SECTION 1 EQUIPMENT IN ANCHORS AND CHAIN CABLES

1 General

1.1 Design assumptions for anchoring equipment

1.1.1 The requirements of the present Section only apply to temporary mooring of yacht within a harbour or sheltered area, where the yacht is awaiting for berth, tide, etc.

1.1.2 The equipment complying with these requirements is not designed to hold a yacht off fully exposed coast in rough weather nor for stopping the yacht which is moving or drifting. In these conditions the loads on anchoring equipment increase to such a degree that its components can be damaged or lost.

1.1.3 The determination of the anchoring equipment, as stipulated in [2] are based on following assumptions:

- wind speed of 38 knots (19,6 m/s)
- current speed of 5 knots (2,5 m/s)
- the water depth for mooring is approximately between one tenth and one sixth of the chain cable length calculated according to [3.2.2]
- under normal circumstances a yacht will use one anchor only.

1.1.4 For yachts where frequent anchoring in open sea is expected, owner's, shipyard's and designer's attention is drawn to the fact that anchoring equipment should be provided in excess to the requirements of this Rules.

1.1.5 The equipment complying with the requirements in [2] to [3] is intended for holding a ship in good holding sea bottom, where the conditions are such as to avoid dragging of the anchor. In poor holding sea bottom, the holding power of the anchors is to be significantly reduced.

1.1.6 Equipment in anchors and cables may be reduced on a case-by-case basis. Nevertheless, it belongs to designer and/or shipyard to submit all the relevant information demonstrating that reduced equipment - its configuration - and all its components, fully copes with the mooring forces most frequently encountered during service.

1.1.7 For yachts of special design or for yachts engaged in special services or on special voyage, the Society may consider anchoring equipment other than defined in the present Section.

1.1.8 Anchors and mooring line components - chain cable and its accessories, wire rope, etc. - are to be manufactured in accordance with relevant requirements of NR216 Materials and Welding.

1.1.9 The bow anchors, connected to their own chain cables, are to be so stowed as to always be ready for use. Other arrangements of equivalent provision in security and safety may be foreseen, subjected to Society's agreement.

Note 1: Towline not covered by the present rule may be requested by Flag administration.

2 Anchoring equipment calculation

2.1 General

2.1.1 All yachts are to be provided with equipment in anchors and chain cables (or cable and ropes) within the scope of classification. This equipment is determined from the dynamical forces due to wind and current acting on the yacht in conditions as defined in [1].

2.1.2 For yachts having a navigation notation **sheltered area** the equipment in anchors and cables may be reduced. This reduction consists to lower the dynamical force calculated in [2.2.1] by 15%.

2.1.3 For **charter yacht** intended to carry more than 12 passengers, Flag authorities may request than the equipment may be determined as defined in NR467 Rules for Steel Ship.

2.1.4 The equipment in anchor and chain cable is to be considered on a case by case basis by the Society when the dynamical force acting on the yacht as defined in [2.2.1] is greater than 50 KN.

2.2 Anchor mooring force calculation for monohull

2.2.1 The dynamical force, in KN, induced by wind and current acting on monohull in mooring condition as defined in [1.1.3] may be calculated as follow:

$F_{EN} = 2\ (F_{SLPH} + F_{SH} + F_{SS} + F_m)$

where:

F_{SLPH} : Static force on wetted part of the hull due to current, as defined in [2.2.2]

F_{SH} : Static force on hull due to wind, as defined in [2.2.3]

F_{SS} : Static force on superstructure due to wind, as defined in [2.2.4]

F_m : Static force on mast and standing rigging due to wind, as defined in [2.2.5].

2.2.2 Static force on wetted part of hull F_{SLPH}

The theoretical static force induced by current applied on the wetted part of the hull, in KN, is defined according to the following formula:

$$F_{SLPH} = \frac{1}{2}\rho C_f S_m V^2 10^{-3}$$

or:

$$F_{SLPH} = 3,385 C_f S_m$$

where:

- ρ : Water density, equal to 1025 kg/m^3
- C_f : Coefficient equal to:

  $$C_f = (1+k)\frac{0,075}{(\log R_e - 2)^2}$$

  Where:

  - R_e : Reynolds number equal to $VL_{WL}/1,054.10^{-6}$
  - k : Coefficient equal to:

    $$k = 0,017 + 20\frac{C_b}{\left(\frac{L_{WL}}{B_{WL}}\right)^2 \cdot \sqrt{\frac{B_{WL}}{T}}}$$

- S_m : Total wetted surface of the part of the hull under full load draught, in m^2

  The value of S_m is to be given by the designer. When this value is not available, S_m may be taken equal to $6\Delta^{2/3}$
- V : Speed of the current, in m/s, as defined in [1].

2.2.3 Static force on hull F_{SH}

The theoretical static force induced by wind applied on the upper part of the hull, in KN, is defined according the following formula:

$$F_{SH} = \frac{1}{2}\rho(C_{hfr}S_{hfr} + 0,2S_{har} + 0,02S_{hlat})V^2 10^{-3}$$

or:

$$F_{SH} = 0,233(C_{hfr}S_{hfr} + 0,2S_{har} + 0,02S_{hlat})$$

where:

- ρ : Air density, equal to 1,22 kg/m^3
- V : Speed of the wind, in m/s, as defined in [1]
- S_{hfr} : Front surface of hull, in m^2, projected on a vertical plane perpendicular to the longitudinal axe of the yacht
- S_{har} : Aft hull transom surface, in m^2, projected on a vertical plane perpendicular to the longitudinal axe of the yacht
- S_{hlat} : Partial lateral surface of one single side of the hull, in m^2, projected on a vertical plane parallel to the longitudinal axe of the yacht and delimited according Fig 1
- C_{hfr} : Coefficient equal to 0,8 sinα, where α is defined in Fig 1

  In Fig 1, B is the breath of the hull, in m.

2.2.4 Static force on superstructure F_{SS}

The theoretical static force induced by wind applied on the superstructure, in KN, is defined according the following formula:

$$F_{SS} = \frac{1}{2}\rho(C_{sfr}S_{sfr} + C_{sar}S_{sar} + 0,08S_{slat})V^2 10^{-3}$$

or:

$$F_{SS} = 0,233(C_{sfr}S_{sfr} + C_{sar}S_{sar} + 0,08S_{slat})$$

where:

- ρ : Air density, equal to 1,22 kg/m^3
- V : Speed of the wind, in m/s, as defined in [1]
- S_{sfr} : Front surface of superstructure, in m^2, projected on a vertical plane perpendicular to the longitudinal axe of the yacht
- S_{sar} : Aft surface of superstructure, in m^2, projected on a vertical plane perpendicular to the longitudinal axe of the yacht
- S_{slat} : Partial lateral surface of one single side of the superstructure, in m^2, projected on a vertical plane parallel to the longitudinal axe of the yacht and delimited according Fig 1
- C_{sfr} : Coefficient equal to 0,8 sinβ, where β is defined in Fig 1
- C_{sar} : Coefficient equal to:
  - If $h/\ell_s \geq 5$, $C_{sar} = 0,7\sin\gamma$
  - If $5 \geq h/\ell_s \geq 0,25$, $C_{sar} = 0,5\sin\gamma$
  - If $h/\ell_s \leq 0,25$, $C_{sar} = 0,3\sin\gamma$

  where h, ℓ_s and γ are defined in Fig 1.

2.2.5 Static force on standing rigging F_m

For sailing yachts, the theoretical static force induced by wind applied on the standing rigging, in KN, is defined according the following formula for each mast:

$$F_m = \frac{1}{2}\rho\left(0,22h_m b_m + 1,2\sum \ell_i d_i\right)V^2 10^{-3}$$

or:

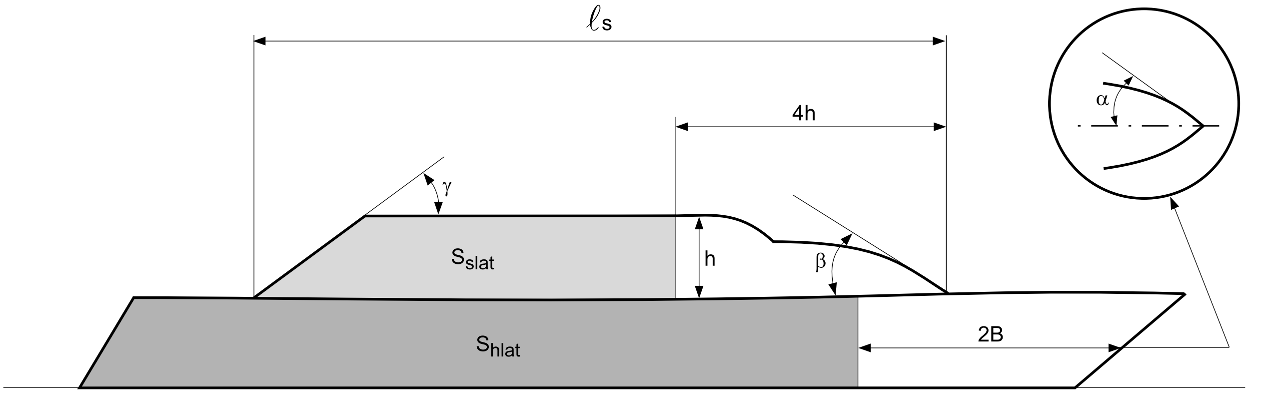
$$F_m = 0,233\left(0,22h_m b_m + 1,2\sum \ell_i d_i 10^{-3}\right)$$

where:

- ρ : Air density, equal to 1,22 kg/m^3
- V : Speed of the wind, in m/s, as defined in [1]
- h_m : Height, in m, of the mast
- b_m : Breadth, in m, of the mast
- ℓ_i : Length, in m, of mast shrouds (lower and upper, fore and backstay)
- d_i : Diameter, in mm, of shrouds.

For sailing yacht having several masts, the total static force induced by wind applied on the standing rigging is to be taken equal to the sum of the forces F_m of each mast and its standing rigging.

Figure 1 : Hull and superstructure surface calculation



2.3 Anchor mooring force calculation for catamaran

2.3.1 The dynamical force, in KN, induced by wind and current acting on catamaran in mooring condition as defined in [1.1.3] may be calculated as defined in [2.2] with the following particular assumptions for the calculation of the static forces on:

- Wetted part of the hull F_{SLPH} : As defined in [2.2.2], taking into account the two floats to calculate the total wetted surface S_m
- Hull F_{SH} : As defined in [2.2.3] taking into account:
  - The two floats for the calculation of S_{hfr}
  - The two floats transom and the aft surface of the aft transversal main beam between the floats for the calculation of S_{har}
  - One single side of one float for the calculation of S_{hlat} ("B" as defined in Fig 1 is to be taken as the breath of one float).
- Superstructure F_{SS}: As defined in [2.2.4] taking also into account the frontal surface of the cross deck.

3 Equipment in chain and anchor

3.1 Anchors

3.1.1 Mass of individual anchor

The individual mass of anchor, in Kg, is to be at least equal to:

- $P = (F_{EN}/7).10^2$ for ordinary anchor,
- $P = (F_{EN}/10).10^2$ for high holding power anchor,
- $P = (F_{EN}/15).10^2$ for very high holding power.

3.1.2 Number of anchors

The number of anchors for anchoring mooring to be provided on board is to be at least:

- One anchor, when the dynamical force F_{EN} calculated according to [2.2], is less than 2,2 KN,
- Two anchors, when the dynamical force F_{EN} calculated according to [2.2], is greater than 2,2 KN.

When two anchors are required, the weight of the second anchor, in kg, may be calculated according [3.1.1] taking into account a dynamical force F_{EN} as defined in [2.2] reduced by 30%.

3.1.3 Anchor design and performance tests

Anchors are to be from an Approved Type. Therefore, Holding power - performance - assessment, Design review and Tests and examination on manufactured product are to be carried-out.

Anchors are to have appropriate shape and scantlings in compliance with Society requirements. Moreover, they are to be constructed in compliance with Society requirements.

A high or very high holding power anchor is to be suitable for use on board without any prior adjustment or special placement on the sea bottom.

For approval and/or acceptance as a high or very high holding power anchor, the anchor is to have a holding power equal, respectively, to at least twice or four times that of a Type Approved ordinary stockless anchor of the same mass.

Holding power is to be assessed by full-scale comparative tests.

For very high holding power anchors, the holding power test load is to be less than or equal to the proof load of the anchor, specified in NR216 "Materials and Welding", Ch 4, Sec 1, [1.5.2].

Comparative tests on Type Approved Ordinary stockless anchors are to be carried out at sea and are to provide satisfactory results on various types of seabeds.

Alternatively sea trials by comparison with a previously approved HHP anchor may be accepted as a basis for approval.

Such tests are to be carried out on anchors whose masses are, as far as possible, representative of the full range of sizes proposed for the approval.

At least two anchors of different sizes are to be tested. The mass of the greatest anchor to be approved is not to be in excess of 10 times that of the maximum size tested and the mass of the smallest is to be not less than 0,1 times that of the minimum size tested.

Tests are normally to be carried out by means of a tug, but, alternatively, shore-based tests may be accepted.

The length of the chain cable connected to the tested anchor, having a diameter appropriate to its mass, is to be such that the pull acting on the shank remains practically horizontal. For this purpose a scope of chain cable equal to 10 is deemed normal; however lower values may be accepted.

Three tests are to be carried out for each anchor and type of sea bottom. Three are the types of sea bottoms in which tests are to be performed, e.g. soft mud or silt, sand or gravel and hard clay or similar compounded.

The pull is to be measured by means of a dynamometer; measurements based on the bollard pull against propeller's revolutions per minute curve may be accepted instead of dynamometer readings.

Anchor stability and its ease of dragging are to be noted down, whenever possible.

Upon satisfactory outcome of the above tests, the Society will issue a certificate declaring the compliance of high or very high holding power anchors with its relevant Rules.

3.1.4 Manufacturing, materials, test and examination

Manufacturing and materials are to comply with relevant requirements of NR216 Materials and Welding.

Tests and examination requirements are to comply with NR216 Materials and Welding, Ch 4, Sec 1, [1.5].

3.2 Chain cables

3.2.1 Chain cable scantling

Chain cable diameter, type and steel grades are to be as defined in Tab 1, according to the minimum breaking BL and proof loads PL, in KN, defined according to the following formulae:

- For steel grade Q_1:

  $BL = 6\ F_{EN}$

  $PL = 0,7\ BL$

- For steel grade Q_2:

  $BL = 6,75\ F_{EN}$

  $PL = 0,7\ BL$

- For steel grade Q_2:

  $BL = 7,5\ F_{EN}$

  $PL = 0,7\ BL$

- For steel grade SL, chain cable diameter is to be determined according Tab 2 on the basis of proof loads defined for steel grade Q.

3.2.2 Length of individual chain cable

The length of chain cable L_{cc}, in m, linked to anchor is to be at least equal to:

- For ordinary anchors:

  $L_{cc} = 30.\ ln(P) - 42$

- For high holding power anchors:

  $L_{cc} = 30.\ ln(P) - 35$

- For very high holding power anchors:

  $L_{cc} = 30.\ ln(P) - 26$

where:

ln(P) : Neperian logarithm of the anchor weight, in kg, defined in [3.1.1] for ordinary, high holding or very high holding power anchor according the considered case.

3.2.3 Number of chain cable

When two chain cable are required according to [3.1.2], the length of the second chain cable, in m, may be calculated according [3.2.2] taking into account an equipment number as defined in [2.2] reduced by 30%.

The second chain cable may be replaced by synthetic fibre ropes as defined in [3.3].

3.2.4 Chain cables arrangements

Normally grade Q2 or Q3 for stud link chain cables and SL2 or SL3 for studless chain cables are to be used with HHP anchors. In case of VHHP anchors, grade Q3 or SL3 chain cables are to be used.

The method of manufacture of chain cables and the characteristics of the steel used are to be approved by the Society for each manufacturer. The material from which chain cables are manufactured and the completed chain cables themselves are to be tested in accordance with the appropriate requirements.

Test and examination requirements are to comply with NR216 Materials and Welding, Ch 4, Sec 1.

3.2.5 Attachment pieces

Both attachment pieces and connection fittings for chain cables are to be designed and constructed in such a way as to offer the same strength as the chain cable and are to be tested in accordance with the appropriate requirements.

3.3 Synthetic fibre ropes

3.3.1 When synthetic fibre ropes are used, the following requirements are to be complied with.

Fibre ropes are to be made of polyamide or other equivalent synthetic fibres, excluding polypropylene.

The effective breaking load P_s, in kN, of the synthetic fibre rope is to be not less than the following value:

$P_s = 1,2 \cdot BL$

where BL, in kN, is the required breaking load defined in [3.2.1] of the chain cable replaced by the synthetic fibre rope.

A short length of chain cable having scantlings complying with [3.2] is to be fitted between the synthetic fibre rope and the bow anchor. The length of this chain part is not to be less than 12,5 m or the distance from the anchor to its stowed position to the windlass whichever is the lesser. In any case this length is to be less than 6,25 m.

Table 1 : Proof and breaking loads for stud link chain cables (quality Q)

Chain diameter (mm)	Grade Q1		Grade Q2		Grade Q3		Minimum mass per meter length (kg/m)
	Proof load (KN)	Breaking load (KN)	Proof load (KN)	Breaking load (KN)	Proof load (KN)	Breaking load (KN)	
11	36	51	51	72	72	102	2.7
12.5	46	66	66	92	92	132	3.6
14	58	82	82	115	115	165	4.4
16	75	107	107	150	150	215	5.7
17.5	89	128	128	180	180	255	6.7
19	105	150	150	210	210	300	7.9
20.5	123	175	175	244	244	349	9.1
22	140	200	200	280	280	401	10.5
24	167	237	237	332	332	476	12.4
26	194	278	278	389	389	556	14.5
28	225	321	321	449	449	649	16.7

Table 2 : Proof and breaking loads for studless link chain cable (quality SL)

Chain diameter (mm)	Grade SL1		Grade SL2		Grade SL3		Minimum mass per meter length (kg)
	Proof load (KN)	Breaking load (KN)	Proof load (KN)	Breaking load (KN)	Proof load (KN)	Breaking load (KN)	
6	6.5	13	9	18	13	26	0,8
8	12	24	17	34	24	48	1.4
10	18.5	37	26	52	37	74	2.4
11	22.5	45	32	64	45	90	2.7
12.5	29	58	41	82	58	116	3.5
14.5	39	78	55	110	78	156	4.6
16	47.5	95	67	134	95	190	5.6
17.5	56.5	113	80	160	113	226	6.8
19	67	134	95	190	134	268	7.9
20.5	78	156	111	222	156	312	9.3
22	90	180	128	256	180	360	10.6
24	106	212	151	302	212	424	12.7
25.5	120	240	170	340	240	480	14.3
27	135	270	192	384	270	540	16.1
28.5	150	300	213	426	300	600	17.9
30	166	332	236	472	332	664	19.8

4 Shipboard fittings for anchoring equipment

4.1 Windlass and chain stopper

4.1.1 Windlass

The windlass is to be power driven and suitable for the size of chain cable and/or synthetic fibre ropes when applicable.

The windlass is to be fitted in a suitable position in order to ensure an easy lead of the chain cable to and through the hawse pipe; the deck, at the windlass, is to be suitably reinforced.

The windlass is to be provided with a brake having sufficient capacity to stop chain cable and anchor where paying out, even in the event of failure of the power supply.

Windlass and brake not combined with a chain stopper have to be designed to withstand a pull of 80% of the breaking load of the chain cable without any permanent deformation of the stressed parts and without brake slip.

Windlass and brake combined with a chain stopper have to be designed to withstand a pull of 20% of the breaking load of the chain cable.

4.1.2 Chain stopper

A chain stopper may be fitted between the windlass and the hawse pipe in order to relieve the windlass of the pull of the chain cable where the ship is at anchor.

A chain stopper with all its parts is to be capable of withstanding a pull of 80% of the breaking load of the chain cable; the deck at the chain stopper is to be suitably reinforced.

Chain tensioners or lashing devices supporting the weight of the anchor where housed in the anchor pocket are not to be considered as chain stoppers.

Where the windlass is at a distance from the hawse pipe and no chain stopper is fitted, suitable arrangements are to be provided to lead the chain cable to the windlass.

4.1.3 Deck reinforcement under windlass and chain stopper

Local reinforcement of deck structure are to be provided in way of windlass and are to be designed in accordance with:

a) Applied force equal to twice the value of F_{EN} (defined in [2.2.1]) associated to admissible stresses as defined in Ch 6, Sec 1 or Ch 7, Sec 4 and

b) Applied force equal to the proof load of the chain cable associated to:

- For structure in steel and aluminium: Maximum admissible stresses equal to R_e or $R'_{p0,2}$
- For structure in composite materials: Minimum rule safety coefficient SF equal to 2.

Note 1: When a chain stopper is provided, the force to apply to the windlass for the examination of the deck reinforcement may be taken equal to 20% of the breaking load of the chain cable instead of value defined in b).

4.2 Chain locker

4.2.1 The chain locker is to be of a capacity adequate to stow all chain cable equipment and provide an easy direct lead to the windlass.

Where two anchor lines are fitted, the port and starboard chain cables are to be separated by a bulkhead in the locker.

The inboard ends of chain cables are to be secured to the structure by a fastening able to withstand a force not less than 15% nor more than 30% of the breaking load of the chain cable.

In an emergency, the attachments are to be easily released from outside the chain locker.

Where the chain locker is arranged aft of the collision bulkhead, its boundary bulkheads are to be watertight and a drainage system provided.

4.3 Anchoring sea trials

4.3.1 General

The anchoring sea trials are to be carried out on board in the presence of a Society surveyor.

4.3.2 Single windlass arrangement

The test is to demonstrate that the windlass complies with the requirements given in [4.1] particularly that it works adequately and has sufficient power to simultaneously weigh the two anchors - excluding the housing in the house pipe - where both are suspended to a 55 m of chain cable in not more than 6 min.

4.3.3 One windlass per mooring line arrangement

Where two windlasses operating separately on each chain cable are adopted, the weighing test is to be carried out for both, weighing an anchor suspended to 82,5 m of chain cable and verifying that the time required for the weighing - excluding the housing on the hawse pipe - does not exceeds 9 min.

4.3.4 The brake is to be tested during lowering operations.

5 Shipboard fitting for towing and mooring

5.1 General

5.1.1 The equipment for mooring and/or towing is not covered within the scope of classification.

However, deck reinforcement under mooring and towing equipment such as, bitts, bollard, fairleads, chocks... are to be examined within the scope of hull drawing examination.

5.1.2 Documents to be submitted

Maximum safe working loads and breaking loads of equipment used for the mooring and the towing are to be specified.

A mooring and towing arrangement plan is to be submitted to the Society for information. This plan is to define the method of use the mooring and towing lines and to include the equipment location on the deck, the fitting type, the safe working and breaking loads and the manner of applying mooring and towing lines (including line angles).

5.1.3 Hull structure reinforcement

As a general rule, hull structure reinforcements in way of mooring and towing equipment are to be examined by direct calculation taking into account:

- the safe working load of the equipment, and
- the admissible stresses and safety coefficients as defined in Ch 6, Sec 1 or Ch 7, Sec 4.

When the safe working loads are not available, the hull structure reinforcement may be examined taking into account the breaking loads of the equipment and admissible stresses equal to 0,9 the maximum breaking stress of the hull reinforcement materials.