Nordic Boat Standard

Commercial Boats less than 15 metres

1990

Denmark

Finland

Iceland

Norway

Sweden

Secretary

PREAMBLE

Nordic Boat Standard for Commercial Boats has been developed in co-operation between the Maritime Administrations in Denmark, Finland, Iceland, Norway, Sweden and Det norske Veritas, in the following called "the Authorities". The Authorities consider that this Standard contain safety requirements which are equivalent to valid national provisions for commercial vessels which are subject to survey in the Nordic countries.

In order to achieve a rational approval procedure for new commercial boats subject to survey within the Nordic countries, the Standard is based on a Nordic reciprocal acceptance of boats with "Nordic Approval" and that such approval thereby also can be the base for a final national approval and certification for commercial vessels subject to survey in the individual countries.

In respect of areas not covered by the Standard the boats shall be surveyed in accordance with provisions issued by the Maritime Administration in the country where the boat shall be registered.

A National Maritime Administration may, based on accidents and other safety considerations, in exceptional cases, adopt additional requirements in areas covered by the Standard. When such additional requirements are applied in an individual country the Administration concerned shall communicate to the Authorities particulars thereof.

A presumption for a reciprocal acceptance of "Nordic Approvals" is that the Authorities shall have reciprocal right to insight into the documentations, surveys and tests on which approvals are based. This right should, however, normally not mean that the Authorities will request full documentation or undertake detailed surveys and tests in respect of each individual boat in areas covered by the approval.

In case of boats with "Nordic Approval" subject to requirements issued by an Administration the documentation in respect of areas not covered by the Standard shall be submitted to the Administration in accordance with the national requirements of the country concerned. In respect of areas covered by the Standard the following documentation shall be submitted

- Copy of documents for "Nordic Approval"
- General Arrangement drawing.

When the national provisions provide for Operation Certificates, such certificates shall be issued by the Administration in the country concerned. Operation Certificates are required in the Nordic countries for the following boats:

Boat type	Denmark	Finland	Iceland	Norway	Sweden
Passenger boat	Number of passenger >12	All	Loa >6 m	All	Number of passenger >12
Fishing boat	Gross tonnage >5	Loa >8,5 m	Loa >6 m	Loa >10,67 m	Gross tonnage >20
Work boat and tug	Gross >5 m	All	Loa >6 m	-	Gross >20 m

Without request for issue of "Operation Certificates" the Standard .is fully or partly applied as Administration requirements for the following boat types

Iceland - All boats imported to Iceland

Norway - Fishing boats with Loa between 5,5 and 10,67 m

Translation from the original languages by Per Eriksson, former Maritime Safety Director of the National Maritime Administration of Sweden.

INDEX

NORDIC APPROVAL

C 1

Table of contents

1 NORDIC APPROVAL

1.1 For boats being built in accordance with the Standard an approval can be issued upon request when it after control as described in this Chapter is established that the requirements of the Standard are complied with.

1.2 The approval is called "NORDIC APPROVAL", which means that the Nordic co-operating authorities are satisfied that the requirements of the Standard are complied with.

1.3 NORDIC APPROVAL can be issued by the Maritime Administrations in Denmark, Finland, Iceland, Norway, Sweden and by Det norske Veritas.

1.4 The approvals do not include periodical controls after the boat has been put in service.

1.5 Nordic approval procedures are not undertaken in respect of existing boats or boats where the control procedures described in paragraphs 3 and 5 of this chapter are not complied with during the building of the boat.

1.6 For boats which have been put in service and which are provided with a Nordic Approval, the approval will cease to be valid when damages, modifications moralterations have the effect that these Standards no longer are complied with.

2 CONTENT OF THE STANDARD

2.1 The Nordic Boat Standard for Commercial Boats contains joint Nordic Standards for commercial boats with a length less than 15 metres.

2.2 The Standard contains primarily direct requirements related to safety but also requirements related to quality, lifetime, fitness for user, etc when such items are of major importance for safety.

2.3 The same importance is, however, not attached to requirement related to quality, lifetime and fitness for the user when these items are not normally of importance for safety.

2.4 Boats built under other production conditions, using other materials, using other methods, with other design or with other installations than those provided for in the Standard may be approved on condition that the alternativ arrangements are at least as effective as those required by the Standard.

2.5 Additional requirements may be applied when found necessary to achieve that the purpose of the Standard is complied with.

2.6 The Standard does not contain requirements in respect of:

- portable safety equipment;
- portable navigational equipment;
- communication equipment;
- portable fire extinguishers;
- electrical installations above 50 V;
- special restrictions concerning operation which have to be decided nationally;
- tankers and other types of ship for carriage of dangerous goods.

2.7 For requirements which are mandatory the expression "shall" or "must not" are used. When the expressions "shall normally" or "shall normally not" are used the intention of the requirements of the Standard shall be complied with.

2.8 The Standard is based on the following conditions for use of boats:

- that the boat is not loaded with a weight greater than that for which it is approved;
- that the boat is handled in a seamanlike manner in particular with regard to weather and sea conditions;
- that the the use of propulsion power is adapted to the conditions;
- that open boats are used in waters where it is possible to search an emergency port before the weather becomes too bad;
- that operational restrictions are applied so as to avoid ice accretion;
- that operation in ice waters only takes place when the requirements of C33 are complied with, and in that case only in waters with thin ice, or with moderate concentration of drifting ice.

3 APPLICATION FOR NORDIC APPROVAL

3.1 Application for Nordic Approval shall be made by the manufacturer of the boat or by his agent. It shall be in writing.

3.2 The one who applies for Nordic Approval undertakes to make possible the control and to submit the information required by the Standard.

4 DOCUMENTATION

4.1 The documentation which shall be available before approval shall be such that it constitutes basis for a total control of that all requirements of the Standards related to construction, scantlings, arrangement, stability and loading, etc are complied with. The documentation shall be made available as a collective documentation.

4.2 With the exemptions referred to in paragraph 4.3, the manufacturer shall for each boat submit the following drawings and specifications in three copies:

(a) general arrangement drawing;
(b) information on the building workshop;
(c) information on which building and dimension requirements are used (cf. C18 - C20 or C21 - C29);
(d) drawing of the hull arrangement indicating material used, scantlings and stiffening system;
(e) lines drawing and body plan;
(f) hydrostatic data for stability;
(g) loading conditions with calculations for loading capacity, trim and maximum draught;
(h) specification or drawings of machinery and tank installation, bilge pumping arrangement, rudder and steering gear, drainage of decks or soles (floorings), closing arrangements for external doors, hatchways, windows, emergency escapes, wheelhouse arrangement, ventilation and electrical installations;
(i) documentation for lifting gears referred to in C15.

4.3 For boats which are built in series with identical main dimension, construction and hull form it will normally be sufficient that documentation and information in respect of paragraphs (b), (c), (d), (e) and (f) are submitted only for the first boat in the series.

5 SURVEYS AND TESTING

5.1 For boats which are built and given scantlings in accordance with C18 to C20 it shall be arranged for a so rational survey that it normally will be sufficient with a final survey which is mandatory for each boat. Where because of insulation and lack of accessibility, etc it is not possible to carry out a complete examination during the final survey the producer shall apply for additional examination during the building period.

5.2 For boats which are given scantlings in accordance with C21 to C25 or which are built of other material or combination of materials other than those referred to in the Standard, it will - in addition to the final survey - normally be required a more extensive examination, material testing, control of the workmanship and other proceedings during the building which will ensure that the requirements of the Standards in C26 to C29 are complied with.

5.3 Generally the final survey and testing shall be so comprehensive that it together with the documentation satisfies that the requirements and the intentions of the Standard, as appropriate, are complied with.

5.4 A trial trip shall be made when the following shall be controlled:

- steering properties to both sides at low speed and at normal speed;
- going astern;
- steering and course stability at low speed;
- stopping properties;

5.5 The result of survey and tests in accordance with 5.3 and 5.4 shall be recorded in a final report which shall be prepared for each individual boat.

6 APPROVAL DOCUMENTS AND IDENTIFICATION MARKING

6.1 The Authority which has given a "Nordic Approval" in accordance with these Standards shall issue a document which certifies that for each individual boat.

6.2 Each individual boat shall be marked for identification by the manufacturer. The marking shall be permanent and contain the name of the manufacturer or builder and the production number or build number of the boat.

6.3 The form for the document referred to in 6.1 is given below.

NORDIC APPROVAL

I, the undersigned certify that this boat with:

Production number/build number .....
Producer/builder .....
.....

complies with the requirements of the Nordic Boat Standard for commercial boats and is given a Nordic Approval as
.....

The hull is built of .....
.....
and is given dimensions in accordance with C ...

Information on the boat

Description/type .....
Loa ..... m B ..... m D ..... m
Total loading capacity ..... kp2)
Maximum deck load ..... kp2)
Maximum number of passengers .....
Freeboard amidships ..... mm3)

Place ..... Surveyor

Date ....

1) The approval does not cover portable safety equipment, communication equipment, and portable navigational equipment, electrical installations with a voltage higher than 50 and operational restrictions in accordance with national requirements, etc. The approval will be unvalid in case of damages, modifications or alterations which lead to that the requirements in the Nordic Boat Standard no longer are complied with. In such cases no new Nordic Approval will be given.

2) Load includes weight of persons, provision, equipment, tank content, portable safety equipment, etc.

3) The boat must not be loaded in such a way that, because of trim, healing, the speed of the boat at sea, etc in any condition a permanent water accumulation on deck/sole (flooring) takes place.

DEFINITIONS AND SYMBOLS

C 2

Table of contents

1 DEFINITIONS OF BOATS

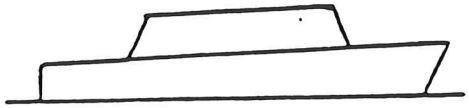
1.1 "Boat" is any craft which is used as a transport means by sea. For the purpose of the Standard the definition of a boat covers also craft which nationally are defined as a ship, vessel, etc.

1.2 "Boat types"

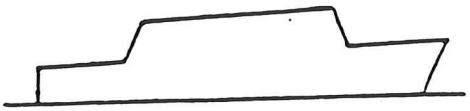
Fishing boat	-	Boat used for commercial fishing
Passenger boat	-	Boat used for conveying passengers
Tug	-	Boat used for towing, see also C32.
Work boat	-	Boat for other professional duties
Commercial boat	-	Joint term for all commercial boats

1.3 Closed boat

A boat which is intended for use in unsheltered waters and which can be **decked** or **covered**. **"Covered boat"** means a boat where the superstructure is weathertight closed in accordance with the Standard and given strength for shipping seawater.



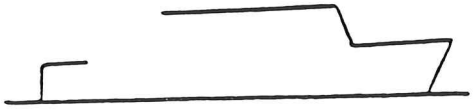
Decked boat



Covered boat

1.4 Open boat

A boat which is intended for use in sheltered waters. It can be **partly covered** or **open**. Partly covered boat means also a boat which is totally covered but where the superstructure is not weathertight.



Partly covered boat

Open boat

2 MAIN DIMENSIONS

2.1 As a principle for measuring the main dimensions all rigid permanent parts of the hull construction including fender lists shall be included. On the other hand, parts which can be disassembled, e.g. hung-on rudders, loose fenders, details which can be dismantled or exchanged, cleats, rails, keels, etc shall not be included.

Loa Length overall in metres including fender lists and rigid permanent parts of the hull construction excluding any hung-on rudder.

Bmax Breadth overall in metres including fender lists.

B Greatest breadth of the hull measured outside the laminate. Fender lists, overhanging covering board, chain plates, etc are not included in the breadth.

D Depth in metres amidships measured from top edge of gunwale or deckline to lower edge of the hull on or at the side of a pronounced keel, at Loa/2.

d Greatest draught in metres including keel.

F Freeboard amidships.

3 MEASURING OF FREEBOARD

3.1 For closed boats the freeboard is measured to the upper side of the deck at side excluding any bulwark. Except in case of passenger boats and tugs, the permitted freeboard shall be marked amidships at both sides of the boat with a contrast-coloured load line mark which shall have a length of about 250 mm and a width of 20 mm.

3.2 For open boats the freeboard is measured to the point where water can penetrate into the boat. The freeboard shall, however, not be limited by openings with a diameter of less than 20 mm where these are located at least 0,5 F above the deepest waterline or provided with a non-return valve. Load line marks are not required for open boats.

3.3 The permitted freeboard amidships shall be recorded in the approval document.

4 LOADING CAPACITY

4.1 The maximum load of a boat (P) includes the weight the boat can carry in addition to its lightweight having regard to its minimum freeboard, strength and stability according to the Standard. The maximum load includes the following weights:

- the weight of the maximum number of persons permitted at 75 kg each;
- the weight of personal belongings which as an average can be taken as 30 kg per person;
- the weight of the maximum content of the tanks;
- the weight of tools, provision, portable safety equipment and any other portable equipment and fittings; and
- the payload

4.2 For closed boats the maximum load shall be established hydrostatically taking into account the trim with cargo in the holds and deckload which is considered evenly distributed over those areas/decks where it is possible to place cargo.

4.3 For open boats the maximum load shall be established in connection with control and, when carried out, calculations of the stability, trim and freeboard in accordance with C3. The trim with cargo evenly distributed over the areas in the boat where cargo can be placed shall be taken into acount.

4.4 The maximum load of the boat and the deckload shall be recorded in the approval document.

5 LIGHTWEIGHT AND DISPLACEMENT

5.1 The lightweight of the boat (G) in kg shall include:

- the weight of the ready-made boat with accommodation and equipment which are permanent parts of the boat;
- the weight of machinery, winches and other permanent systems including the weight of hydraulic and lubricating oil, cooling water and other system liquids;
- anchors and mooring equipment.

5.2 The lightweight of the boat is established through hydrostatics or weighing.

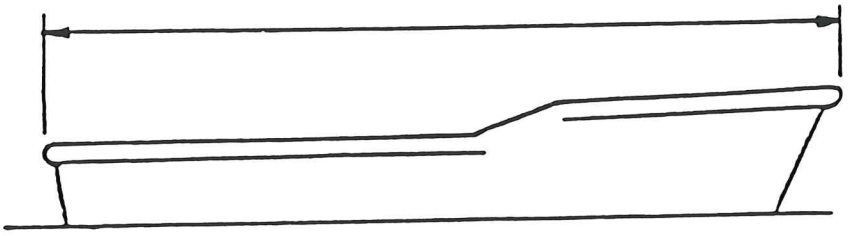
5.3 The displacement fully loaded is

$$\Delta = P + G$$

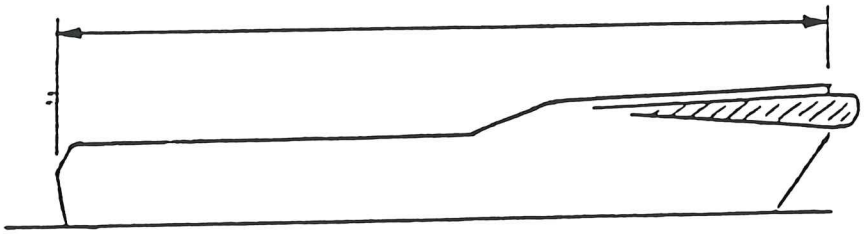
6 SKETCHES SHOWING HOW TO MEASURE THE MAIN DIMENSIONS AND FREEBOARD

6.1 The measuring of length overall is shown in the sketches below.

Loa



Loa



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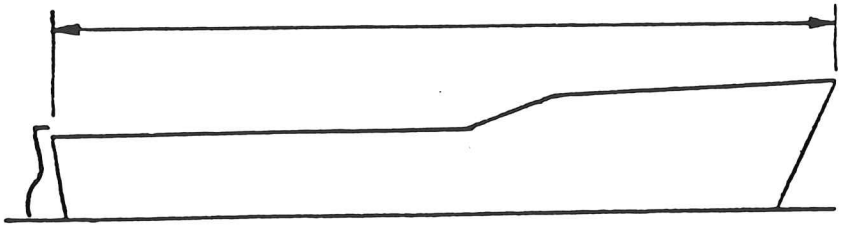
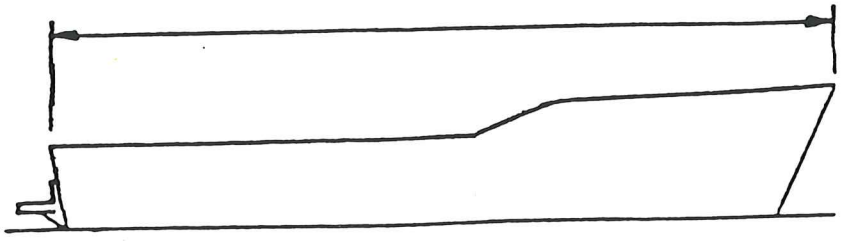
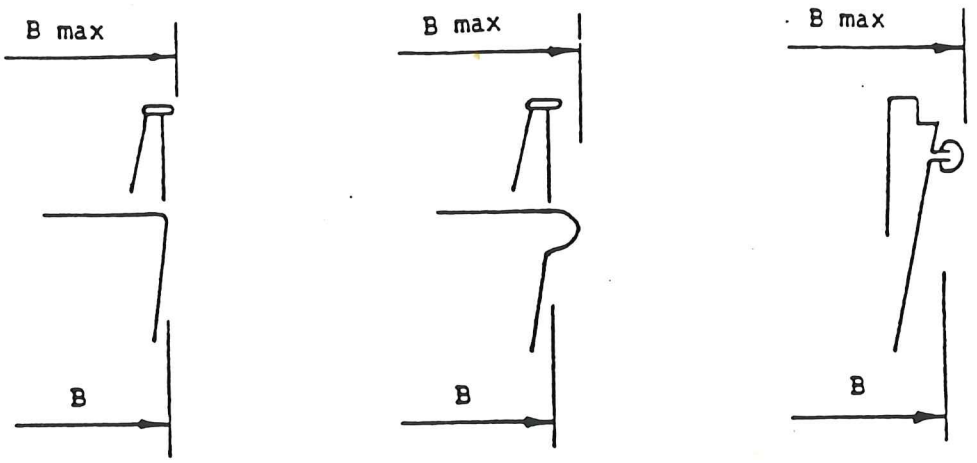


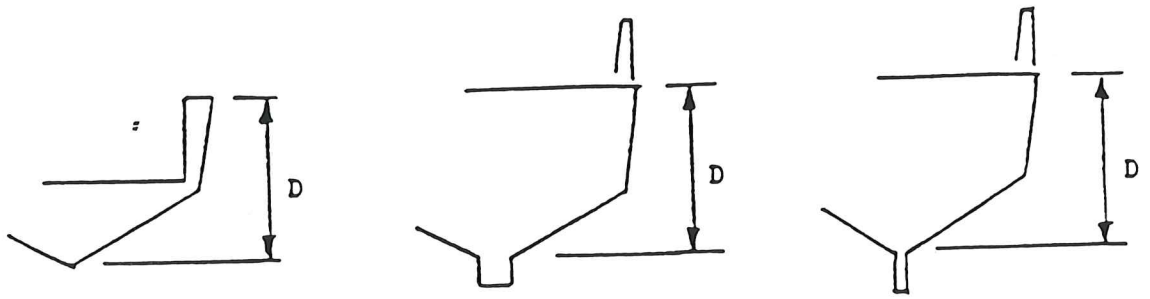
Loa



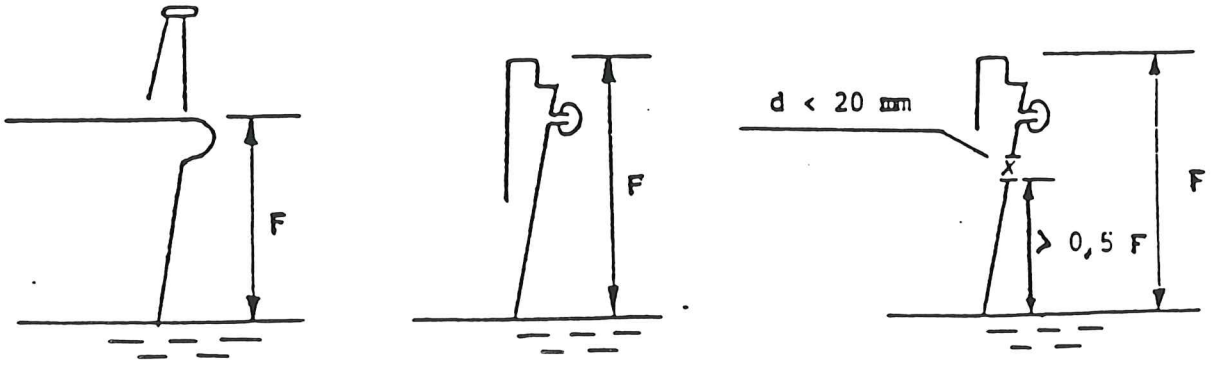
6.2 The measuring of breadths is shown in the sketches below.



6.3 The measuring of the depth (D) is shown in the sketches below.

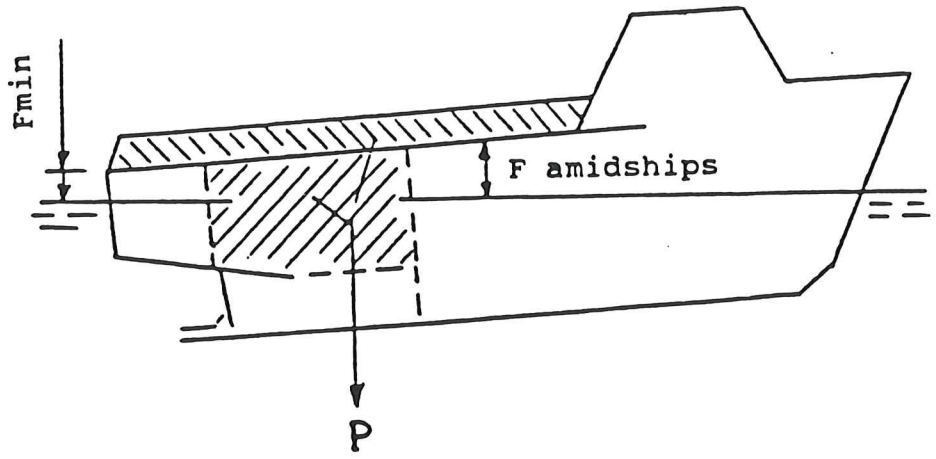


6.4 The measuring of the freeboard is shown in the sketches below.

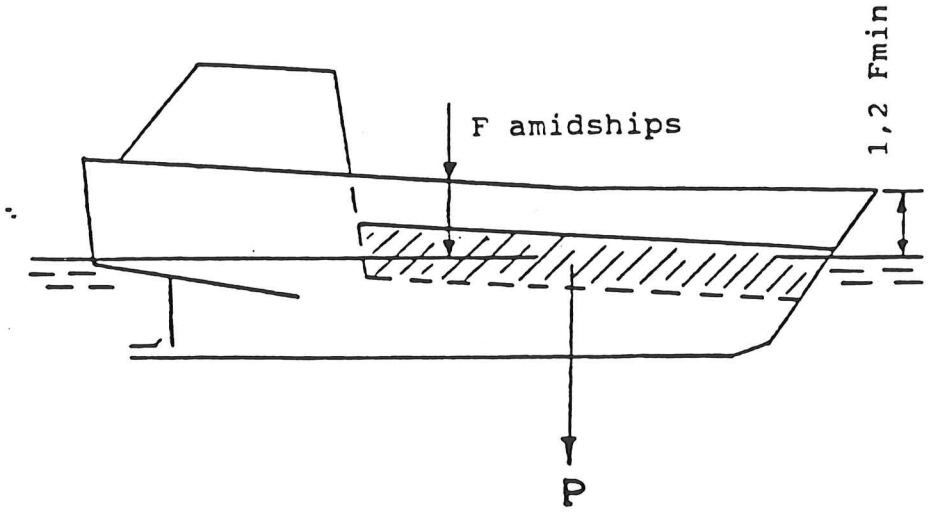


Closed boat Open boat Open boat

6.5 Example of influence of the location of the cargo and the trim on the calculation of the freeboard amidships compared to the minimum freeboard in accordance with C3.



closed boat



open boat

7. SYMBOLS AND UNITS

7.1 Symbols

Symbol	Unit	Eqivalence
A	m2	area
A	A	ampere
a	cm2	area
B	m	breadth
b	cm	-"
C	m3/	volume
c	c	centi
D	m	depth
d	m	draught
d	mm	diameter
E	N/mm2	modulus of elasticity
F	m	freeboard
G	kg	lightweight displacement
H	m	height
h	m	-"
I	cm4	moment of inertia
J	J, Nm	joule
K	N, kp	force
k	k	correction factor
k	k	kilo
L	m	length
Loa	m	length overall
l	mm	length of span
M	Nm	moment
m	m	meter
m	m	milli
N	N	Newton
n	number	number, number of persons
o	degrees	degrees Celcius
P	Kp, N	force, weight, load
p	N/mm2	pressure
p	kW	motor effect (engine power)
Q	m3/min	capacity
R	cm	radius
r	revolution/sec	revolution
S	cm, mm	moment arm
s	mm	frame/stiffener spacing
t	mm	thickness
V	knots	speed
v	kg/m3	density
W,Z	cm3	section modulus
W	W	Watt
	degree	angle degree
	-"-	-"
	N/mm2	mechanical stress
	kg	displacement

7.2 Units

BASIC SI UNITS:

Quantity		Name
Length	m	metre
	cm	centimetre
	mm	millimetre
Mass	kg	kilogram
	t	tons
Time	s	second
Electrical current	A	ampere

DERIVED SI UNITS:

Quantity		Name/definition
Frequency	Hz	hertz = /s
Force	N	newton = kg * m/s2
	kN	kilonewton
Pressure	kN/m2	= kPa, kilopascal
	bar	= 105 Pa
Bending moment	N * m	newton-metres
Torsional moment	kN * m	kilonewton-metres
Work, energy	J	joule = Nm
Heat	kJ	kilojoule
Power	kW	kilowatt
Temperature	oC	degrees Celsius

SI/TS CONVERTION RELATION

SI-unit	TS-convertion relation	Other
1 N	0,1020 kp	
1 kN/m2 1kPa, 0,01 bar	0,0102 kp/cm2	0,1 m H2O
1 N/mm2, 1 MPa, 10 bar	10,20 kp/cm2	100 m H2O
1 N.m, 1 J	0,1020 kp.m	
1 kJ	0,2388 kcal	
1 kW	1,36 Hp	
1 W	0,860 kcal/h	

FREEBOARD AND STABILITY

C 3

Table of contents

1 FREEBOARD FOR CLOSED BOATS

1.1 The freeboard amidships is decided having regard to stability, trim and hull strength, etc, but shall not in any case and condition be less than 200 mm measured from the upper side of the deck at side to the waterline.

1.2 The forecastle deck or the freeboard deck forward shall in any load condition have a height above the waterline of at least 17 * Loa + 700 mm. The height of forecastle/freeboard deck forward may be reduced to the minimum freeboard gradually over a length of 0,3 Loa from the stem.

2 FREEBOARD FOR OPEN BOATS

2.1 The freeboard is decided having regard to stability, trim and hull strength, etc, but shall amidships not be less than the greater of:

(a) $F = 3{,}2 * \Delta / (1000 * Loa * B)$ m

(b) $F = 0{,}5$ m

2.2 Forward the freeboard shall not be less than 1,2 F. Aft the freeboard shall not be less than 0,8 F.

3 STABILITY FOR CLOSED BOATS

3.1 Inclination tests shall be carried out with each individual boat. The tests shall be carried out with a ready-made boat with all permanent equipment installed. Particulars of the inclination tests shall be recorded in a report form and lightweight and location of centre of gravity shall be calculated.

3.2 When boats are built in series with identical main dimensions, construction, hull form, weight and location of permanent equipment, the requirement may be dispensed with provided that it by calculation or weighing can be established that the lightweight of the boat is the same as that calculated at the inclination test of a previous boat. An inclination test shall always be carried out with the two first boats in a series.

3.3 The righting arm (GZ) with free trim shall be calculated for the following conditions:

(a) Lightweight condition with the minimum amount of fuel, water, equipment and persons on board. The total weights other than the lightweight (G) shall not be greater than 10 per cent of the maximum load of the boat (P);

(b) Loaded condition with maximum cargo in the hold, fuel tanks and other tanks totally full and maximum deck load. The total weight of cargo, equipment, persons, fuel and water must not be less than the total loading capacity (P);

(c) Arrival condition with 10 per cent content in fuel and other tanks, empty holds and maximum deck load;

(d) Other conditions which will give a less favourable result than (a), (b) and (c).

The centre of gravity in each of the conditions referred to in (a) to (d) shall be calculated as follows:

- For cargo holds including volumes in hatchway coamings, fuel tanks and other tanks the volumetric centre of gravity is calculated;
- For deckload except passengers and heavy items with a relatively high centre of gravity, the centre of gravity is calculated with an evenly distributed deckload with a density of 1,0 tons/m^3, however, not less

than 0,10 m above deck;
- Passengers are calculated as evenly distributed deckload with the centre of gravity 1,0 m above deck/flooring;
- For boats intended for the carriage of deckload in the form of heavy items such as vehicles with a relatively high centre of gravity the most relevant centre of gravity shall be assumed having regard to type of cargo in question.

3.4 Closed boats shall in all conditions have:

- a righting arm at 30 degrees heeling of at least GZ30 = 0,20 m;
- the greatest value of the GZ curve shall be at an angle of heel greater than 25 degrees;
- the GZ curve shall be positive up to heeling angle of 40 degrees; and
- the GZ curve shall be terminated at the heeling angle where a filling opening will come below water.

3.5 Openings which are not provided with weathertight closing arrangements shall be considered as filling openings where water will flood the boat when such an opening is submerged.

3.6 For the calculation of GZ curves, small penetration openings for wires, chains, etc in deckhouses or superstructures may be considered as tight. Small openings with a diameter of less than 20 mm which are located more than 380 mm above the freeboard deck need not be considered as filling openings when they will come into the water at a heeling angle of more than 30 degrees.

3.7 For boats with lifting gears, such gear shall not in the most unfavourable condition give a heeling of more than 10 degrees in the lightweight condition.

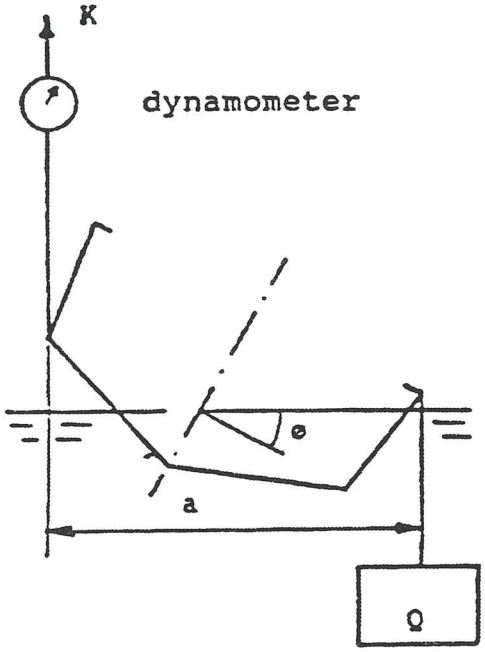
3.8 Special additional requirements apply to the stability for fishing boats, passenger boats and tugs, see C30 to C32.

4. STABILITY FOR OPEN BOATS

4.1 Normally an inclination test shall be carried out to establish the metacentric height (GM) for the boat in lightweight condition. The metacentric height shall normally not be less than, GM = 0,35 m.

4.2 The weight displacement of the boat shall be established through weighing or by a hydrostatic calculation.

4.3 A metacentric height less than that required in 4.1 may be accepted only if a calculation shows that the GZ curve for the boat in the lightweight condition satisfies the requirements for closed boats up to a heeling angle of 30 degrees. As an alternative to calculations the GZ30 = 0,20 m in the lightweight condition may be established through the following method where GZ15 and GZ25 shall indicate a natural form of the GZ curve.



Requirements:

GZ30 = 0,20 m

$Q = \Delta * 0{,}20 / a$

where
a is measured with $\phi = 30°$
Q is measured with the weight submerged

15°	25°	30°
K= kp	K= kp	K= kp

Requirement for K at $\phi = 30°$: K > O

In order to avoid lift of the boat during the measuring, the dynamometer and the weight shall be placed longitudinally so that the trim of the boat will not change during the test.

4.4 Where the height of the sole (flooring) and other areas for cargo is such that the cargo mainly will be located above the waterline in fully loaded condition, a stability test with a load (weights) which is half the loading capacity of the boat (0,5 P) placed on one side of the centreline at 0,25 B at the cargo area shall be carried out. This must not result in:

- a heeling angle greater than 15 degrees;
- a freeboard of less than 200 mm at the place where water first will flood the boat.

Such a stability test is not required for passenger boats.

5 BALLAST

5.1 Ballast shall be secured in the boat in such a way that it will not move even if the boat is inclined to 90 degrees.

DOORS, HATCHWAYS AND WINDOWS

C 4

Table of contents

1 WEATHERTIGHT HATCHWAYS ON CLOSED BOATS

1.1 Coamings of hatchways on exposed freeboard decks shall have a height above the deck of at least 380 mm. Similar hatchways on first deck above freeboard deck shall have a coaming height of at least 300 mm.

1.2 Coaming heights as for hatchways in paragraph 1.1 may never the less be reduced to 230 mm and 150 mm as the case may be, on condition that minimum freeboards are increased accordingly.

1.3 Hatchways which may be opened at sea shall be hinged or attached with chains and be capable of being secured when open.

1.4 Coamings of small hatchways (companionway hatchways, etc) which are not normally opened when the boat is at sea may be minimum 230 mm on the freeboard deck and 100 mm on the first deck above freeboard deck.

1.5 Heights of hatchway coamings may further be reduced or omitted for

- machinery space hatchways which are used only in connection with maintenance and repair of machinery and other hatchways which similarly are not necessary for the normal operation of the boat;
- small hatchways with an area of not more than 0,1 m^2.

This applies on condition that the covers have gaskets and securing means with small spacing and which cannot be opened without special measures.

1.6 In order to ensure that the hatchways are weathertight it is required that

- the hatchway covers are fitted so that they are not pressed out;
- battening down devices are fitted at distances of not more than 600 mm.

2 DOORS ON CLOSED BOATS

2.1 Openings which from an exposed freeboard deck lead to a space below deck or a superstructure which is part of the boyancy of the boat for stability shall have doors which cannot be opened inwards. The door shall be stiffened and constructed in such a way that the whole construction is of equal strength as the bulkhead otherwise. Devices for weatertight closing of such doors shall be gaskets and at least two securing devices in addition to the hinges.

2.2 Doors shall be capable of being opened and closed from both sides of the bulkhead.

2.3 The sill height of such doors on the freeboard deck shall be at least 380 mm. Similar doors on the first deck above freeboard deck shall have a sill height of at least 300 mm.

2.4 The sill heights as for doors in paragraph 2.3 may nevertheless be reduced to 230 mm and 150 mm as the case may be, on condition that minimum freeboards are increased accordingly.

3 HATCHWAYS AND DOORS ON OPEN BOATS

3.1 Hatchways to machinery spaces and hatchways and doors to covered accommodation spaces shall be provided with closing devices.

4 WINDOWS

4.1 Windows shall be given pane thickness as indicated in the following table which applies to panes of tempered glass, carbonate glass, acrylic glass and laminated glass.

Thickness in mm required for panes with height (h) and breadth (b) in mm:

h	200			300			400			500			600			700		
col	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1
b																		
200	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5
300	4	5	5	4	5	5	4	5	6	4	5	6	4	5	6	4	5	6
400	4	5	5	4	5	6	4	5	6	4	6	6	4	6	8	5	6	8
500	4	5	5	4	5	6	4	6	6	4	6	8	5	6	10	5	8	10
600	4	5	5	4	5	6	4	6	8	5	6	10	5	8	10	5	8	10
700	4	5	6	4	6	8	5	6	8	5	8	10	5	8	10	5	8	10
800	4	5	-	4	6	-	5	6	-	5	8	-	5	8	-	6	10	-
900	4	5	-	4	6	-	5	6	-	5	8	-	6	10	-	6	10	-
1000	4	5	-	5	6	-	5	8	-	5	8	-	6	10	-	6	10	-
1100	4	5	-	5	6	-	5	8	-	6	10	-	6	10	-	6	12	-
1200	4	5	-	5	6	-	5	8	-	6	10	-	6	10	-	6	12	-
1300	4	5	-	5	6	-	6	8	-	6	10	-	6	12	-	6	12	-
1400	4	5	-	5	6	-	6	8	-	6	10	-	6	12	-	6	12	-

4.2 The application of column 1, 2 or 3 depends on window location and closed/open boat as follows.

Column 1

(a) Windows from 0,5 m to a height of

$$3{,}2 * \Delta / (1000 * Loa * B)$$

above the load waterline. In displacement boats the windows/port holes in this location shall be provided with hinged deadlights.

(b) Horizontal hatchways/windows which can be exposed to local loads in deck or super structure tops on closed boats and which are located higher than

$$3{,}2 * \Delta / (1000 * Loa * B)$$

above the load waterline. Such hatchways/ windows with lower location shall be considered separately.

Column 2

(a) Windows in a superstructure, wheelhouse, etc on closed boats where the window location is higher than

$$3{,}2 * \Delta / (1000 * Loa * B)$$

Column 3

(a) Windows in superstructures on open boats (partly covered boats) where the window location above the load waterline is higher than F for the boat.

(b) Windows in the second superstructure on closed boats, except in the front bulkhead of the wheelhouse, in which case column 2 shall be applied.

4.3 Windows in the hull side shall never be placed lower than 500 mm above the load waterline and shall be placed at least 10 mm inside the hull side. A window frame which is arranged outside the glass must not project more than 5 mm outside the hull side.

4.4 Coloured glass or window of a material which is susceptible to scratching must not be used in the front of and at the sides of the operator's place.

4.5 Windows shall be satisfactorily fastened taking into account particularly the risk for being pressed in. When the risk for that the glass is pressed out of the frame because of the size of the window, the bending properties of the glass, the location of the window near the waterline, etc, special measures shall be taken to prevent the pressing in of the glass by increasing the contact surface between glass and frame or by fixing the glass to the frame.

4.6 Windows in spaces which shall be included in the buoyancy for stability shall be fastened in a fixed frame which is mechanically attached.

4.7 Where rubber profiles are used the glass shall be mounted in a way that is safe in respect of pressing in and the thickness of the glass in column 1 and 2 shall be increased with 20 percent. If glass other than tempered glass is used the thickness shall be adapted to the stiffness and strength of the material.

4.8 If windows with greater length or breadth than those in the table are used, equivalent strength and stiffness shall be demonstrated.

5 PORTS IN THE HULL

5.1 Ports in the hull constituting the freeboard on open boats shall be so constructed that they are watertight. Ports and coamings shall have at least the same strength as the hull otherwise. Ports at sides, stem and stern on closed boats must not be fitted below the freeboard deck.

5.2 The lowest point of a port opening on open boats must not be lower than 200 mm above the load waterline.

5.3 For ports with the lowest point of the opening lower than 500 mm above the load waterline solid gaskets and battening down devices with a distance of not more than 300 mm are required. Ports located higher than 500 mm above the load water line shall be so arranged that significant amounts of water will not penetrate into the boat and shall be fitted with satisfactory closing arrangement.

5.4 Ports which can be folded down shall be fitted with stopping arrangements in the lowest position.

FREEING PORTS AND HULL PENETRATIONS

C 5

Table of contents

1 DRAINAGE OF DECKS ON CLOSED BOATS

1.1 Freeing ports shall be distributed along the deck in such a way that the locations are concentrated to the areas where the collection of water on deck will be the greatest having regard to sheer, probable trim, etc.

1.2 On boats where the bulwark, end bulkheads of closed superstructures, deckhouses, etc constitute wells, the minimum effective freeing port area at each side of the boat shall be:

$$A = 0,02 * V \quad m^2$$

where V is the volume of well in cubic metres.

1.3 The volume of the well is calculated as deckarea times bulwark height minus volume of hatchways, deckhouses, etc up to the bulwark height.

1.4 Flaps or external rubber claps in freeing ports, if fitted, shall be fastened with hinges at the upper edge. Such devices shall have sufficient clearance to prevent jamming. The hinges shall be made of non-corroding material. Arrangements for locking of freeing port flaps are not permitted.

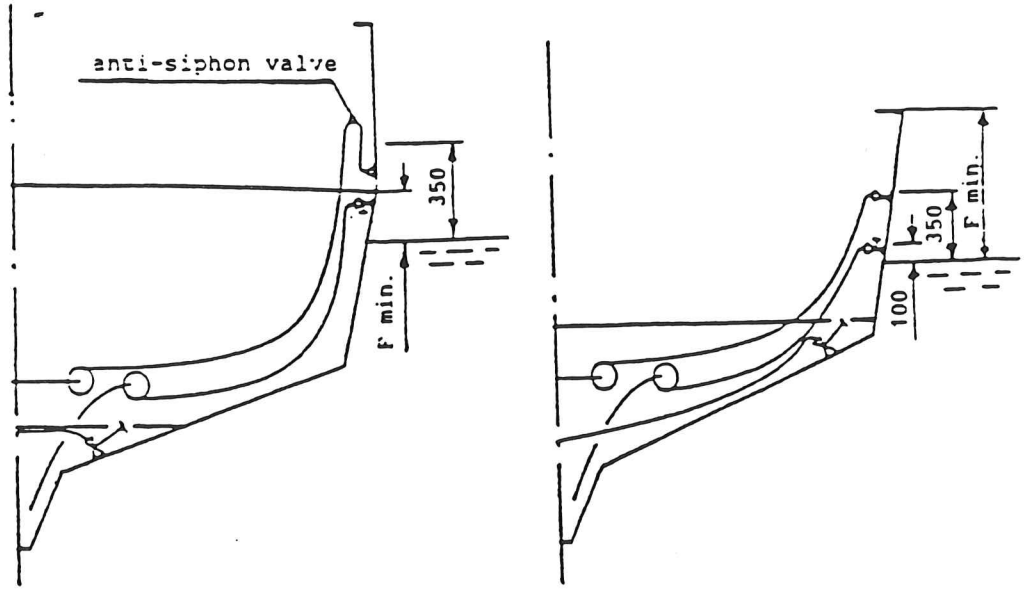
1.5 Large freeing ports shall be fitted with bars, spaced with a maximum distance of 330 mm apart, the distance below the lowest bar shall, however, not be greater than 230 mm.

2 HULL PENETRATIONS

2.1 Hull penetrations with the opening less than 100 mm above the load waterline or below the sole (flooring) on open boats shall be provided with a closing arrangement.

2.2 Valves on hull penetrations shall be suitable for use in boats and be installed in such a way that they are easily accessible under all conditions, i.e. valves must not be placed in cargo holds or below the flooring if the manoeuvring device is not extended to above the flooring. Valves with screw-on covers shall be constructed in such a way that the cover cannot loosen when the valve is being opened or closed.

2.3 Openings in the hull above the waterline at the lightweight of the boat (G) and less than 350 mm above the load waterline as well as hose systems with an inside open end shall have a non-return valve which prevents water penetration if the entire system is lower than 350 mm above the load waterline.



2.4 Pipe systems connected to a hull penetration shall be so arranged that water will not enter the boat if valves are open.

2.5 Pipe systems connected to a hull penetration located lower than 350 mm above the load water line shall have double hose clamps in both ends. the pipe system is carried above the 350 mm, double hose clamps are required only at the hull penetration.

3 VENTILATION OPENINGS

3.1 On closed boats the ventilation openings shall have a height of at least 450 mm above deck and shall be, such that they because of their arrangement and location will not cause water filling of the boat in breaking seas. Height and location of vents shall be such that the ventilation openings will not come below water at a heeling of up to 30 degrees on open boats and 40 degrees on closed boats.

4 AIR PIPES

4.1 Air pipes shall have a height to the upper edge of the bulwark, however, at least 450 mm above the deck and shall be so located that they are protected against damages in connection with work on deck.

4.2 The air pipes shall be so arranged, e.g. with a non-return valve or a goose-neck, that a sea shipped will not penetrate into a tank, battery room, etc.

4.3 The air pipes to fuel tanks shall terminate outside the boat on open boats and above deck on covered boats.

WATERTIGHT SUBDIVISION AND BILGE PUMPING

C 6

Table of contents

1 WATERTIGHT SUBDIVISION

1.1 Engine compartments, cargo holds and accommodation spaces in closed boats shall from bottom to deck be subdivided by watertight bulkheads. In open boats the machinery space shall have a watertight bulkhead up to the waterline in loaded condition.

1.2 Hatchways and door openings in watertight bulk heads shall be provided with closing arrangements and have the same strength as the bulkhead where they are arranged.

1.3 Where pipes and electrical wires are carried through a watertight subdivision bulkhead, the penetration arrangements shall be made to ensure the watertight integrity of the bulkheads.

2 COLLECTION OF OIL SPILLS

2.1 The bottom space in the engine compartment shall preferably be capable of being drained with the aid of a fixed bilge pumping system to a bilge water tank. The system must not have connection to the bilge system otherwise or a connection for discharge into the sea.

2.2 The bilge water tank shall be a permanently installed tank. Alternatively several portable tanks with a capacity of not more than 25 litres each may be used. Such tanks shall be suitable for taking ashore.

2.3 A permanently installed bilge water tank shall have air pipes to the open deck. The content of the tank shall be capable of being discharged to a reception facility ashore via a connection on deck.

3 MAIN BILGE SYSTEM

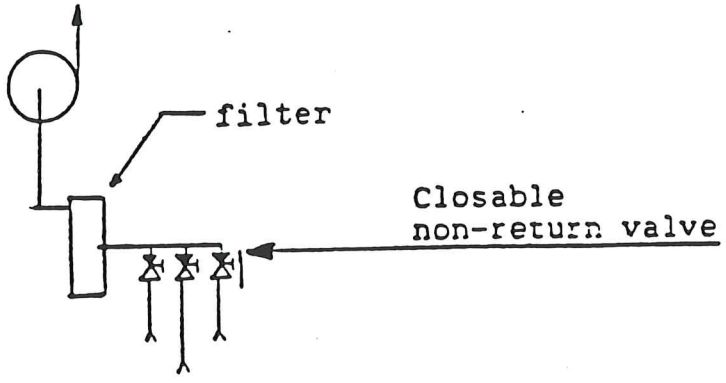
3.1 The main bilge system shall be capable of pumping from and draining of all watertight compartments. Watertight compartments of limited size may be drained to an adjacent space. The drainage hole shall in such cases be tightened with a firmly fitted plug.

3.2 A fixed motor driven or electrically driven bilge pump shall be installed which via a fixed piping system with a non-return-valve mounted to each suction pipeline is capable of draining all watertight compartments. Alternatively each compartment can be drained with a separate pump. Each pump shall be capable of being operated from the steering place.

3.3 Each pump shall have at least the following capacity:

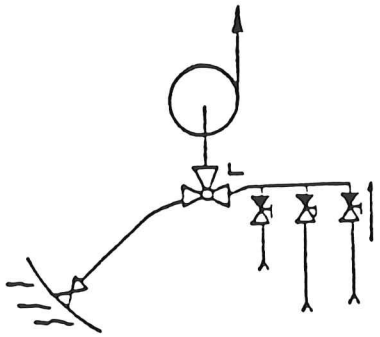
Loa	Litres per minute
5,50 - 8,00	60
8,00 - 9,99	80
10,00 - 11,99	120
12,00 -	180

3.4 The arrangement of the bilge pumping system shall be such that water cannot flow from one watertight compartment to another via the bilge pumping system.



3.5 If the bilge pumping system is arranged with electrically driven pumps, the pumps must not be connected to the starting accumulator of the motor. If the bilge pump is located in the cargo hold, it shall be easily accessible for cleaning under all conditions or alternatively a stand-by pump shall be available in the cargo hold.

3.6 The bilge pumping system shall normally not be used for any other purpose than draining. A sea chest may, however, be connected to the bilge pumping system provided that the boat is fitted with at least two power driven pumps. The pipelines shall be connected in such a way that sea water cannot flow into the boat via the bilge pumping system. A system as the one shown in the sketch below can be accepted.



3.7 The parts of the system must not be combined in such a way that galvanic corrosion can arise.

4 EMERGENCY BILGE PUMPING SYSTEM

4.1 It shall be possible to drain engine rooms by a fixed permanent bilge pump fitted outside the room.

4.2 The capacity of the pump shall normally not be less than that shown in the table below.

Loa	Litres per stroke cycle	
	diaphragm pump	piston pump
5,50 - 8,00	0,5	0,7
8,00 - 10,00	0,7	1,0
10,00 -	0,9	1,25

4.3 If the boat has two engines installed, or an auxilliary engine is installed, the manual pump may be substituted by a pump direct or indirectly driven by the auxilliary engine or driven by the other than the main engine mentioned in 3.2.

5 WATER LEVEL ALARM

Closed boats shall be fitted with an alarm for a high water level in the motor room.

6 DRAINAGE PIPES AND HOSES

6.1 The bilge water pumping system in the motor room shall be of non-combustible material or flexible hoses which shall be approved in accordance with section MC11.

6.2 Bilge piping systems are to be properly installed in the entire length.

RUDDER AND STEERING ARRANGEMENTS

C 7

Table of contents

1 INSTALLATION

1.1 The steering gear shall ensure a steady and safe manoeuvring of the boat at the maximum engine power for which the boat is certified. The steering devices and wheel, if fitted, shall comply with chapters MC12 and MC14. The steering devices shall be protected so that they do not come in contact with cargo or the like which can block or make difficult the steering.

1.2 Rudder stops are required in case of remote control of the steering.

1.3 Boats approved for outboard motors with a higher power than 15 kW shall be fitted with a permanent wheel steering.

1.4 A steering console or similar arrangement in the steering system shall be built, stiffened and secured in such a way that it can absorb the forces to which it will be exposed taking into account also the forces the operator of the boat will transfer to the wheel at heeling and other movements of the boat. At specially exposed places be bolt connections shall be made of stainless steel. All bolt connections which are part of the steering system installation in the boat shall be locked.

1.5 All penetrations in a motor well such as holes for a steering cable shall be effectively sealed by means of a sleeve or similar device.

1.6 Hydraulic hoses and pipes shall be protected from contact with hot parts and from mechanical wear and be clamped at intervals of 300 mm. The oil fill opening and air bleeders shall be easily accessible.

1.7 Emergency steering shall be possible on all rudderstocks in case of remotely controlled steering. Emergency steering below deck may be accepted provided that communmication to the open deck is arranged.

Emergency steering is not required in boats with two propéllers provided that it from the results of the manoeuvring tests is evident that the boat can be steered safely with the propellers.

Emergency steering is not required in boats where two independent steering systems are installed and where a hydraulic system does not contain flexible hoses.

2 FORCES ACTING UPON STEERING SYSTEMS

2.1 Unless otherwise stated, the following symbols shall be used:

- K steering force in Newton;
- P rudder force in N ; $P = 110 * A * V^2$
- A rudder area in m^2
- V the maximum speed of the boat in knots
- Sa length in mm of the steering arm
- Sb distance in mm from the centre of pressure (Tc) to the nearest rudder shaft bearing above the rudder
- Sv perpendicular distance in mm from the centre of pressure to the centre of rotation of the rudder. Plate rudders have the centre of pressure at a point situated 40 per cent aft of the leading edge of the rudder
- U maximum motor power in kW
- M moment in N mm
- d_v diameter in mm of massive rudderstock
- $\sigma_{0.2}$ yield stress in N/mm^2.

2.2 The steering force in boats with outboard motors or I/O drives is:

$$K = 10 * U \quad N$$

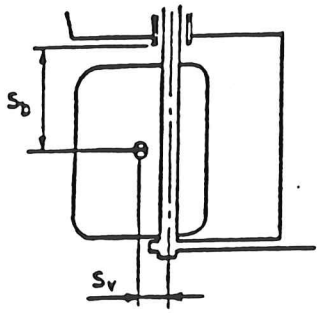
2.3 The steering force in boats with rudder is:

$$K = P * Sv/Sa \quad N$$

3 RUDDER STOCKS

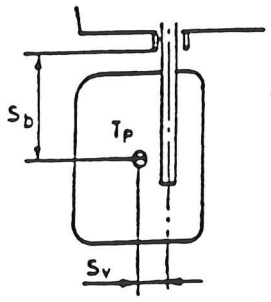
3.1 If the rudder has a lower bearing point (heel pintle) with at least the same stiffness sidewise as the rudderstock, the moment is calculated as follows:

$$M = 1{,}15\ (0{,}25*P*Sb + 0{,}5*P\ \sqrt{Sb + 2*Sv^2}\ )$$



3.2 A rudder stock of a spade-rudder shall be considered to have a combined torque and bending moment of:

$$M = 1{,}15\ (0{,}5*P*Sb + 0{,}5*P\ \sqrt{Sb^2 + 2*Sv^2}\ )$$



3.3 The diameter of the rudder stock must not be less than:

$$d_v = 2{,}2\ \sqrt[3]{M/\sigma_{0,2}} \quad \text{mm}$$

3.4 Tubular rudder stocks shall have dimensions in accordance with the following formula:

$$d_v = \sqrt[3]{(d_1 4 - d_2 4)/d_1} \quad \text{mm}$$

where

d_v diameter of solid rudderstock in mm
d_1 external tube diameter in mm
d_2 internal tube diameter in mm

3.5 The bearings of the rudder stock and their fastenings shall be dimensioned for the rudder force (P). The length of the bearings shall be at least d_v. The pintle shall have a diameter of at least $d = 5 + 0,6*d_v$ mm. For spade-rudders an upper bearing point shall normally be arranged at a distance of at least (Sb) above the lower bearing.

3.6 The diameter of the bolts in a rudder coupling must not be less than

$$d_b = 0,65 * d_v / \sqrt{n} \quad \text{mm}$$

where

d_b bolt diameter in mm
n number of bolts, not less than four.

The pitch circle radius for the coupling bolts must not be less than the diameter of the rudder stock. The thickness of the coupling flange and the width of the flange outside the bolt holes must not be less than d_b.

3.7 The top packing box of the rudder stock housing shall have a height of at least 350 mm above the load waterline and be provided with a sealing. Where this is not practially possible a grease filled packing box shall be arranged.

4 RUDDERS

4.1 Rudders of steel, aluminium, and glass fibre reinforced polyester shall have an all through rudder stock from the rudder coupling down to the pintle. The diameter of the rudder stock must not be less than the diameter of the pintle in accordance with 3.5. In case of spade-rudders the diameter may, however, be reduced linearily down from the rudder-coupling.

4.2 Rudders of steel and aluminium constructed as plate rudders or profile rudders shall have at least two reinforcements across the rudder stock with a distance of maximum 600 mm. The thickness of the reinforcements must not be less than the thickness of the plate in the profile rudder according to 4.4.

4.3 Plate-rudders shall have a thickness of at least

$$t_e = 3 + 0,125 * d_v \quad \text{mm}$$

4.4 The plating in a profile rudder shall have a thickness of at least

$$t_d = k * t_e \quad mm$$

where

k = 0,46 for steel or aluminium
k 0,33 for stainless steel
t_e thickness of plate-rudder according to 4.3.

4.5 Rudders made of glass fibre reinforced polyester shall be profile rudders and have steel reinforcements welded to the rudder stock with maximum distance of 200 mm. The thickness of the steel reinforcements shall at least the same as the thickness of a plate rudder according to 4.3, the breadth at least ten times the thickness and the length not less than 75 per cent of the distance from the rudder stock to the trailing edge or leading edge of the rudder.

4.6 A rudder made of glass fibre reinforced polyester which is laminated in two parts shall be filled with reinforced polyester or equivalent material and the parts shall be effectively glued together on flanges and at the edges. The thickness of the side parts shall not be less than the thickness of the plate in a profile rudder of steel or aluminium according to 4.4.

4.7 Wooden rudders shall be made of oak and be attached to the rudder stock and the pintle with steel forks with a thickness of a plate-rudder according to 4.3. The steel forks shall be welded with continous welds to the rudder stock and the pintle and bolted to the rudder with at least three upper bolts and two lower bolts which shall have the same diameter as bolts in a rudder coupling according to 3.6.

4.8 Rudders of oak shall have a thickness of at least:

$$t_t = 7,3 * t_e \quad mm$$

where t_e is the thickness of a plate-rudder according to 4.3.

ENGINE INSTALLATIONS C 8

Table of contents

1 ENGINES

1.1 Commercial boats shall be provided with diesel engines. Commercial boats other than passenger boats may, however, have gasoline outboard motors provided that Loa * B is less than 20.

1.2 Inboard propulsion engine with power greater than 100 kW shall be type approved for marine use. Individual survey certificates are not required.

1.3 Where elastic mounting of a propulsion engine is used, the propeller shaft shall be longer than 40 times the diameter of the shaft when an elastic shaft coupling is not arranged.

2 ENGINE SPACES

2.1 The engine space shall be arranged so that it cannot be used for other purposes. The normal service points of the engine shall be easily accessible. Stowage spaces shall be separated from the engine space by bulkheads or similar arrangements. In order to simplify big service work on the engine the divisions may be detachable if acceptable having regard to the division requirements.

2.2 Windows or other types of lighting glass must not be fitted in the boat side, engine casing or the deck above the engine space. The room shall be equipped with electrical light.

3 INSTALLATION

3.1 Flexible hoses shall be accessible and visible for inspection. They shall comply with chapters MC9, MC10 and MC11 and be fitted with double acid resistant hose clamps.

4 EXHAUST SYSTEMS

4.1 Material in the seawater cooling system shall be corrosion resistant. The parts of the system must not be combined in such a way that galvanic corrosion will arise.

4.2 In the case of a multiple engine installation each motor shall have its separate exhaust system.

4.3 Exhaust pipes shall be mounted so that mechanical wear is avoided. Moulding in of an exhaust line is, however, not permitted. Drainage is not permitted at a part of the line which passes through enclosed accommodation spaces.

4.4 Exhaust outlets shall be at least 100 mm above the load waterline or connected to a fixed pipeline which is drawn up to at least 100 mm above the load waterline. An exhaust line shall always be drawn so that a part of it is at least 350 mm above the load waterline with a slope downwards to the outlet.

5 ENGINE CONTROL

The propulsion engine shall be capable of easy manouevring from the steering place and the control devices for inboard engines shall be arranged so that the following information is available at the steering place:

- the revolution of the propulsion machinery
- lubrication oil pressure of the propulsion engine
- lubrication oil pressure of the gear and hydraulic pressure, if applicable
- cooling water temperature
- cooling water failure in the exhaust system.

The control instruments shall be marked with abnormal operational conditions and fitted with adjustable lighting. The functions listed above except the revolution of the propulsion machinery shall be fitted with alarms.

6 INSTALLATION OF OUTBOARD MOTORS

6.1 The transom shall be fitted with a well attached plate as a protection for the fastening bolts for the engine. The upper part of the plate shall have a marked ridge of at least 5 mm. A suitable protection plate shall be mounted at the outer side of the transom.

6.2 Outboard motors with a power greater than 15 kW shall be fastened to the stern using through bolts with nuts.

6.3 Boats with motors having a power greater than 15 kW shall have an motor well drained to the sea through at least one hole with a diameter of at least 15 mm.

6.4 Holes for the control cable and fuel pipe in the engine well shall be tightened with sleeves or the like.

6.5 The well shall have such a size that the motor can be easily manoeuvred and tilted.

7 SEAWATER COOLING SYSTEM

7.1 Materials in a seawater cooling system shall be corrosion resistant. The parts of the system must not be combined in such a way that galvanic corrosion arises.

7.2 Seawater intake shall be provided either with a strainer or a filter.

7.3 External cooling water line shall be protected at the forward end.

7.4 If a filter is part of a seawater cooling system for the cooling of the engine, the filter shall be mounted so that it can be cleaned without tools and when the engine is running.

7.5 Pipes and filters in the engine space must not be made of thermoplastics. Small hose sections may be accepted.

8 VENTILATION OF ENGINE AND TANK SPACES

8.1 The air intake for the engine space shall be arranged so that the air needed for the engine in accordance with the engine manufacturer's guide lines, but at least 7 cm^2/kW, is satisfied. The air intake for the engine space shall be placed in the opposite side to the air intake for the engine.

8.2 The ventilation openings shall be provided with closing devices which are operated from a place outside the engine space and which can be secured in both open and closed position.

8.3 Fuel filling opening and tank vent fitting shall be arranged and mounted so that any spill at over filling or gas from the vent fitting will not penetrate into the boat.

FUEL INSTALLATIONS

C 9

Table of contents

1. GENERAL

1.1 Fuel lines to the engine shall be fixed mounted and shall be fitted with a filter and a water separating system which both shall becapable of being drained and cleaned without use of tools.

Filters must not be located in fuel tanks.

1.2 The return fuel line shall end near the bottom of the tank.

1.3 Fuel tank shall be mounted on and be attached to a strong bed. A fuel tank shall not be located adjacent to other parts in such a way that the air circulation is obstructed.

2 FUEL TANKS

2.1 For diesel oil tanks a fuel line with a shut-off valve in the bottom of the tank is accepted.

Drainage valve with tightening plug (tätnings plugg) is also accepted in the tank bottom. Connection piping between dieseloil tanks may be accepted. A shut-off valve shall than be fitted at each tank connection.

2.2 Boats with outboard motor shall have an appropriate fastening arrangement for a portable gasoline tank when a permanently mounted tank is not arranged. The arrangement shall be such that the tank can easily be put into place.

2.3 A fixed installed gasoline tank shall be made of stainless steel or aluminium and be located in a space which is gastightly separated from the rest of the boat and which has natural ventilation to the open air.

2.4 A tank with a volume of more than 50 litres shall have the necessary wash bulkheads. The wash bulkhead shall have openings between the sections both at top and bottom.

All parts of the tank shall be accessible for cleaning through a manhole which shall be located so that it is easily accessible.

Tanks with a volume of more than 1 500 litres shall be fitted with an inspection hatch with a size of at least 450 x 350 mm.

2.5 Each tank shall have a mechanical device for indication of level or be fitted with an electrical level indicator. In case of external indicating pipes a selfclosing valve is required.

2.6 Fuel tank made of glass fibre reinforced polyester (GRP) shall be made of polyester of grade 1 and be internally coated with gelcoat or topcoat.

2.7 Non-integral fuel tanks of steel, stainless steel or aluminium shall be manufactured as a fully welded construction, i.e. an edge welding cannot be accepted.

2.8 Fuel tanks shall be given dimensions having regard to stiffening but shall have material thickness according to the following table.

Volume in litres	50	50-99	100-199	200-499	500-999	1000-
	mm	mm	mm	mm	mm	mm
Steel 37-2	1,5	2,0	3,0	4,0	5,0	6,0
Stainless steel AISI 316L	1,25	1,25	2,0	3,0	3,0	4,0
Seawater resistant Aluminium	2,0	3,0	4,0	5,0	5,0	6,0
GRP	4,0	4,0	4,0	5,0	5,0	6,0
Polyetylen	5,0	7,0	9,0	-	-	-

3 FUEL LINES

3.1 Fuel lines shall normally be pipes made of steel or copper. Short hose sections may be used provided that they comply with the requirements in chapter MC8 or ISO/DIS 8469 (Small Craft-Non-Fire Resistant Fuel Hoses) and be marked accordingly.

3.2 Each permanently mounted tank shall have separate filling and ventilation lines. The outlet of the ventilation line shall have flame arresters and be so arranged that water normally cannot flow into the tank. The filling line shall have an internal diameter of at least 38 mm and the ventilation line at least 12 mm.

3.3 A shut-off valve shall be fitted in the fuel line as close as possible to the tank. The valve shall be possible to close from an accessible place above deck. The valve shall be fire resistant.

3.4 A fuel line shall be properly clamped and protected so that it is not exposed to mechanical damage or wear. Pipes and hoses shall be arranged with sufficient expansion bends. Metallic components in a fuel line must not be combined so that they give rise to a damaging corrosion.

Details assembled in a piping system shall be of the same standard.

3.5 Connections of hoses shall be arranged in an appropriate way. If hose clamps are used, double clamps shall be fitted at each coupling. Hose fittings shall be of sufficient length and shall be ribbed.

Hose clamps shall be made of acid resistant material.

3.6 After final installation the whole fuel system shall be subjected to a test for tightness with an overpressure of at least 0,02 N/mm^2. The tightness test may be carried out with air and soapy water.

PROPELLER SHAFTS AND PROPELLERS

C 10

Table of contents

1 PROPELLER SHAFTS

1.1 The shaft diameter shall comply with the engine manufacturer's requirements but shall be at least

$$d = k \sqrt[3]{p/r} \quad \text{mm}$$

where

p is the maximum continuous power in kW
r propeller revolutions per second
k = 30 for carbon steel
23 for AISI 316 austenitic stainless steel
22 for AISI Y31 martensitic stainless steel
18 for Hickal-Copper aloy K 500
21 for AISI 429

1.2 Other shaft material shall be specially considered having regard to the seawater fatigue properties of the material.

1.3 Shaft penetrations in a watertight bulkhead shall be arranged so that the watertight integrity and strength of the bulkhead is maintained.

2 SHAFT BRACKETS

2.1 The wall thickness of a shaft bearing shall be at least:

$$t = d + 230/32 \quad \text{mm}$$

whered is the shaft diameter in mm.

The length of the shaft bearing shall be at least 3 d for bearings in stern tubes and 2 d for other brackets.

2.2 One-armed shaft brackets shall have a minimum moment of resistance (section modulus) (W) at the bottom of the boat calculated according to the following formula:

$$W = l * d^2/(112 * \sigma_B)$$

where

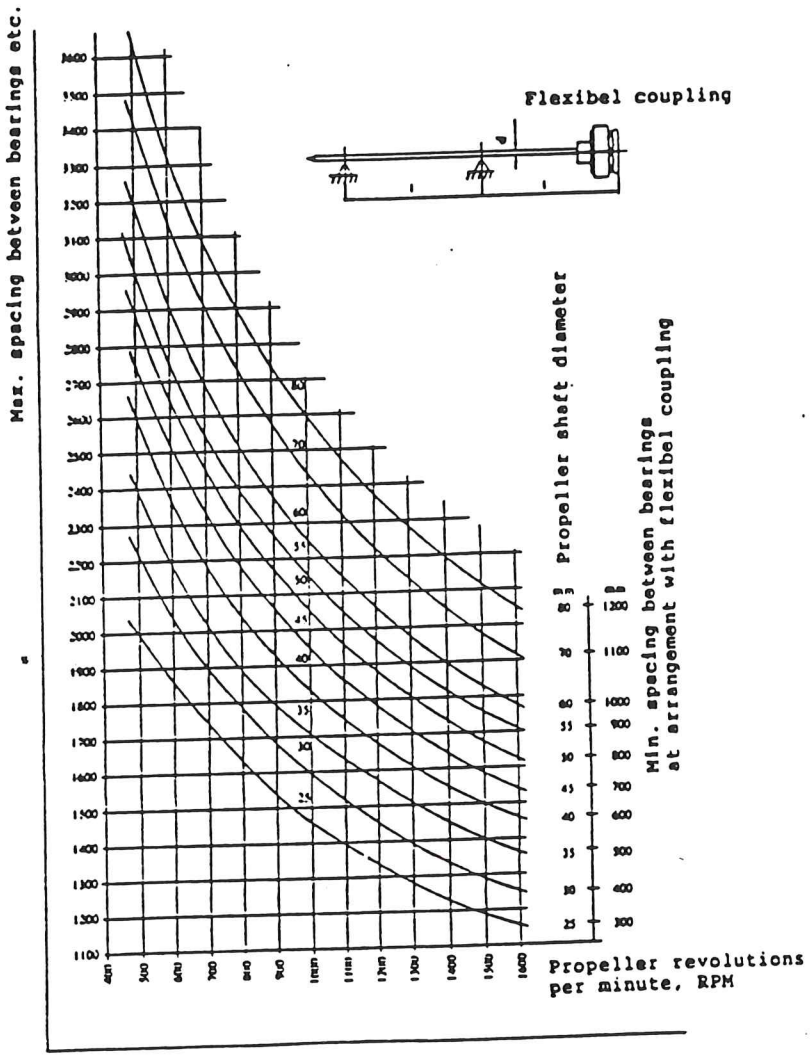
l is the length of the shaft bracket in mm

σ_B the tensile strength of the material.

At the propeller shaft the section modulus of the shaft bracket shall be at least 60 per cent of the-above requirement.

3 FREE PROPELLER SHAFT LENGTHS

3.1 The distance between the shaft supports (bearings) must not be greater than that specified by the diagram.


Flexibel coupling
Max. spacing between bearings etc.
Propeller shaft diameter
Min. spacing between bearings at arrangement with flexibel coupling
Propeller revolutions per minute, RPM

ELECTRICAL INSTALLATIONS C 11

Table of contents

1 SCOPE

1.1 These requirements apply to direct current installations with a rated voltage up to 50 V. For other installations reference is made to the requirements of the national administration.

1.2 The Standard does not cover electrical components installed in propulsion engines or auxiliary engines or equipment in apparatus such as radioapparatus, electrical motors, signal horns, instruments, etc. If, however, it can be established that such apparatus are defective from a safety point of view, improvement or replacement may be required.

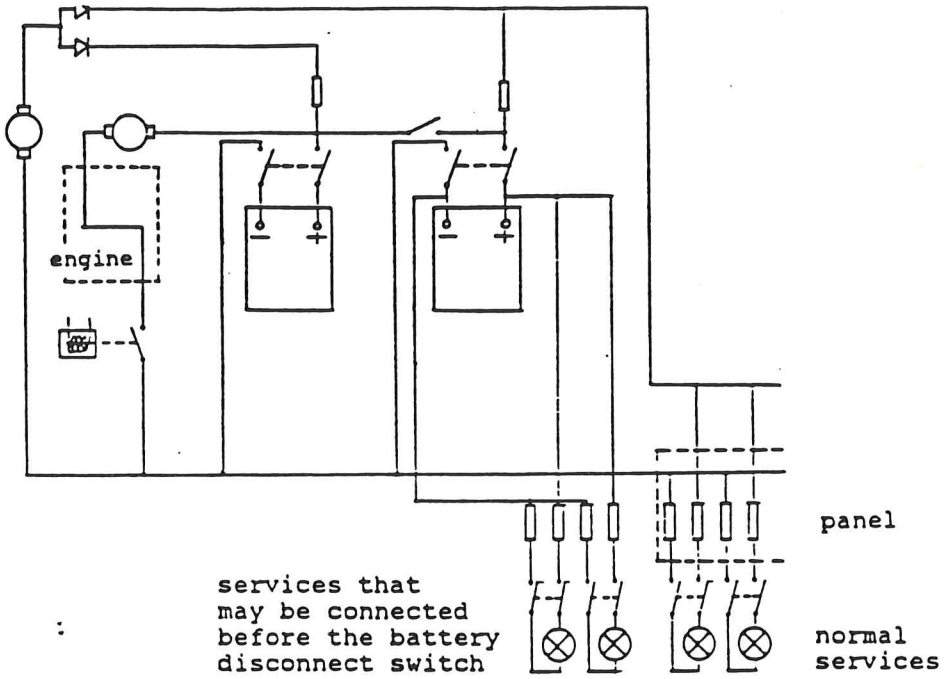
1.3 The Standard does not cover protective measures against electromagnetic influence on persons from apparatus such as radars and viewing screens.

2 SYSTEM REQUIREMENTS

2.1 Systems shall normally be installed as insulated two conductor systems.

2.2 For propulsion engines with a power less than 100 kW it is permitted that the engine be used as conductor during start.

The figure below shows an example where the engine is used as conductor during start and where either of the batteries can be used to start the engine.



2.3 Supply from a battery installation to other consumers than those on the boat's engine is to be led to one or more centrally located distribution and fuse panels via overload protected main cable and disconnect switch near the battery. Gas and burglar alarms, heating equipment and automatic bilge pumps may, however, be connected before the battery disconnect switch but must have separate fuses. A cable to a machine which is used only for short periods, e.g. anchor gears, may be connected to a battery without fuse but shall comply with the requirements of 7.3. The voltage drop in the cables from the central to the consumers must not at full load be more than 6 per cent of the voltage at the main central.

3 GROUP CONNECTION AND CONTROL CIRCUITS

3.1 Each navigation light shall have its own separate fuse.

3.2 Each navigation light, where supervision from the steering position is not possible, shall be provided with either an optical indicator at the steering pulpit which shows if the light works or a joint audible alarm indicating malfunction. Malfunction of the indicator must not affect the light.

3.3 The ordinary lighting on board should be divided into at least two groups.

3.4 Safety equipment, such as radio, signal horn, searchlight, etc, as well as consumers larger than 5 A shall have separate fuses.

4 ACCESSIBILITY AND MARKING

4.1 Batteries, cables and other electrical components shall be located so that they can be supervised and maintained also when the boat is in operation. A wiring diagram for the installation shall be supplied with the boat.

4.2 All markings shall be made with permanent marking signs with durable text.

4.3 Connected equipment and rated current shall be stated at each fuse. The circuit number given in the wiring diagram shall correspond to the circuit number marking on the fuse base. A wiring diagram shall be posted in the central on the inside of the door or hatch. Each group shall be accessible for insulation measurement.

4.4 Measuring instruments, switches, signal lamps, etc in apparatus cabinets shall be fitted with clear marking.

4.5 Socket outlets shall have marking signs indicating voltage and type of current. In boats with only 12 or 24 V direct current socket outlets without marking are accepted.

4.6 Conductors and multiconductors shall have a durable marking e.g. with colours, so that they can be identified with the aid of the wiring diagram.

4.7 Marking shall indicate the use of each battery and how a possible transfer between batteries is made.

5 OVERLOAD PROTECTION

5.1 Cables shall be so dimensioned that they under

normal operation conditions, will not reach a hazardous temperature or be damaged by thermal or mechanical loads at short circuit. A connection between battery and starting motor shall not be provided with a fuse. For connection battery starting motor and generator-battery the motor manufacturer's recommendations instructions concerning cable area should be complied with, the voltage drop must, however, not be more than 8 per cent.

5.2 Overload protection shall protect the cables against overload and at short circuit break the current within a period of not more than five seconds in accordance with the table below. The overload protection shall be placed in the central and near the battery respectively. Each group shall be protected at both poles. Cables which only transfer signals to instruments or the like may have a smaller cross section than the smallest in the table.

Cable cross section	dimensioning continuous load	max fuse against overload	max fuse against short-circuit in series with overload protect.
mm^2	A	A	A
1,5	9	10	20
2,5	12	16	35
4	16	20	35
6	21	25	63
10	28	35	100
16	37	50	160
25	49	63	200
35	60	80	315
50	76	100	400

5.3 Fuses of type neozed, diazed and those complying with DIN 72581 part 3 rated according to the table column "maximum fuse against overload" shall be considered as complying also with the requirements for short circuit protection. Circuit breakers must be of the manually reset trip free type and shall be able to break short circuit currents of at least 100 A.

6 BATTERY ARRANGEMENT

6.1 There shall be arrangements for charging the batteries continuously under way.

6.2 The electric starter of the propulsion engine shall be possible to connect to two independent batteries or groups of batteries. One group of batteries shall be the normal starting group which must not be the normal power source for other consumers. The other group may be the lightingbattery group provided it has sufficient capacity to start the propulsion engine.

6.3 Each group of batteries shall have a two pole disconnector.

6.4 Batteries positioned in the watertight engine compartment shall be arranged so as not to short circuit when the compartment is flooded up to the load waterline. As an alternative an emergency battery supplying power for emergency lighting and radio may be installed on deck or in the wheelhouse for operation of emergency lighting, navigational equipment and radio.

6.5 Batteries shall be securely fastened so that they cannot come loose. Batteries constructed so that they may leak under heavy heeling shall be placed in a liquid tight case of a material which is resistant to the electrolyte.

6.6 Battery installations of more than 5 kWh, equivalent to 208 Ah at 24 V and 416 Ah at 12 V shall be placed in a separate compartment with ventilation to the open air. The arrangement shall be such that the air circulation is not blocked.

7 CABLE DRAWING AND PLACING OF COMPONENTS

7.1 Cables shall be securely clamped or run in conduits. The conduits shall either be properly fastened by clamps or be matted in. Direct embedding of cables in GRP laminates is not accepted. Cables must not be fastened direct to tanks, oil pipes or water pipes, etc.

7.2 Cables shall be located in such a way that they are protected against heat. Cables which can be subjected to mechanical wear shall be armoured or placed in tubing. The pipes shall either be properly clamped or protected by tubing. Cables positioned below machinery or flooring shall be protected by tubing or equivalent. Tubing for cables shall be positioned so that possible water or condensation will flow out of the tube. Cable penetrations of decks or watertight bulkheads shall be watertight. Cable entrances should be from below or from the side.

7.3 The following cables shall be separate insulated single conductors which shall be located so that they are well protected against mechanical damage:

generator - battery;
battery - starting motor;
battery - central.

Where these cables are fastened to an electrically conductive material they shall be single conductor cables or insulated single conductors in separate sheaths of insulating material.

7.4 Cable ends shall be securely connected in such a way that the conductors are not damaged. Cable sheaths shall reach into the entrance to the connection. Cables which shall comply with the requirements of 7.3 should be connected with pressed on cable-thimbles with lock washer and nut. Other connections shall be made on terminals or with fixed clips.

7.5 Fuses or batteries must not be located in the same compartment as gasoline tanks or space with containers for substances which can emit explosive gases. Fuses must also not be located in a closed battery space. Switches and lighting fittings in such spaces shall be of explosion proof construction.

8 ENCLOSURE PROTECTION

8.1 The minimum requirements concerning enclosure class for equipment in the indicated spaces are given in the following table. The first number represents the maximum permissible opening for risk of touching and penetration of foreign objects into a piece of equipment. The second number represents the protection against penetration of liquids. Where the table does not indicate enclosure class the installation is not permitted.

First number	Touching protection	Second number	Liquid protection	Symbol
0	No requirement	0	Normal design	
1	Openings < 50 mm	1	Protection against dripping water	
2	Openings < 12 mm	2	Protection against dripping water when tilted up to 15 degrees	
3	Openings < 2,5 mm	3	Spraying proof	
4	Openings < 1,0 mm	4	Splashing proof	
5	Dust protecting	5	Washing proof	
6	Dust proof	6	Protected against immersion	

Detailed requirements are given in the IEC publication 529.

location	engines	panels, displays	lighting fittings	heaters	cooker, refrigerator	other installation material
accomodat	IP20	IP20	IP20	IP20	IP20	IP20
wheelhouse	IP20	IP20	IP20	IP20	IP20	IP20
control station	IP22	IP22	IP22	IP22	IP22	IP22
engine space	IP22	IP22	IP44	IP44	-	IP44
steering gear space	IP22	-	IP44	IP44	-	IP44
cargo hold	-	-	IP56	IP56	-	IP56
pentry	-	IP44	IP22	IP22	IP44	IP22
wet spaces	IP44	-	IP44	IP44	-	IP55
refriger chamber	IP44	-	IP44	-	-	IP55
below soles	IP44	-	IP55	-	-	-
open deck	IP56	IP56	IP55	-	-	IP56

9 CABLES AND FITTINGS

9.1 Cables shall have a voltage class of at least 60 volt. Cables in accommodation and on deck shall have a temperature rating of minimum 60o C. Cables in engine spaces and cables to fire and bilge pumps shall have a temperature rating of minimum 85o C.

9.2 Fixed cables shall be multistranded conductors. Cables which will be subjected to movements shall have multistranded conductors.

9.3 Switches shall be arranged for breaking the current and voltage concerned.

9.4 Lighting fitting shall be provided with a protective lattice over the glass if the glass otherwise can be easily damaged.

9.5 Fluorescent tube fitting shall be of an approved type and marked in accordance with established standard.

ACCOMMODATION

C 12

Table of contents

1 TOILETS

1.1 Closed boats with a length overall of more than 8 metres shall be provided with at least one toilet.

1.2 All toilet spaces shall have a lockable door and be well lightened up. Each space shall be provided with a wash basin with water and drain.

2 VENTILATION

2.1 Accommodation spaces shall be so ventilated as to ensure sufficient supply and exhaust of air when doors, sidescuttles, windows and similar apertures are closed.

2.2 The ventilation apertures for inlet and outlet of air shall be so located as to obtain best possible ventilation.

2.3 Cowl for fresh air supply shall be located so that there is no danger of inlet of harmful combustion products. By natural ventilation the channels shall be as short as possible with a minimum of bend.

2.4 By natural ventilation the sectional area of flow of supply and exhaust channels shall be a minimum of 7,5 square centimetres per seat in the room or equivalent.

2.5 A cowl with exhaust into the open air shall be mounted above any cooking place. The channel shall be provided with a ventilation fan.

2.6 Toilet spaces shall be provided with separate exhaust to the open air.

3 FRESH WATER SYSTEMS

3.1 Fresh water tanks shall be readily accessible for cleaning.

3.2 Tanks shall have an inspection hatch with a diameter of at least 150 mm.

3.3 Fresh water tanks shall be capable of being drained through a valve at the lowest point of the tank or through a suction line. The suction line shall end in a well in the bottom of the tank.

PROTECTION OF PERSONNEL C 13

Table of contents

1 NON-SLIP ARRANGEMENTS ON DECK

1.1 Open decks, the space around winches and windlesses and spaces where persons can be expected to walk or stay shall be provided with non-slip surfaces in order to get a safe foothold.

2 RAILS AND HAND HOLDS

2.1 Open decks intended to be used by persons shall be equipped with a bulwark or fixed rail. The rail may be portable if necessary for the operation of the boat.

2.2 The height of bulwark and rail shall be at least 750 mm. A rail must not have an opening greater than 230 mm below the lowest bar. The distance between the bars otherwise must not be more than 330 mm.

2.3 All boats shall be provided with the necessary hand holds or other arrangements for persons to keep a firm hold to protect themselves from being injured.

3 SHARP EDGES

3.1 Sharp edges which can cause injuries to persons are not permitted at places where persons shall move or stay.

4 NON-SLIP ARRANGEMENTS IN ENGINE SPACES

4.1 Surfaces where persons can walk shall be non-slip and must not absorbe oil. Soles (floorings) shall be firmly mounted.

5 SAFETY AT MOVING AND HOT ITEMS

5.1 If persons shall stay or move at machines and apparatus with hot or moving parts, these shall be arranged so that risk for injuries is avoided. Exhaust pipes with a surface temperature of more than 80° C must not be easily accessible for touching.

Rotating parts shall be shielded so that clothes or the like are not entrapped.

5.2 Wire reels shall be so arranged that the wire end does not strike up against the person who serve at the reel.

6 EMERGENCY ESCAPES

6.1 All spaces in which persons can be present shall have two exits. Only one exit can, however, be accepted for small rooms provided that it will not be blocked by a fire in the engine room, pentry or the like.

6.2 The exits shall be as far as possible from each other and suitable for use in an emergency. Ladders, steps and hand holds are required if the exit otherwise is not easily accessible.

6.3 The opening of exits shall be at least 450 x 450 mm or have a diameter of at least 450 mm.

6.4 The exits shall easily be capable of being opened from the inside without use of tools. Sliding covers shall be provided with hand hold on the inside.

The exit shall also be capable of being opened from the outside. The use of a loose handle, fire axe or equivalent for opening is, however, accepted if such devices are available at the central place in the boat, e.g. in the wheelhouse.

6.5 If access to an exit pass through another enclosed room, doors to such rooms may be lockable only if they have a kick-plate which can be removed in the direction of escape.

7 BOARDING ARRANGEMENTS

7.1 All boats shall have a permanently mounted rescue ladder or equivalent suitable arrangements which will enable a person who has fallen overboard to get on board again. Convertible rope ladders are not regarded as permanently mounted. The lowest step shall be arranged at least 300 mm below the waterline.

FIRE SAFETY

C 14

Table of contents

1 INSTALLATION OF COOKER

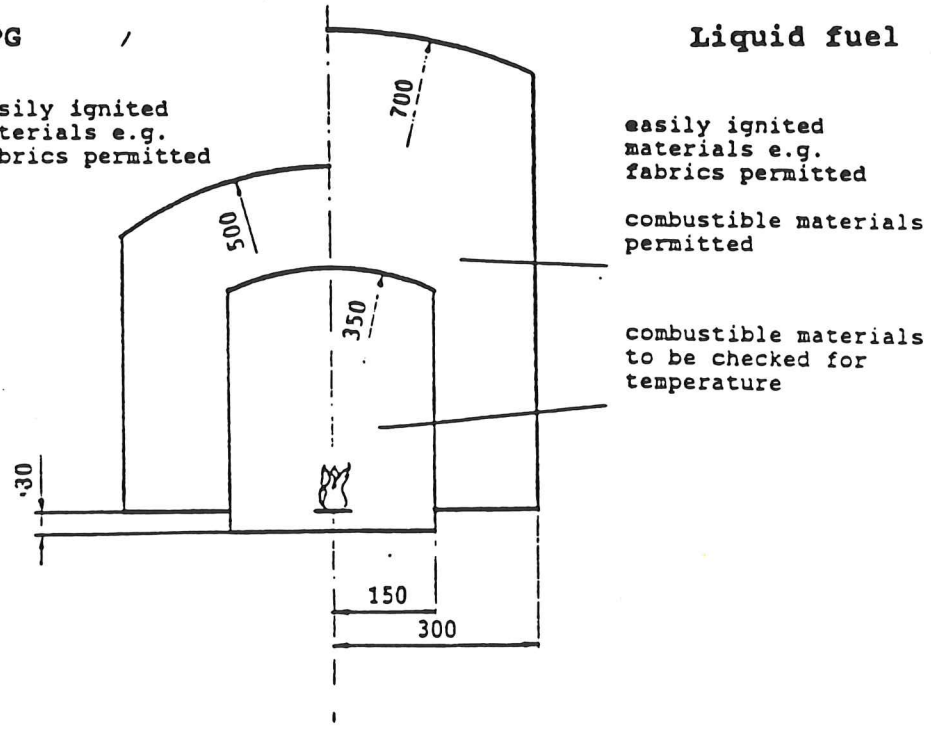
1.1 Cooker constructed so that fuel can be spilled during filling or so that fuel can leak if the flame goes out shall be placed in or over a liquid tight case. The sides of the case shall have a height of at least 20 mm.

1.2 Oil fired heaters with an open burning shall be provided with a valve which automatically close the oil supply if a fire arises in the apparatus.

1.3 LPG fired apparatus shall be provided with a shut-off valve. The valve shall be accessible near the apparatus and be capable of being manoeuvered in case of a fire in the apparatus. If the valve on the bottle is easily accessible near the apparatus the shut-off valve is not required.

1.4 LPG fired combustion apparatus other than ovens shall be of the sealed combustion chamber type and be installed so that the combustion system is completely separated from the air in the boat. Spaces in which a gas fired combustion apparatus is installed shall be ventilated.

1.5 Combustion apparatus shall be installed so that the surrounding parts will not be subjected to hazardous heating. Combustion material must not be subjected to a higher temperature than 80° C. The figure below shows the distances from an open flame which are permitted and when control of heating of combustible material shall be carried out. Protection against heating of combustible material may be achieved through shielding with non combustible material which is thermally insulated from the combustible material.



1.6 A safety barrier shall be arranged in front of a gimbaled stove. The oven shall be possible to lock in horizontal position.

1.7 Combustion apparatus shall be fastened in such a way that they cannot come loose because of the movements of the boat at sea.

2 LPG INSTALLATIONS

2.1 These requirements apply to permanently installed LPG systems except those used in connection with propulsion engines and those with a pressure of not more than 35 mbar.

2.2 Components of a LPG system shall comply with the requirements in MC15.

2.3 Pipelines shall not have more joints than necessary. Pipelines shall not be drawn through the engine compartment.

2.4 Pipelines shall be fastened with clamps or equivalent so that wearing and vibration are avoided. Clamps and other devices shall be made of corrosive resistant material and shall not damage the pipeline with sharp edges or by wear and must also not damage the pipeline material in any other way.

2.5 Flexible hoses shall not have a length of more than one metre except when the distance between the bottle and the apparatus is not more than 1,5 metres and only one apparatus is connected to the bottle. Rubber hoses, if used, shall be accessible for inspection.

2.6 The space for the bottle shall have arrangements for securing the bottle against movement. A regulator which is not designed for mounting direct on the bottle shall be fixed mounted in the same space. It shall not be possible to use the bottle space for storage of other equipment. Spaces for spare bottles, both filled and empty, shall comply with the same requirements as those for bottles. Safety devices shall be mounted in such a way that they can withstand the movements which normally can be expected at sea. Systems with two connected bottles shall have a valve for changing over from one bottle to the other. This valve will not substitute the bottle shut-off valve.

2.7 The space for LPG bottles, regulator and safety devices on open deck, on the top of a superstructure, outside the cockpit well or an enclosed space shall be a case with direct ventilation to the open air.

2.8 A space for an LPG bottle, gas regulator and safety devices below deck and in the cockpit shall be gastightly separated from the accommodation and openable only from above and arranged so that gas cannot flow into the boat. The space shall be positioned above the waterline and shall, if covered, be rapidly accessible and capable of being opened without tools so that the bottle valve can be manoeuvered and so that the system can be pressure tested for tightness and a pressure gauge be read, if fitted.

The space shall have a ventilation opening in the bottom with an inner diameter of at least 12,5 mm which leads to the outside of the boat without pockets through the hull to a point lower than the bottom of the space but above the waterline. The opening must be located at least 500 mm from other hull openings which lead into the boat.

2.9 The system shall after final completion be controlled in respect of leakage, using soapy water or a detergent solution at all couplings and at possible leakage warning devices. Leakage must not exist. The pipeline shall before it is connected to the gas regulator or to the leakage warning device, if fitted, be pressure tested with air at at least 35 kPa. Leakages must not exist.

3 STRUCTURAL FIRE PROTECTION

3.1 Insulation materials which are used and their surfaces shall have an oxygen index of at least 21.

3.2 Insulation materials in engine rooms shall be covered by a surface layer impermeable to oil and oil mist.

3.3 Oil tanks and bilge water tanks located totally or partly above the flooring in the engine room shall be insulated with a hard mineral wool block with a thickness of at least 15 mm or with expanding, fire protecting paint with equivalent insulation effect. The sides which are protected by the hull need not be insulated.

4 FIXED FIRE EXTINGUISHING SYSTEM

4.1 Boats with a length overall greater than 8 metres shall have a fixed fire extinguishing system in the engine room. In closed and partly covered boats a fire alarm system is in addition required for the engine room. The signal device shall be located at the steering place.

4.2 The requirements below apply to an extinguishing system with carbon dioxide as the extinguishing medium. Other extinguishing media which give equivalent safety and function are also accepted.

4.3 The extinguishing system shall be able to be released manually only. The release device shall be centrally positioned in the boat outside the engine room and the tank space and be protected against splash water and risk for unintentional release. An instruction shall be fitted at the release place.

4.4 The bottles for extinguishing medium shall be positioned in a space where sea water splash, mechanical damage or temperatures above 50°C are not expected. Bottles must not be placed in the engine room.

4.5 Pipelines and nozzles shall be designed and placed so that an even distribution of the extinguishing medium is achieved. The amount of extinguishing medium and discharge time shall be so adapted that an effective extinction is achieved.

4.6 The amount of carbon dioxide shall be 1,5 kg per cubic metre of the gross volume of the engine room, however, at least 2 kg. At least half the filling ratio shall be achieved in not more than ten seconds.

4.7 Ventilation openings and their closing devices shall be so arranged that a damaging overpressure will not arise at release of the extinguishing system.

4.8 The engine room and spaces for carbon dioxide bottles and other parts of the system where leakage can occur shall be separated in such a way that leaking gas cannot penetrate into spaces for personnel which can be closed. Spaces for bottles shall have ventilation direct to the open air.

LIFTING GEARS

C 15

Table of contents

1 SCOPE

1.1 These requirements apply to power driven lifting gears.

2 MEASURES AGAINST OVERLOAD

2.1 Lifting gears shall be so arranged that they without engagement with tools make it impossible

- to lift a bigger load than that for which the gear is constructed; and
- to expose the boat to a greater heeling moment than that permitted by the stability requirements.

A lifting gear which is lifting the load with a wire shall be designed so that the wire cannot be overloaded when the hook reaches its innermost position.

2.2 The greatest permitted load shall be marked at a clearly visible place on the lifting gear. At least three different loads with the corresponding reach-outs which in the most unfavourable position give a permitted heeling angle shall be indicated. The marking may in case of automatic load limitation indicate different greatest permitted load for different crane positions. Other markings which can be mixed up with that required are not allowed.

3 DOCUMENTATION OF STRENGTH

3.1 For each lifting gear documentation showing for which load it has been approved by the authorized testing body shall be provided.

3.2 Calculations which prove that the safety factor for metal is at least 5 and for glass reinforced polyester at least 7 is required for the lifting gear fastening and the part of the boat which is affected.

MOORING AND ANCHORING EQUIPMENT

C 16

Table of contents

1 BOLLARDS AND FAIRLEADS

1.1 The boat shall be provided with approved bollards according to chapter MC16 and hawsepipes arranged so that the boat can be anchored, tow other ships, be towed and moored satisfactorily.

1.2 All boats shall have at least one mooring cleat forward and one aft. When two cleats are fitted forward or aft they shall be located as near as possible to boat sides. For larger boats additional mooring cleats may be required.

1.3 One cleat forward and one aft shall be placed in such a way that towing is possible. If a towing cleat mounted on the stern is easily accessible it can be approved also as a mooring cleat in open boats without a deck forward.

1.4 Mooring cleats and their mountings shall be strongly designed and mounted. The cleats and their mountings shall be strongly designed and mounted. The cleats and their mountings shall be capable of withstanding a tensile load (P) in the longitudinal direction as follow:

$$P = 50 * \quad /Loa \qquad N$$

where is the displacement fully loaded in kg.

1.5 Appropriate reinforcements shall be provided where the cleats are fastened. Bolts, nuts and other mounting details shall be made of corrosion resistant materials.

1.6 Mooring cleats shall either be welded or mounted

with through bolts. Large washers shall be fitted below the nuts and the nuts shall be locked.

2 AHCHORING EQUIPMENT

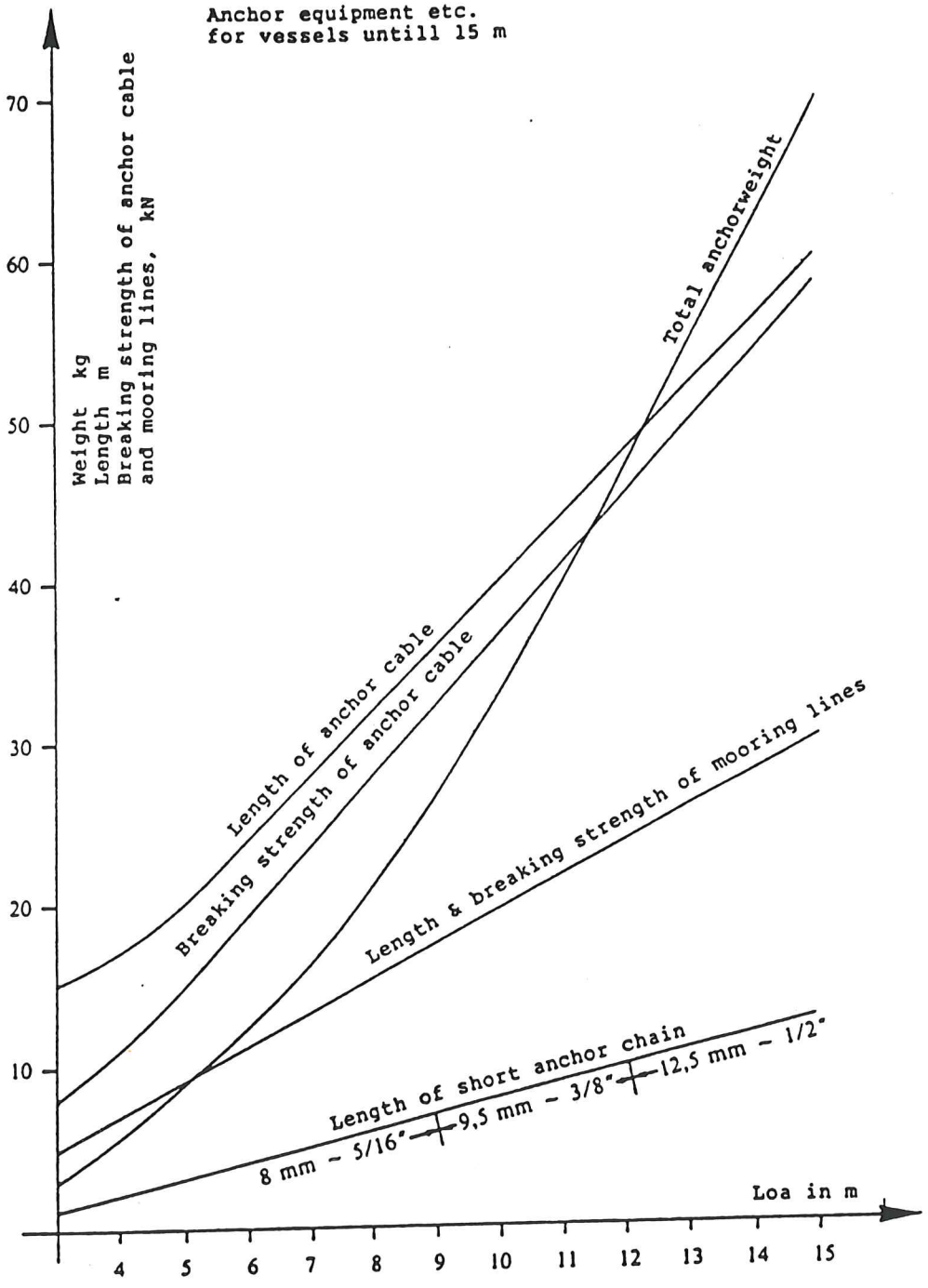
2.1 The boat shall be provided with anchoring equipment at least according to the following diagrams. The equipment shall be arranged in such a way that it is possible to anchor rapidly and reliably.

2.2 The anchor weight may be distributed on two anchors one of which must have at least 2/3 of the required weight. The required anchor weights are based on traditional anchor types. If the anchor is of a type with extra high holding capacity, e.g. anchors approved by a recognized classification society with the designation "high holding anchor" the anchor weight may be decreased with up to 25 per cent.

2.3 The boat shall be equipped with at least one short chain-cable of a length and dimension according to the diagram below.

2.4 The boat shall be equipped with at least one anchor rope (anchor cable) and three mooring ropes of a length and minimum breaking strength given in the diagram.

2.5 Boats which shall sail in a particularly wind exposed area shall have measured anchor weight and short chain cable in accordance with national rules (requirements).


Anchor equipment etc.
for vessels untill 15 m
Weight kg
Length m
Breaking strength of anchor cable
and mooring lines, kN
70
60
50
40
30
20
10
Total anchorweight
Length of anchor cable
Breaking strength of anchor cable
Length & breaking strength of mooring lines
Length of short anchor chain
8 mm - 5/16"
9,5 mm - 3/8"
12,5 mm - 1/2"
Loa in m
4
5
6
7
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15

BRIDGE AND NAVIGATIONAL EQUIPMENT

C 17

Table of contents

1 WHEELHOUSE

1.1 There shall be clear visibility from the wheelhouse forward, to the sides and astern. In addition, the front windows shall be so arranged that they can be kept free of rain, splash and condensation.

1.2 The arrangement in the wheelhouse shall be as follows:

- Instruments, control handles, control lamps, etc shall be suitably positioned;
- Details at the steering panel and in the field of vision shall, as far as practicable, be made of non-reflecting material;
- The free height shall normally be at least 1,98 metres.

2 COMPASSES

2.1 Any boat shall be equipped with a magnetic compass which shall comply with the national requirements.

3 SOUND SIGNALS

3.1 Boats with a length of at least 12 metres shall have fixed mounted whistle and ship bell.

3.2 Whistles and ship bells shall comply with the requirements of the International Regulation for Preventing Collisions at Sea, 1972, Annex III.

4 LIGHTS

4.1 All boats shall have fixed mounted lights (lanterns). In respect of size, type, location and arrangement they shall comply with the International Regulations for Preventing Collisions at Sea, 1972, with later revisions.

4.2 A combined side light may be used. In boats with a length overall of less than 12 metres a combined top and aft light may also be used.

For fishing boats special provisions apply during fishing activities.

4.3 Lights shall be approved and marked by one of the Nordic Maritime Administrations or be provided with individual certificates in accordance with national provisions.

4.4 Lights shall, if necessary, be screened off in order to avoid confusing reflexes.

SIMPLIFIED STRENGTH REQUIREMENTS FOR GRP BOATS

C 18

Table of contents

1 GENERAL

1.1 Boats of GRP may be built in accordance with the following provisions of this chapter provided

A that the speed of the boat does not exceed 15 knots

B that the construction is built up as single laminate

C stiffenings, bulkheads and other structural parts shall be accessible for control. Thickness and measurement shall be possible to carry out on the bottom, sides and deck of the hull.

1.2 If the above limitations cannot be complied with, the boats shall be built in accordance with chapters C21, C22 and C26.

2 MATERIALS

2.1 During the construction it shall be documented that rawmaterial according to the requirements in chapters MC2 and MC3 or equivalent are used.

2.2 It shall be documented that the properties of the finished laminate complies with the requirements in chapter MC2.

2.3 If such documentation is not available a material sample shall be taken for testing.

3 MANUFACTURING PREMISES

3.1 Manufacturing premises shall be arranged so that the following can be complied with.

1 During the moulding and curing the air temperature shall be uniform and minimum 18 degrees Celsius

2 The necessary ventilation system must not cause draught

3 Direct sunlight is not acceptable in places where moulding and curing are in progress

4 Grinding work must not take place in the same premises as that where moulding is in progress.

4 WORKMANSHIP

4.1 The laminate moulding shall be carried out with customary good workmanship and the laminate shall be well cured and not discoloured.

Laminate which will be subjected to water shall be protected by gelcoat or topcoat.

5 DIMENSIONING

5.1 The minimum dimensions shall be in accordance with the following table:

Area	Extension	Dimension
Keel and stem laminate	80 * Bmax from the centre in mm	tk = 7,0 + 1,3*Loa
Bottom laminate	Up to the full load waterline	tb = 6,0 + 0,7*Loa
Laminate in the side and super-structures, strength and tank bulkheads	Above the load waterline	td = 3,0 + 0,6*Loa
Laminate in deck and deckhouses		ts = 6,0 + 0,8*Loa
Bilge	100 mm on each side	tc = 6,0 +0,8 Loa

5.2 Maximum frame distance and minimum section modulus for stiffeners shall be in conformity with the table below:

Frame	Maximum frame distance in mm	Minimum section modulus in cm^3
Bottom	5,4*Loa + 400	$Wb = 0,006*Loa*S*L^2*10^{-6}$
Side	16*Loa + 400	$Ws = 0,0038*Loa*S*L^2*10^{-6}$
Deck	26*Loa + 300	$Wd = 0,87\ (0,01+0,002*Loa)\ S*L^2*10^{-6}$

5.3 Floors shall be installed with a maximum relative distance of 1,0 metre and they shall have a height of at least hb above the keel:

$hb = B/3 * 100 * S$ mm, minimum 100 mm

where S is the distance between the floors in mm.

5.4 Bulkheads of plywood shall be made of water proof material and have a thickness of at least

$$t = 2 * Loa - 2 \quad mm$$

Bulkheads of other materials shall be dimensioned to equivalent strength.

6 CONTROL

6.1 The requirements in the above tables and the documentation and the workmanship shall be controlled for each individual boat during the final survey according to chapter C1.

SIMPLIFIED STRENGTH REQUIREMENTS FOR STEEL BOATS

C 19

Table of contents

1 GENERAL

1.1 Steel boats can be built in accordance with the paragraphs in this chapter on condition that:

A The speed of the boat must not be greater than 15 knots;

B Bulkheads, frames, floors and other structural elements shall be accessible for control and thickness measurement shall be possible to carry out in respect of the bottom, sides and deck of the hull.

1.2 If the above conditions are not fulfilled, the boat shall be built in accordance with chapter C21, C23 and C27.

2 MATERIALS

2.1 During the construction it shall be documented that materials used are of ship quality with certificates issued by a classification society or a Maritime Administration and with at least the following properties:

Minimum yield stress	240 N/mm^2
Tensile strength	410 N/mm^2
ultimate strain	22 %

3 WORKMANSHIP

3.1 Adjusting of materials, welding and detailed performance shall normally be carried out in accordance with chapter C27.

4. DIMENSIONING

4.1 The minimum dimensions shall be in accordance with the table. Interpolation shall be used for boats with a length overall between 8 and 15 metres.

5 CONTROL

5.1 The requirements in the above table and the material documentation and the workmanship shall be controlled for each individual boat at the final survey in accordance with chapter C1.

5.2 Control of welded joints by x-ray or similar method can be carried out in cases were such a control is considered necessary.

Designation	Loa < 8,0 m	Loa = 15,0 m	Remarks
Frame distance	Max 500 mm	Max 500 mm	-
Bar keel	Sectional area 15 cm^2	Sectional area 15 cm^2	Where bar keel is omitted keelplate = 1,5 x t bottom. Total breadth 30 x Loa mm
Centerkeel	Sectional area 15 cm^2. Min. thick-ness 6 mm	Sectional area 20 cm cm^2. Min. thickness 6 mm	Required only where the bar keel is omitted
Floor	Height 200 mm thickness 4,5 mm	Height 250 mm thickness 3,5 mm	Required only at every third frame on the other frames sceleton floors
Flange on top of floor	50 x 3,0 mm	50 x 5,5 mm	May be omitted where cement is inserted up to the top of the floors
Keelson	UNP 100	UNP 120	Required only where center keel is omitted
Frames	90 x 6,0 mm (9,5 cm^3)	100 x 6,5 mm (18,0 cm^3)	-
Bottom plates	4,5 mm	7,0 mm	Keel plates and stem plates to be increased with 1,0 mm
Shell plates	4,0 mm	6,0 mm	-
Bulkheads	4,5 mm	6,0 mm	-
Bulkhead stiffeners	50 x 6,0 mm (6 cm^3)	50 x 6,5 mm (7 cm^3)	Max. spacing 750 mm
Deck	4,0 mm	6,0 mm	-
Deck beams	90 x 8 mm (22 cm^3)	90 x 8 mm (22 cm^3)	Maximum distance 500 mm. Maximum span 3,5 m
Bulkwark	4,0 mm	5,0 mm	Stiffener 50 x 6 mm. Maximum distance 500 mm
Super-structure/ deckhouse	4,0 mm	5,0 mm	Stiffener 50 x 6 mm. Maximum spacing 500 mm

SIMPLIFIED STRENGTH REQUIREMENTS FOR ALUMINIUM BOATS

C 20

Table of contents

1 GENERAL

1.1 Boats of aluminium can be built in accordance with the following paragraphs in this chapter on condition that:

A The speed of the boat must not be greater than 15 knots.

B Bulheads, frames, floors and other strength elements shall be accessible for control and thickness measurement shall be possible to carry out on the bottom, sides and deck of the hull.

1.2 If the above conditions are not fulfilled the boats shall be built in accordance with chapters C21, C24 and C28.

2 MATERIALS

2.1 During the construction shall be documented that materials of seawater resistant aluminium with certificates issued by classification society or a Maritime Administration and with at least the following properties:

$$\sigma_{0,2} = 170 \text{ N/mm}^2$$

3 WORKMANSHIP

3.1 Workshops and fitting of materials, welding, riveting, glueing and detailed construction shall normally be carried out in accordance with chapter C28.

4 DIMENSIONING

4.1 Minimum dimensions shall be in accordance with the table. Interpolation shall be used for boats with a length overall between 8 and 15 metres.

5 CONTROL

5.1 The requirements in the above table and material documentation and workmanship shall be controled for each individual boat at the final survey in accordance with chapter C1.

5.2 Control of welded joints by x-ray or similar method can be carried out in case such control is considered necessary.

Designation	Loa < 8,0 m	Loa = 15,0 m	Remarks
Frame spacing	Max 300 mm	Max 300 mm	-
Bar keel	Sectional area 18 cm^2. Min. thickness 16 mm	Sectional area 24 cm^2. Min. thickness 20 mm	Where bar keel is omitted keelplate = 1,5 x t bottom. Total breadth 30 x Loa mm
Centerkeel	Sectional area 18 cm^2. Min. thickness 6 mm	Sectional area 24 cm^2. Min. thickness 8 mm	Required only where the bar keel is omitted
Floor	Height 200 mm thickness 5,0 mm	Height 250 mm thickness 6,0 mm	Required only at every third frame on the other frames sceleton floors
Flange on top of floor	50 x 5,0 mm	50 x 6,0 mm	May be omitted where cement is inserted up to the top of the floors
Keelson	UNP 100	UNP 120	Required only where center keel is omitted
Frames	90 x 8,0 mm (22 cm^3)	100 x 8,0 mm (27 cm^3)	-
Bottom plates	4,5 mm	7,0 mm	Keel plates and stem plates to be increased with 1,0 m
Shell plating	4,0 mm	6,0 mm	-
Bulkheads	4,5 mm	6,0 mm	-
Bulkhead stiffeners	50 x 6,0 mm (6 cm^3)	50 x 8,0 mm (8 cm^3)	Maximum distance 500 mm
Deck	4,0 mm	6,0 mm	-
Deck beams	90 x 8 mm (27 cm^3)	90 x 8 mm (27 cm^3)	Maximum distance 300 mm. Maximum span 3,5 m
Bulwark	4,0 mm	5,0 mm	Stiffener 50 x 6 mm. Maximum distance 600 mm
Super-structure	3,0 mm	5,0 mm	Stiffener 50 x 6 mm. Maximum distance 300 mm

LOADS

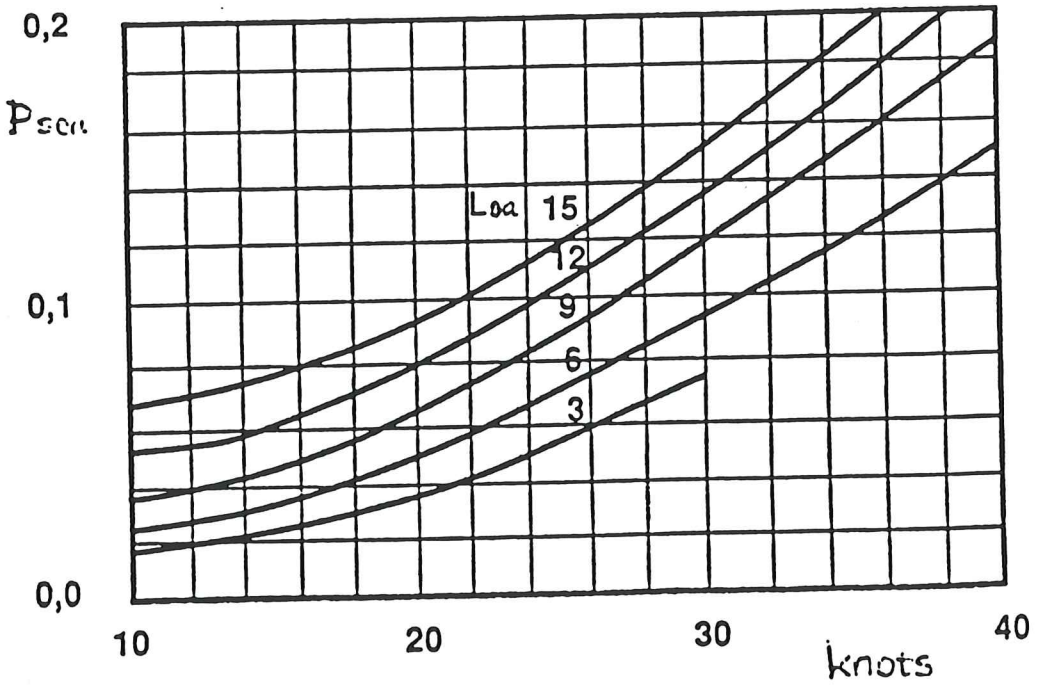
C 21

Table of contents

1 HULL LOADS

1.1 Wells, decks, floorings and superstructures shall be dimensioned for sea loads in relation to the size, speed, displacement and height above the waterline.

1.2 The following figure gives maximum sea loads with the maximum speed the boat can reach with little load.



The length overall Loa in metres. Intermediate values will be obtained by interpolation. Dimensions shall not be calculated for a speed of less than 10 knots.

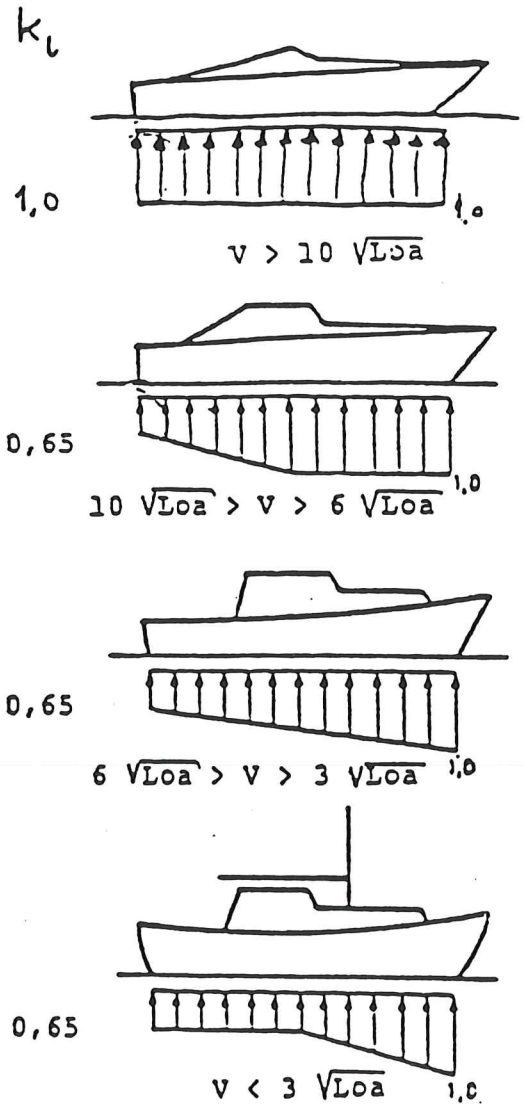
The dimensioning load (p) for the bottom is taken as the greater of

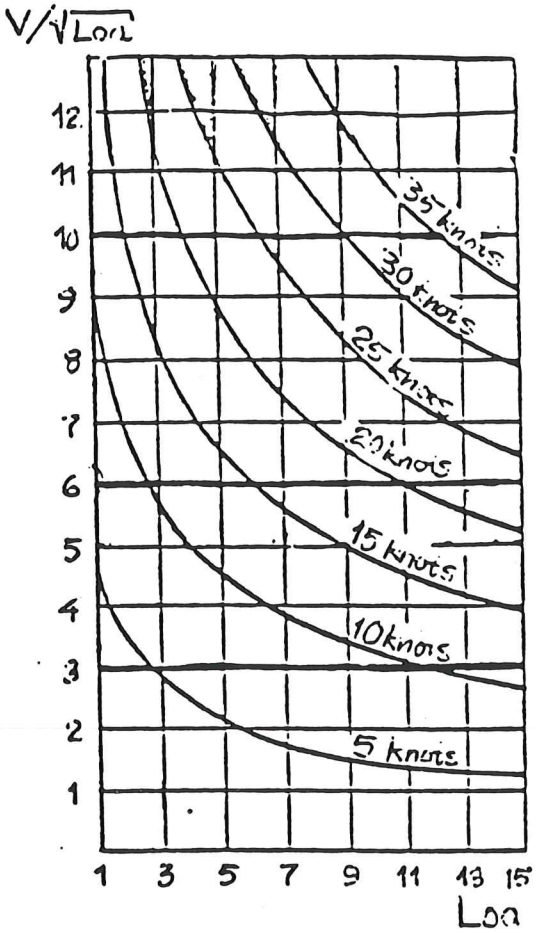
$$p = k_l * p_{sea}$$

$$p = p_{min}$$

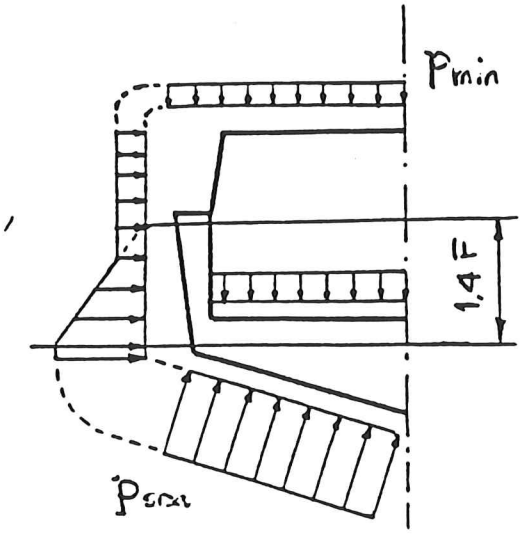
where k_l is the longitudinal correction in 1.3.
p_{min} the minimum pressure in 1.6

1.3 The sea load correction factor k_l, varies longitudinally as shown in the following figures. When the bottom rise angle amidships is less than 12 degrees, 1,0 p is maintained for the whole length of the boat if $V/\sqrt{Loa} > 6$.





1.4 The sea load correction factor (k_t) varies with the height above the waterline as shown in the figure below. The height of the sea load is determined in relation to the freeboard height (F) according to chapter C3 2.1 (a) and (b).



1.5 The load which determines the dimension for sides, deck and soles (floorings) is calculated as follows:

For height (h) to load on sides:

$$p = k_t \ (1{,}4 * F - h) * p_{sea} \ / \ (1{,}4 * F),$$

however, minimum side load:

$$p = 0{,}3 * p_{sea}$$

For superstructure sides on a closed boat:

$$p = 0{,}2 * p_{sea}$$

For deck and flooring:

$$p = 0{,}01 + 0{,}002 * Loa + 0{,}06 * p_{sea}$$

For deck and flooring for load (g) in tons/m^2:

$$p = 0{,}08 * g$$

1.6 The general minimum load and the load for structural bulkheads is taken as:

$$p_{min} = 0{,}003 * Loa$$

DIMENSIONING OF GRP BOATS C 22

Table of contents

1 SCOPE

1.1 The following dimensioning requirements apply to boats with conventional design.

2 MATERIALS

2.1 Glassfibre and polyester shall be in accordance with chapters MC2 and MC3.

2.2 Glassfibre reinforced polyester shall have at least the following mechanical properties:

tensile strength	Rm	80 N/mm^2
flexural strength	Rmb	130 N/mm^2
tensile modulus		7000 N/mm^2
flexural modulus		6000 N/mm^2

2.3 Tensile strength and modulus shall be determined in accordance with ISO 3268. Test specimens should be taken at right angles. Flexural strength and modulus shall be determined in accordance with ISO 178. Test specimens should be taken at right angles. The mould face shall be subjected to compression.

2.4 The mean value of the results from the abovementioned tests shall comply with the stipulated requirements. No single value must be lower than 80 % of the value used in the calculation.

2.5 The glass content in the cured laminate shall be at least 27 % and no more than 45 % by weight measured in accordance with ISO/R 1172-1975. The glass content must not vary with more than $\pm$ 4 %. All individual values must comply with these requirements.

3 DEFINITIONS

3.1 Unless otherwise expressly stated, the following terms apply:

p	dimensioning load
V	highest speed of the boat in knots
t	thickness of the laminate
W	section modulus in mm^3
W/s	section modulus per breadth unit mm^3/mm
l	span in mm of frames, stiffeners and beams
s	stiffener/frame/beam spacing in mm.

4 CORRECTIONS

4.1 The correction factors for laminate thickness according to 4.2 - 4.5 shall be used for calculating a resulting correction factor:

$$f = f1 * f2 * f3 * f4$$

however, always at least 0,7.

4.2 In case the laminate has a greater flexural strength than 130 N/mm^2, the laminate thickness according to formulae where (f) is a factor, may be multiplied by a factor:

$$f1 = \sqrt{130/Rmb}$$

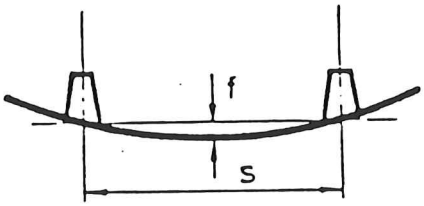
where Rmb is the flexural strength of the laminate.

4.3 When the ratio (a/b) between the sides in a not stiffened laminate panel (where (a) is the length of the greatest side and (b) the smallest) is less than 2, the laminate thickness according to formulae where (f) is a factor may be multiplied by a factor:

$$f2 = 0,6 + 0,2\ a/b$$

4.4 If the laminate has a significant curving, the laminate thickness according to formulae where (f) is a factor may be multiplied by a factor:

$$f3 = 1 - h/s, \text{ however, at least } 0,8.$$



4.5 If the core of the frames has a greater breadth (k) than 0,1 * s, the laminate thickness according to formulae where (f) is a factor may be multiplied by a factor:

$$f4 = 1,1 - k/s, \text{ however at least } 0,7.$$

4.6 The requirements in respect of section modulus are based on a tensile strength of at least 80 N/mm^2. When a laminate of higher tensile strength is applied, the requirements to section modulus may be reduced accordingly by multiplying with the factor

$$fw = 80/Rm$$

where Rm is the tensile strength of the laminate.

5 SANDWICH PANELS

5.1 The following requirements apply to load carrying sandwich panels consisting of a core with face laminates on both sides.

5.2 In these strength requirements it is considered that normal and flexural stress is carried by the faces while the shear stresses are carried by the core.

5.3 A sandwich-panel shall at least have the same strength as that specified for an equivalent single skin construction in those rule formulae where the stiffener spacing (s) is included. This is considered fulfilled when the section modulus per breadth unit (W/s) for the sandwich panel complies with the requirements in 11.2, 13.3 and 13.4. For the calculation (s) shall be taken as 1 mm and as l is taken the shortest side of the panel.

Examples of section modulus for panels are shown in figure 22.5. The requirements in respect of section modulus may be multiplied by the factor f6 shown in the figure in 5.5.

5.4 The core material in sandwich constructions must not have a lower shear strength than:

$$\tau = 0{,}25 * f7 * p * l/d \quad N/mm^2$$

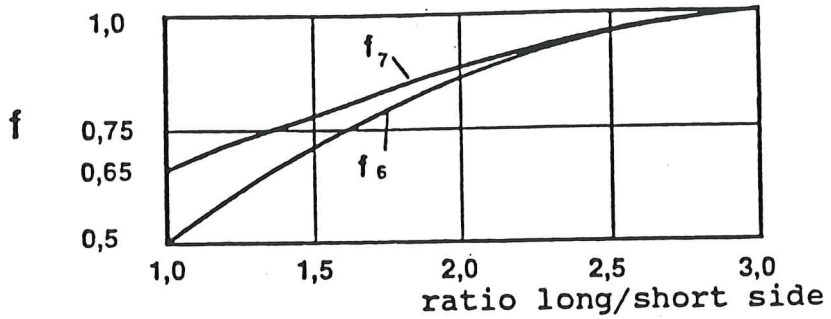
and must not be thinner than 0,01 l. In bottom panels the shear strength must not be lower than:

$$\tau = 0{,}046 * V \quad N/mm^2,$$

however at least 0,7 N/mm^2, where

- d distance between the middle of the faces
- l the shortest side of the panel
- f7 correction factor according to 5.5.

5.5 If the ratio between the long and short sides is less than 3 the required section modulus per breadth unit may be multiplied by the factor (f6) and the required shear strength by the factor (f7) shown in the figure below.



5.6 The thickness of the outer face laminate in the keel, stem, bottom, bilge and sides should normally not be less than 40 per cent and in deck 60 per cent of the requirement for a single skin construction given in the formulae where the stiffener spacing (s) is not included.

Thinner face laminates may be accepted in bottom and sides, provided it is verified by testing that the impact strength of the sandwich panel is at least equivalent to that of a single skin panel with minimum laminate thickness for the boattype in question.

5.7 The ratio between the thickness of the thinnest and thickest face laminate should normally not be less than 0,75.

6 KEEL

6.1 The basic requirement for laminate thickness is:

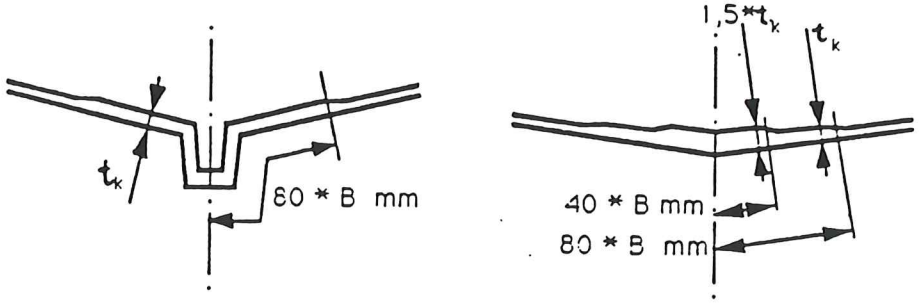
$$tk = 1{,}15\ (2{,}9 + 0{,}9 * f1 * Loa + 0{,}1 * V) \quad mm$$

A keel of type 1 shall have a section modulus of at least:

$$W = 3{,}45 * G * Loa \quad mm^3$$

where G is the lightweight of the boat in kg.

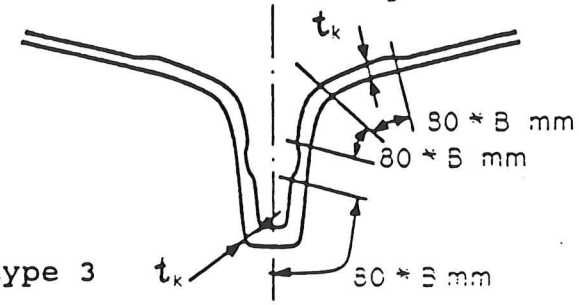
In this section modulus may be included laminate out to 5 * t from the profile. The thickness requirement is shown in the following figure:



Keel type 1 Keel type 2

B is the breadth of the boat in metres.

6.2 Keels of type 2 and skegs shall at least have thicknesses in accordance with the figure above. The thickness (tk) shall be kept at least down to the upper edge of the ballast moulded in. When a keel profile or equivalent inside strengthening is not fitted, the laminate thickness shall be at least as indicated in the figure for a type 3 keel.



Keel type 3

6.3 For hulls which are made in two halves, the laminate joining the two halves shall have the thickness required for a keel. The thickness of the original halves shall be tapered smothly towards the joining line over a width not less than 20 times the thickness of the laminate.

7 STEM AND BULWARK

7.1 The laminate in the stem shall have a thickness of at least

$$t = 1{,}15\ (2{,}9 + 0{,}9 * f1 * Loa) \quad mm$$

7.2 This laminate thickness shall be maintained over a transverse distance from the stem of at least 80 * B mm, but it need not have a breadth of more than 200 mm. A laminate joining of hull halves shall have the thickness which is required for a stem. The thickness of the original halves shall be tapered smoothely towards the joining line over a width not less than 20 times the thickness of the laminate.

8 BOTTOM

8.1 The bottom laminate is to extend at a constant thickness up to the larger of the following heights:

- up to the deepest load waterline
- up to a pronounced bilge

8.2 The thickness of the bottom laminate is to be not less than the greater of:

$$tb = 0{,}081 * f * s * \sqrt{p} \quad mm$$

$$tb = 1{,}15\ (1{,}4 + 0{,}5 * f1 * Loa + 0{,}08 * V) \quad mm$$

8.3 At a skeg or fin keel the difference in thickness between bottom laminate and keel laminate is to be tapered over a width of at least 40 times the thickness difference.

9 SIDE

9.1 The laminate thickness in the sides and in structural bulkheads must not be less than the greater of:

$$ts = 0{,}062 * f * s * \sqrt{p} \quad mm$$

$$ts = 1{,}15\ (1{,}7 + 0{,}5 * f1 * Loa) \quad mm$$

Superstructures shall have a thickness of at least 75 % of that given by the latter formula.

10 BILGE

10.1 If the radius of curvature in the bilge (chine) is less than 20 times the rule thickness of the bottom laminate, for a width of at least 100 mm on each side, the laminate thickness (t) is not be less than:

$$tc = 1{,}15\ (2{,}4 + 0{,}7 * f1 * Loa + 0{,}06 * V)$$

in mm, however not less than the actual bottom laminate thickness.

11 DECK AND SOLE

11.1 The laminate thickness of deck and soles (flooring) must not be less than the greater of:

$$tc = 0{,}063 * f * s * \sqrt{p} \quad mm$$

$$td = 1{,}05\ (1{,}6 + 0{,}4 * f1 * Loa) \quad mm$$

11.2 At the centre of their span the beams must not have a section modulus of less than:

$$W = 0{,}76 * fw * s * p * l^2 * 10^{-3} \quad mm^3$$

11.3 For small decks not exposed to loads, the required stiffening may be reduced.

12 SUPERSTRUCTURES AND DECKHOUSES

12.1 Superstructures and deckhouses exposed to sea loads shall be given scantlings as required for the hull sides. Sea load is considered to extend to a height stipulated in chapter C21.

12.2 The scantlings of superstructure decks and cabin tops, etc which are expected to be exposed to load by persons shall be in accordance with the requirements of paragraph 11.

13 LONGITUDINAL STIFFENING

13.1 When calculating the section modulus the effective flange shall be taken as the sum of 20 * t and the width of the stiffener.

13.2 Boats for a maximum speed of more than 6 * $\sqrt{L}$ knots should be longitudinally stiffened in the bottom.

13.3 The section modulus of longitudinal bottom frames should not be less than:

$$W = 1{,}15 * fw * s * p * l^2 * 10^{-3} \quad mm^3$$

Longitudinal steps and spray strips may be considered as stiffening.

13.4 The section modulus of longitudinal frames in the sides and stiffeners on structural bulkheads and superstructures subjected to sea loads should not be less than:

$$W = 0,725 * fw * s * p * l^2 * 10^{-3} \quad mm^3$$

Longitudinal steps and spray strips may be considered as stiffening.

13.5 Longitudinal frames are normally to be supported by transverse girders or transverse bulkheads.

13.6 Transverse girders for longitudinal frames are to be calculated as transverse frames. For boats with a pronounced keel profile the length is measured from the center line.

13.7 For planing boats without longitudinal stiffening in the form of a pronounced keel the bonding of the girders into the hull sides is to have a shear area not less than:

$$A = 0,0006 * s * b * p \quad mm^2$$

where

$$s = 0,5 * l_1 + 0,5 * l_2$$

l_1 and l_2 are the lengths of the span fore and aft of the transverse stiffener.

14 TRANSVERSE STIFFENING

14.1 Boats with a maximum speed of up to $6\sqrt{L}$ knots may have transverse stiffening with frames and only the keel construction as longitudinal stiffening.

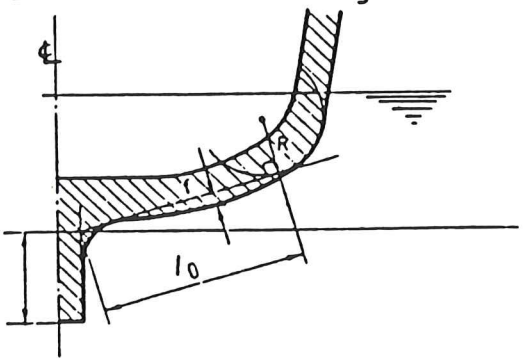
14.2 The transverse frames shall either be continuous across the keel or connected to transverse floors. The top of the frames shall be supported transversely by deck beams, deck laminate or longitudinal girders.

14.3 To the upper part of the bilge (chine) the section modulus of the transverse frames must not be lower than:

$$W = 0,69 * fw * s * p * l^2 * 10^{-3} \quad mm^3$$

where

$l = l_0 - 3 * f + 0,3 * R$ (the length of the frame in accordance with the figure below).



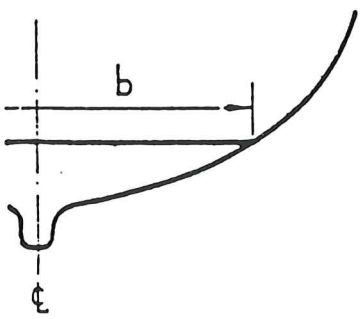
14.4 In the sides the section modulus at the upper part of the frame shall be at least 40 % of the value required for the bottom. The tapering from the top of the bilge shall be uniform.

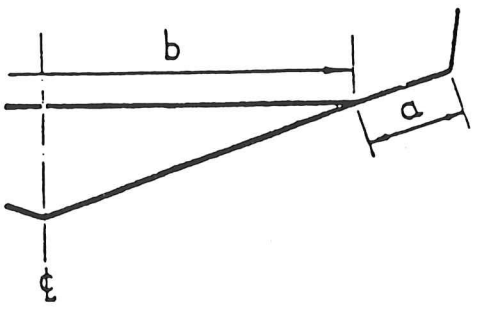
15 OTHER TYPES OF STIFFENING

15.1 Benches, flooring or other accommodation may replace side stiffeners if they are bonded properly to the hull along their full length.

15.2 The specified requirements for stiffening structure may be reduced provided the hull geometry itself contributes to the transverse or longitudinal strength.

15.3 In open boats the bottom stiffening may be wholly or partly made by a fixed bonded-in flooring. The breadth (b) must not be less than 0,25 * B. The distance (a) to the bilge (chine) must not be less than 0,15 * B.





15.4 If the hull is stiffened by foam, the foam is to have a sufficient compression and shear strength to provide adequate total stiffening of the bottom panels. The type of foam, its quality and the foaming process will be considered for approval in each individual case.

16 TRANSOM

16.1 Transom not subjected to loads from engine or rudder installation shall have scantlings as required for side laminate.

16.2 Transom for outboard motor mounting should be built as a sandwich-panel with a core of waterproof plywood or equivalent material. The lowest permitted total thickness for the parts of the transom subjected to loads from the engine installation is given in the table below:

Engine power as specified by the manufacturer		Total thickness of transom
kW	hk	mm
18 - 30	25 - 40	30
30 - 60	40 - 80	35
60 - 150	80 - 200	40

For higher power output the transom construction is considered in each individual case.

16.3 The transom for I/O units shall be built in accordance with 16.2, the total thickness shall, however, be increased by 5 mm beyond the table values.

16.4 The inner laminate on the core should not have a thickness of less than 60 % of that for the side and the outer not less than 60 % of that for the bottom. Here is referred to the formulae where the stiffening spacing (s) is not included. The inside laminate shall extend in the sides and bottom of the boat and be gradually tapered in thickness.

17 DESIGN DETAILS

17.1 Structures of glassfibre reinforced plastics should as far as practicable be designed with well rounded transitions and without sharp edges. Where sharp edges cannot be avoided, e.g. at steps and imitated lap strakes, which are subjected to high flexural stresses, compensation shall be provided by additional reinforcement strips or overmoulding with additional laminate. The geometry must not be too complicated and constructions which make survey and repair difficult shall be avoided.

17.2 Structural designs which will introduce tensile stresses (dragpåkänningar) perpendicular to the laminate shall be avoided where such stress may lead to delamination or peel-off.

17.3 The stiffening members must not have significant discontinuities. Load carrying ends shall be sniped or connected to other structural parts.

17.4 Thickness transitions shall have a smooth taper of at least 20 times the thickness difference and in case of heavily loaded laminates at least 40 times the thickness difference.

In the design of sandwich panels the following shall be taken into account:

- the face layers shall be carried continuously through frames and other stiffeners
- in transitions from sandwich panels to single skin laminates, the core shall be tapered smoothly over a distance of two times the core thickness
- in way of local compression loads perpendicular on the panel the face laminate shall be reinforced or a massive core inserted for efficient load distribution
- where frames, bulkheads and similar members are fastened the thickness of the face layer shall be at least equal to that of the fastening laminate. The face layer shall be tapered smoothly over a distance of 20 times the thickness difference.

18 ENGINE FOUNDATION

18.1 If the engine is mounted directly on longitudinal bottom stiffeners they shall be interconnected in the transverse direction and their scantlings shall be increased. The engine foundations shall be designed so that there will be sufficient stiffening between engine and shaft bearing.

18.2 The foundation shall be so designed that forces from engine, gear, pumps and shaft arrangements are properly transferred to the hull.

19 BALLAST KEEL

19.1 In the area of attachment of the ballast keel, the hull shall be stiffened.

19.2 Instead of an external ballast keel, ballast may be placed loose in a moulded keel built integral with the hull. The thickness of the laminate in way of the keel and its transition to the hull is determined on the basis of the expected loads on the structures. Loose ballast shall be moulded over to prevent any movement. Ballast of concrete may be placed only in a space where the laminate is coated with topcoat or protected in another way.

20 CLEATS

20.1 The hull and deck where cleats are attached shall be reinforced in such a way that a sufficient distribution of the loads is achieved.

20.2 The reinforcement may be extra thickness of laminate, embedded plywood, metal plate or similar. When working out these extra reinforcements the size and direction of the loads shall be taken into account. The matting-in shall cover a sufficiently large area around the insert and the individual layers of the laminate shall overlap well.

21 CONNECTIONS

21.1 Connections shall be of simple design and easily accessible for inspection. The construction shall be such that there will be no risk of delamination of the connected laminates.

21.2 Rivets, bolts and washers shall be of corrosion resistant material or be protected against corrosion.

21.3 Holes for rivets and bolts shall be drilled and shall have the same diameter as the rivet or bolt. The distance from the laminate edge shall be at least 2,5 times the hole diameter for rivets and 3 times the hole diameter for bolts.

21.4 In stressed connections the bolt head and the nut shall be fitted with washers of external diameter at least 2 times the hole diameter and a thickness of at least 0,1 times the hole diameter, minimum 0,5 mm. If the dimensions of the bolt head meet the requirements stipulated for the washer, the latter may be dispensed with. In highly stressed connections larger washers can be required.

21.5 In watertight connections a sealing agent shall be applied to the rivets/bolts before they are inserted.

21.6 Self tapping screws may be accepted in lightly stressed joints after consideration in each individual case. The screws shall be fitted perpendicular to the laminate. The laminate holding the screw shall have a sufficient thickness (at least 5 mm). Alternatively another screw hold may be fitted in or on the back of the laminate.

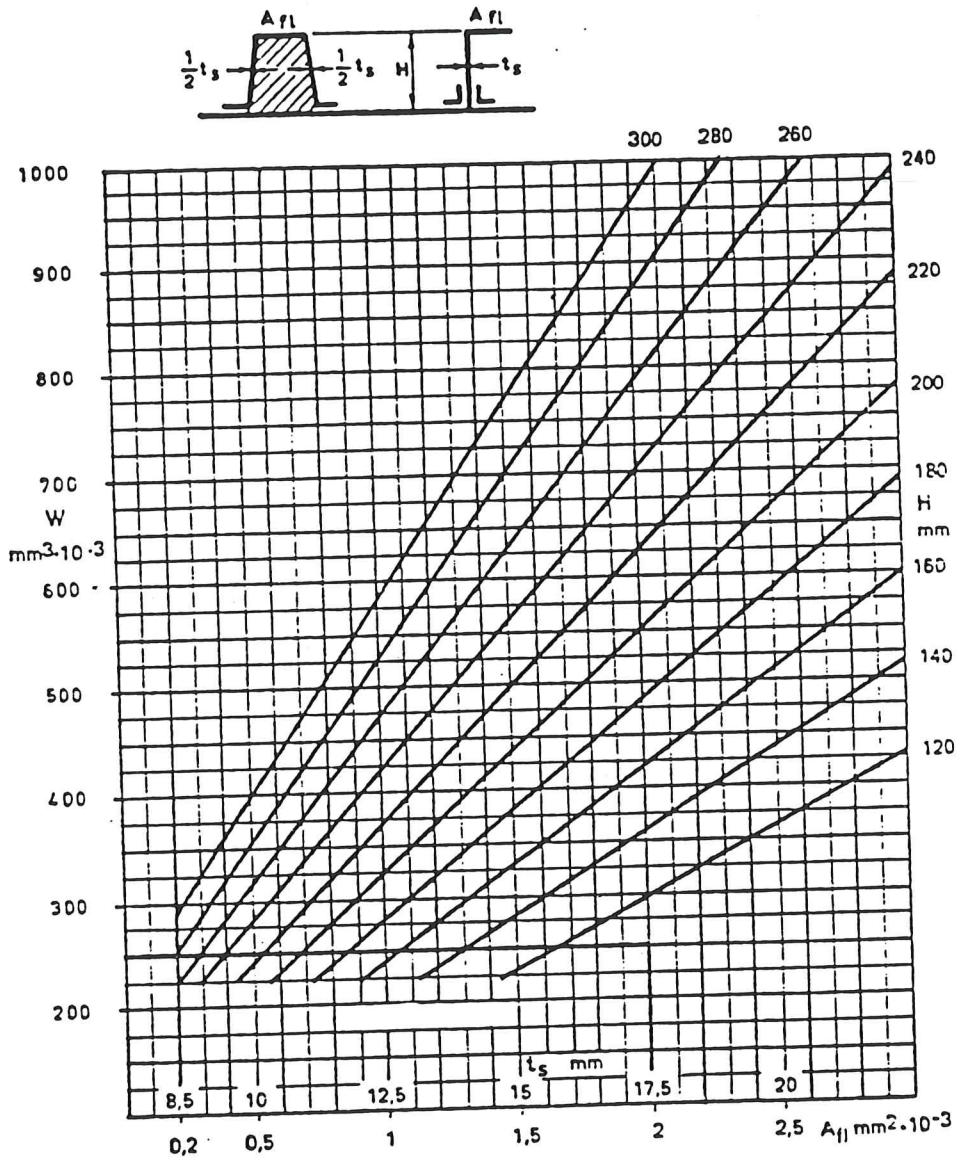


Figure 22.1

Section modulus, including contribution from the main laminate, for sections as function of flange area Afl, core height H and web thickness ts.

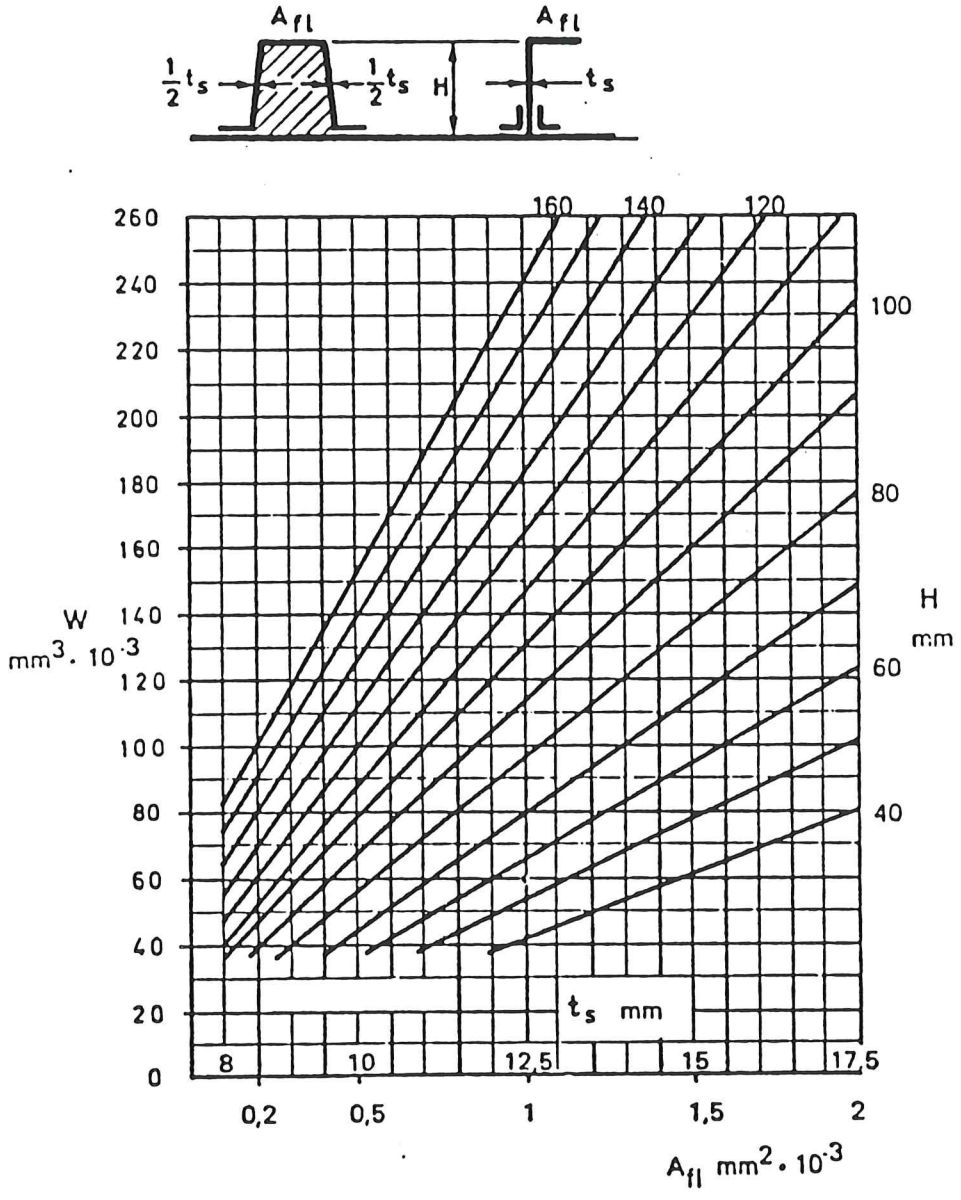
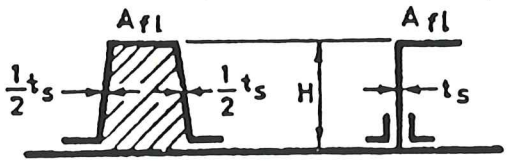


Figure 22.2

Section modulus, including contribution from the main laminate, for sections as function of flange area Afl, core height H and Web thickness ts.



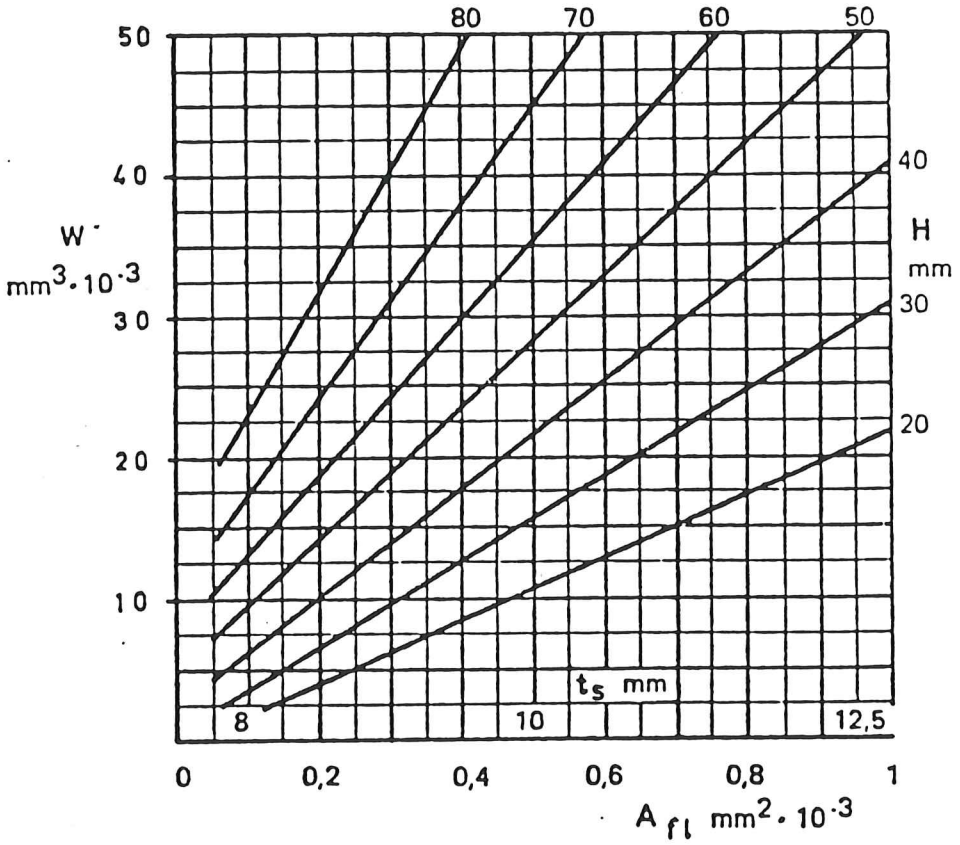


Figure 22.3

Section modulus including contribution from the main laminate of sections as funcition of flange area Afl, core height H and web thickness ts.

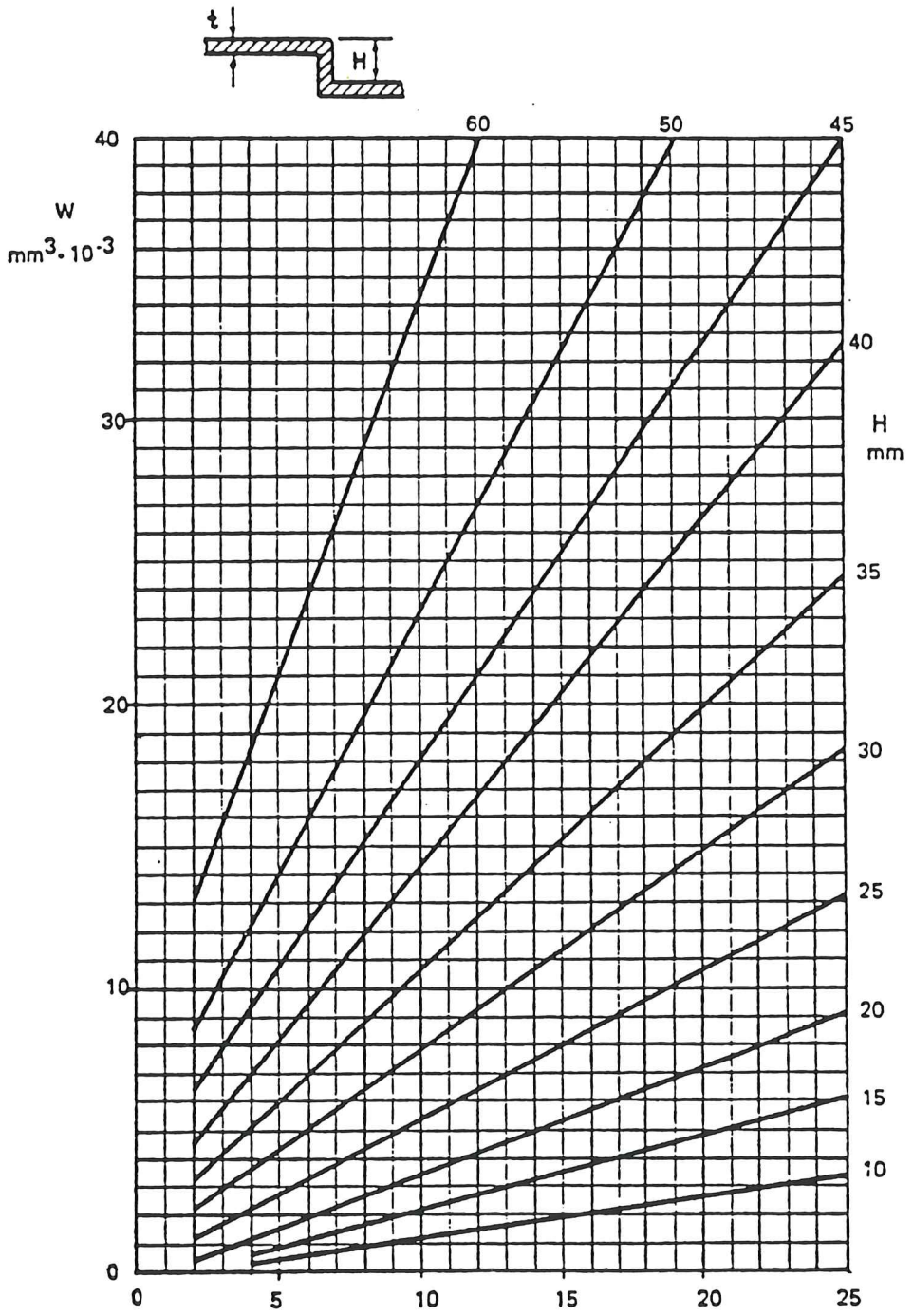


Figure 22.4

Section modulus of skin laminate steps as function of step height H and laminate thickness t.

DIMENSIONING OF STEEL BOATS C 23

Table of contents

1 MATERIALS

1.1 Normal shipbuilding steel shall have at least the following mechanical properties:

yield stress	240 N/mm^2
tensile strength	410 N/mm^2
ultimate strain	22 %

2 CORRECTIONS

2.1 The dimensioning is based on a material with yield stress $\sigma_{0,2}$ = 240 N/mm^2. If steel with another yield stress is used the requirement to plate thickness may be multiplied by:

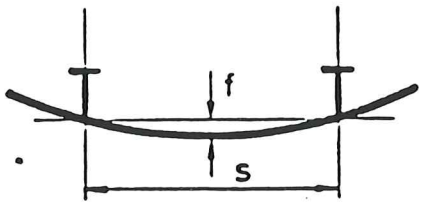
$$f1 = \sqrt{240 / \sigma_{0,2}}$$

2.2 When the ratio (a/b) between the sides in an unstiffened panel (where (a) is length of the largest side and (b) is length of the shortest side) is less than 2, the requirement to plate thickness may be multiplied by:

$$f2 = 0,6 + 0,2 * a/b$$

2.3 If the plate has a significant curvature, the requirement to thickness may be multiplied by:

$f3 = 1 - 0,8 * f/s$, however at least 0,85



2.4 For thickness of plates the correction factors are combined as follows:

$f = f1 * f2 * f3$

2.5 If the material has another yield stress than 240 N/mm^2, the section modulus may be multiplied by:

$fw = 240 / \sigma_{0,2}$

3 KEEL AND STEM

3.1 The keel and stem stiffening shall normally consist of a profile.

3.2 The section modulus for the keel profile with an effective flange (20 t) shall be at least:

$W = 1,04 * G * Loa \quad mm^3$

where G is the lightweight of the boat.

3.3 If there is no profile keel, intended as a wear keel, the thickness of the plates at centre line shall be increased to:

$t = 1,5 * tb \quad mm$

where tb is the thickness of the bottom plates according to 4.2.

The total breadth of the keel plate shall be at least

$b = 10 * Loa \quad mm$

4 BOTTOM PLATING

4.1 The thickness of plates in the bottom shall be continued to the greatest of the following heights:

- up to the bilge (chine);
- up to the load waterline.

4.2 The thickness of the plates in the bottom shall be equal to the greater of the following values:

$$tb = 0{,}049 * f * s \sqrt{p} \quad mm$$

$$tb_{min} = 1{,}15\ (0{,}4 + 0{,}2 * f1 * Loa + 0{,}04 * V)$$

5 SIDE PLATING AND BULKHEADS

5.1 The thickness of plates in the sides and in structural bulkheads shall be at least equal to the greater of the following values:

$$ts = 0{,}023 * f * s \sqrt{p} \quad mm$$

$$ts_{min} = 1{,}15\ (0{,}2 * f1 * Loa + 0{,}04 * V) \quad mm$$

$$tbulkhead_{min} = 0{,}75 * ts_{min} \quad mm$$

6 DECK PLATING

6.1 The thickness of plates in decks shall be at least equal to the greater of the following values:

$$td = 0{,}032 * f * s \sqrt{p} \quad mm$$

$$td = 1{,}05\ (0{,}8 + 0{,}2 * f1 * Loa) \quad mm$$

7 STIFFENINGS

7.1 As effective flange may be taken (20 t) of the plate panel, however not more than (s).

7.2 The section modulus of stiffenings in the bottom shall be at least:

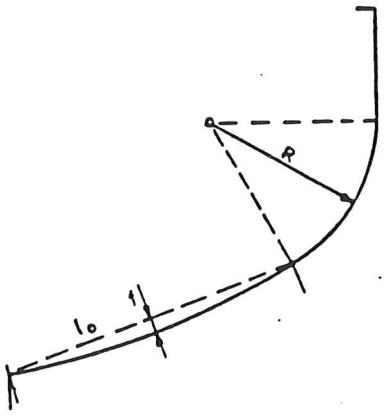
$$W = 1{,}73 * fw * s * p * l^2 * 10^{-4} \quad mm^3$$

7.3 The section modulus of stiffenings in the sides and in structural bulkheads shall be at least:

$$W = 1{,}27 * fw * s * p * l^2 * 10^{-4} \quad mm^3$$

7.4 When calculating the section modulus of transverse frames an (l) according to the following formula is used

$l = l_0 - 3 * f + 0,3 * R$ (the length of the frame in accordance with the figure below).



7.5 Deck beams shall have a section modulus of at least:

$$W = 1,68 * fw * s * p * l^2 * 10^{-4} \quad mm^3$$

7.6 Stiffeners should normally be profiles with flanges. If a plate profile without flange is used the stiffness against buckling should be checked

8 TRANSOM AND ENGINE FOUNDATION

8.1 The transom for outboard motors and stern drive (I/O units) shall be constructed so that the forces from the engine are transferred to the stiffening system in the hull.

8.2 The thickness of plates in the transom for outboard motors and stern drives is considered in each individual case but must never be less than the thickness required for the bottom. In case of larger outboard motors and stern drives the transom shall be strengthened with a beam construction which takes up the forces from the engine.

8.3 A transom which is not subjected to loads from the motor shall have scantlings as required for the side plating.

8.4 Inboard engines shall be mounted on an engine bed which shall be interconnected in the transverse direction. The engine bed shall be waningly extended beyond the ends of the engine for a distance equal to the length of the engine, however, at least 0,5 metre. The extension shall be carried regardless of bulkheads or other longitudinal stiffenings.

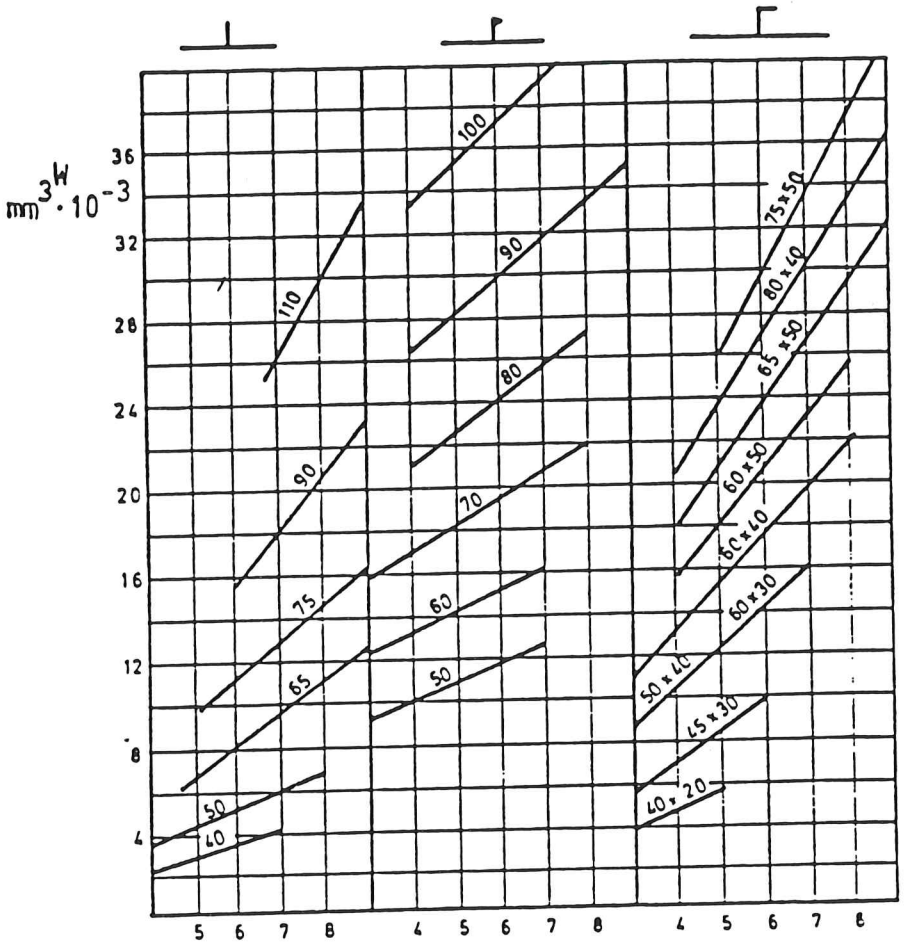
9 SUPERSTRUCTURE, DECKHOUSE AND STRENGTHENINGS

9.1 Superstructures and deckhouses exposed to sea pressure shall be dimensioned as required for the side plating.

9.2 Superstructure decks, cabin tops, etc which are expected to be exposed to loads by persons shall be dimensioned as for decks.

9.3 Outlets and holes in the hull with a diameter of more than 250 mm shall be strengthened.

9.4 Hull and deck where cleats shall be attached shall be strengthened so that a sufficient distribution of the load is achieved.



Section modulus for profiles welded to plates with a thickness of 4 to 6 mm. The values at the curves refer to profile height in mm.

DIMENSIONING OF ALUMINIUM BOATS

C 24

Table of contents

1 MATERIALS

1.1 Materials of the following categories shall normally be used:

category 1 non-heat treatable alloy examples

content limitations		ASTM	DIN 1725
		5052	AlMg2,5
Cu max	0,2 %	5083	AlMg4,5Mn
Fe max	0,5 %	5086	AlMg4Mn
Mg min	2,0 %	5154	AlMg3
		5454	AlM2,7Mn

category 2 treatable alloy examples

content limitations		ASTM	DIN 1725
		6005	AlMgSi0,7
Cu max	0,4 %	6063	AlMgSi0,5
Fe max	0,5 %	6351	AlMgSi1

In table 24.1 some common alloys and their strength properties are listed.

2 CORRECTIONS

2.1 The dimensioning is based on materials with a yield stress of:

$$\sigma_{0,2} = 170 \text{ N/mm}^2$$

If aluminium with another yield stress is used, the plate thickness shall be corrected by the following factor:

$$f1 = \sqrt{170/\sigma_{0.2}}$$

For welded constructions the yield stress is calculated as follows if not otherwise documented:

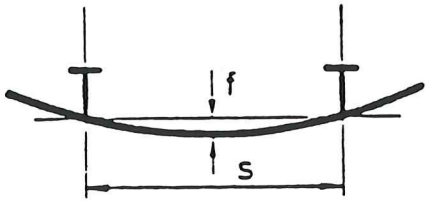
$$\sigma_{0,2 \text{ welded}} = \sigma_{0.2} * \sigma_{B \text{ welded}} / \sigma_B$$

2.2 When the ratio (a/b) between the sides of an unstiffened panel (where (a) is the length of longest side and (b) the length of the shortest side) is less than 2 the plate thickness may be multiplied by the factor f2:

$$f2 = 0,6 + 0,2 * a/b$$

2.3 If the plating has a pronounced curvature the plate thickness may be multiplied by the factor f3:

$$f3 = 1 - 0,8 * f/s, \text{ however at least } 0,85$$



2.4 If the stiffeners have a breadth (k) greater than (0.1 s), the plate thickness may be multiplied by the factor f4:

$$f4 = 1,1 - k/s, \text{ however at least } 0,7$$

2.5 If more than one correction is used at the same time the total correction of the thickness will be:

$$f = f1 * f2 * f3 * f4$$

2.6 Sandwich constructions shall be performed after the same principle as that in chapter C22 section 5.

2.7 If aluminium with another yield stress than 170 N/mm^2 is used, the section modulus shall be corrected by the factor fw

$$fw = 170/\sigma_{0,2}$$

where $\sigma_{0,2}$ is the yield stress, for a welded construction the $\sigma_{0,02\ welded}$ shall be used, see 2.1.

3 KEEL, STEM AND BILGE

3.1 The reinforcement of the keel and the stem shall normally be a profile.

3.2 The section modulus for the keel profile with an effective-flange (20 t) shall be at least:

$$W = 1,44 * G * Loa \quad mm^3$$

where G is the lightweight of the boat.

3.3 If there is no profile keel, intended as a wear keel, the thickness of the plates at the centre line shall be increased to

$$t = 1,5 * tb \ mm$$

where tb is thickness of the bottom plates according to 4.

The total breadth of the keel plate shall be at least:

$$b = 10 * Loa \quad mm$$

3.4 Keel, stem, bilge area and other parts which are particularly exposed to wear shall be designed so that the strength in joints are not significantly decreased through wear.

4 BOTTOM PLATING

4.1 The thickness of the plates in the bottom shall be continued to the greatest of the following heights:

- up to the bilge
- up to the load waterline.

4.2 The thickness of the plating in the bottom shall be equal to the greater of the following values:

$$tb = 0,049 * f * s * \sqrt{p} \quad mm$$

$$tb = 1,15\ (0,4 + 0,2 * f1 * Loa + 0,04 * V)\ mm$$

5 PLATING IN THE SIDES AND IN BULKHEADS

5.1 The thickness of plates in the sides and in structural bulkheads shall be at least equal to the greater of the following values:

$$ts = 0,028 * f * s * \sqrt{p} \quad mm$$

$$ts_{min} = 1,15\ (0,2 * f1 * Loa + 0,04 * V)$$

for bulkheads $0,75\ ts_{min}$

6 DECK PLATING

6.1 The thickness of plates in decks shall be at least equal to the greatest of the following values:

$$td = 0,038 * f * s * \sqrt{p} \quad mm$$

$$td = 1,05\ (0,8 + 0,2 * f1 * Loa),\ \text{min } 1,5\ mm$$

7 STIFFENINGS

7.1 As effective flange may be taken (20 t) of the plate panel, however not more than (s).

7.2 The section modulus of stiffenings in the bottom shall be at least

$$W = 2,4 * fw * s * p * l^2 * 10^{-4} \quad mm^3$$

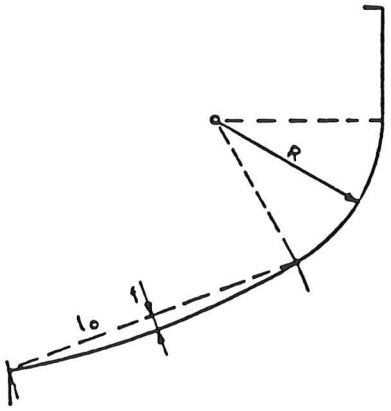
7.3 The section modulus of stiffenings in the sides and in structural bulkheads shall be at least

$$W = 1,5 * fw * s * p * l^2 * 10\text{-}4 \quad mm^3$$

7.4 When calculating the section modulus of transverse frames an (l) according to the following formula is used:

$$l = l_o - 3f + 0,3\ R$$

where lo is length of the straight part of the frame in the bottom as shown in the sketch below.



7.5 Deck beams shall have a section modulus of at least:

$$W = 2,4 * fw * s * p * l^2 * 10^{-4} \quad mm^3$$

7.6 The stiffenings should normally be of a profile with a flange. If a plate profile without flange is used the stiffness against buckling should be controlled.

8 TRANSOM AND ENGINE FOUNDATION

8.1 The transom for outboard motors and stern drive (I/O units) shall be constructed so that the forces from the engine are transferred to the stiffening system in the hull.

8.2 The thickness of plates in the transom for outboard motors and stern drives (I/O units) is considered in each individual case but must never be less than the thickness required for the bottom. In case of larger outboard motors and stern drives (I/O units) the transom shall be strengthened with a beam construction which takes up the forces from the engine. For outboard motors below 7,4 kW (10 hk), strengthenings of plywood on the transom can be accepted.

8.3 A transom which is not subjected to loads from the engine shall have scantlings as required for the side plating.

8.4 Inboard engines shall be mounted on an engine bed which shall be interconnected in the transverse direction. The engine bed shall be waningly extended beyond the ends of the engine for a distance equal to the length of the engine, however, at least 0,5 metre. The extension shall be carried regardless of bulkheads or other longitudinal stiffenings.

9 SUPERSTRUCTURES, DECKHOUSES AND STRENGTHENINGS

9.1 Superstructures and deckhouses exposed to sea pressure shall be dimensioned as required for the side plating.

9.2 Superstructure decks, cabin tops, etc which are expected to be exposed to loads by persons shall be dimensioned as for decks.

9.3 Outlets and holes in the hull with a diameter of more than 250 mm shall be strengthened.

9.4 Hull and deck where cleats shall be attached shall be strengthened so that a sufficient distribution of the load is achieved.

Table 24.1

Examples of category 1 marine grade aluminium. Three conditions are listed for each alloy.

Alloy	Condition 1)	Yield stress $\sigma_{0,2}$ N/mm^2	Ultimate strength σ_B N/mm^2	Elongation A_5 %	Ultimate strength as welded $\sigma_{B\ welded}$ N/mm^2
ISO AlMg2,5					
DIN AlMg2,5	W17(.10)	60	170	20	170
AA 5052	O	65	170	17	170
DIN AlMg2,5	F23 (.26)	180	230	5	170
AA 5052	H34	180	235	4	170
DIN AlMg2,5	F27(.30)	240	270	3	170
AA 5052	H38	220	270	4	170

Alloy	Condition 1)	Yield stress $\sigma_{0,2}$ N/mm²	Ultimate strength σ_B N/mm²	Elongation A_5 %	Ultimate strength as welded $\sigma_{B\ welded}$ N/mm²
ISO AlMg3Mn					
DIN AlMg2,7Mn	F22(0.7)	100	215	17	215
AA 5454	0	85	215	12	215
DIN AlMg2,7Mn	G25(.25)	180	245	10	215
AA 5454	H32	180	250	5	215
DIN AlMg2,7Mn	G27(.27)	200	270	9	215
AA 5454	H34	200	270	4	215
ISO AlMg3					
DIN AlMg3	W19(.10)	80	190	20	190
AA 5154	0	75	205	13	205
DIN AlMg3	F24(.26)	190	240	5	190
AA 5154	H32	180	250	6	205
DIN AlMg3	F29(.30)	250	290	3	190
AA 5154	H36	220	290	5	205
ISO AlMg4Mn					
DIN AlMg4Mn	W24(.10)	100	240	18	240
AA 5086	0	95	240	16	240
DIN AlMg4Mn	F30(.26)	240	300	5	240
AA 5086	H34	235	300	5	240
DIN AlMg4Mn	F33(.28)	270	325	4	240
AA 5086	H36	260	325	4	240
ISO AlMg4,5Mn					
DIN AlMg4,5Mn	W28(.10)	125	275	17	275
AA 5083	0	125	275	16	275
DIN AlMg4,5Mn	G31(.25)	205	310	10	275
AA 5083	H32	235	310	8	275
DIN AlMg4,5	G35(.27)	270	345	6	275
AA 5083	H34	270	345	6	275

Examples of category 2 marine grade aluminium. Profiles and rods according to DIN 1748 and ASTM B 221 standards. Two conditions are listed for each alloy. The conditions given within brackets refer to "werkstoff no." according to DIN 17007.

Alloy	Condition 1)	Yield stress $\sigma_{0,2}$ N/mm²	Ultimate strength σ_B N/mm²	Elongation A_5 %	Ultimate strength as welded $\sigma_{B\ welded}$ N/mm²
ISO Al-SiMg					
DIN AlMgSi0,7	-				
AA 6005	T1	105	170	14	130
DIN AlMgSi0,7	F27(.61)	225	270	8	160
AA 6005	T5	240	260	8	155
ISO Al-MgSi					
DIN AlMgSi0,5	F13(.51)	65	130	15	100
AA 6063	T4	70	130	12	100
DIN AlMgSi0,5	F22(.71)	160	215	12	110
AA 6063	T6	170	205	7	115
ISO Al-SiMgMn					
DIN AlMgSi1	F21(.51)	110	205	14	160
AA 6351	T4	130	220	14	175
DIN AlMgSi1	F28(.71)	200	275	12	170
AA 6351	T6	255	290	8	180

DIMENSIONING OF WOODEN BOATS

C 25

Table of contents

1 DEFINITIONS

1.1 Unless otherwise stated, the following symbols apply:

- p load factor
- v maximum speed of the boat in knots
- t material thickness in mm
- W section modulus in mm^3
- l length of span of frames, stiffeners and beams in mm
- s spacing of frames, stiffeners and beams in mm measured between their centrelines.

2 GENERAL

2.1 The dimensioning requirements for boats with transverse frames are based on that the speed does not exceed 15 knots.

2.2 The dimensioning requirements for planing boats with a speed of more than 15 knots are based on that the boats have longitudinals in the bottom.

2.3 Boats with longitudinal planking shall have transverse framing.

3 WEIGHT CLASSES FOR TIMBER

3.1 The requirements for scantlings and moduli are based on use of air-dried timber which shall have the following standard weights at 15% moisture content:

Double grown frames Bent frames Engine seats	$v_r = 720$ kg/m^3
Keel Keelson Hog Stem Sternpost Counter timber Knees	$v_r = 640$ kg/m^3
Outside planking, except clinker Longitudinals Laminated frames Stringers Deck beams Covering board	$v_r = 560$ kg/m^3
Clinker planking Deck planking Deckhouse	$v_r = 430$ kg/m^3

3.2 Boats with a length of less than 6 metres may be built of timber weighing less than stated in the table above on condition that the necessary strength can be achieved.

4 CORRECTIONS

4.1 If the weight of the timber used is different from the table values, the scantlings shall be correct in direct proportion:

$$f_1 = vr/va, \quad \text{minimum } 0,9$$

where

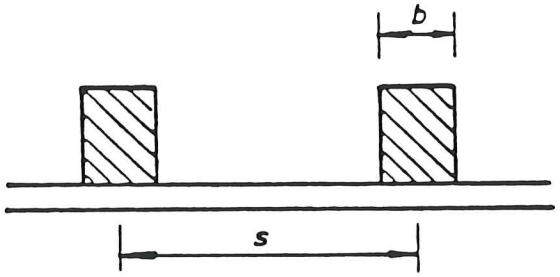
vr is the weight of timber according to table
va actual weight of the timber concerned

4.2 Where the width of the frames exceeds (0,1 s), the thickness of the outside planking required by a formula where (f) appears, may be corrected by multiplication by the factor (f2):

$$f_2 = 1,1 - b/s, \quad \text{minimum } 0,8$$

where

b is width of frames
s spacing of frames



4.3 If both corrections are used the correction factor is as follows:

$$f = f_1 * f_2$$

5 KEEL AND STEM

5.1 The section modulus of keel and stem for massive timber shall not be less than:

$$W = 8 * f * Loa^2 * 10^3 \quad mm^3$$

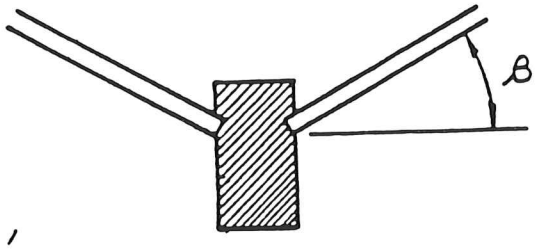
and for laminated timber not less than:

$$W = 6,4 * f * Loa^2 * 10^3 \quad mm^3$$

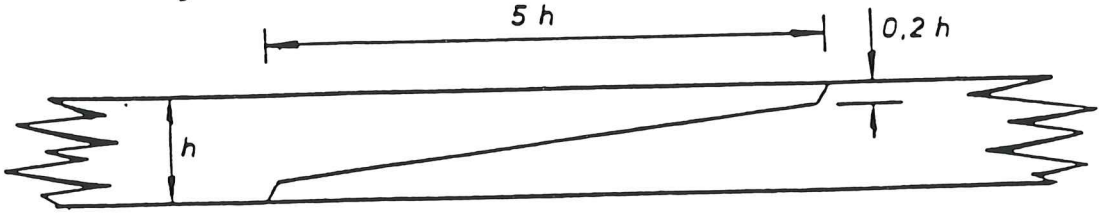
The aspect ratio of moulding/siding is not to be less than 2 and not to exceed 3.

The section modulus may be corrected for raised bottom and acute angle of outside planking to stem by multiplying the rule demand with the following factor:

$$k = 1,5 - 0,025 * \beta, \quad \text{minimum } 0,5.$$



5.2 The keel should preferably be built in one unit. When a scarf is necessary, its length shall be at least 5 times the height of the keel. The scarf shall be bolted by minimum 6 bolts, three on each side of the centre line. A scarf must not be at the location longitudinally of the engine seating ends. Boats intended for running up on the shore shall be provided with an extra wear keel and strengthened stem.



5.3 Displacement boats with a length overall of more than 8 metres shall within 0,7 Loa amidships have a keelson with dimensions not less than

breadth (b) = 12 * Loa mm

height (h) = 10 * Loa - 40 mm

5.4 On boats with a length overall of more than 6 metres the frames shall be fastened to the keel by through bolts of diameters of not less than:

d = 1,0 * Loa mm

The keel bolts shall go through keel, inner keel, keelson and frame or floor and shall be fitted in a zigzag manner.

5.5 On boats with a length overall of less than 6 metres the keel may be fastened by screws to the frames and floors or vice versa. There shall be two screws in each frame and their diameter shall not be less than 6 mm.

5.6 The ballast keel shall be sufficiently fastened by bolts of stainless steel or equivalent material with respect to the keel material. The number and diameter of the bolts is determined in each individual case.

5.7 For boats with clinker planking or plywood planking the contact surface of the inner keel against the planking shall have a thickness and breadth of at least 1,5 times the thickness of the planking.

If necessary in order to achieve a sufficient contact surface against the planking, an inner stem (apron) shall be built-in and have a thickness of at least:

$$t = 20 + 4 * Loa \quad mm$$

The inner stem shall be fastened to the stem by through bolts of the same diameter as the keel bolts.

5.8 The thickness of the stern post on each side of the sterntube shall be at least 3 Loa mm.

5.9 The thickness of deadwoods shall not be less than the thickness of the keel and stem. The length of the arms on each side of the joint between keel and stem shall be at least:

$$l = 150 + 40 * Loa \quad mm$$

The deadwoods shall be fastened to the keel and stem with at least two bolts with the same diameter as the keel bolts in each arm of the deadwoods.

6 DOUBLE GROWN FRAMES

6.1 By double grown frames is meant that two frames are bolted together with their butts staggered (overlapping in the middle). If the frame is straight enough to be without butts, e.g. in the foreship, the frames may be single.

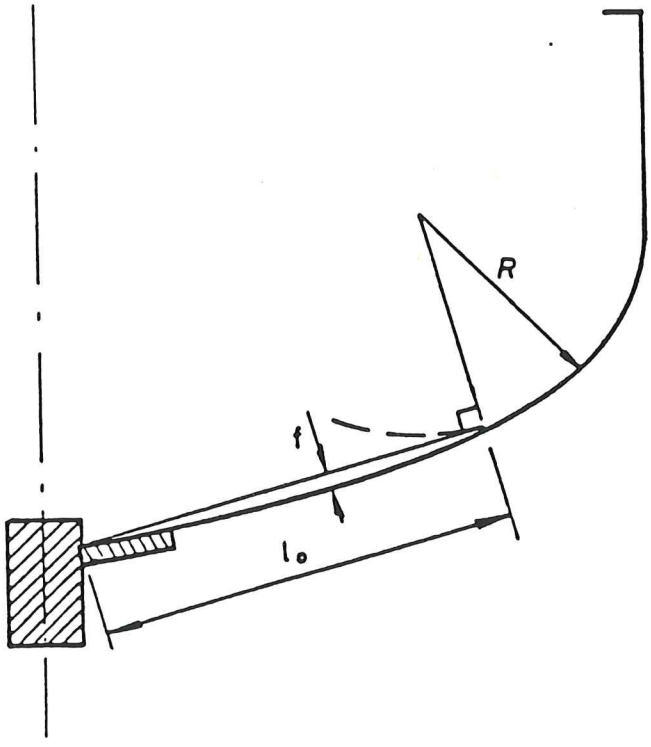
6.2 The section modulus of each frame section in the bottom shall not be less than:

$$W = 4,8 * f * s * p * l^2 * 10^{-3} \quad mm^3$$

where

$l = l_0 - 3 * f + 0,3 * R$ (the length of the frame in accordance with the figure below).

The ratio height/breadth shall not exceed 1.5.



6.3 The section modulus above the bilge may be reduced gradually to 0,5 W by the top of the frames.

6.4 Double grown frames shall normally be fastened together by at least three 10 mm bolts.

6.5 Butts shall be fitted closely and stagger at least:

$$l = 100 + 100 * B \quad \text{mm}$$

where B is the extreme breadth of the hull in metres.

6.6 When the angle of frame against the planking in the fore and aft ship exceeds 60 degrees, the frames shall be fitted perpendicularly to the planking.

7 LAMINATED FRAMES

7.1 The section modulus of the frames in the bottom shall not be less than:

$$W = 3,7 * f * s * p * l^2 * 10^{-3} \quad \text{mm}^3$$

7.2 The section modulus above the bilge may be reduced gradually to 0,5 W by the top of the frames.

7.3 The height of the frames must not be greater than the breadth.

7.4 Where the frames are continuous across the keel, the height in the centre line shall not be less than that required for floors.

8 LONGITUDINALS

8.1 The section modulus of the longitudinals must not be less than:

$$W = 4,6 * f * s * p * l^2 * 10^{-3} \quad \text{mm}^3$$

8.2 The section modulus of the uppermost longitudinal shall be not less than 1,3 times that required for longitudinals in the side of the boat and it shall extend from stem to stern. On boats with a raised deck forward, the longitudinal below the forecastle shall extend from stem to stern.

8.3 Longitudinals shall normally be supported by bulkheads or web frames.

9 WEB FRAMES

9.1 The section modulus of web frames shall not be less than:

$$W = 3,7 * f * s * p * l^2 * 10^{-3} \quad mm^3$$

where

$$s = 0,5 * l_1 + 0,5 * l_2$$

l_1 and l_2 are the lengths of the span fore and aft of the transverse stiffener.

10 BENT FRAMES

10.1 The section modulus of bent frames shall be at least:

$$W = 3,7 * f * s * p * l^2 * 10^{-3} \quad mm^3$$

10.2 Several bent frames may be installed one after the other and the section modulus may be calculated for the collected thickness. Each layer shall not be less than 15 mm.

10.3 Where a bent frame is continuous across the keel, the necessary spacer blocks shall be inserted as an alternative to floors. The spacer block and the frame shall together fulfil the requirement for floors.

10.4 Carvel built boats shall not be built with only bent frames. In boats where it is used a combination of built (laminated/double grown frames) and bent frames, the number of bent frames shall not exceed three between each built (shaped) frame.

10.5 When intermediate bent frames do not fulfil the requirements in 10.1, this shall be taken into account in the correction of the requirement in respect of built frames by multiplying the spacing of the built frames with the following factor:

$$f = 1 - 0,5 * W_{bent} / W_{built}$$

where

W_{built} is the requirement for built frames
W_{bent} sum of bent frames between built frames.

11 ENGINE SEATS

11.1 The engine seat shall be arranged in the longitudinal direction and be mounted on floors. It shall be dimensioned with respect to the frame spacing and size of the engine.

11.2 The engine seat shall be sufficiently stiffened sideways if the floors do not give a sufficient transverse support.

11.3 The engine seat shall be through bolted to floors and planking. The number and dimension of the bolts shall be at least equal to those for the engine fastening bolts. The bolts shall be accessible for tightening also after the engine has been installed.

11.4 The engine seat longitudinals shall extend at least 500 mm forward and aft of the engine.

12 FLOORS

12.1 Floors shall be installed (mounted) at each transverse frame.

12.2 The floors shall have at least the same breadth as the frames and the height in the center line (h1) shall be at least:

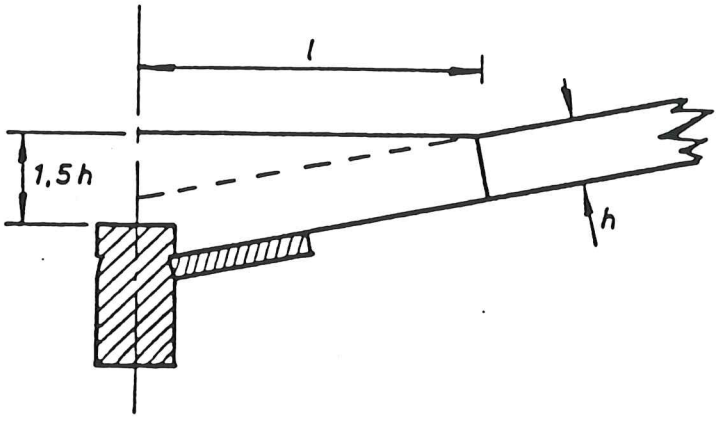
$$h1 = 1,5 * h \quad mm$$

where h is the height of the frames in the bottom in mm.

12.3 The length of the floors from the center line shall be at least:

$$l = 100 + 100 * B \quad mm$$

where B is the greatest breadth of the hull in m.



13 CLINKER PLANKING

13.1 The thickness of the planking shall not be less than the greater of the following values:

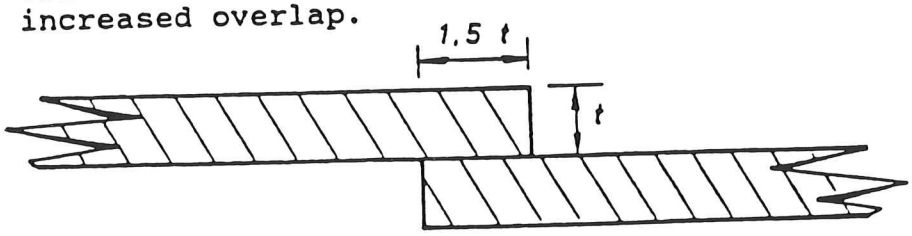
$$t = 0{,}39 * f * s \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 2{,}2 * \text{Loa} \quad \text{mm, however minimum 12 mm.}$$

13.2 The thickness of the sheer strake on 0,5 Loa midship shall be at least 1,5 times the thickness of the planking. On boats with a transom the increased thickness shall extend to the transom.

13.3 The breadth of each plank shall not exceed 200 mm.

13.4 The overlap of clinker shall be at least 1,5 times the plank thickness. The increased thickness of the sheer strake does not require an increased overlap.



13.5 The spacing of rivets shall not exceed 110 mm. Overlaps shall be clenched to each frame except where through bolts are in way of a beam stringer and bilge stringer, etc.

13.6 Butts in the planking shall be strapped between frames. The thickness of the butt straps shall not be less than the thickness of the planking and the length not less than:

$$l = 30 + 5 * t \quad \text{mm}$$

where t is the thickness of the planking.

The butt straps shall be clenched to the planking.

14 CARVEL PLANKING

14.1 The thickness of the planking shall not be less than the greater of the following values:

$$t = 0{,}52 * f * s \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 2{,}4 * \text{Loa} \quad \text{mm, however min. 15 mm.}$$

14.2 The thickness of the sheer strake on 0,5 Loa midship shall not be less than 1,2 times the thickness of the planking. On boats with a transom the increased thickness shall be extended to the transom.

14.3 The planking shall be fastened to double grown frames and laminated frames by:

- two nails or screws in planks 150 mm wide or less
- three nails or screws in planks wider than 150 mm
- two nails or screws in butt ends

and to intermediate bent frames by:

- two rivets

Nails and screws may be omitted where through bolts are used in way of beam stringer.

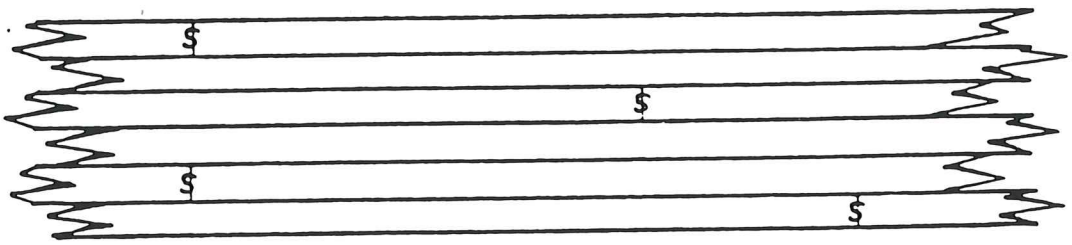
14.4 Spacing of butts shall not be less than:

600 + 30 * Loa mm where butts are on adjacent strakes

400 + 20 * Loa mm where one passing strake is between the butts

200 + 10 * Loa mm where two passing strakes are between the butts.

At the same frame where three passing strakes are between the butts.



14.5 Butts in the planking shall either be placed on a double grown frame or strapped between frames. The thickness of the butt strap shall not be less than the thickness of the planking and the length not less than:

$$l = 30 + 5 * t \quad \text{mm}$$

where t is the thickness of the planking.

The width of the butt strap shall be sufficient to overlap the adjacent planks by at least 50 mm. The butt strap shall be clenched to both planks and adjacent planks.

15 STRIP PLANKING

15.1 The thickness of the planking shall not be less than the greater of the following values:

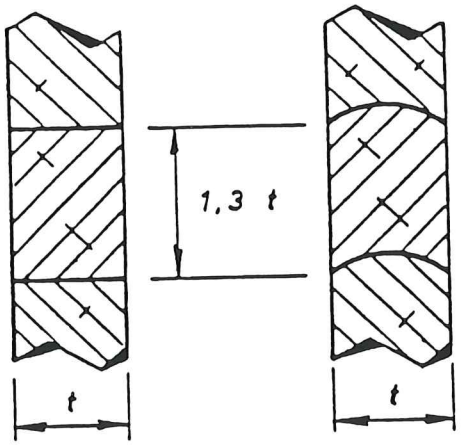
$$t = 0{,}39 * f * s \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 2{,}2 * Loa \quad \text{mm, however min. 12 mm}$$

15.2 The thickness of the sheer strake on 0,5 Loa midship shall be at least 1,2 times the thickness of the planking. On boats with a transom the increased thickness shall extend to the transom.

15.3 The width of the strips shall normally be 1,3 times the thickness. Strips at the deck and at the keel may have a breadth of up to 200 mm.

15.4 The strip edges may be planed or rounded and shall be such that the joining surfaces fit close to each other.



16 PLYWOOD PLANKING

16.1 The thickness in the bottom shall not be less than the greater of the following values:

$$t = 0{,}2 * f * s \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 1{,}2 * Loa \quad \text{mm, however min. 6,0 mm.}$$

16.2 The thickness in the sides shall not be less than the greater of the following values:

$t = 0,2 * f * s \sqrt{p}$ mm

$t = 2,0 + 1,4 * Loa$ mm, however min. 4,0 mm.

The plywood shall be fitted in as large panels as practicable.

17 LAMINATED PLANKING

17.1 The thickness of the planking shall not be less than the greater of the following values:

$t = 0,2 * f * s \sqrt{p}$ mm

$t = 2,0 + 1,4 * Loa$ mm, however min. 6,0 mm.

17.2 The thickness of each individual layer shall not be more than 3,5 mm and the width shall not exceed 130 mm.

17.3 The veneers shall normally have an angle of 45 degrees against the keel line.

18 TRANSOM

18.1 The thickness of the transom shall not be less than the thickness of the planking.

18.2 The transom shall be sufficiently fastened to the bottom and sides by frames and knees.

18.3 Transoms for outboard engines shall be strengthened in such a way that the load is distributed to the stiffening system of the boat.

19 BEAM STRINGERS AND BILGE STRINGERS

19.1 Boats with a length overall of more than 8 metres, without longitudinals, shall have beam stringers extending from stem to stern and bilge stringers on 0,5 Loa midships. On boats with a raised deck the lower beam stringer shall extend from stem to stern.

19.2 The scantlings of beam stringers and bilge stringers shall be at least:

width:	$10 + 11 * Loa$	mm
thickness:	$0,3 * b$	mm

where b is the breadth of the planking.

19.3 The bilge stringer shall be fitted on the center of the bilge or where a straight line from the under side of the keel touches the planking of the bilge at amidship.

19.4 Beam stringers and bilge stringers shall be fastened to each frame with a bolt of the same diameter as the bolt fastening the frame to the keel.

20 DECK BEAMS

20.1 The section modulus of the beams shall be at least, for massive timber:

$$W = 1,2 * f * s * p * l^2 * 10^{-3} \quad mm^3$$

and for laminated timber:

$$W = 0,9 * f * s * p * l^2 * 10^{-3} \quad mm^3$$

20.2 The beams shall have a camber of at least 22 mm for each metre of the breadth of the boat.

20.3 Each beam shall normally be fastened to a frame. Beams fastened to beam stringer or other longitudinal stiffening between the frames, may be accepted.

20.4 Deck beams below a superstructure, mast, deck fitting, etc shall be supported by a bulkhead or pillars.

20.5 The thickness of beam knees shall be at least 0,75 times the beam height. The length of the arms shall be at least:

$$l = 200 + 40 * B \quad mm$$

20.6 Beam knees shall be fastened to frame and beam with at least two bolts in each arm of the knee.

21 BREASTHOOK AND AFTERHOOK

21.1 All boats shall have a breasthook and afterhook closely fitted to the uppermost longitudinal stiffening, the top of the frames or to the uppermost planking strake.

21.2 The breasthook and afterhook shall have an arm length of at least:

$$l = 300 + 20 * B \quad mm$$

where B is the greatest breadth of the hull in metres.

21.3 A breasthook and afterhook shall be fastened by at least five 10 mm through bolts, the bolt in the middle shall go through the stem and the others through frame and planking. On boats with longitudinal stiffenings on the top of the frames the breasthook and afterhook may be glued and fastened with screws to the longitudinal stiffening.

22 DECK PLANKING

22.1 The thickness of the deck planking shall when the planks are glued to each other be at least equal to the greater of the following values:

$$t = 0{,}27 * f * s \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 2{,}1 * Loa \quad \text{mm, minimum 12 mm}$$

and when the planks are not glued to each other:

$$t = 0{,}00042 * f * s^2 \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 2{,}4 * Loa \quad \text{mm, minimum 15 mm.}$$

22.2 The width of the deck planks shall not exceed 130 mm. If the decking is glued, the width of the planks shall not exceed 80 mm.

22.3 The deck planks shall be fastened to each beam in the following way:

- one nail or screw when the plank is less than 80 mm
- two nails or screws when the breadth of the plank is 80 mm or more

Butt ends shall be fastened in the same way. Nails and screws shall be countersunk by 0,3 times the thickness of the planks. The holes shall be plugged.

22.4 The butt spacing shall be at least

- two beam spacings if the butts are on adjacent planks
- one beam spacing if one passing plank is between the butts
- on the same beam if three passing planks are between the butts.

Butts shall be arranged on beams and shall normally be of a square butt type.

22.5 A covering board shall have at least the same thickness as that required for decks and a breadth of at least 160 mm. The covering board shall be fastened to the deck beams in the same way as the deck planking.

23 PLYWOOD DECK

23.1 The thickness of plywood decks shall be at least equal to the greater of the following values:

$$t = 0{,}21 * f * s \sqrt{p} \quad \text{mm}$$

$$t = 2{,}0 + 1{,}6 * Loa \quad \text{mm, minimum 12 mm.}$$

23.2 The plywood shall be fitted in as large panels as practicable.

23.3 Butts shall not be arranged in the same longitudinal position as butts in the side planking or at hatch ends, masts, mooring fittings or other fittings that may cause load.

23.4 If a plywood deck is to be sheathed with glass reinforced polyester, the sheathing shall not be taken into account when thickness of the plywood is determined. The workmanship of the glass reinforcement shall nevertheless be in accordance with chapter C26.

24 SUPERSTRUCTURES AND DECKHOUSES

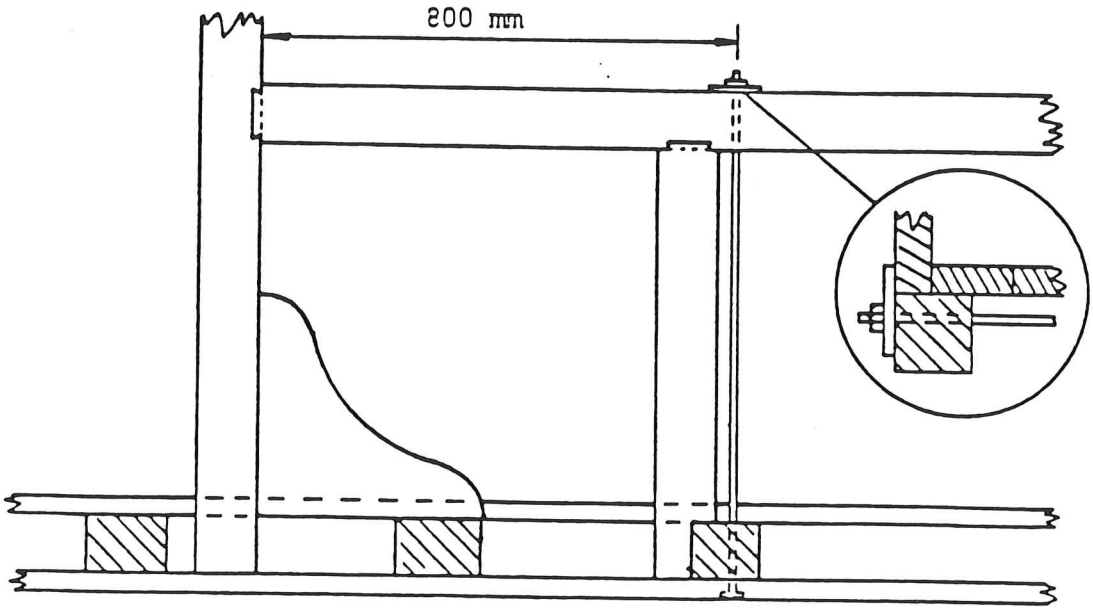
24.1 Superstructures and deckhouses which are subjected to sea loads shall be dimensioned as hull sides.

24.2 Superstructures and deckhouses other than those referred to in 24.1 shall be dimensioned at least in accordance with the minimum loads in chapter C21.

24.3 Superstructures and deckhouses shall be fastened to the deck beams with through bolts or glue and screws.

Beams in a superstructure deck shall be fastened to the side stiffeners.

24.4 Tie rods shall be fitted under the deck at openings. The distance between the rods or from the end of the opening to the first rod shall not exceed 800 mm.



25 WATERTIGHT BULKHEADS

25.1 Watertight bulkheads shall be dimensioned as the hull sides for the respective type of timber.

25.2 Watertight bulkheads shall be stiffened and fastened to the hull in such a way that they withstand the water pressure which can arise at either side of the bulkhead.

26 CLEATS

26.1 Mooring cleats, winches, etc shall be fastened to deck beams with through bolts.

27 THWARTS

27.1 Open boats shall have thwarts with appropriate distances.

27.2 Thwarts shall be fitted on the frames and supported with knees fastened with at least one bolt through the thwart and one bolt through the frame and planking.

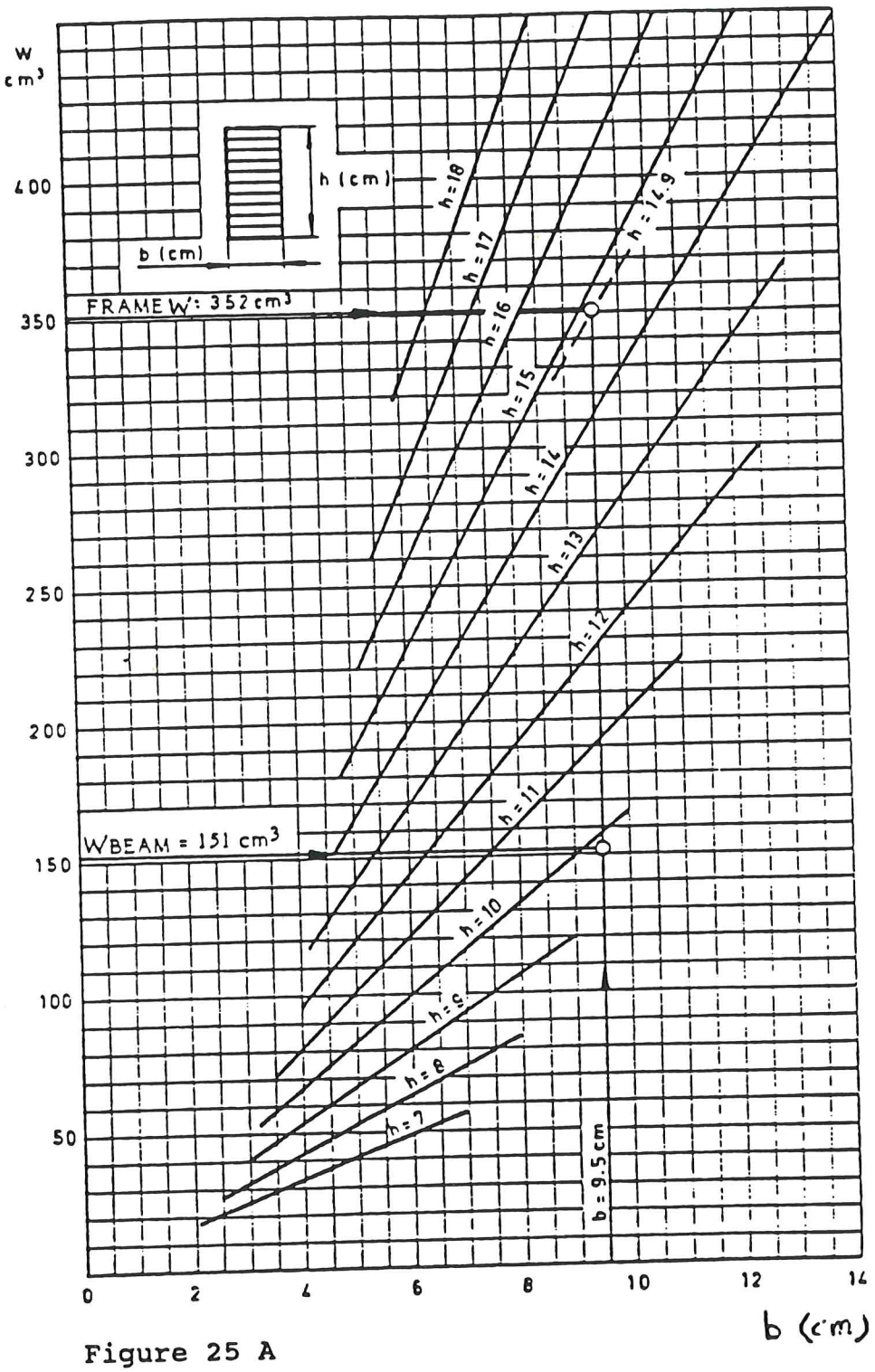


Figure 25 A

Section modulus $W = b * h^2/6$ for a section with breadth b (cm) and height h (cm).

Section modulus W (mm^3) = 10^3 * W (cm^3)

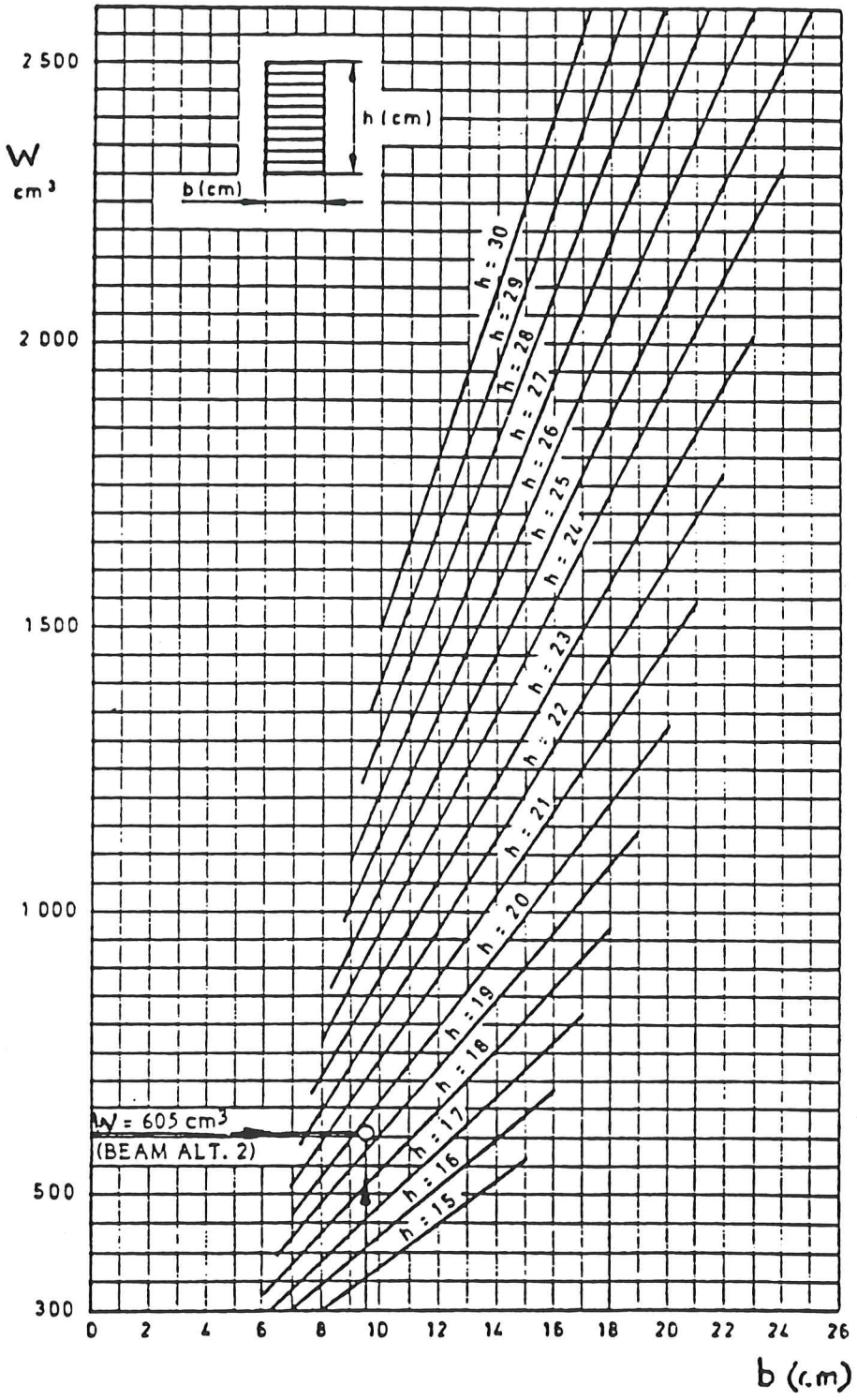


Figure 25 B

Section modulus $W = b * h^2/6$ for a section with breadth b (cm) and height h (cm).

Section modulus W (mm^3) = 10^3 * W (cm^3)

BUILDING OF GRP BOATS

C 26

Table of contents

1 GENERAL

1.1 The following provisions apply to boats made of fibre reinforced plastic which are surveyed individually during the building.

1.2 It is assumed that the manufacturer complies with the guidelines given by the raw material manufacturer concerning the various products used for the building of glass-reinforced polyester.

2 MANUFACTURING PREMISES

2.1 The moulding premises shall be draught free so that a uniform temperature can be maintained during the moulding process.

2.2 The air temperature in the moulding premises shall not be lower than 18 degrees Celsius and the temperature during the moulding process shall not vary by more than 6 degrees Celsius.

2.3 The moulding premises shall be insulated or built in such a way that the indoor temperature is not significantly affected by the outdoor temperature or sun heating.

2.4 Windows, if fitted, shall, if necessary, be over-painted or screened off if they will be subjected to direct sun radiation.

2.5 The moulding premises shall be tight so that they during a heavy rain will not allow any water to penetrate into the premises.

2.6 The moulding premises shall be kept clean and free of dust.

2.7 The moulding premises shall be well illuminated and arranged in such a way that light will come down to the moulds used.

3 MATERIALS

3.1 It shall be documented that gelcoat, polyester, glass-reinforcement, core material, adhesives and topcoat are approved for the use concerned.

3.2 Polyester materials shall not be stored too long so that the storing affects their qualities.

3.3 Polyester shall not be added additives other than those required for the necessary thixotropic property.

3.4 A curing and accelerating system which is adapted to the polyester concerned and to the moulding times and temperatures shall be used.

3.5 Plywood which is moulded-in or fastened shall be of a waterproof type.

4 LAMINATE LAY-UP

4.1 All laminates shall at the outside have a layer of gelcoat with a uniform thickness or be coated with an equivalent surface protection after the moulding.

4.2 Below the waterline at least one layer of a powder bound mat moulded by isophtalic resin shall normally be applied next to the gelcoat.

4.3 If ortophtalic resin is used in the hull or in other construction which are permanently exposed to water, the laminate shall be given at least two extra layers with surface protection outside the gelcoat.

4.4 Emulsion bound mats shall not be used in connection with isophtalic resins.

4.5 A light mat of maximum 450 g/m^2 on surfaces with sharp curvature and maximum 600 g/m^2 on plane surfaces shall normally be applied against the gelcoat.

4.6 The reinforcement lay-up of the laminate shall be laid in the approved sequence.

4.7 A suitable topcoat shall be applied on the inside of the laminate in the keel and in bilge wells where it can be assumed that water can be accommodated.

4.8 Where the laminate is not covered with topcoat or the like, the last layer of polyester shall contain wax so that the curing against air will be satisfactory.

5 HAND LAY-UP

5.1 The overlap of two layers of reinforcement material shall be at least 50 mm.

5.2 Polyester resin shall be applied uniformly on each layer of reinforcement.

5.3 For at least every second reinforcement layer, the laminate shall be rolled so that the polyester becomes uniformly distributed and the laminate so free as practicable from gas and air pockets.

5.4 All fibres shall be well wetted but there shall be no surplus of polyester on the surface.

5.5 The time interval between each layer of reinforcement shall be adapted to the ongoing curing process. Lamination shall not be continued on a previous layer which develops exothermic heat during the curing. The time between each layer in a laminate shall on the other hand not be so long that the previous layer is fully cured. If it has been fully cured, the requirements for secondary bonding shall be complied with.

5.6 During rolling over sharp edges, corners, etc it shall be ensured that the amount and thickness of the reinforcement will not be less than required.

6 SPRAY LAMINATION

6.1 When spraying glass and polyester the dosage device shall be adjusted to the glass percentage the laminate shall have.

6.2 The glass cutter of the spraying equipment shall be so adjusted that the fibre length will be at least 20 mm.

6.3 The spraying equipment shall be so adjusted that it gives a uniform distribution of glass and polyester.

6.4 The spray operator shall distribute the material uniformly over the laminate surface. If necessary, it can be required that spray roving with colour indicator is used for control of uniform distribution.

6.5 It shall be ensured that the work conditions are such that no part of the laminate will be lying in the spray shadow.

6.6 Next to the gelcoat the laminate thickness after the first rolling out shall be not more than 1,5 mm.

6.7 Subsequent rollings shall be carried out so that there is not more than 2,5 mm thickness increase between each rolling.

6.8 A hull made of spray moulded laminate shall contain at least one layer of woven roving.

7 SANDWICH IN MOULDS

7.1 The type and weight per cubic metre of the core material shall be in accordance with the approved specification.

7.2 Core material with open cells in the surface shall be coated with polyester so that the cells are filled before the core material is layed against another laminate.

7.3 Grid cut core material layed down in a wet laminate shall be added so much polyester that a surplus comes up in the cuts.

7.4 When core material is layed in wet laminate the latter shall be at least 450 g/m^2 on plane surfaces and 900 g/m^2 on curved surfaces.

7.5 Core material of stiff foam or plywood shall, if necessary, be loaded so that it is pressed totally into the polyester during the curing process.

7.6 All joints in the core material shall be filled before further lamination.

7.7 The wet laminate in which the core material is layed shall be allowed to cure to some extent before further moulding on the core material is permitted.

8 SANDWICH WITHOUT MOULD

8.1 When building up the core, all joints in the core shall be glued with an adhesive material or equivalent.

8.2 The core material shall not be bent so much that the properties of the core are affected.

8.3 The surface of the core shall be ground removing all irregularities in particular at joints.

8.4 The core shall be primed before further lamination.

8.5 Mat reinforcement shall always be layed against the core.

9 SECONDARY BONDING

9.1 If a further lamination shall be carried out on a laminate which has cured for more than 48 hours, the laminate shall be ground so that the glass fibres are exposed in the surface.

9.2 If there is wax on the surface on which further lamination shall take place, the laminate shall always be cleaned unless it is not fully gelled and the wax can dissipate in the next layer of laminate.

9.3 Topcoat shall always be ground away before further lamination.

10 STIFFENERS

10.1 Stiffeners shall be fixed to the laminate with a breadth of at least 20 times the thickness of the fastening.

10.2 Stiffeners shall have at least the same moulding breadth of the fastening at the ends.

10.3 If a stiffening ends at an unstiffened panel, the fastening material shall be layed also in the prolongation of the stiffener.

11 CURING

11.1 Gelcoat shall not have cured for more than 24 hours before lamination.

11.2 Laminates shall not be loaded or worked at during the curing process except for trimming of the edges.

11.3 Curing shall not take place at so high a temperature that the laminate is discoloured.

11.4 The curing shall take place at the temperature and for the time the polyester system requires.

12 MOULDED LAMINATE

12.1 After a construction has been moulded, the obtained thickness of the laminate shall, when necessary, be compared with the nominal thicknesses which are approved.

12.2 The thickness can be measured including gelcoat and topcoat but then it shall be taken into account that the measured thickness is respectively about 0,6 and 1,0 mm higher than the actual laminate thickness.

12.3 The nominal thickness of the laminate is considered to be fulfilled if the mean value of 20 measuring points on the same laminate is higher than the requirement and no single value is lower than 85 per cent of the nominal thickness requirement.

12.4 The variation coefficient V_L for a laminate with the same reinforcement lay-up shall normally be less than 0,14:

$$V_{Lmax} = S/t$$

where

$$S = \sqrt{(t_i - t_o)^2/(n-1)}$$

t_i single measured value
t_o mean value
t required nominal thickness
n number of measured values

12.5 If spray lamination is applied, thickness measurements are to be carried out.

12.5 Documentation shall be available showing that the reinforcement materials and the polyester which are used give the mechanical properties on which the approval is based with the glass percentage assumed.

12.6 The glass percentage in the bottom laminate shall be calculated based upon the stated reinforcement weight and the mean thickness in question.

BUILDING OF STEEL BOATS

C 27

Table of contents

1 GENERAL

1.1 The following provisions apply to steel boats which are surveyed individually during the building.

2 MATERIALS

2.1 Documentation shall be available in the form of Class Society certificates or yard certificates stating that plates and profiles are of the types and qualities which are approved for the building number in question.

2.2 The materials shall be dry and without corrosion attacks.

2.3 Each plate shall have a mean thickness which at least corresponds to the nominal thickness of the plate.

3 ALIGNMENT OF MATERIALS

3.1 The construction and welded joints in the material shall be such that there is good accessibility for the welding work.

3.2 The alignment of plates and profiles shall be so satisfactory that the welded joints will get a correct scantling corresponding to the thickness of the material.

3.3 The cutting of plates shall be done satisfactorily so that a good welded connection can be achieved.

4 WELDING

4.1 All welding work shall be carried out professionally. Any failure or unsatisfactory piece of work shall be corrected before the material is covered with paint, etc.

4.2 The welding of the hull shall be carried out under supervision and be inspected upon completion by an approved welder.

4.3 When welding at low temperatures or damp weather, preheating of the steel shall be arranged.

4.4 At welding of plates thicker than 4 mm either a 30 degrees joint shall be used or also welding on the back side.

4.5 Double continuous welding shall always be used in case of:

- foundations
- end connections and brackets for stiffeners.

4.6 Continuous welding shall always be used for plates in:

- the hull plating
- deck and superstructures
- tanks
- bulkhead connection to bottom and sides.

4.7 Double intermittent welding may be used in other cases. The interruptions shall not be longer than the length of the welding and the total length of weldings shall at least correspond to that of a continuous welding.

4.8 One-sided intermittent welding may be used for fastening of stiffeners which are not subjected to a load, e.g. buckling stiffeners.

4.9 Fillet welds shall normally have an a-measure of at least 3,5 mm.

5 DETAILED CONSTRUCTION

5.1 Structural continuity is to be maintained at all primary structural members.

5.2 Knee plates shall be used where necessary in order to achieve a sufficient fastening area.

5.3 Stiffeners shall be welded to the web frames and girders also where the stiffeners are all continous through.

BUILDING OF ALUMINIUM BOATS C 28

Table of contents

1 GENERAL

1.1 The following provisions apply to aluminium boats which are surveyed individually during the building.

2 STORAGE OF MATERIAL

2.1 Plates, profiles and other aluminium materials shall be stored horisontally so that the materials are not damaged or deformed.

2.2 Storage premises for welding equipment and electrodes shall be kept dry and clean.

2.3 Aluminium materials shall not be stored together with other metallic materials.

3 MANUFACTURING PREMISES

3.1 Work up and welding of aluminium shall be carried out at a dry place under roof and screened off for weather and wind.

3.2 The work place shall be kept clean and free of work on other metallic materials.

3.3 If a lower temperature than 0 degrees Celcius can occur, the manufacturing premises shall be so arranged that it can be made tight and heated.

4 MATERIALS

4.1 Documentation shall be available in the form of Class certificates or Yard certificates stating that plates and profiles are of the types and qualities which are approved for the building number in question.

4.2 The material used shall be straight and undamaged and have the required scantlings.

4.3 Plates which shall be used for the hull shall be sea water resistant and shall normally have the following material composition:

Cu max 0,2 %
Fe max 0,5 %
Mg max 2,0 %

The following examples fulfil these requirements:

ASTM: 5052, 5083, 5086, 5154, 5454
DIN 1725: AlMg2,5, AlMg4,5Mn, AlMg4Mn, AlMg3, AlMg2,7 Mn

4.4 Stiffeners and profiles shall normally have the following material composition:

Cu max 0,4 %
Fe max 0,5 %

The following examples fulfill these rewuirements:

ASTM: 6005, 6063, 6351
DIN 1725: AlMgSi0,7, AlMgSi0,5, AlMgSi1

5 SHAPING OF MATERIALS

5.1 Hardened aluminium materials shall normally not be shaped with heat added and cold shaping shall only be used when there is low tensions in the material. Aluminium materials shall normally be straight or shaped by rolling.

5.2 Curving of plates shall normally be made by rolling. Bending to 90 degrees shall not be made unless the inner bending radius (R) is at least:

$$R = f * t$$

where f is the bending factor according to the table below
t is the thickness of the material

Alloy	Condition	Bending factor for material thickness (t) in mm					
		1,0	1,5	3,0	4,5	6,0	9,0
AlMg2,5	02	0	0	0	1	1	1,5
	14	0	1	1,5	2	3	3
	08	2	3	4	5	6	7
AlMg4,5Mn	02	-	0,5	1	1	1,5	2
	32	-	1,5	3	3	3,5	

5.3 The cutting of materials shall be done so that the edges become straight and without burns or other damages.

6 WELDING

6.1 Welding shall not be carried out at a lower temperature than + 5 degrees Celsius.

6.2 Welding of hull and deck shall be carried out only by welding operators who have passed a welding operator qualification test for the materials and equipment used.

6.3 Normally welding electrodes of AlMg4,5Mn or AlMg6 are to be used unless it is documented that another electrode will give a better result.

6.4 All welding shall have full burning through and a smooth surface without burrs or edge burns.

6.5 All plates and fastening of watertight bulkheads shall be welded with continuous welding.

6.6 If intermittent welding is used, the length of weld shall be at least as long as the spacing and always end with a continuous weld.

6.7 The welding shall comply with the dimensions approved in beforehand.

6.8 The weld at representative places shall be controlled with penetrating liquids. Surface cracks are not accepted.

7 RIVETING

7.1 Riveting may be used in decks and superstructures but not in the hull plating.

7.2 Rivets fitted from only one side are not permitted in constructions subjected to loads except when tested and approved in beforehand.

7.3 Rivets shall normally have a diameter of at least 3 times the thickness of the plates and a rivet spacing of maximum 15 times the thickness of the plates.

8 GLUEING

8.1 Glueing shall be used only if a static and dynamic test of the type of glue connection in question is undertaken in beforehand and the use is approved in each case.

8.2 Only glue types with documented good long term properties when exposed to moisture environment within the temperature areas in question shall be used.

8.3 An approved procedure for the glue process shall be available.

9 OTHER JOININGS

9.1 Joints between aluminium and acid proof steel are accepted without insulation. In joints with other metals the materials shall be insulated from each other.

BUILDING OF WOODEN BOATS C 29

Table of contents

1 GENERAL

1.1 The following provisions apply to boats which are surveyed individually during building.

1.2 Deviations from the provisions of this chapter can be accepted if it can be documented that an alternative solution by experience has given an acceptable result. If such modification is accepted it shall be reported to the Authorities.

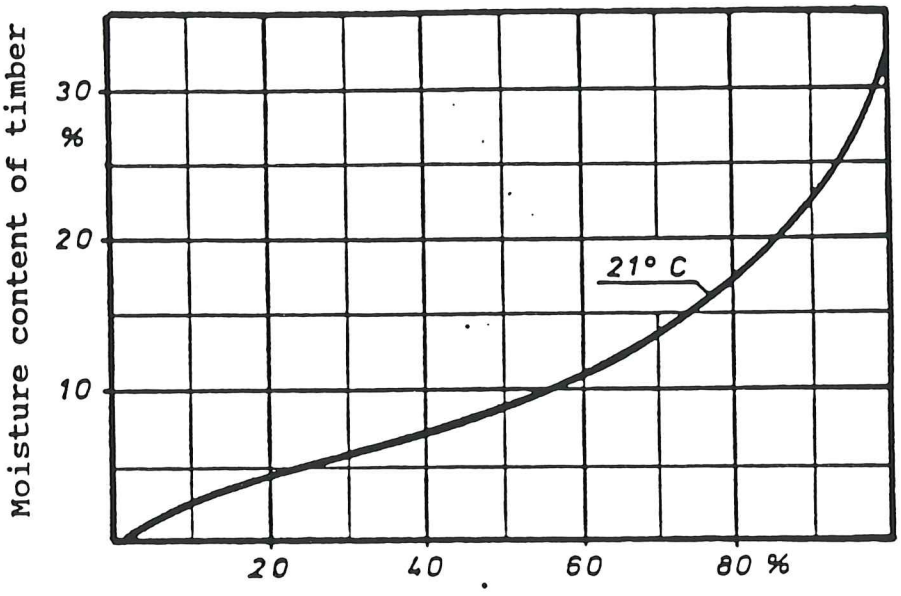
1.3 It is assumed that the glue and other materials which are used are in accordance with the guidelines issued by the deliverer of the raw material.

2 MATERIAL STORAGE

2.1 Timber shall be stored in dry and well ventilated premises where it is protected from direct sunlight and dampness.

2.2 Timber shall be stored horisontally and each layer shall be layed upon transverse strips so that a good air circulation is achieved around each piece. Plywood sheets shall be stored flat on a level bed.

2.3 The moisture content in stored materials may be based on the humidity in the storage premises according to the following figure.



Average air humidity of storage premises

3 MANUFACTURING PREMISES

3.1 Wooden boats shall be built in a well ventilated workshop where the temperature is at a sufficient level to prevent moisture content in the timber to increase during the building period.

3.2 Boats with bonded hull, deck or superstructure shall be built in premises where the temperature is not below 10 degrees Celsius during the building period.

4 TIMBER MATERIAL

4.1 Timber material shall be of first class quality specially selected for boat building.

4.2 Timber material shall be free from heart, insect attack, splits, loose knots, sapwood, decay or other imperfections which decrease the material quality.

4.3 The moisture content in timber material shall normally not exceed 20 per cent and not exceed 15 per cent in materials which shall be bonded.

4.4 The timber for use in outside planking, deck planking and laminated or bent frames shall be straight grained parallell with the length direction and quarter sawn.

5 PLYWOOD

5.1 Plywood for use in outside planking, deck and superstructure shall be of marine quality complying with B.S. 1088-1966, B.S. 4079-1966 or equivalent specification.

5.2 Plywood shall be of first class quality and selection. Face veneers shall have good solid surface free from visible defects.

5.3 Plywood used for non-structural purpose where requirements are not provided for in respect of strength and quality may be of lower selection but shall be bonded with weather and boil proof resin according to B.S. 1203-1979 or equivalent specification.

5.4 Where plywood boards are scarfed the breadth of the scarf shall be at least 8 times the thickness of the board. Where plywood boards are abutted the breadth of the scarf shall be at least 18 times the thickness of the board.

6 GLUED JOINTS

6.1 Glue shall be weather and boil proof complying with B.S. 1204-1979 WBP or equivalent specification.

6.2 All faying surfaces shall be satisfactorily fitted for gluing. Faying surfaces shall be clean and free from dust, grease, etc which can weaken the glued joint.

6.3 Glued joints shall be fastened with nails, screws or bolts. For plywood the distance must not be greater than 10 times the plywood thickness.

7 LAMINATED CONSTRUCTIONS

7.1 Boat builders using laminated constructions are subject to special approval. The boat builder shall possess all necessary equipment for lamination, such as pressure devices, gauge to measure moisture content, machine to mix the glue, etc.

7.2 The layers comprising the laminated construction shall be of similar material and have the same moisture content.

7.3 The thickness of each layer shall not exceed 30 mm. Layers bent at the lamination must not be thicker than that a uniform and good glue joint between the layers can be achieved.

7.4 The spacing of scarf joints of layers shall not be less than:

25 * t where the scarf joints are on adjacent layers

20 * t where one passing layer is between the scarf joints

12 * t where two passing layers are between the scarf joints

where t is the thickness of the layers.

7.5 The pressure during glueing shall be at least 0,6 N/mm^2. When laminating hardwood the pressure shall be at least 1,2 N/mm^2. The pressure shall be checked and adjusted 15-30 minutes after joining.

7.6 The strength of the adhesion shall be tested. Test sample shall be taken from the end of the laminated construction and be representative for the materials, glue, the pressure during the glueing, curing, etc which are used for the construction in question.

8 BOLTING AND NAILING

8.1 Nails, screws and bolts shall be of corrosion resistant material or hot-dipped galvanized. Bolts, nuts, rivets and washers connected together shall be of equal material.

8.2 Washers of external diameter at least two times the bolt diameter shall be fitted under the bolt heads and the nuts. Washers may be dispensed with if the dimension of the bolt head has a satisfactory diameter. In highly stressed construction larger washers can be required.

8.3 For fastening of hull planking and deck planking shall be used screws or nails with a length (l) of at least:

$l = 2,0 * t$ mm for screws

$l = 25 + 2,0 * t$ mm for nails

where t is the thickness of the planks in mm.

8.4 Screws and bolts shall normally be fitted perpendicularly to the planking. The planking shall be bored in beforehand.

9 VENTILATION OPENINGS AND WOOD PRESERVATION

9.1 All closed constructions shall be fitted with a necessary ventilation. Specially good ventilation shall be arranged on top of frames and behind tanks and linings.

9.2 Timber material in closed constructions, faying surfaces and between double grown frames shall be treated with recognized wood preservatives.

ADDITIONAL REQUIREMENTS FOR FISHING BOATS

C 30

Table of contents

1 GENERAL

1.1 The requirements in this chapter are additional to those in the other chapters and apply to boats which shall be approved as fishing boats.

2 INCREASE OF THE FREEBOARD

2.1 The load waterline must not at any place be above the lower edge of any drainage flap and the free board (F), amidships shall never be less than 350 mm in case of boats with drainage flaps as in 7.1 for direct drainage from covered service spaces.

2.2 The freeboard (F) amidships shall never be less than 500 mm in case of boats with freeing ports as in 7.2 for direct drainage from covered service spaces.

3 STABILITY OF CLOSED FISHING BOATS

3.1 The GM of the loaded condition shall be at least 0,35 m.

3.2 The righting arm (GZ) between 40 and 65 degrees shall be at least 0,10 and the GZ-curve shall be positive up to an angle of 70 degrees when all closing arrangements are closed.

3.3 For boats with a lifting gear or corresponding mechanical fishing gear, the area below the GZ-curve shall in addition be at least 0,03 metre-radians between 30 and 40 degrees.

3.4 For boats with hatchways complying with 4.1, the volumes of the hatchways may, when calculating the area in 3.3, be included in the buoyancy to the heeling angle where the lowest edge of the hatchway will be submerged.

4 OUTSIDE OPENINGS TO ENCLOSED SERVICE SPACES ON THE FREEBOARD DECK

4.1 Side hatch and stern hatch which may be kept open during fishing shall have a limited size and shall normally have a sill height above the deck of at least 1000 mm.

4.2 Closing appliances for such hatch openings shall have at least the same strength as the super structure in which they are arranged. The openings shall at any time be capable of being closed rapidly by one person without use of tools.

4.3 If a side hatch can be closed from the wheelhouse, an alarm shall be provided at the hatch place which warns when the closing is started.

4.4 Side and stern hatch shall be clearly marked with a sign indicating that the hatch shall be kept closed when not in use during fishing and when there is a danger for water filling the service deck.

5 DRAINAGE/WELLS IN THE FREEBOARD DECK IN A COVERED SERVICE SPACE WITH OPENINGS IN SIDES

5.1 In each service space which is enclosed by a bulkhead shall where the freeboard deck is the lowest have a drainage well in each side of the deck wingward.

If the breadth of the service space is less than 0,5 B for the whole length, a drainage well only in one side can be accepted.

5.2 The volume of each drainage well shall be at least equal to the greater of the following:

$V = 0.5 * A * l * b \quad dm^3$

$V = 150 \quad dm^3$

where

A is area of outside side opening in m^2
l the length of the service space in metres
b the breadth of the service space in metres.

5.3 The depth of drainage wells shall be at least 350 mm.

6 DRAINAGE OF THE FREEBOARD DECK IN A COVERED SERVICE SPACE WITH OPENINGS IN THE SIDES

6.1 The drainage of the freeboard deck shall normally be by separate pumps in each drainage well.

6.2 Pumps shall be of a type which can serve both in submerged condition and stand operation in "dry" condition. They shall have manual stop and start.

6.3 The arrangement of drainage wells and pumps shall be such that the suction side of the pumps will not easily be blocked by angle, fish waste, etc. The pumps shall also be capable of pumping some fish waste, etc. overboard together with the water.

6.4 The total drainage capacity for the pumps in each service space which is limited by bulkhead shall at least be equal to the greater of the following values:

$Q = 3 \frac{1}{2} B * A$

Q = 1,25 times the maximum washing capacity in the service space

where

Q is capacity in m^3/hour
A area of outside side opening in m^2
B breadth in metres.

6.5 The outlets overboard from the pumps shall be located at least 600 mm above the freeboard deck. The outlets shall have a closable flap-valve which can be manoeuvred from an easily accessible place at least one metre above the freeboard deck.

6.6 Discharge pipes from the pumps shall have a diameter which is adapted to the capacity of the pump and shall have a material thickness (godstjocklek) of at least 5 mm or equivalent.

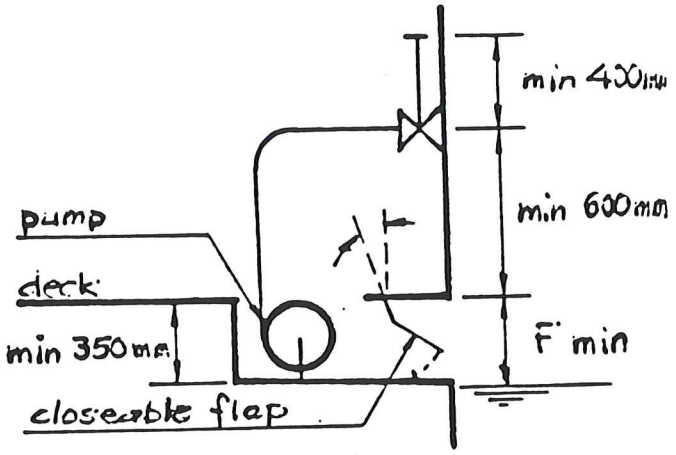
6.7 The freeboard deck shall be provided with a level alarm coupled to the wheelhouse which is activated when drainage wells are full.

7 OTHER DRAINAGE OF THE FREEBOARD DECK IN A COVERED SERVICE SPACE WITH OPENINGS IN SIDES

7.1 In addition to the pumps referred to in 6, drainage flaps in drainage wells for direct drainage overboard as shown in the figure below may be accepted to the following conditions:

- the drainage flaps shall be let in from the hull side
- the drainage flaps shall in closed condition be watertight and easily accessible for cleaning and supervision
- the drainage flaps shall be arranged for remote closing from the wheelhouse
- a panel in the wheelhouse shall show which drainage flaps are open/closed

- drainage flaps shall also be capable of being closed from a place at least one metre above the deck
- the opening for a drainage flap shall not be greater than 0.06 m^2.



7.2 As an alternative to separate pumps from the drainage wells, drainage from the freeboard deck direct overboard can be arranged through normal freeing ports in the sides subject to the following conditions:

- the arrangement and area of the freeing ports shall be as specified in 5.1.1 - 5.1.5
- covered service spaces must not be included in the buoyancy for stability.

8 DRAINAGE OF WEATHERTIGHT ENCLOSED SERVICE SPACES ON THE FREEBOARD DECK WITHOUT OPENINGS IN THE SIDES

8.1 Drainage can be by separate pumps in drainage wells and discharge as specified in paragraphs 5 and 6.

8.2 Alternatively drainage pipes from the drainage wells may be connected to the normal bilge system.

8.3 The total drainage capacity shall in both cases be at least 1,25 times the maximum washing capacity on the freeboard deck (service deck).

8.4 Drainage flaps referred to in 7.1 are not allowed.

9 GARBAGE DUCTS IN COVERED OR WEATERTIGHT ENCLOSED SERVICE SPACES ON THE FREEBOARD DECK

9.1 The discharge outlet overboard shall have a height above deck and closing arrangements as specified in 6.5 and 6.6.

9.2 The arrangement of garbage ducts shall be easy to supervise.

10 ERECTIONS WHICH CAN PREVENT DRAINAGE OF THE DECK ON CLOSED BOATS

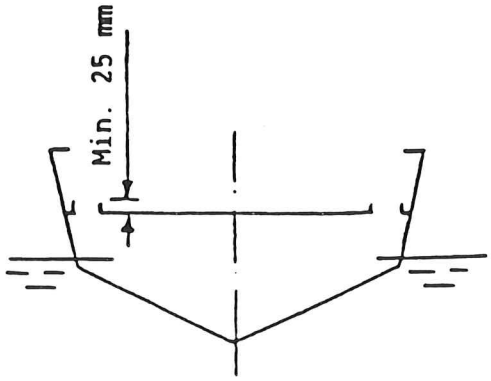
10.1 Open deckhouses with side walls at the sides of the boat, separate sidewalls at the sides of the boat for protection during navigation or similar erections on deck are normally not permitted because such erections will prevent a rapid and effective drainage of water on deck. In the case of such sidewalls, freeing ports in accordance with chapter C5 are not considered as an effective drainage arrangement. A bulwark with a height of more than 1000 mm will be considered as a sidewall.

10.2 If bins are arranged on deck, a good drainage from the bins and overboard shall be provided.

11 DRAINAGE OF THE FLOORING ON OPEN BOATS

11.1 If the flooring is located above the waterline on the boat in light condition and is so tight that water can assemble on the flooring, at least the following conditions for safeguarding the stability of the boat shall be complied with:

- Drainage openings shall be arranged at both sides of the flooring for drainage of water to the bottom of the boat (see the figure below)
- The drainage area shall be at least 75 per cent of the requirement for freeing ports for drainage of the deck overboard
- The intake to the bilge pump shall be easily accessible.



12 FISHING LIGHTS x)

12.1 Fishing boats with a length overall of more than 7,0 metres shall be provided with fishing lights, two all-round light, one of them one metre vertically above the other. The lower light shall be white and on boats engaged in trawling the upper light shall be green. On boats for other types of fishing the upper light shall be red.

x) See Rule 26 of the Collision Regulations

13 PERSONAL SAFETY AT WINCHES

13.1 Net and line winches shall be secured so that the winches stop when a person is drawn into the winch.

14 SCANTLING CORRECTIONS

14.1 All formulae for thickness and section modulus which are given in the chapter for dimensioning of various construction materials shall be multiplied by a factor for field of application in accordance with the following table.

Bottom and bilge	1,05
Side and transom	1,05
Deck and forecastle deck	1,15
Superstructure	1,10

As the coefficient for shear strength of the core in sandwich panels 1,05 shall be used.

15 LOCAL STRENGTHENINGS

15.1 Areas loaded by trawling equipment or equivalent shall be dimensioned for the load which occurs. Plastic and wooden boats shall also be strengthened for local wear.

ADDITIONAL REQUIREMENTS FOR PASSENGER BOATS

C 31

Table of contents

1 GENERAL

1.1 The requirements in this chapter apply together with the other chapters to boats which shall be approved for conveying passengers.

2 PROTECTION AGAINST WATER FILLING

2.1 Passenger boats shall have such protection that a significant leakage at the following places does not lead to an immediate water filling of adjacent spaces:

- stem
- bottom forward on high speed boats
- bottom in the after part of boats with free lying rudder or propeller.

The adjacent spaces shall be capable of being drained by the main bilge system in the boat.

2.2 At a door which shall be tight if the boat shall be considered as a closed boat, the required sill height of 380 mm may be reduced to 100 mm on condition that the freeboard nowhere is less than 500 mm.

3 STABILITY

3.1 The stability range for closed boats shall be at least 50 degrees (the GZ-curve shall be positive up to at least 50 degrees), however 40 degrees is acceptable on condition that the area below the curve between 30 and 40 degrees is at least 0,03 metre-radians.

3.2 The heeling in a passenger boat must not be greater than 12 degrees when a weight corresponding to the greatest permitted number of passengers is placed as far to the side of the boat as possible distributed with 300 kg/m2. No weight may be placed nearer to the center line than 0,2 B. The freeboard with this weight distribution must nowhere be less than 200 mm.

4 FUEL

4.1 Installations for fuel with a flashpoint of less than 60 degrees Celsius are not permitted.

5 FIRE INSULATION AND SURFACES

5.1 Bulkheads, linings and similar arrangements in the accommodation which are combustible shall be covered by a surface layer which fulfils the requirements according to NT Fire 004.

5.2 Glassfiber reinforced polyester above the flooring in the engine room should have a protection against fire consisting of a 15 mm thick rigid mineral wool block or expanding fire protection paint with a corresponding insulation effect. Also the insulation effect of a self extinguishing sandwich core may be credited.

5.3 In boats with the greatest permitted number of passengers of more than 12, the engine room shall be fire insulated so that smoke and flame will not penetrate within a period of 30 minutes fire exposition in accordance with ISO 834. Hull sides of steel and bottom constructions need not fulfil this requirement.

6 PROTECTION AGAINST FALL

6.1 Rails which constitute a protection against falling overboard at passenger spaces must not be detachable. The height shall be at least 1000 mm.

6.2 The boat shall be provided with an arrangement such that embarkation and disembarkation can take place without danger, e.g. through an opening in the rail for a gangway.

6.3 Stairways shall be arranged longitudinally.

7 PASSENGER SPACES AND MEANS OF ESCAPE

7.1 Seats shall have a breadth of at least 0,5 m and a free height of at least 0,9 m above the back of the seat and at least 0,75 m leg space counted from the back support. Loose arrangements or foldable seats are not considered as seats.

7.2 The passenger spaces shall be fitted with at least the same number of seats as the permitted number of passengers.

7.3 The passengers shall be able easily to move to and from the passenger space. Stairs and doors shall have a breadth of at least 750 mm. Each passenger space shall have two exits. The escape routes shall, except stairs and doors have a breadth of at least 800 mm. This requirement applies also to the space between transverse seat rows where more than four persons may need to escape. The smallest escape opening shall be at least 600 x 600 mm. The route to the escape not normally used shall be clearly marked "EMERGENCY ESCAPE".

7.4 Spaces for passengers and passages to passenger spaces shall have a free height of at least 1,98 m. Other accommodation spaces shall have a free height of at least 1,80 m. A lower height may be accepted in door openings, emergency escapes and above seats.

8 TOILET, TANK AND PUMPING ASHORE

8.1 Boats with a greatest permitted number of persons greater than 10 but not greater than 50 shall have at least one toilet. If the number is greater than 50 the boat shall have at least two toilets. Toilets shall be connected to a holding tank.

8.2 The retention system shall be designed to allow emptying by means of vacuum through a shore connection in accordance with ISO 4567 or be constructed as indicated in 8.3 and 8.4.

8.3 Systems constructed with pipeline and pump for pumping the toilet waste ashore shall have a shore connection flange with dimensions in accordance with the table below.

8.4 The pipeline for pumping toilet waste ashore shall be capable of being flushed preferably with sea water. The pipeline system on the pressure side of the pump and the connection shall be constructed for a pressure of at least 0,6 MPa. The pump must not be able to give a higher pressure.

STANDARD DIMENSIONS OF FLANGES FOR DISCHARGE CONNECTIONS

Description	Dimension
Outside diameter	210 mm
Inner diameter	Minimum 38 mm
Bolt circle diameter	170 mm
Slots in flange	4 holes 18 mm in diameter equidistantly placed on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 18 mm
Flange thickness	16 mm
Bolts and nuts	4 pieces, each of 16 mm diameter and a suitable length

The flange shall be designed to accept pipes up to a maximum internal diameter of 100 mm and shall be of steel or other equivalent material having a flat face.

ADDITIONAL REQUIREMENTS FOR TUGS

C 32

Table of contents

1 DEFINITIONS

1.1 A "tug" is a boat which is intended for towing other vessels, timber rafts or floating objects with a cable and which for this purpose is equipped with hook, winch, bollard or similar device.

A boat, the propulsion machinery of which has a power of less than 150 kW, and which is not arranged for towing of vessels which use their own propulsion machinery or for towing of a vessel in co-operation with a tug, is not considered as a tug.

2 STABILITY REQUIREMENTS

2.1 For the control of the stability of a tug, the righting arm curve and the heeling arm curve, calculated in accordance with 3.1 for the most unfavourable towing condition shall be plotted in the same diagram. The resulting area above the heeling arm curve between the healing and the righting arm curves, calculated up to a heeling angle of 40 degrees shall be at least 0,01 metre-radians.

For tugs intended for assistance of vessels which use their own propulsion machinery or which assist vessels in co-operation with other tugs, a special approval of the stability is required.

3 HEELING MOMENT

3.1 The curves for the heeling arms shall be calculated in accordance with the following formula:

$$k = 0{,}07 * C * T\ (h*\cos\varphi - 0{,}8*r*\sin\varphi + 5 * d)/\Delta$$

where

C $4*l/L$, but not greater than 1,0

r radius of the towing arc in metres. If the radius varies: the distance from the centerline of the boat to the centre of effort of the hook when the pull is acting atwarthships

d the mean draught of the ship in metres

h the height of the towing point above the waterline

k nominal heeling arm in metres

L the length between perpendiculars of the boat in metres

l the horizontal distance between the towing point and the aft perpendicular in metres

T the static bollard pull in kilonewtons

Δ the displacement of the boat in metric tons

φ heeling angle.

4 SPECIAL REQUIREMENTS

4.1 The towing cable shall be capable of being rapidly released at full load.

4.2 The towing hook with winch system shall be dimensioned on the basis of the maximum traction force with a safety factor of 5 in relation to the tensile strength of the material.

ICE STRENGTHENING

C 33

Table of contents

1 DEFINITIONS

"Ice area": The hull from fore to after end within an area of 300 mm above the full load waterline and down to 300 mm below the waterline without cargo. The area shall in addition comprise the whole bottom within 0,2 Loa counted from the stem.

2 DESIGN AND CONSTRUCTION

The ice strengthening consists of the following strengthening construction elements:

- stem profile
- strengthened keel
- ice lining on the ice area in wooden boats
- strengthened hull in the ice area
- strengthened frames in the ice area
- strengthened propeller shaft.

2.1 Stem profile

A stem profile with an area of 80 Loa mm^2 shall be mounted on the stem. The stem profile shall go from the foremost point of the stem to one metre aft of the dividing point between the stem and the keel.

2.2 Strengthened keel

The section modulus of the keel shall be doubled in relation to those given in chapters C22-C25.

2.3 Ice lining on wooden boats.

Ice lining shall be arranged on wooden boats in the whole ice area. The ice lining shall be of iron, aluminium or copper. The thickness of the lining shall be adapted to the size of the boat and it shall be properly attached. Aluminium and copper plates must not be in contact with iron parts.

2.4 Strenghtened hull

The requirements in respect of the thickness of the hull shall be calculated as follows:

$$t_{ice} = 1,3 * t + 1,5 \quad \text{mm}$$

where t is the laminate/plating/planking thickness requirement according to chapters C22-C25.

2.5 Strengthened frames

The flexural strength requirements for frames according to chapters C22-C25 shall in the ice area be multiplied with 1,5.

2.6 Strengthened propeller shafts

The requirement for propeller shaft diameter according to chapter C10 shall be multiplied with 1,15.