RULES FOR CONSTRUCTION OF WOODEN HULLED SHIPS

TABLE OF CONTENTS

Part A
Rules for Hull Construction

Part B
Rules for Machinery Installation

Part C
Rules for Propulsion, Shafting & Propellers

Part D
Rules for Electrical Installation

Part E
COLREG, 1972

Part A
Rules for Hull Construction

GENERAL REQUIREMENTS

General

1. Application

1.1 The following Rules shall apply to all ships of wooden hulled construction.

1.2 Where ships of unusual design forms or proportions will be individually considered if this Authority satisfied and the safety will not be impaired.

2. Definitions

2.1 Administration – refers to the Maritime Industry Authority

2.2 Length

1. Length Overall (LOA), is a distance, in meters, measured parallel to the static load waterline from the fore side of the stem to the after side of the stern or transom, excluding rubbing strakes and other projections.

2. Waterline Length (LWL), is the distance, in meters, measured on the static load waterline from the fore side of the stem to the after side of the stern or transom.

3. Scantling Length, L, is to be taken as: $L = \frac{LOA + LWL}{2}$ *meters*

2.3 Breadth, B - is the extreme breadth, in meters, measured between the outer sides of the hull, excluding rubbing strakes or other projections.

2.4 Bulkhead Deck - is the uppermost deck to which watertight bulkheads and the watertight shell extends.

2.5 Collision Bulkhead - is a watertight bulkhead fitted up to the freeboard deck. This is located at a distance from the forward perpendicular of not less than 5% and not more than 8% of the length of the ship.

2.6 Depth, D - is the distance, in meters, at amidships, measured from the bottom of the keel, or ballast keel, if fitted, to the top of the upper deck or gunwale at side.

SECTION 1 - Materials

1.1 Wood Species

1.1.1 The species of wood which may be used for the various constructional members are given in Table 1. A general indication of their known performance in service has been indicated, but in view of the differences in construction methods and in the use of the ship, design considerations may influence the selection of species.

1.1.2 Group 1 are the species of wood considered to be the most suitable for the purposes set out in Table 1. Group 2 and Group 3 are in descending order of preference, but within each group no attempt has been made to list the individual species in order of preference. It is presumed that the designer will relate the known characteristics, e.g. strength, density, bending and working capabilities, of particular species to the constructional design.

1.1.3 The inclusion of a wood in Table 1 does not imply that all material available under the particular name is suitable for the use shown, and care must be exercised to ensure that an appropriate grade is obtained.

1.2 Wood Quality

1.2.1 The wood is to be of good quality and properly seasoned and is to be free from heart, sapwood, decay, insect attack, splits, shakes and other imperfections which would adversely affect the efficiency of the material. It is also to be generally free from knots, although an occasional sound inter grown knot would be acceptable.

1.2.2 The wood for the centreline members is to be reasonably seasoned and, where there is a risk of excessive drying-out, it is to be coated with boiled linseed oil or varnish, as soon as erected to prevent splitting.

1.3 Plywood

1.3.1 The plywood used for the hull and deck planking should be of high grade marine quality.

1.4 Metal Fastenings

1.4.1 The materials used for fastenings are to be a suitable composition of the following metal:

- Copper
- Galvanized Iron
- Galvanized steel
- Silicon bronze

- Aluminium bronze
- Stainless steel

Table 1 Suitable Woods for Moulded Hull Construction

SPECIES		
Group 1	**Group 2**	**Group 3**
Aranga	Banuyo	Almanit
Bansalagin	Dungon	Amugis
Ipil	Guijo	Apitong
Molave	Kalamansanay	Lumbayao
Narra	Malugai	Mayapis
Supa	Mangachapuy	Pagatpat
Tindalo	Narig	Palosapis
Yacal		Pine (Benguet)
		Red Lauan
		Tanguile

1.5 Other materials

1.5.1 Other materials intended for structural use are to be of good quality, suitable for the purpose intended and to comply with the Administration requirements appropriate to the material. Details of these materials are to be stated on the relevant construction drawings.

1.5.2 Suitable arrangements are to be made to insulate aluminium alloys from timber and dissimilar metals. Paints containing either lead, mercury or copper are not to be used in conjunction with these alloys.

SECTION 2 - Determination of Scantlings

2.1 General

2.1.1 The scantlings of a wooden hulled ship of conventional form and proportions, up to a length of 30 m are to be determined from Tables 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 14.

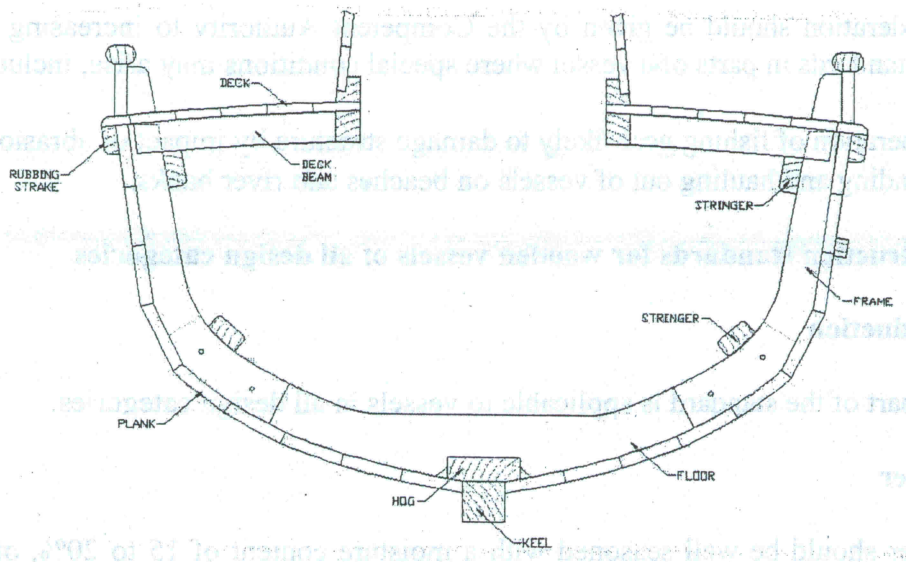
2.1.2 The scantlings will be specially considered where the ship is of unusual design, form or proportions or where either the speed exceeds 20 knots or the length, L, exceeds 30 m.

2.2. Recommended Wood for Hull Construction

2.2.1 The scantlings for the wood members shown in Tables 1, 2, 3, 4, 6, 7, 11, 12 and 14 are based on the following groups, which are for an air-dried condition of about 15 per cent moisture content:

Frames Floors	Group 1
Keel Stem Sternpost Deadwood Counter timbers	Group 2
Hull planking Shelves and clamps Stringers Beams and knees Deck Planking Deckhouse	Group 3

Fig. 1 Typical midship section for wooden hulled ship



SECTION 3 – Centerline Structure

3.1 Wood Keel

3.1.1 The scantlings of wood keels or the wood keel and hog are given in Table 2. The Rule moulding is to be maintained throughout but the siding may be tapered towards the ends where it is to be not less than the Rule siding of the stem or sternpost. The rabbet for the garboard strake is to have a faying surface not less than twice the thickness of the garboard strake or, for plywood, as given in Table 9.

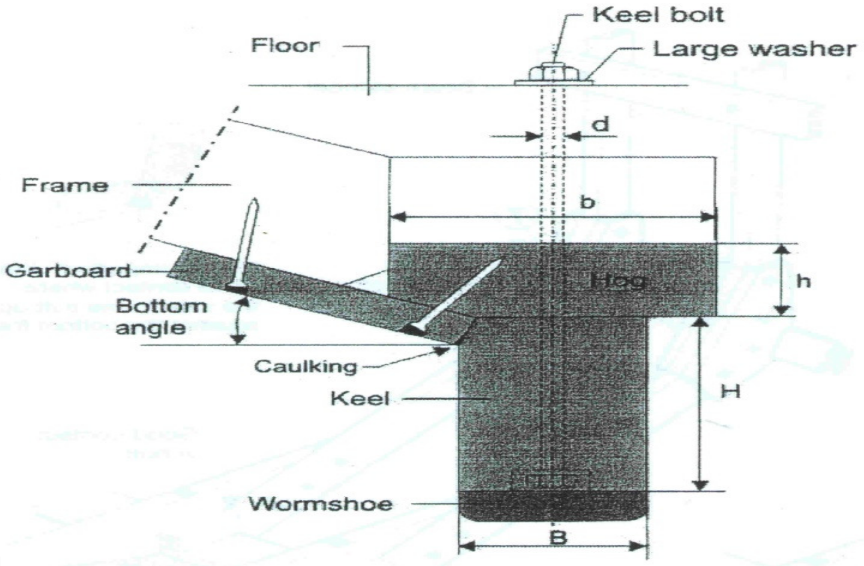


Fig. 2
Wood Keel

3.1.2 When the length, *L,* does not exceed 10 m the wood keel is to be in one length. In larger craft, the keel should, where possible, be in one length but when a scarph is necessary in the centreline structure it is to have a length, *l*, not less than 6 times the moulding, *m,* of the item. The scarph is to be of the hooked or tabled type if bolted (*see* Fig. 3), or plain type without lips if glued. The depth of the lips is to be about 1/4 to 1/7 of the moulding.

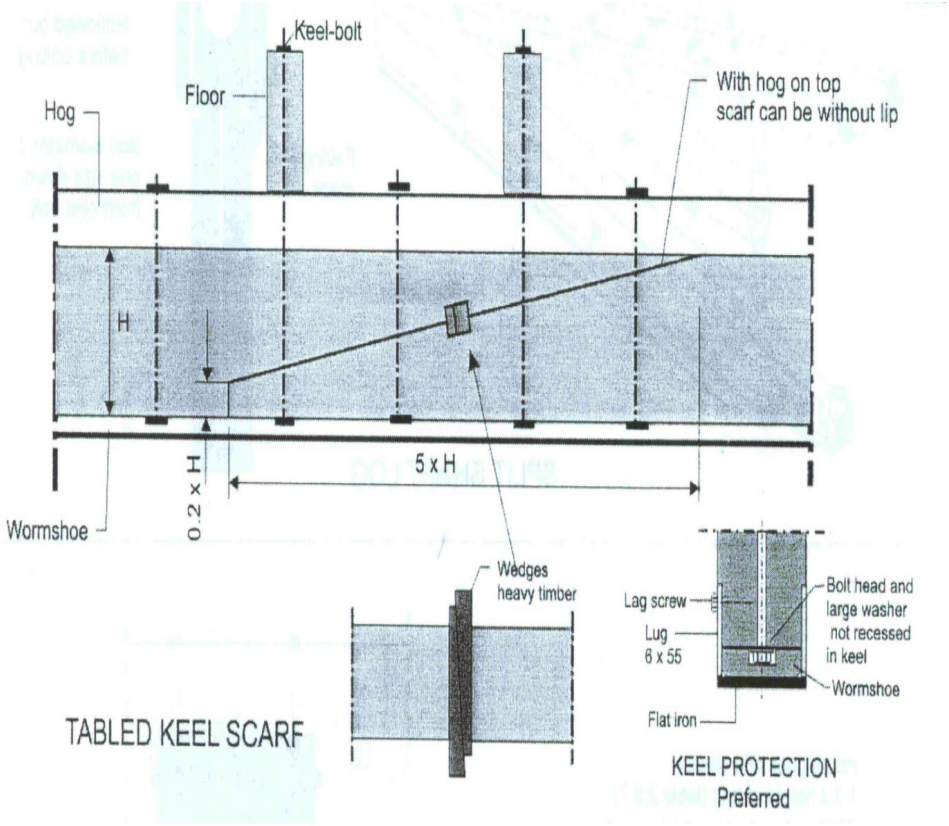


Fig. 3 Common types of scarphed joints

3.1.3 Softwood stopwaters are to be fitted in bolted scarphs in keels and other centerline structure, in way of plank back rabbet and in other positions where considered necessary by the Administration. For typical details, *see* Fig. 3.

3.1.3 Scarphs in the keel and hog are to be at least 1.5 m apart and the keel scarph, where fitted, is to be clear of engine seating.

3.1.4 Where the keel is cut for a centerboard the siding is to be increased.

Table 2 Keel, Hog, Stem, Sternpost and Fastenings

Length L, m	Moulding and Siding of Keel		Siding and Moulding of Stem at Heel, mm	Siding and moulding of Stem at Head and Sternpost Mm	Diameter of Bolts	
	Minimum Siding of Keel, mm	Sectional Area of Keel or Keel and Hog, cm^2			Centerline Structure	Keel Scarph
6	70	80	75	75	10	8
8	80	130	90	85	10	8
10	90	190	110	95	12	8
12	105	250	125	105	14	10
14	115	310	140	115	14	12
16	125	380	160	125	16	12
18	140	450	175	140	18	12
20	150	520	195	150	20	12
22	165	600	210	160	20	14
24	180	690	230	170	20	14
26	190	770	245	180	20	14
28	205	860	260	190	20	16
30	220	950	280	200	21	18

Notes:

1. The moulding of the keel is to be not less than the siding, and the moulding of the hog is to be not less than twice the thickness of the outside planking.

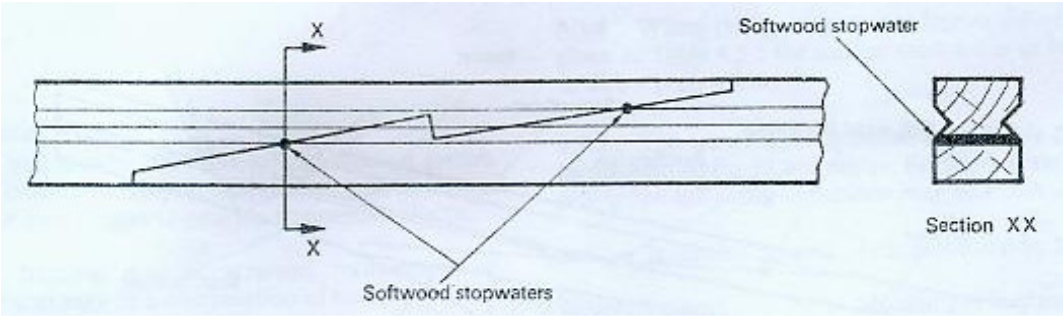


Fig. 4 Typical Hooked Keep Scarph Showing Position of Stopwaters

3.2 Stem

3.2.1 The scantlings of the stem are given in Table 2 and are to be uniformly tapered from head to heel. The scantlings at the heel may be required to be increased, depending on the shape of the forefoot, to enable an adequate scarph to the keel to be arranged.

3.2.2 Where the hull form is such that there is a large radius at the stem head a suitable apron (or fashion pieces) is to be provided to give adequate landing for the outside planking.

3.2.3 For size of fastenings, *see* Table 2.

3.3 Sternpost

3.3.1 The scantlings of the sternpost are given in Table 2. The sternpost may be tapered to suit the form of the craft but the siding at the after edge of the back rabbet is to be not less than that required by Table 2 and care is to be taken to ensure there is adequate material to take the fastenings of the outside planking.

3.3.2 The lower end of the sternpost is to be tenoned or half-lapped to the keel. An inside deadwood or knee is to be fitted and adequately through fastened to the sternpost, and false keel, if fitted.

3.3.3 For size of fastenings, *see* Table 2.

3.4 Counter Wood

3.4.1 The area of the counter wood at its forward end is to be not less than the Rule area of the sternpost and may gradually be reduced to 75 percent of this area at its after end.

3.4.2 The counter wood is to be securely fastened to the sternpost and it is recommended that, where practicable, the sternpost should be tenoned or scarphed to the counter timber and through fastened.

3.4.3 For size of fastenings, *see* Table 2.

SECTION 4 - Framing

4.1 General

4.1.1 The hull is to be provided with an efficient system of side and bottom framing in conjunction with stringers, bulkheads or web frames to provide transverse rigidity.

4.1.2 The framing may be arranged transversely or longitudinally or may be a combination of both.

4.1.3 All frames are to be bevelled or formed to fay closely against the planking.

4.1.4 Where the heels of frames terminate at the centreline construction members they are to be let into and fastened to them unless floors are fitted at every frame.

4.2. Types of Frames

4.2.1 The following types of frames may be used, subject to the limitations given in Sections 4.2.3 and 4.2.4:

Type 1 Bent frames only

Type 2 Grown frames only

4.2.2 Alternative framing systems to those in Section 4.2.1 will be specially considered.

4.2.3 The use of Type 1 is to be confined to ship having a depth, *D*, not exceeding 2.7 m.

4.2.4 Where the depth, *D,* exceeds 3.0 m the framing must be Type 2.

4.3 Scantlings

4.3.1 The scantlings and spacing of the various types of frames are given in Table 3.

4.3.2 In no case is the mean moulding of grown, bent or laminated frames to be less than two-thirds of the actual siding except where an increase in the siding is required by Section 5.3.6. In all cases the siding is to be suitable for the required fastenings.

4.3.3 Where the spacing of steel frames differs from that given in Table 3 the section modulus is to be modified in direct proportion.

4.3.4 The scantlings determined from Table 3 are to be maintained for $^{3}/_{5}$ *L* amidship. Forward of and abaft this region the following reductions may be made:-

Bent frames	- Siding reduced by 10 percent
Grown frames	- Moulding at heel and siding at head and heel reduced by 20 percent

4.3.5 In ships the framing adjacent to the mast is to be increased each side as given below or equivalent arrangements provided:-

Type 1:	Bent frames only	Three grown frames of Type 2 or 3 scantlings (see Table 3) are to be fitted or alternatively, the siding of three bent frames increased by 60 percent
Type 2:	Grown frames only	The siding of three frames increased by 50 percent

4.3.6 Where internal ballast is fitted the frames may be required to be increased in strength.

4.4 Grown Frames

4.4.1 Grown frames are to be cut to shape from wood having the required curvature of grain.

4.4.2 The siding of each grown frame is to be uniform over its length and the moulding is to be a fair taper from heel to head.

4.4.3 Grown frames may be butted or scarphed. Scarphs are to be glued and have a length not less than 6 times the siding. Where frames are butted, the butts are to be close fitted and side clamps arranged. The clamps are to have a sectional area not less than that of the frame and a length not less than 12 times the frame siding. The clamp is to be through fastened to the frame by not less than three fastenings on each side of the butt and is to fay closely to the planking.

4.5 Bent Frames

4.5.1 The siding and moulding of bent frames are to be uniform over the length of the frame. Each frame is to be in one piece from keel to gunwale and, where the form is suitable, may be continuous from gunwale to gunwale.

Table 3 Frames

Depth, D,m	Type 1 Bent Wood Frames only			Type 2 Grown Frames only		
	Siding, mm	Moulding, mm	Frame spacing, mm	Siding, mm	Moulding mm	
					At heel	At head
1.5	24	19	115	24	31	24
1.8	34	25	170	34	40	31
2.1	40	30	185	42	50	37
2.4	48	36	200	52	61	46
2.7	56	40	215	62	74	55
3	65	45	230	72	87	65
3.3	---	---	---	81	100	80
3.6	---	---	---	90	117	98
3.9	---	---	---	100	140	117

Notes:
1. For limitation on use of Types 1, , *see* Section 4.2.3 and 4.2.4
2. The frame spacing given in the Table is measured from center to center .

SECTION 5 - Floors

5.1 General

5.1.1 Wood floors are to be cut from timber having a suitable grain.

5.1.2 Where, at the ends, the frames are continuous across the centerline structure, floors are not required but, where practicable, the frames are to be attached to the centerline structure by two through fastenings.

5.1.3 Limber holes are to be provided in the bottom structure as required for efficient drainage of the ship.

5.2 Type of Floors

5.2.1 The type of floor to be fitted is dependent on the frame type adopted as follows:

Type 1:	Bent frames only	(a) Strap floors on every frame within $^3/_5$ *L* amidships (on alternates if *D* does not exceed 2.4 m for motor ship and on every third frame forward and aft. (b) Angle floors spaced as for strap floors in (a). (c) Where $^3/_5$ *L* amidships falls within the waterline length floors are to be on alternates to end of waterline. (d) The fitting of wood floors in association with bent frames will be specially considered.
Type 2:	Grown frames only	(a) Wood floors on every frame

5.3 Scantlings and Construction

5.3.1 The scantlings of floors are to be as given in Table 4 and the lengths of arms, etc., are to be measured as shown in Fig. 5. At the ends of the ship the length of arms need not exceed one-third the length of the frame.

5.3.2 The cross-sectional area at the ends of the arms is to be not less than half that given in Table 4 for the middle line.

Table 4 Floors

Depth, D, mm	Floors on Grown						Floors Bent Wood Frames		
	Length of Arms, mm		Strap Floors, mm		Wood Floors at middle line		Length of Arms, mm	Strap Floors, mm	
	For 3/5 L Amidships	Beyond 3/5 L Amidships	At Throat	At Point	Moulding, mm	Siding, mm		At Throat	At Point
1.5	380	250	25 x 10	20 x 10	55	25	250	25 x 6	15 x 6
1.8	430	300	35 x 13	30 x 10	75	35	300	25 x 9	17 x 6
2.1	480	350	45 x 16	40 x 10	95	45	350	25 x 12	19 x 6
2.4	530	390	50 x 19	45 x 10	115	55	390	27 x 12	21 x 6
2.7	580	430	55 x 22	50 x 12	135	62	430	29 x 15	24 x 6
3.0	630	480	62 x 25	53 x 14	155	70	480	32 x 16	26 x 6
3.3	680	530	70 x 28	56 x 16	170	80	530	35 x 17	29 x 6
3.6	730	570	75 x 31	60 x 18	185	90	-	-	-
3.9	780	620	80 x 31	63 x 20	200	100	-	-	-

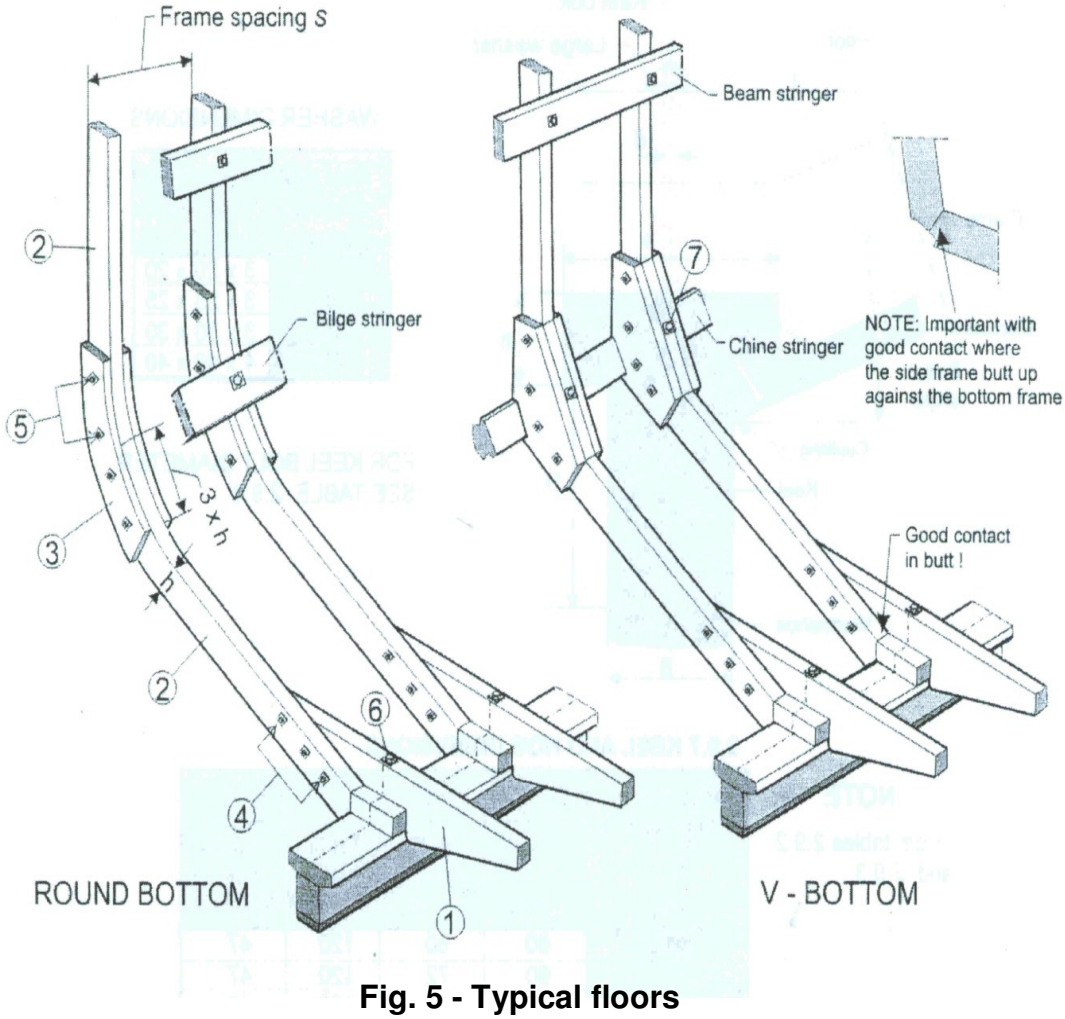


Fig. 5 - Typical floors

5.4 Fastenings

5.4.1 The size of the floor fastenings are to be as given in Table 5.

5.4.2 There are to be not less than three fastenings in each arm where the length of arm does not exceed 250 mm or four when the arm is 250 mm or greater.

5.4.3 The throat is to be attached to the wood keel by not less than two through bolts where practicable.

Table 5 Floor Fastenings

Depth, D, m	**Diameter of Bolts in Throat, mm**		**Diameter of Bolts at Arms, mm**	
Ship	Grown Frames	Bent Frames	Grown Frames	Bent Frames
1.5	8	6	6	6
1.8	10	8	8	6
2.1	12	8	8	6
2.4	12	10	10	8
2.7	14	12	12	8
3.0	18	12	12	10
3.3	20	12	12	10
3.6	20	-	14	-
3.9	20	-	16	-

SECTION 6 - Beam Shelf and Clamp, Bilge Stringers, Breast Hooks and Bottom Girders

6.1 Beam Shelf

6.1.1 The cross-sectional area of beam shelf for $^{3}/_{5}$ *L* amidships is to be given in Table 6. Outside this length the area may be gradually reduced to the ends where it may be 25 per cent less than that amidships.

6.1.2 The area of beam shelf determined from Table 6 is to be that clear of beams; the section removed for the beam end is not to impair the efficiency of the shelf.

Table 6 Beam Shelf and Bilge Stringer Scantlings and Fastenings

Length, L, m	Cross Sectional Area of Beam Shelf cm²	Cross sectional Area of Bilge Stringer cm²	Diameter of Bolts, mm		
			Arms of Breast hooks	Beam Shelf Stringer	Hanging Knees
6	32	22	8	6	6
8	40	29	8	6	6
10	50	35	8	6	6
12	60	50	10	8	8
14	80	60	12	8	8
16	100	70	12	8	8
18	110	85	12	10	10
20	130	100	14	12	12
22	150	110	14	12	12
24	170	125	14	12	12
26	190	140	14	12	12
28	210	150	16	12	12
30	240	165	18	14	14

6.1.3 Where the beam shelf is not fitted in one length, a plain glued scarph is to be arranged. Scarphs are to be suitably positioned in relation to joints in other longitudinal members and to hanging knees, etc. The face of the scraph is generally to be in the vertical plane.

6.1.4 Where there is a raised deck, it is recommended that the main beam shelf be carried to the ends. Where, however, this is not done suitable arrangements are to be made to maintain the longitudinal continuity of the shelf, and the frame scantlings in way may be required to be increased.

6.1.5 The beam shelf is to be attached to each frame by one through fastening where the moulding of the shelf does not exceed 180 mm and by two through fastenings where the moulding exceeds 180 mm. The size of fastenings is given in Table 6.

6.1.6 For size of fastenings, *see* Table 6.

6.2 Bilge Stringer

6.2.1 A bilge stringer is to be fitted where the framing is Type 1 (bent only), or where the length, *L*, exceeds 9.0 m for Type 2.

6.2.2 The cross-sectional area of bilge stringers for $^3/_5$ L amidships is to be given in Table 6. Outside this length the area may be gradually reduced to the ends where it may be 25 percent less than amidships. The greatest dimension of the stringer is to be fitted against the frames.

6.2.3 Scarphs in the port and starboard stringers are to be staggered and suitably positioned in relation to joints in other members. The face of the scarph in the stringer is to be cut parallel to the frames.

6.2.4 Stringers are to be attached to each frame by one through fastening where the moulding of the stringer does not exceed 180 mm and by two through fastenings when the moulding exceeds 180 mm.

6.2.5 As an alternative to the fitting of a bilge stringer two or more side stringers may be fitted. Where two side stringers are fitted the cross-sectional area of each is to be not less than 60 per cent of the Rule area for the bilge stringer.

6.2.6 For size of fastenings, *see* Table 6.

6.3 Breast Hooks

6.3.1 The beam shelf and stringer ends are to be efficiently attached to the centerline construction. Breast hooks and transom quarter knees are to be fitted as necessary.

6.3.2 The ends of the ship are to be suitably strengthened and particular attention is to be given to this where there is a large overhang.

6.3.3 For size of fastenings, *see* Table 6.

6.4 Bottom Girders

6.5.1 The engine seating is to be of substantial construction to suit the power of the machinery.

6.5.2 The longitudinal girders forming the engine seating is to extend as far forward and aft as practicable and to be adequately supported by transverse floors and/ or brackets.

6.5.3 Additional side girders may be required in the machinery space and in the bottom of the ship forward.

SECTION 7 - Bulkheads

7.1 General

7.1.1 Collision bulkhead shall be fitted which shall be watertight up to the freeboard deck. This bulkhead shall be located at a distance from the forward perpendicular of not less than five percent and not more than eight percent of the length of the ship. No doors are to be fitted in collision bulkheads.

7.1.2 In collision bulkheads the spacing of stiffeners is to be not greater than 460 mm.

7.1.3 In ships of 15 m Rule length and above, the machinery is to be enclosed between watertight bulkheads extending to the upper deck. Where the arrangement of the bulkheads to the upper deck interferes with the accommodation, modified arrangements may be submitted for consideration. Where accommodation is fitted over the machinery space, the deck is to be gastight.

7.1.4 In ships of less than 15 Meters Rule length, the machinery is to be enclosed by gastight bulkheads to protect accommodations spaces from gas and vapor fumes from machinery, exhaust and fuel systems.

7.1.5 Where practicable, the stern tube should be enclosed in a watertight compartment.

7.1.6 All bulkheads should be watertight.

7.1.7 The scantlings of wood bulkheads will be specially considered depending on the method of construction.

7.1.9 At the level of the decks below the upper deck, angles or flats are to be suitably attached to the bulkheads for taking the fastenings of the wood deck.

SECTION 8 - Hull Planking

8.1 General

8.1.1 The outside shell may be constructed with wooden planks or marine plywood.

8.1.1 The thickness of the outside shell and deck planking is to be given in Table 7.

Table 7 Outside and Deck Planking

Length, L, m	Wooden Plank mm	Marine Plywood mm
6	19	9.5
8	21.5	9.5
10	24	9.5
12	28	12.7
14	32	12.7
16	36	12.7
18	39	19.05
20	41.5	19.05
22	43.5	19.05
24	45.5	25.4
26	47.5	25.4
28	50	25.4
30	52	25.4

Notes
1. The basic thicknesses are applicable to single skin carvel or strip outside planking and to a laid deck.

8.2 Single Skin

8.2.1 Butts of the outside planking are to be spaced not less than 1.2 m apart and no butts are to be in the same frame space unless there are three strakes between, *see* Fig. 5. The arrangement of butts at the ends of the craft is to be to the Surveyor's satisfaction.

8.2.2 The butts in the garboard strake are to be kept clear of the keel scarph. Butts in the sheerstrake are to be clear of butts in the covering board.

8.2.3 Butts in the planking are to be strapped or scarphed.

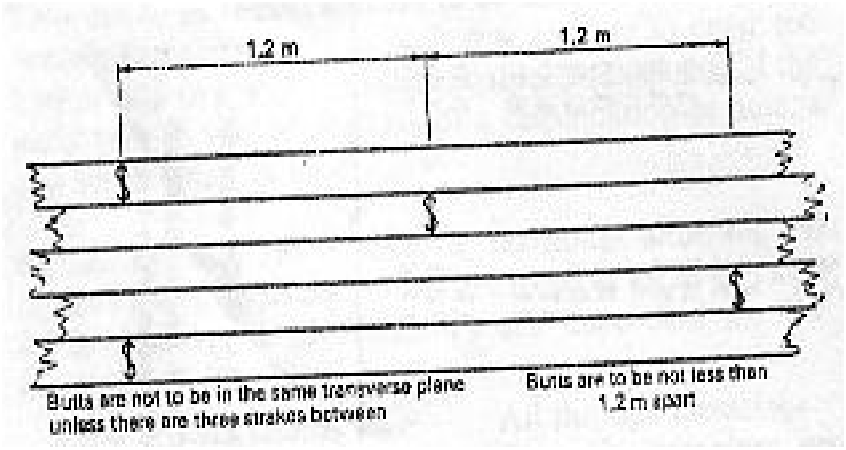


Fig. 6
Spacing of Butts

8.2.4 Wood or metal butt straps are to be arranged between the frames but a drainage space is to be left between the strap and the frame. The breadth is to be sufficient to overlap the adjacent planks by about 12 mm.

8.2.5 Wood butt straps are to have the same thickness as the planking. Metal straps are to be not less than $^1/_6$ of the planking thickness, *see* Fig. 7.

8.2.6 The planking and the straps are to be through fastened. The size of the fastenings is to be as required by Table 8 for planking to frames, and the number is to be as follows:-

Width of planking, mm	Number of fastenings in each plank end
Under 100	3
100 and under 200	4
200 and under 250	5

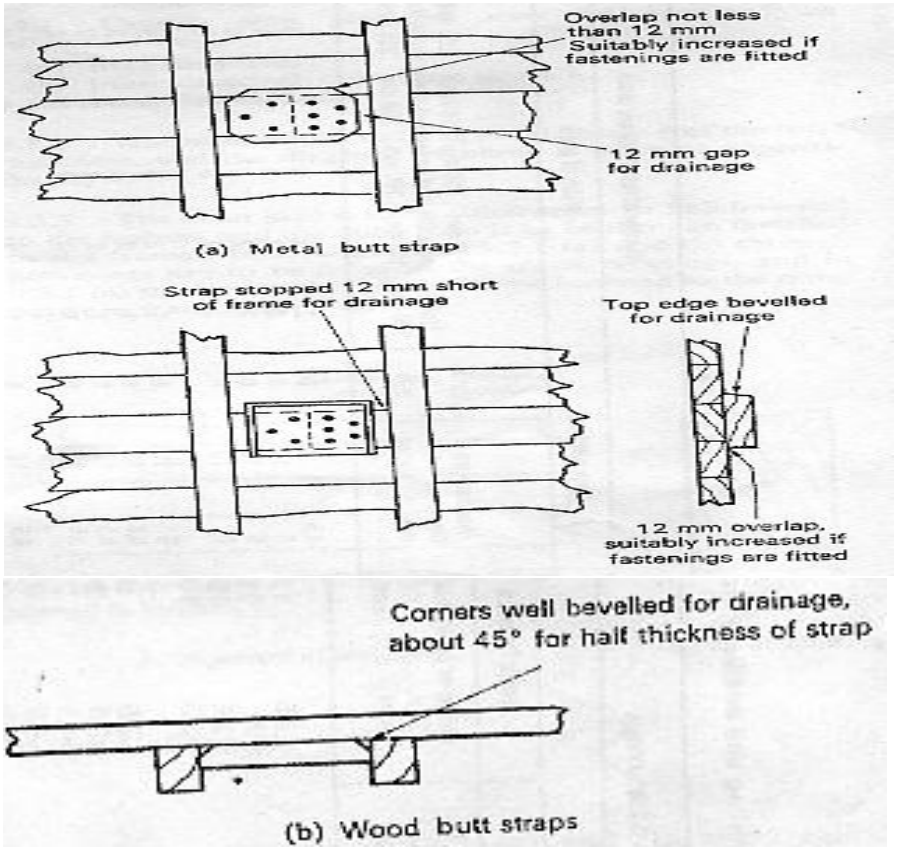


Fig. 7 Typical butt straps on single skin hull planking

8.2.7 Where, with planks of normal breadth, the length of snaped ends exceeds 250 mm, the planks are to be checked into the centreline structure (*see* Fig. 7). The size of the fastenings is to be as for the garboard strake (*see* Section 8.2.8).

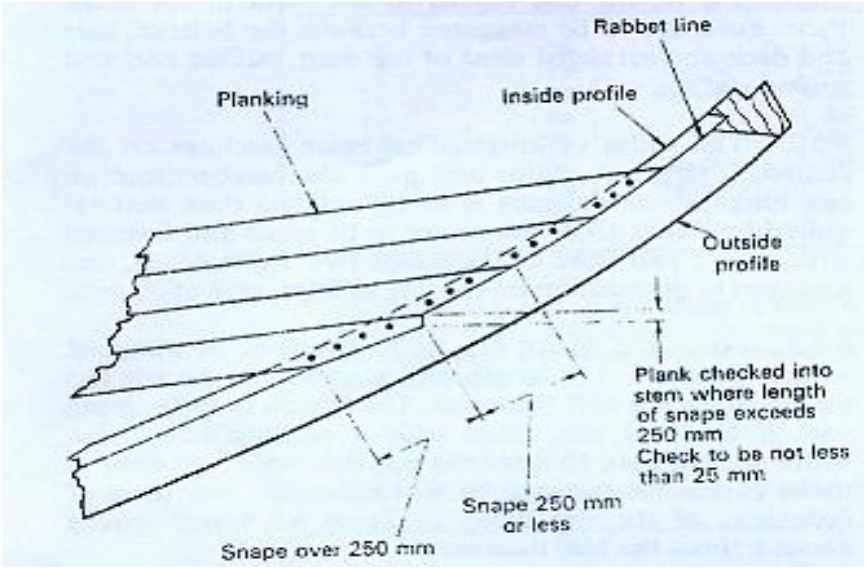


Fig. 8 Connection of single planking to centreline structure (for normal breadth of planking)

8.2.8 The garboard strakes are to be screw fastened to the keel or hog. The screws are to be of the size required by Table 8 for outside planking to Type 2 grown frames. They are to be reeled, and are to be spaced not more than twelve diameters apart in each row and are to enter the keel or hog to a depth at least equal to the thickness of the garboard. In way of deadwoods a combination of dumps and screws may be used.

8.2.9 Seams between planks should be caulked with an organic material and then filled with flexible waterproof filler. Synthetic fibers should not be used for caulking.

8.2.10 The size and number of fastenings attaching the outside planking to the frames are to be as given in Table 8. The type of fastenings are dependent on the framing as follows:

Type 1:	Bent frames	All throughout fastenings
Type 2:	Grown frames	Through fastenings to be arranged in way of beam shelf, bilge (or side) stringer. The remainder may be screws.

Table 8 Fastenings for Outside and Deck Planking

Planking Thickness mm	Size of Fastenings						
	Outside Planking						
	Grown Frames					Bent Frames	
	Bolts mm	Wood Screws		Copper Ship Nails		Copper Ship Nails	
		Dia. mm	Gauge	Size mm	Gauge	Size mm	Gauge
19	5	5	10	4.5	7	2.5	12
20.5	5	5	10	5	6	3	11
22	6	5	10	6.5	3	3.5	10
23.5	6	5	10	6.5	3	3.5	10
25	6	5.5	12	6.5	3	3.5	9
26.5	6	5.5	12	6.5	3	3.5	9
28	6	5.5	12	6.5	3	4.5	7
29.5	6	5.5	12	6.5	3	4.5	7
31	8	6.5	14	7.5	1	5	6
32.5	8	6.5	14	7.5	1	5	6
34	8	6.5	14	7.5	1	5.5	5
35.5	8	7	16	7.5	1	5.5	5
37	8	7	16	7.5	1	5.5	5
38.5	8	7	16	7.5	1	5.5	5
40	10	8	16	9.5	3/0	6	4
41.5	10	8	18	9.5	3/0	6	4
43	10	8	18	9.5	3/0	-	-
44.5	10	8	18	9.5	3/0	-	-
46	12	8.5	20	11	5/0	-	-
47.5	12	8.5	20	11	5/0	-	-
49	12	8.5	20	11	5/0	-	-
50.5	12	10	24	12.5	7/0	-	-
52	12	10	24	12.5	7/0	-	-

Continuation - Table 8 - Fastenings for Outside and Deck Planking

Planking Thickness mm	Number of fastenings per plank							
	Deck Planking			Width of Plank				
	Wood Screws		Bolts, mm	Under 100 mm	100 mm and under 150 mm	150 mm and under 180 mm	180 mm and under 205 mm	205 mm and under 225 mm
	Dia. mm	Gauge						
19	4.5	8	5	2	2	3	3	3
20.5	5	10	5	2	2	3	3	3
22	5	10	6	2	2	3	3	3
23.5	5	10	6	2	2	3	3	3
25	5	10	6	1	2	2	3	3
26.5	5.5	12	6	1	2	2	3	3
28	5.5	12	6	1	2	2	3	3
29.5	5.5	12	6	1	2	2	3	3
31	5.5	12	6	1	2	2	3	3
32.5	6.5	14	8	1	2	2	3	3
34	6.5	14	8	1	2	2	3	3
35.5	6.5	14	8	1	2	2	3	3
37	6.5	14	8	1	2	2	2	3
38.5	7	16	8	1	2	2	2	3
40	7	16	8	1	2	2	2	3
41.5	7	16	8	1	2	2	2	3
43	8	18	10	1	2	2	2	3
44.5	8	18	10	1	2	2	2	3
46	8	18	10	1	2	2	2	3
47.5	8	18	10	1	2	2	2	3
49	8	18	10	1	2	2	2	3
50.5	8.5	20	12	1	2	2	2	3
52	8.5	20	12	1	2	2	2	3

8.3 Plywood Planking

8.3.1 Plywood is to be fitted in as large panels as practicable having due regard to the form of the ship. Panel butts are to be staggered between the bottom, side and deck and arranged clear of the mast, and engine seating.

8.3.2 The width of longitudinal seam landings on the centerline structure, chine and gunwale members and on any longitudinal stringers is to be not less than that required by Table 9. Seams are to be glued and fastened with one or two rows of fastenings (*see* Table 9), and arranged to give maximum spacing of fastenings of 50 mm.

8.3.3 Butts and seams are to be scarped or strapped where necessary. The length of a scarph is to be not less than 8 times the hull thickness. The

scarph is to be glued and, if made in situ, fitted with a backing strap of a width not less than 10 times the hull thickness. The strap is to be glued and fastened to the hull with two rows of fastenings of the size given in Table 10 and spaced about 8 times the hull thickness.

8.3.4 Butt straps are to be of the width given in Table 10 and the same thickness as the hull planking. The strap is to be glued and double or triple fastened to the hull with two rows of fastenings of the size given in Table 10.

8.3.5 The hull planking is to be attached to the frames by fastenings of the size given in Table 9, spaced generally not more than 75 mm apart.

8.4 Hull Sheathing

8.4.1 While is not required of the Rules that the outside planking be sheathed, if this is done it must be efficiently carried out to the satisfaction of the Administration.

Table 9 - Plywood Planking: Overlaps and Fastenings

Plywood planking thickness, mm	Minimum breadth of landing between			Fastenings		
	Hull planking and keel or chine, mm		Hull or deck planking and shelf or longitudinal, mm	Wood screws		Copper boat nails, gauge
				Gauge	Dia, mm	
6	25	Single fastened	25	8	4.2	10
8	28	Single fastened	28	10	4.9	10
10	32	Single fastened	32	10	4.9	8
13	44	Double fastened	35	12	5.6	8
16	50	Double fastened	44	12	5.6	8
19	57	Double fastened	50	14	6.3	6
22	63	Double fastened	57	14	6.3	3
25	63	Double fastened	57	16	7.0	3

Table 10 - Plywood Planking: Butts and Straps

Plywood planking thickness, mm	Breadth of butt strap, mm		Fastenings		
			Wood screws		Copper boat nails, gauge
			Gauge	Dia, mm	
6	Double fastened	150	8	4.2	10
8		175	10	4.9	10
10		200	10	4.9	8
13		250	12	5.6	8
16		280	12	5.6	8
19	Treble fastened	330	14	6.3	6
22		355	14	6.3	3
25		380	16	7.0	3

Notes
1. The gauge of woods screws given in the Table is Standard Gauge
2. The diameter of the wood screw is the nominal diameter of the unthreaded shank.

SECTION 9 - Beams

9.1 Scantlings

9.1.1 The scantlings of ordinary beams, half beams and strong beams are to be not less than those given in Table 11.

9.2 End Attachments

9.2.1 All beams are to be fastened to the shelf by dovetails or dowels. *See* Fig. 9.

9.2.2 As an alternative to Section 9.2.1, where a plywood deck is fitted the beams need not be dovetailed or dowelled but may be carried past the shelf and checked over it. The depth of the check is to be about one-quarter of the depth of the beam and the beam is to be screw or dump fastened to the shelf.

9.2.3 Hanging knees are to be fitted as required by Table 11 and are to be arranged at the mast and other strong beams to give a suitable disposition over the length of the ship.

9.2.4 Hanging knees may be steel straps, flanged plates, angle bar, or grown or laminated timber.

9.2.5 The dimensions of strap hanging knees are given in Table 11 but at the ends of the craft the length of arms need not exceed one-third of the length of the frame or beam. Angle knees are to have equivalent strength.

9.2.6 The minimum moulding at the throat of grown or laminated knees is to be 60 or 40 percent, respectively, greater than that required by Table 3 for ordinary grown frames at the heel.

9.2.7 Each arm is to be connected to the beam and to the frame by four bolts of the diameter given in Table 6. The bolts need not pass through the deck or outside planking.

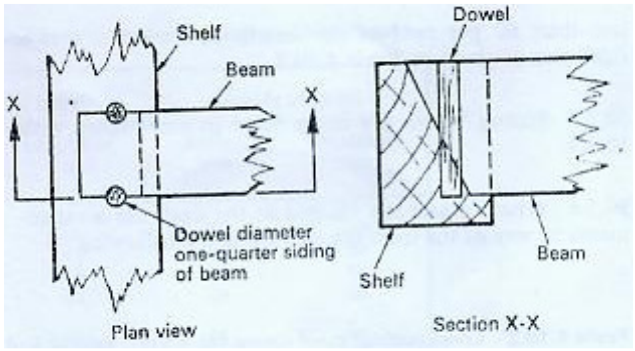


Fig 9 – Dowell fastening of Beam and at Shelf

Table 11 - Beams and Hanging Knees

Length of beam m	Spacing of ordinary beams center to center mm	Ordinary beams for 3/5 L amidship				Ordinary beams beyond 3/5 L amidship, half beams throughout			
		At middle		At ends		At middle		At ends	
		Siding mm	Moulding mm	Siding mm	Moulding mm	Siding mm	Moulding mm	Siding mm	Moulding mm
1.8	250	30	45	30	30	26	33	26	26
2.1	175	36	53	36	36	32	40	32	32
2.4	300	41	60	41	41	36	45	36	36
2.7	325	46	66	46	46	40	50	40	40
3.0	350	51	72	51	51	43	54	43	43
3.3	375	55	78	55	55	46	58	46	46
3.6	400	59	83	59	59	50	63	50	50
3.9	425	62	88	62	62	53	66	53	53
4.2	450	66	94	66	66	56	70	56	56
4.5	475	69	99	69	69	58	74	58	58
4.8	500	72	103	72	72	61	78	61	61
5.1	525	75	108	75	75	63	82	63	63
5.4	550	79	112	79	79	65	86	65	65
5.7	575	82	117	82	82	67	91	67	67
6.0	600	85	121	85	85	69	96	69	69
6.3	625	88	125	88	88	70	100	70	70
6.6	650	91	130	91	91	71	105	71	71
6.9	675	96	137	96	96	73	112	73	73
7.2	700	102	145	102	102	75	120	75	75

9.3 Local Reinforcements

9.3.1 The beams and deck are to be suitably strengthened in way of masts, windlass, cleats, sheet winches, etc. Where a mast is stepped on the deck the structural arrangements will be specially considered.

9.3.2 All deck openings are to be properly framed with carlings fitted to receive the half beams.

.

SECTION 10 – Deck Planking

10.1 General

10.1.1 Decks may consist of laid planks or marine plywoods.

10.1.2 The thickness of laid planks and marine plywoods is to be as given in Table 7.

10.1.3 Where the beam spacing differs from that given in Table 11, the Table thickness is to be modified at the rate of 1.5 mm per 50 mm difference.

10.2 Laid decks

10.2.1 Butts of the deck planking are to be spaced not less than 1.2 m apart and no butts are to be in the same transverse plane unless there are three strakes between. *See* Fig. 6.

10.2.2 Butts are to be arranged on a beam and are to be of the scarph or caulked lip unless the siding of the beam is sufficient to allow a caulked square butt to be used. *See* Fig. 10.

10.2.3 Deck planks are to be attached to the beams by either screw fastenings from above, or side fastening by nails. *See* Fig. 11.

10.2.4 Where the beam spacing has been increased it may be necessary to fit horizontal dowels in the planking between the beams.

10.2.5 The number and size of screws are to be as given in Table 8. Deck covering boards are to be screw fastened to the sheerstrake and beams. The screws to the sheerstrake are generally to be spaced not more than 12 diameters apart.

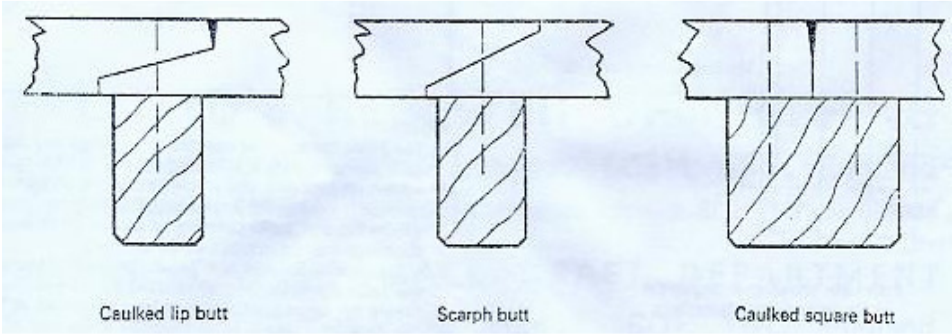


Fig. 10 Butts of deck planking

10.3 Plywood Decks

10.3.1 Plywood decks are to be fitted in panels as large as practicable.

10.3.2 Butts are to be clear of those in the side planking and are not to be placed in the vicinity of the mast. They are to be on a strong beam or are to be strapped.

10.3.3 Seams are to be strapped or scarphed or may be arranged on a longitudinal member having a width sufficient to give a landing of not less than that required by Table 9. Butts and seams are to be sealed watertight.

10.3.4 Plywood decks are to be glued or bedded to the beams and at the deck edges. They are also to be fastened to the beams and at the edges by screws or barbed nails, as required by Table 9. The fastenings in seams and butts landing on structural members are to be as required for deck edges. If a strap is fitted, it is to be as required by Section 8.5.4 for hull plywood planking.

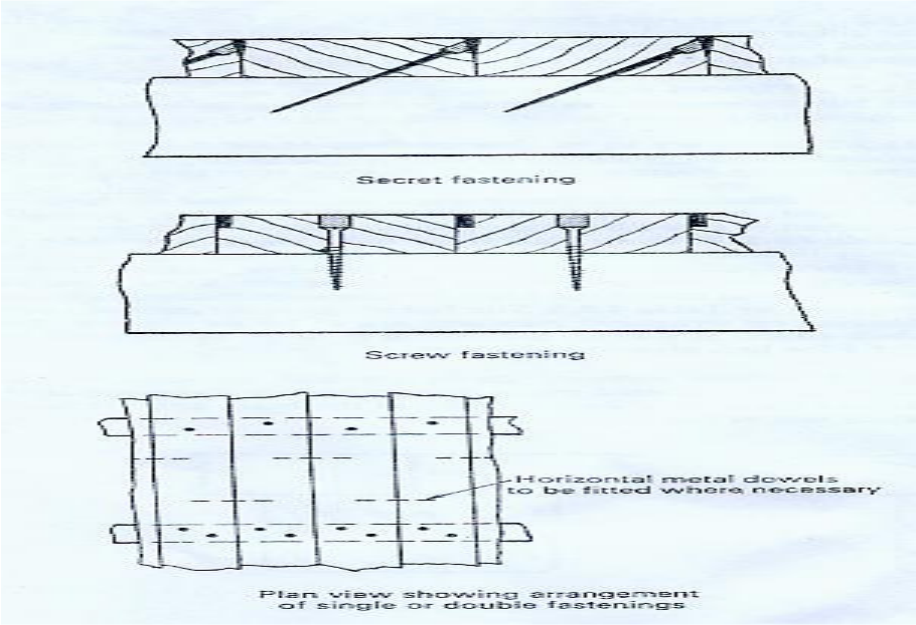


Fig. 11 Deck fastenings (laid decks)

10.4 Watertightness

10.4.1 Laid decks are to be caulked or any acceptable deck seaming compound, applied in accordance with the manufacturers' recommendations, may be used. Wood dowels are to be glued.

10.4.2 All weather decks are to be hose tested on completion.

10.5 Deck Fittings

10.5.1 Fittings fixed to the deck are to be bedded on a suitable waterproofing compound to maintain the watertightness of the deck.

10.5.2 It is recommended that in way of heavy fittings such as windlasses, winches, fairleads, etc., the deck planking and the fastening holes be coated with a suitable wood preservative prior to the application of the waterproofing compound.

10.5.3 Guard rail stanchions are to be bedded on a suitable waterproofing compound and are to have not less than three fastenings through the palm, one of which is to be a through fastening.

SECTION 11 – Deckhouse

11.1 General

11.1.1 Deck deckhouses are to be substantially constructed and efficiently connected to the carlings and beams.

11.2 Deckhouse

11.2.1 The scantlings of a deck house to be as given in Tables 12 and 14

Table 12 Scantling of Deckhouse

Length, *L,* m	Coaming Thickness, mm	Coachroof Deck Thickness, mm
6	17	13
8	19	15
10	22	17
12	24	19
14	26	22
16	29	24
18	32	26

Notes

1. Where the deckhouse coaming or deck is of plywood the Table thickness may be reduced by 30 percent.
2. If the deck is covered with canvas or other approved sheathing the Table thickness may be reduced by 1.5 mm.
3. Where the beam spacing differs from that given in Table 14, the deck thickness is to be modified at the rate of 1.5 mm per 50 mm difference

Table 14 Deckhouse Beams

Length of Beam, mm	Spacing Center to Center mm	At Middle of Beam		At Ends of Beam	
		Siding mm	Moulding mm	Siding mm	Moulding mm
1.2	255	28	41	28	28
1.5	280	30	44	30	30
1.8	305	34	48	34	34
2.1	330	38	53	38	38
2.4	2.4	41	57	41	41
2.7	2.7	43	60	43	43
3.0	3.0	44	63	44	44
3.3	3.3	44	65	44	44
3.6	455	41	68	46	46
3.9	480	48	71	48	48
4.2	505	50	75	50	50

11.2.2 Where the deckhouse deck is of plywood the thickness determined from Table 12 may be reduced by 30 percent.

11.2.3 Where plywood is sheathed with a laid deck the combined thickness may be 30 per cent less than the thickness in Table 12 provided that: --

(a) the thickness of the plywood is not less than 30 per cent of the combined thickness and in no case is less than 6 mm, and
(b) where the laid planking is less than 19 mm, the seams are filled with an approved flexible seam compound.

11.2.4 If the deckhouse deck is covered with canvas or other approved sheathing the thickness determined from Table 12 may be reduced by 1.5 mm.

11.2.5 Where the deckhouse beam spacing differs from that given in Table 14 the strength of the beams is to be modified in direct proportion and the deck thickness is to be modified at the rate of 1.5 mm per 50 mm difference.

11.2.6 On small deckhouse where it is desired to dispense with beams the deck thickness will be specially considered.

11.2.7 The deckhouse and side deck are to be adequately stiffened in way of the mast. Where a mast is stepped on the coachroof the structural arrangements will be specially considered.

SECTION 12 - Cruising Multi-Hulls

12.1 General

12.1.1 The procedure given in this Section for determining scantlings assumes that:

- a catamaran has two identical, but opposite handed, hulls,
- a trimaran has a main hull and two identical, but opposite handed, floats having a length not less than 80 percent of that of the main hull.

12.1.2 The scantlings of the hulls and floats are related to the dimensions of the craft as defined as follows: --

- Catamarans: Breadth, B, is the greatest breadth over both hulls.
- Trimarans: Breadth, B, is the greatest breadth over floats.

12.1.3 The breadth, B_1, is the greatest breadth of a single hull in a catamaran and of the main hull in a trimaran. It is to be measured between the points of intersection of the extension of hull sides to the normal line of deck.

12.2 Keel and Centerline Structure

12.2.1 The scantlings of the keel and hog are to be 30 per cent of the cross-sectional area given in Table 2. The moulding is to provide an adequate landing, as given in Table 9, for the bottom planking, but the siding may be tapered from amidships to the end and may be shaped to form. The keel assemble may be required to be increased over the ½ *L* amidships where the bulkheads or frames are widely spaced to support the hull when aground or on a carriage.

12.2.2 The moulding of the stem is to provide an adequate landing in accordance with Table 9 for the hull planking. The stem may be sided to form, but is to be not less than 1 ½ times the moulding at the foot. The moulding may be required to be increased if its strength is impaired by the checking out for longitudinal stringers. A fore-foot knee, sided not less than the stem, and with adequate arms, is to be fitted. An external apron piece, moulded not less than 60 per cent of the stem moulding, is to be glued and screwed to the stem. A nosing or fairing piece is to be adequately fastened to the stem apron.

12.2.3 Where a counter-stern is fitted, the sternpost and counter timber are to comply with Section 3 & 4, and the scantlings are to be not less than 50 per cent of those given in Table 2. In transom stern designs, the transom is to be not less than the hull planking required by Section 8, and is to be attached to the keel by a knee similar to that of the stem forefoot.

12.3 Framing

12.3.1 The frames and floors are to be in accordance with Sections 4 and 5.

12.3.2 The gunwale and chine members are to be in accordance with Section 6 and the areas are to be not less than 50 per cent of those given in Table 6 for a beam self or bilge stringer, respectively. The landing for the hull planking is to be not less than that given in Table 9.

12.4 Main Beams or Outriggers

12.4.1 The hulls in catamarans and the floats in trimarans are to be supported by two or more continuous beams extending over the breadth, *B,* of the craft. The main beams are to be suitable positioned longitudinally to keep racking stresses to a minimum.

12.4.2 The beams may be of solid or laminated timber, or may be fabricated webs with top and bottom plates, with no undue breaks in the strength of the beams. The beams are to be attached to suitable bulkheads or webs in the hulls and floats.

12.5 Hull Planking

12.5.1 The hull planking is to be in accordance with Section 8 and may be generally be reduced in thickness by an additional 10 per cent. The planking of the underside of the hull bridge or float arms may generally be reduced by 25 percent.

12.5.2 The forward end of the hull bridge is to be substantially framed, and the planking is to be of the same thickness of the main hulls.

12.6 Deck Structure

12.6.1 The beams and deck planking are to be in accordance with Sections 9 and 10. The deck planking may be reduced by 10 percent.

12.7 Superstructures

12.7.1 The superstructures are to in accordance with Section 12, but the scantlings given in Table 12 and 14 may be reduced by 15 percent.

12.8 Equipment Number

12.8.1 The equipment of anchors, chain cables, hawsers and warps are to be determined based on an 'Equipment' which is to be calculated as follows: -

For catamarans:

Equipment Number = $21.52L\left(\frac{B_1}{2}+D\right)+5.38A$

For trimarans:

Equipment Number = $16.14L\left(\frac{B_1}{2}+D\right)=5.38A$

Where: L , and D, are as defined in General Requirements -Definitions
B and B_1 , are defined in Sections 12.1.2 and 12.1.3.
A = the summation of the respective length times height, in m^2, of all erections above the weather deck which have a length or breadth greater than $\frac{B}{2.}$

Part B
Rules For Machinery Installation

General Requirements for the Installation Of Machinery

Scope

The requirements of this Part are applicable to main propulsion and essential auxiliary machinery.

SECTION 1 - Power Ratings and Definitions

1.1 Power Ratings

1.1.1 Where the dimensions of any particular component are determined from shaft power, *P*, in kW (*H*, in shp) and revolutions per minute, *R*, the values to be used are to be derived from the maximum shaft power and corresponding revolutions per minute giving the maximum torque for which the machinery is to be classed.

1.2 Definitions

1.2.1 Units and formula included in the Rules are shown in SI units followed by metric units in brackets, where appropriate.

1.2.2 Where the metric version of the shaft power, i.e. (shp), appears in the Rules 1 shp is equivalent to 75 kgf m/s or 0.735 kW.

SECTION 2 - Plans and Particulars

2.1 Plans

2.1.1 The following plans in triplicate, are to be submitted for consideration at the earliest opportunity: --

- Arrangement and details of the straight shafting and stern tube, including the method of attachment of the stern tube to the hull and any bracket or supports.
- Propeller, where the diameter exceeds 1 m.
- Diagrammatic arrangement of exhaust systems indicating materials, methods of cooling and, if water spray injected, the method of draining.

- Starting air system and receivers
- Diagrammatic arrangement of pump and piping systems, including air and sounding pipes.
- Diagrammatic arrangement of bilge pumps and piping
- Diagrammatic arrangement of oil fuel piping.
- Separate fuel tanks having a capacity exceeding 250 Liters.

Particulars

2.1.2 The following particulars are to be submitted with the plans of the crankshaft and gearbox, as applicable: --

- Name of manufacturer.
- Type of designation
- Number of cylinders
- Firing order of cylinders from free end of the engine.
- Maximum combustion pressure and mean indicated pressure.
- Proposed shaft power and revolutions per minute of the engine.
- Revolutions per minute of the propeller.

2.1.3 Where the ship have a Rule length of 12 m or less and have no sub-division, plans of bilge systems are not required but particulars of the bilge pumps and diameters of suction pipes are to be submitted.

SECTION 3 - Materials

3.1 General

3.2 Shafting

3.2.1 Shafts are to be manufactured from carbon or carbon manganese steel or corrosion resistant ferrous or non-ferrous materials which have been forged or rolled.

3.2.2 Proposals to use extruded non-ferrous materials will receive special consideration.

3.2.3 Material tests are not required where the maximum diameter does not exceed 80 mm provided suitable documentary evidence of the material specification can be verified.

3.3 Pumps and Piping Systems

3.3.1 Hull-side valves and cocks, inlet chests, distance pieces and other sea connections are to be of steel, bronze or other approved ductile material, but due attention is to be paid to the compatibility of the material with that of the hull structure. Ordinary cast iron is not acceptable.

3.3.2 In bilge pump systems and in engine cooling water systems, the pipes are to be manufactured of steel, copper or, in general.

3.3.3 In oil fuel and lubricating oil systems, the pipes are to be manufactured from steel or copper. However, the use as short joining lengths to the engine of flexible pipes of approved type such as synthetic rubber hoses with single or double closely woven integral wire braid reinforcement or convoluted metal pipes with wire braid protection will receive special consideration.

3.4 Separate Oil Tanks

3.4.1 Separate oil tanks are to be manufactured from steel, aluminium or a suitable alloy. Steel tanks will require protection against corrosion.

3.4.2 A suitable means for draining water or sludge from the base of fuel tanks should normally be provided.

SECTION 4 - Engine Seating

4.1 General

4.1.1 Rigid engine seating is to be constructed integral with the hull of the craft. They are to permit easy access to any fittings such as lubricating oil connections, bilge suctions and sea cocks.

4.1.2 Where the hulls are constructed of wood and the hull surfaces in the vicinity of the engine seating are not adequately protected against oil contamination, drip trays are to be fitted under those parts of the engine and gearbox where leakage of oil fuel or lubricating oil might occur. Means are to be provided for removing any leakage easily.

4.2 Holding Down Bolts

4.2.1 A sufficient number of fitted bolts or dowels or, alternatively, adequate thrust and collision chocks are to be provided.

4.2.2 The heads and nuts of holding down bolts are to be properly landed in the fully tightened position and the nuts provided with suitable locking arrangements.

4.2.3 Where the seating is formed from deep wooden bearers the recesses to accommodate the nuts and washers of the holding down bolts are to be cut at a sufficient depth to ensure ample wood in compression when the nuts are tightened.

4.2.4 Engine mountings of wood or fabricated from approved reinforced plastics are to be provided with steel or other suitable metal plats in way of engine feet.

4.3 Resilient Mountings

4.3.1 Where resilient mountings are fitted, the name of the manufacturer and details of the type of mounting are to be indicated on the plan of shafting.

4.3.2 Suitable flexible shafting, electric cabling and piping connections are to be provided between the machinery seated on resilient mountings and the associated fixed installations.

4.3.3 Satisfactory arrangements are to be made to transmit the propeller thrust.

Section 5 - Starting Arrangements

5.1 Starting Capacity

5.1.1 Air receivers or batteries used for starting main propulsion engines are to have sufficient capacity to provide, without recharging, not less than twelve consecutive starts of each main engine, if of the reversible type, and not less than six consecutive starts, if of the non-reversible type.

5.2 Compressed Air

5.2.1 Where compressed air is used for starting purposes, at least two air compressors are to be provided. One compressor may be operated from the main engine, the other is to be independently driven.

Part C
Rules For Propulsion, Shafting and Propellers

SECTION 1 - Screw Shafts and Tube Shafts

1.1 Tube Shafts

1.1.1 A tube shaft is a shaft which passes through a stern tube, but does not carry a propeller.

1.2 Materials

1.2.1 Screw shafts and tube shafts are to be manufactured, in general, from materials having chemical composition and mechanical properties as shown in Table 2.1.1.

1.2.2 Where it is proposed to use materials other than those included in Table 2.1.1, particulars of the chemical composition and mechanical properties including the corrosion fatigue strength in sea water are to be submitted for consideration.

1.2.3 In the selection of materials for propellers, shafts, keys', locking nuts, etc.,consideration is to be given to their compatibility.

1.3 Diameter of Shafts

1.3.1 The diameter of screw shafts and tube shafts of materials having properties as shown in Table 2.1.1, is to be not less than that obtained from Fig. 2.1.1, where P(H) and R are as defined in Part B, Section 1.1.1. In no case is the diameter to be less than 25 mm for carbon and carbon manganese steel shafts and 20 mm for the other materials included in Table 2.1.1.

1.3.2 Where it is proposed to use materials other than those included in Table 2.1.1, the diameter will be specially considered.

Table 2.1.1 Chemical composition and mechanical properties of screw shaft materials

Material	Chemical composition In %				Minimum tensile strength, in N/mm2 (kgf/mm2)	Minimum yield or proof stress, in N/mm2 (kgf/mm2)	Elongation on 5.65 $\sqrt{So}$
Carbon and carbon manganese steel	C	0.16	to	0.24			
	Si Mn	0.45 0.50	Max to				
	S P	} 0.05	max	0.9	400 (41)	200(20.5)	26
Stainless steel type 316 (austenitic)	C Si Mn	70.0	Max to	1.0			
	Si	0.2	to	2.0			
	Mn	0.05	to	13.0	460(47)	165(47)	40
	Ni	10	to	18.5			
	Cr	16.5	to	3.0			
	Mo	2.25	to				
Stainless stell type 431 (martensitic)	C	0.12	to				
	Si	0.8	to				
	Mn	1	to	0.2	850(87)	675(69)	11
	Ni	2	to	3			
	Cr	15	to	18			
Manganese bronze (high tensile brass)	Cu	56	max to				
	Sn	1.1	to	60			
	Pb	0.05	to	1.5	510(52)	245(25)	20
	Mn	0.03	to	2			
	Fe	0.025	to	1.2			
	Zn remainder						
Aluminum bronze	Al	8	to	11			
	Ni	4	to	6			
	Fe	4	to	6			
	Mn	2	max		740(75)	390(40)	40
	Cu remainder						
Nickel copper alloy-monel	Ni	63	to 70				
	Mn	2	max				
	Fe	2.5	max				
	C	0.3	max		580(59)	380(39)	40
	Si	0.5	max				
	Si	0.025	max				
	Cu remainder						
Nickel copper allo-monel K 500	Ni	63	to 70				
	Mn	1.5	max				
	Fe	2	max				
	C	0.25	max				
	Si	1	max		960(98)	685(70)	18
	Si	0.01	max				
	Al	2	to				
	Ti	0.25	to				
	Cu remainder						

1.4 Shaft Protection

1.4.1 Screw shafts and tube shafts made from carbon or carbon manganese steel are to be protected by a continuous bronze liner, where exposed to sea water. Alternatively, the liner may be omitted provided the shaft is arranged to run in an oil lubricated bush with an approved oil sealing gland at the after end. Lengths of shafting between stern tubes and brackets which are readily visible when the craft is slipped may be protected by approved coatings.

1.4.2 Means for the protection of screw shafts and tube shafts are not required when the shafts are made of corrosion resistant material such as stainless steel and bronze.

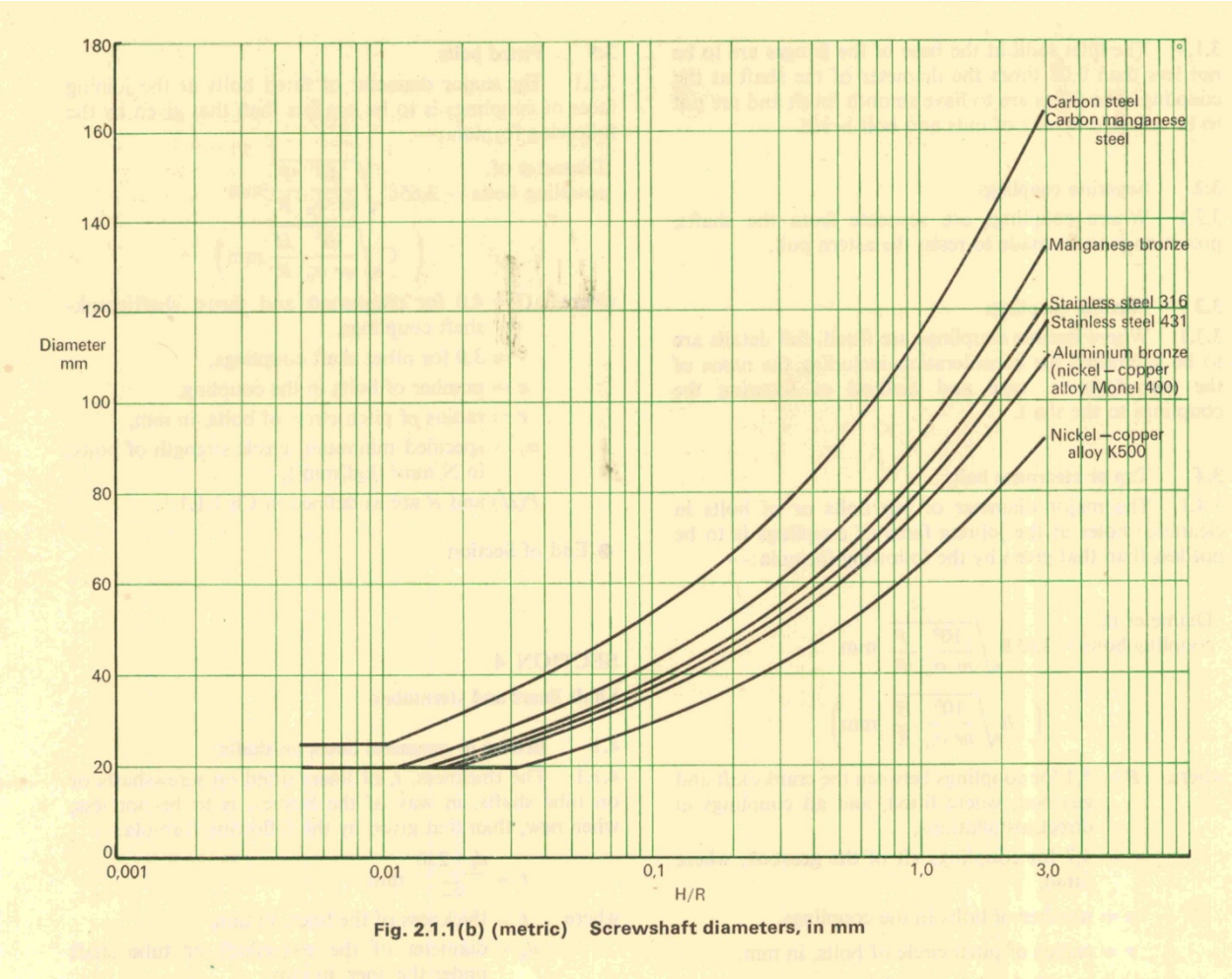


Fig. 2.1.1(b) (metric) Screwshaft diameters, in mm

Fig. 2.1.1 (metric) - Screw Shaft Diameters, mm

SECTION 2 - Intermediate Shafts

2.1 Shaft Diameter

2.1.1 The diameter, d, of a carbon or carbon manganese steel intermediate shaft is to be not less than determined by the following formula: --

$$d = 0.8 ds \sqrt[3]{\left(\frac{560}{\sigma_u + 160}\right)} \quad mm$$

$$\left(d = 0.8 ds \sqrt[3]{\left(\frac{57}{\sigma_u + 16}\right)} \quad mm \right)$$

where d_s = Rule size of a carbon manganese steel screw shaft obtained from Fig. 2.1.1, in mm,

σ_u = specified minimum tensile strength of the intermediate shaft material, in N/mm^2 (kgf/mm^2).

2.1.2 Where it is proposed to use materials other than carbon and carbon manganese steel, particulars of the chemical composition and mechanical properties are to be submitted and the diameter will be specially considered.

SECTION 3 - Couplings

3.1 Coupling Flanges

3.1.1 The thickness of the coupling flanges at the pitch circle of the bolt holes is to be not less than the diameters of the bolts at the joining faces of the couplings.

3.1.2 In no case is the thickness of the intermediate shaft coupling flange to be less than 0.2 of the diameter of the intermediate shaft required by Section2.1

3.1.3 The thickness of the screw shaft coupling flange is to be not less than 0.25 of the diameter of the intermediate shaft as required by Section 2.1 based on the screw shaft material.

3.1.4 The fillet radii at the base of the flanges are to be not les than 0.08 times the diameter of the shaft at the coupling. The fillets are to have smooth finish and are not to be recessed in way of nuts and bolt heads.

3.2 Separate Couplings

3.2.1 Where couplings are separate from the shafts, provision is to be made to resist the astern pull.

3.3 Flexible Couplings

3.3.1 Where flexible couplings are fitted, full details are to be submitted for consideration including the name of the manufacturer, type and method of securing the couplings is to the shaft.

3.4 Tap or Clearance Bolts

3.4.1 The major diameter of tap bolts or of bolts in clearance holes at the joining faces of couplings is to be not less than that given by the following formula:

$$\text{Diameter of coupling bolts} = 3.65B\sqrt{\frac{10^6 P}{nr\sigma_o R}}mm$$

$$\left(B\sqrt{\frac{10^6 H}{nr\sigma_o R}}mm\right)$$

where B = 5.1 for couplings between the crankshaft and gearbox, where fitted, and all couplings in direct installations
= 4.7 for couplings aft of the gearbox, where fitted
n = number of bolts in the couplings
r = radius of pitch circle of of bolts, in mm,
σ_o = specified minimum yield stress of the bolt material, in N/mm^2 (kgf/mm^2),
P (H) and R are as defined in Part B Section 1.1.1

Where it is proposed to use waisted bolts, the shank diameter is to be not less than 90 percent of that required by the formula.

3.4.2 In order to obtain the required force at the joining faces of the coupling, the bolt tightening torque, T_b, is to be not less than that given by the following formula:--

$$T_b = A\frac{d_b}{nr}\frac{P}{R}Nm$$

$$\left(Tb = \frac{A}{13.35}\frac{d_b}{nr}\frac{H}{R}kgfm\right)$$

but in no case is T_b to exceed $\frac{d^3{}_b\sigma_o}{11600}Nm(kgfm)$

where A = 31000 for couplings between the crankshaft and gearbox, where fitted, and all couplings in direct drive installations,
= 26300 for couplings aft of the gearbox, where fitted,
d_b = actual major diameter of bolt, in mm.
σ_o = specified minimum yield stress of the bolt material in N/mm^2 (kgf/mm^2)
n, r P(H) R are as defined in 3.4.1

3.5 Fitted Bolts

3.5.1 The major diameter of fitted bolts at the joining faces of couplings is to be not less than that given by the following formula: --

Diameter of coupling bolts = $3.65C\sqrt{\frac{10^6 P}{nr\sigma_o R}}\ mm$

$$\left(C\sqrt{\frac{10^6 H}{nr\sigma_o R}}\ mm\right)$$

where C = 4.0 for crankshaft and thrust shaft/crankshaft couplings,
= 3.0 for other shaft couplings,
n = number of bolts in the couplings
r = radius of pitch circle of of bolts, in mm,
σ_o = specified minimum tensile strength of bolts, in N/mm^2 (kgf/mm^2)

P (H) and R are as defined in Part B Section 1.1.1

SECTION 4 - Shaft Liners and Stern Tubes

4.1 Bronze or Gunmetal Liners on Shafts

4.1.1 The thickness, t, of liners fitted on screw shafts or ion tube shafts, in way of the bushes, is to be not less, when new, than that given by the following formula: --

$$t = \frac{d_S + 230}{32} \ mm$$

Where:

t = thickness for the liner, in mm,

d_s = diameter of the screwshaft or tube shaft under the liner, in mm.

4.1.2 The thickness of a continuous liner between the bushes is to be not less than $0.75t$.

4.1.3 Where a liner is fitted, effective means are to be provided for preventing water from reaching the shaft at the part between the after end of the liner and the propeller boss.

4.2 Stern Tubes

4.2.1 The length of the bearing in the stern tube or propeller bracket next to and supporting the propeller is to be as follows;---

(a) For water lubricated bearings the length is to be not less than four times the diameter required for the screw shaft.

(b) For water lubricated bearings lined with two or more circumferentially spaced sectors of an approved plastics material, in which it can be shown that the sectors operate on hydrodynamic principles, the length of bearing is to be such that the nominal bearing pressure will not exceed 0,

(c) 0.55 N/mm^2 (5.6 kgf/cm^2). The length of the bearing is to be not less than twice its diameter.

(d) For bearings which are white-metal lined, oil lubricated and provided with an approved type of oil sealing gland, the length of the bearing is to be approximately twice the diameter required for the screw shaft and is to be such that the nominal bearing pressure will not exceed 0.8 N/mm^2 (8.1 kgf/cm^2). The length of the bearing is to be not less than 1.5 times its diameter.

(e) For bearings of cast iron and bronze which are oil lubricated and fitted with an approved oil sealing gland, the length of the bearing is, in general, to be not less than four times the diameter required for the screw shaft.

(f) For bearings which are grease lubricated, the length of the bearing is to be not less than four times the diameter required for the screw shaft.

4.2.2 The bearing in the stern tube is to be secured to prevent rotational and axial movement.

4.2.3 Where screw shaft bearings and tube shaft bearings are made of lignum vitae or approved plastics materials, they are to be so designed as to ensure adequate water lubrication. Depending on the location of the bearing, it may be necessary to supply water to the bearing from a circulating pump or other pressure source.

4.2.4 Stern tubes are to be carefully fitted and well secured to the hull of the craft. The stern tube, propeller brackets and fastenings in wood craft are to be of corrosion resistant material. The tubes are to be of adequate thickness to provide support for the shaft bushes and to maintain shaft alignment.

4.2.5 In steel or aluminium craft where the stern tubes are fabricated from the same material as the hull and are not supported and connected at intervals throughout their length to the hull structure, the thickness is to be not less than 0.05 times the internal diameter of the tubes.

4.2.6 Where stern tubes are fabricated from glass reinforced plastics, full details of the lay-up are to be submitted. The concentricity and alignment of the tube are to be assured and suitable surface finish and fit are to be provided for supporting bushes.

4.2.7 The sealing gland at the forward end of the stern tube is to be readily and easily accessible for examination and adjustment. The adjustment and securing of the sealing gland is to me made of studs and nuts.

Section 5 - Shaft Bearing and Alignment

5.1 Shaft Bearings

5.1.1 Long unsupported lengths of shafting are to be avoided by the fitting of steady bearings at suitable positions. Where the span between bearings exceeds 30 diameters, whirling calculations of the propeller and shafting system are to be submitted for consideration.

5.1.2 Bearings fitted under flooring are to be readily accessible.

5.2 Shaft Alignment

5.2.1 The engines, shafting, stern tubes and propeller brackets are to be carefully fitted and well secured to the hull of the craft so that satisfactory alignment of the shafting will be maintained in service.

5.2.2 The alignment of the stern tube and propeller brackets is to be demonstrated before launching and the shafting and engine alignment verified when afloat.

5.2.3 An approved level-indicating device or a glass level gauge fitted with a self-closing valve at the lower end may be used in lieu of sounding pipes for sounding the tanks.

Section 6 - Propellers

6.1 Propeller Boss

6.1.1 The propeller boss is to be a good fit on the screw shaft cone. The forward edge of the bore of the propeller boss is to be rounded. The length of the forward fitting surface is to be approximately equal to the Rule diameter of the screw shaft.

6.1.2 It is recommended that audible or visual alarms be fitted to give warning of loss or excessive temperature of cooling water.

6.2 Keys and Keyways

6.2.1 Rounded ended or sled-runner ended keys are to be used, and the keyways in the propeller boss and cone of the screw shaft are to be provided with a smooth fillet at the bottom of the keyways. The radius of the fillet is to be at least 0, 0125 of the diameter of the screw shaft at the top of the cone. The sharp edges at the top of the keyways are to be removed.

6.2.2 Two screwed pins are to be provided for securing the key in the keyway, and the forward pin is to be placed at least one-third of the length of the key from the end. The depth of the tapped holes for the screwed pins is not to exceed the pin diameter, and the edges of the holes are to be slightly bevelled. The omission of pins for keys for small diameter shafts will be specially considered.

6.2.3 The distance between the top of the cone and the forward end of the keyway is to be not less than 0.2 of the diameter of the screw shaft at the top of the cone.

6.2.4 The effective sectional area of the key in shear is to be not less than:

$$\frac{d_3}{2.6d_1}\ mm^2$$

where d = diameter required for the intermediate shaft determined in accordance with 2.1.1, based on material having a specified minimum tensile strength of 400 N/mm^2 (41 kgf/mm2), in mm

d_1 = diameter of shaft at mid length of the key, in mm.

6.3 Propeller Brackets

6.3.2 Propeller brackets are ti be carefully fitted and well secured to the hull of the craft.

6.3.3 For the scantlings of the arms of propeller brackets.

Part D
Rules for Electrical Installation

SECTION 1 - General Requirements

1.1 General

1. The requirements of this part are applicable to the electrical installations in wooden hulled ship where :

   a. all electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions will be ensured without recourse to the emergency source of electrical power;

   b. electrical services essential for safety will be ensured under various emergency conditions; and

   c. the safety of passengers, crew and ship from electrical hazards will be ensured.

1.2 Plans

1. The following plans, in triplicate copies to be signed and sealed by Professional Electrical Engineer (PEE) and submitted for approval: --

   - Schematic Wiring Diagram
   - Schedule of Load and Specification

1.3 Additions and Alterations

1. An addition, temporary or permanent, is not to be made to the rated load of an existing installation until it has been established that the rating of the existing cables, switchgear and other equipment is adequate for the increased load subject for approval of the Administration.

1.4 Survey

1. The installation is to be under the charge of a duly registered professional electrical engineer or registered electrical engineer or registered master electrician and shall be inspected and tested by the MARINA surveyor to their satisfaction.

SECTION 2 - System Design – General

2.1 Systems of Distribution

Type of Systems

1. Alternating Current System:

   - 3-phase, 3 wire insulated system;
   - Single phase, 2 wire insulated system,

2 For Direct Current System, 2 wire insulated system

Note: Per P.E.C. Art. 10.6.1 The watercraft structure shall not be used as a normal current carrying conductor for power, heating and lighting system.

Earthing connections are ***not to be made*** to hull sheathing, skin fittings or plumbing.

a. SYSTEM PROTECTION

1. Electrical systems and equipment shall be protected from the effects of over current by suitably rated fuses or circuit breaker.

2. Circuit breakers shall be:

   (a) the proper voltage type and rating;
   (b) be the manual reset type;
   (c) have instantaneous short circuit protection capable of repeatedly opening the circuit in which they are used without failure; and
   (d) be of trip-free type

3. Fuses of the proper rating may be used for circuit protection, but shall be used in conjunction with a switch located between the fuse and source of power, fuse holders shall be suitable for use in sea atmospheres.

4. A master battery isolating switch shall be provided in accordance with the following:

   (a) be capable of carrying the continuous maximum current of the system in each ungrounded conductor;
   (b) the continuous rating of the switch shall be not less than the total ratings of the main overcurrent protection devices connected to it;
   (c) be capable of carrying the intermittent maximum cranking current of the largest engine cranking motor;

(d) shall be located as close to the battery as practicable but readily accessible in the event of an emergency;
(e) when used with a diode rectified alternator or third brush generator incorporate a means for breaking the field circuit when the battery load is removed from the system.

5. Each ungrounded conductor of circuits supplying lights, motors or electrical accessories shall be protected against overload at the distribution panel or switchboard serving as the source of power; each navigation light branch circuit shall be protected by a separate overcurrent device installed in each ungrounded conductor.

b. BATTERIES

1. Batteries shall be located in a compartment, locker or boxed reserved solely for that purpose; they shall not be located in accommodation spaces; batteries intended for emergency purposes shall be installed in a protected location as high as possible in the vessel.

2. Indication shall be provided that the battery is being maintained in a state of charge.

c. CABLES

1. Cables may be of a suitable commercial grade with stranded copper conductors and rated for at least 75° C service.

2. Portable cords or portable cables shall not be used for fixed wiring.

3. Cables shall be secured by clips or straps of non-ferrous material; staples shall not be used for this purpose.

4. Cables shall be routed as high as possible above the bilge with prime consideration given to the protection of the wiring from mechanical damage and heat damage.

5. Exposed wiring subject to mechanical damage shall be protected by conduit or other equivalent means.

6. Cables terminating in equipment capable of generating high temperatures such as lighting fixtures etc., shall be suitable for operation at the temperature of the equipment.

7. Current carrying capacities of cables will be assigned in accordance with current rating specified on Philippine Electrical Code.

d. SWITCHBOARDS & DISTRIBUTION PANELS

1. Switchboard and electrical distribution panels shall be located in accessible well ventilated locations protected from rain spray, where necessary, panels shall be provided with a drip shield.

2. Switchboard or other electrical panels or junction boxes located adjacent to weather decks or in open cockpits shall be enclosed or protected from deck wash.

3. Switchboards shall be so installed that no pipes or tanks are above them within the same space; where this is unavoidable, pipes shall be without joints in such positions.

4. Switchboard supports shall be of substantial and durable construction and shall be capable of withstanding electro-mechanical stresses which may arise from short-circuit faults; all panels shall be of substantial construction to withstand vibration, and hinged panels and doors of dead front switchboards shall be provided with positioners and stops.

5. Switchboards and panel boards shall be designed so there are no exposed live parts accessible to operating personnel under normal operation.

e. DISTRIBUTION

1. Joints and connections in all electrical conductors shall be mechanically and electrically secure and made only in junction or outlets boxes.

2. Joints shall be capable of withstanding the vibration and movement encountered in normal service.

3. Metal alloys used shall be corrosion-resistant and galvanically compatible with copper conductors.

4. With the exception of the thread cutting type of connector, twist-on type connectors shall not be used for making joints in cables.

5. Lamps which are exposed to the weather, spray and drip shall be enclosed in weatherproof fittings.

Part E
Regulations for Preventing Collisions at Sea, 1972

Light and Shapes

Rule 20
Application

(a) Rules in this part shall be complied with in all weathers.

(b) The Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.

(c) The lights prescribed by these Rules shall, if carried, also be exhibited from sunrise to sunset in restricted visibility and may be exhibited in all other circumstances when it is deemed necessary.

(d) The Rules concerning shapes shall be complied with by day.

(e) The lights and shapes specified in these Rules shall comply with the provisions of Annex I to these Regulations.

Rule 21
Definitions

(a) **"Masthead light"** means a white light placed over the fore and aft centreline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 225 degrees abaft the beam on either side of the vessel.

(b**)** **"Sidelights"** means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on its respective side. In a vessel of less than 20 metres in length the sidelights may be combined in one lantern carried on the fore and aft centreline of the vessel.

(c) **"Sternlight"** means a white light placed as nearly as practicable at the stern showing an unbroken light over an arc of the horizon of 135 degree and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel.

(d) **"Towing light"** means a yellow light having the same characteristics as the "sternlight" defined in paragraph (c) of this Rule.

(e) **All-round light"** means a light showing an unbroken light over an arc of the horizon of 360 degrees.

(f) **"Flashing light"** means a light flashing at regular intervals at a frequences of 120 flashes or more per minute.

Rule 22
Visibility of Lights

The lights prescribed in these Rules shall have an intensity as specifies in section 8 of Annex I to these Regulations so as to be visible at the following minimum ranges:

(a) In vessels of 12 metres or more in length but less than 50 metres in length:

- a masthead light, 5 miles; except that where the length of the vessel is less than 20 metres, 3 miles;
- a sidelight, 2 miles;
- a sternlight, 2 miles;
- a towing light, 2 miles;
- a white, red, green or yellow all-round light, 2 miles.

(b) In vessels of less than 12 metres in length:

- a masthead light, 2 miles;
- a sidelight, 1 miles
- a sternlight, 2 miles;
- a towing light, 2 miles;
- a white, red, green or yellow all-round light, 2 miles

(c) In inconspicuous, partly submerged vessels or objects being towed:

- a white all-round light, 3 miles.

Rule 23
Power-Driven Vessels Underway

(a) A power-driven vessel underway shall exhibit:

(i) a masthead light forward;
(ii) a second masthead light abaft of and higher than the forward one; except that a vessel of less than 50 metres in length shall not be obliged to exhibit such light but may do so;

(iii) sidelights;
(iv) a sternlight.

Rule 26
Fishing Vessels

(a) A vessel engaged in fishing, whether underway or at anchor, shall exhibit only the lights and shapes prescribed in this Rule.

(b) A vessel when engaged in trawling, by which is meant the dragging through the water of a dredge net or other apparatus used as a fishing appliance, shall exhibit:

(i) two all-round lights in a vertical line, the upper being green and the lower white, or a shape consisting of two cones with their apexes together in a vertical line one above the other;

(ii) a masthead light abaft of and higher than the all-round green light; a vessel of less than 50 metres in length shall not be obliged to exhibit such a light but may do so

(iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.

(c) A vessel engaged in fishing, other than trawling shall exhibit:

(i) two all-round lights in a vertical line, the upper being red and the lower white, or a shape consisting of two cones with apexes together in a vertical line one above the other;

(d) A vessel when not engaged in fishing shall not exhibit the lights or shapes prescribed in this Rule, but only those prescribed for a vessel of her length.

POSITIONING AND TECHNICAL DETAILS OF LIGHTS AND SHAPES

1. Definition

The term "height above the hull" means height above the uppermost continuous deck. This height shall be measured from the position vertically beneath the location of the light.

2. Vertical Positioning and Spacing of Lights

(a) On a power-driven vessel of 20 metres or more in length the masthead lights shall be placed as follows:

(i) the forward masthead light, or if only one masthead light is carried, then that light, at a height above the hull of not less than 6 metres, and, if the breadth of the vessel exceeds 6 metres, then at a height above the hull not less than such breadth, so however that the light need not be placed at a greater height above the hull than 12 metres;

(ii) when two masthead lights are carried the after one shall be at least 4.5 metres vertically higher than the forward one.

(b) The vertical separation of masthead lights of power-driven vessels shall be such that in all normal conditions of trim the after light will be seen over and separate from the forward light at a distance of 1.000 metres from the stem when viewed from sea-level.

(c) The masthead light of a power-driven vessel of 12 metres but less than 20 metres in length shall be placed at a height above the gunwale of not less than 25 metres.

(d) A power-driven vessel of less than 12 metres in length may carry the uppermost light at a height of less than 2.5 metres above the gunwale. When however a masthead light is carried in addition to sidelights and a sternlight or the all-round light prescribed in Rule 23(c)(i) is carried in addition to sidelights, then such masthead light or all-round light shall be carried at least 1 metre higher than the sidelights.

(e) (i) The masthead light or lights prescribed in Rule 23(a) shall be so placed as to be above and clear of all other lights and obstructions except as described in subparagraph (ii).

(ii) When it is impracticable to carry the all-round lights prescribed by Rule 27(b)(i) or Rule 28 below the masthead lights, they may be carried above the after masthead light(s) or vertically in between the forward masthead light(s) and after masthead light(s), provided that in the latter case the requirement of section 3(c) of this Annex shall be complied with.

(g) The sidelights of a power-driven vessel shall be placed at a height above the hull not greater than three quarters of that of the forward masthead light. They shall not be so low as to be interfered with by deck lights.

(h) The sidelights, if in a combined lantern and carried on a power-driven vessel of less than 20 meters in length, shall be placed not less than 1 meter below the masthead light.

(i) When the Rules prescribe two or three lights to be carried in a vertical line, they shall be spaced as follows:

(i) on a vessel of 20 meters in length or more such lights shall be spaced not less than 2 meters apart, and the lowest of these lights shall, except where a towing light is required, be placed at a height of not less than 4 meters above the hull;

(ii) on a vessel of less than 20 meters in length such lights shall be spaced not less than 1 meters apart and the lowest of these lights shall, except where a towing light is required, be placed at a height of not less than 2 meter above the gunwale;

(iii) when three lights are carried they shall be equally spaced.

(j) The lower of the two all-round lights prescribed for a vessel when engaged in fishing shall be at a height above the sidelights not less than twice the distance between the two vertical lights.

(k) The forward anchor light prescribed in Rule 30(a)(i), when two are carried, shall not be less than 4.5 meters above the after one. On a vessel of 50 metres or more in length this forward anchor light shall be placed at a height of not less than 6 meters above the hull.

3 . **Horizontal Positioning and Spacing of Lights**

(a) When two masthead lights are prescribed for a power-driven vessel, the horizontal distance between them shall not be less than one half of the length of the vessel but need not be more than 100 meters. The forward light shall be placed not more than one quarter of the length of the vessel from the stem.

(b) On a power-driven vessel of 20 meters or more in length the sidelights shall not be placed in front of the forward masthead lights. They shall be placed at or near the side of the vessel.

(c) When the lights prescribed in Rule 27(b)(i) or Rule 28 are placed vertically between the forward masthead light(s) and the after masthead light(s) these all-round lights shall be placed at a horizontal distance of not less than 2 meters from the fore and aft centerline of the vessel in the athwartship direction.

(d) When only one masthead light is prescribed for a power driven vessel, this light shall be exhibited forward of amidships; except that a vessel of less than 20 meters in length need not exhibit this light forward of amidships but shall exhibit it as far forward as is practicable.

4. **Screens for Sidelights**

The sidelights of vessels of 20 meters or more in length shall be fitted with inboard screens painted matt black, and meeting the requirements of section 9 of this Annex. On vessels of less than 20 meters in length the sidelights, if necessary to meet the requirements of section 9 of this Annex, shall be fitted with inboard matt black screens. With a combined lantern, using a single vertical filament and a very narrow division between the green and red sections, external screens need not be fitted.

5. **Shapes**

(a) Shapes shall be black and of the following sizes:

(i) a ball shall have a diameter of not less than 0.6 meter;

(ii) a cone shall have a base diameter of not less than 0.6 meter and a height equal to its diameter;

(iii) a cylinder shall have a diameter of at least 0.6 meter and a height of twice its diameter;

(iv) a diamond shape shall consist of two cones as defined in (ii) above having a common base.

(b) The vertical distance between shapes shall be at least 1.5 meters.

(c) In a vessel of less than 20 meters in length shapes of lesser dimensions but commensurate with the size of the vessel may be used and the distance apart may be correspondingly reduced.

6. **Colour Specification of Lights**

The chromaticity of all navigation lights shall conform to the following standards, which lie within the boundaries of the area of the diagram specified for each colour by the International Commission on Illumination (CIE). The boundaries of the area for each colour are given by indicating the corner co-ordinates, which are as follows:

(i) White

x	0.525	0.525	0.452	0.310	0.310	0.443
y	0.382	0.440	0.440	0.348	0.283	0.382

(ii) Green

x	0.028	0.009	0.300	0.203
y	0.385	0.723	0.511	0.356

(iii) Red

x	0.680	0.660	0.735	0.721
y	0.320	0.320	0.265	0.259

(iv) Yellow

x	0.612	0.618	0.575	0.575
y	0.382	0.382	0.425	0.406

7. **Intensity of Lights**

(a) The minimum luminous intensity of lights shall be calculated by using the formula:

$$I = 3.43 \times 10^6 \times T \times D^2 \times K^{-D}$$

I = 3.43 x 106 x T x D2 x K-D

where
- I is luminous intensity in candelas under service conditions,
- T is threshold factor 2 x 10 -7 lux,
- D is range of visibility (luminous range) of the light in nautical miles,
- K is atmospheric transmissivity.

For prescribed lights the value of K shall be 0.8, corresponding to a meteorological visibility of approximately 13 nautical miles.

b) A selection of figures derived from the formula is given in the following table:

Range of visibility (luminous range) of light in nautical miles D	Luminous intensity of light in candelas for K = 0.8 miles
1	0.9
2	4.3
3	12
4	27
5	52
6	94

Note: The maximum luminous intensity of navigation lights should be limited to avoid undue glare. This shall not be achieved by a variable control of the luminous intensity.

8. **Horizontal Sectors**

(a) (i) In the forward direction, sidelights as fitted on the vessel shall show the minimum required intensities. The intensities shall decrease to reach practical cut-off between 1 degree and 3 degrees outside the prescribed sectors.

(ii) For stem lights and masthead lights and at 22.5 degrees abaft the beam for sidelights, the minimum required intensities shall be maintained over the arc of the horizon up to 5 degrees within the limits of the sectors prescribed in Rule 21. From 5 degrees within the prescribed sectors the intensity may decrease by 50 per cent up to the prescribed limits; it shall decrease steadily to reach practical cut-off at not more than 5 degrees outside the prescribed sectors.

(b) (i) All-round lights shall be so located as not to be obscured by masts, topmasts or structures within angular sectors of more than 6 degrees, except anchor lights prescribed in Rule 30, which need not be placed at an impracticable height above the hull.

(ii) If it is impracticable to comply with paragraph (b)(i) of this section by exhibiting only one all-round light, two all-round lights shall be used suitably positioned or screened so that they appear, as far as practicable, as one light at a distance of one mile.

9. **Vertical Sectors**

(a) The vertical sectors of electric lights as fitted, with the exception of lights on sailing vessels underway shall ensure that:

(i) at least the required minimum intensity is maintained at all angles from 5 degrees above to 5 degrees below the horizontal;

(ii) at least 60 per cent of the required minimum intensity is maintained from 7.5 degrees above to 7.5 degrees below the horizontal.

(b) In the case of sailing vessels underway the vertical sectors of electric lights as fitted shall ensure that:

(i) at least the required minimum intensity is maintained at all angles from 5 degrees above to 5 degrees below the horizontal;

(ii) at least 50 per cent of the required minimum intensity is maintained from 25 degrees above to 25 degrees below the horizontal.

(c) I In the case of lights other than electric these specifications shall be met as closely as possible.

10. **Manoeuvring Light**

Notwithstanding the provisions of paragraph 2(f) of this Annex the manoeuvring light described in Rule 34(b) shall be placed in the same fore and aft vertical plane as the masthead light or lights and, where practicable, at a minimum height of 2 metres vertically above the forward masthead light, provided that it shall be carried not less than 2 metres vertically above or below the after masthead light. On a vessel where only one masthead light is carried the manoeuvring light, if fitted, shall be carried where it can best be seen, not less than 2 metres vertically apart from the masthead light.

14. **Approval**

The construction of lights and shapes and the installation of lights on board the vessel shall be to the satisfaction of the Administration.

ADDITIONAL SIGNALS FOR FISHING VESSELS FISHING IN CLOSE PROXIMITY

1. **General**

The lights mentioned herein shall, if exhibited in pursuance of Rule 26(d), be placed where they can best be seen. They shall be at least 0.9 metre apart but at a lower level than lights prescribed in Rule 26(b)(i) and (c)(i). The lights shall be visible all round the horizon at a distance of at least 1 mile but at a lesser distance than the lights prescribed by these Rules for fishing vessels.

2. **Signals for Trawlers**

(a) Vessels of 20 metres of more in length when engaged in trawling, whether using demersal or pelagic gear, shall exhibit:

(i) when shooting their nets: two white lights in a vertical line;
(ii) when hauling their nets: one white light over one red light in a vertical line;
(iii) when the net has come fast upon an obstruction: two red lights in a vertical line.

(b) Each vessel of 20 metres or more in length engaged in pair trawling shall exhibit:

(i) by night, a searchlight directed forward and in the direction of the other vessel of the pair;

(ii) when shooting or hauling their nets or when the nets have come fast upon an obstruction, the lights prescribed in 2(a) above.

(c) A vessel of less than 20 metres in length engaged in trawling, whether using demersal or pelagic gear or engaged in pair trawling, may exhibit the lights prescribed in paragraphs (a) or (b) of this section, as appropriate.

3. **Signals for Purse Seiners**

Vessels engaged in fishing with purse seine gear may exhibit two yellow lights in a vertical line. These lights shall flash alternately every second and with equal light and occultation duration. These lights may be exhibited only when the vessel is hampered by its fishing gear.