systems are always to be submitted for approval.

Appendix B Conversion particulars - Information for approval fee calculation

Submit this form to the nearest local DNV station or to the DNV Head Office for calculation of approval fee.

Name of vessel:				DNV Id. No.:	
Vessel owner:					
Class notation after conversion: Please underline new notations.					
Shiptype after conversion:				Flag after conversion:	
Conversion yard (if decided):				Start of shop work:	
Yard address:				Delivery date:	
Particulars:	Before	After			Change in internal subdivision:
Length:			Lengthened stern or midship:		
Breadth:			Length of pontoons:		
Depth:			New strength deck?		
Draught:			Freeboard deck changed?		

Other structural additions or alterations	
Number and area of new accommodation decks:	
New weather- or tween decks, area and load (t/m^2):	
Number of berths after conversion:	
Change in internal subdivision:	
New tanks, give number, type and size if known:	
Increased air pipe heights on existing tanks, number of tanks:	
Number of new hatches and ports:	
Number of new work winches:	
New cranes with SWL:	
New stern A-frame, SWL:	
Number of other A-frame or davits:	
Number and type of new thrusters:	
New helicopter deck:	

New systems for propulsion, steering, navigation, etc.	
New or additional main engines (number and effect):	
New or additional generators (number and effect):	
Alterations to main switchboard:	
New rudder(s):	
New nozzle(s):	

New tonnage certificates	
Certificate of Tonnage Measurement 1969	
Suez Canal Special Tonnage Certificate	
Panama Canal Tonnage Certificate	

Short description of conversion:

Please note that our offer will include plan approval only. Certification of materials and components, surveys and travel expenses will be invoiced separately.

Place ..... Date ..... Signature and stamp .....

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