GUIDE FOR THE OPTIONAL CLASS NOTATION

DEEP WATER ANCHORING FOR OIL TANKERS AND BULK CARRIERS (DWA)

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Updates

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- May 2011 version plus Corrigenda/Editorials

Foreword

In many instances the increase in the number and size of oil tankers and bulk carriers has out paced the ability of ports to provide sheltered anchorage locations for these vessels. As a consequence, there has been a growing need for owners, operators and the vessel's crew to anchor these vessels outside a harbor or similar areas of sheltered water. Noting the need to provide these same owners, operators and vessel crews, as well as designers and equipment providers, with a guide to assess the adequacy of anchoring equipment, ABS has, in response to requests from our clients, developed this Guide.

This Guide specifies the ABS requirements and criteria for obtaining the optional class notation Deep Water Anchoring (DWA). Included within this Guide are requirements detailing the anchor size, chain length and size, and windlass particulars considered necessary to withstand the environmental conditions that vessels anchoring outside a harbor or similar areas of sheltered water may be exposed to.

This Guide becomes effective on the first day of the month of publication.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

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SECTION 1 Anchoring, Mooring and Equipment

1 General

1.1 Scope and Application

The objective of this Guide is to provide a standard to assess the adequacy of the anchoring arrangements and equipment for vessels engaging in deep water anchoring. The requirements as specified in this Guide are additional to all other relevant requirements of ABS Rules and Guides associated with the Ⓔ symbol. Classed vessels designed, constructed and surveyed in full compliance with the criteria contained within this Guide may be assigned a class notation **DWA**, Deep Water Anchoring for Ships, in addition to the usual Ⓔ symbol, thus ✠ **A1** Ⓔ **DWA**. This notation is optional and, at this time, only applicable to oil tankers and bulk carriers having length of 150 meters or more.

1.3 Basis of Notation

DWA will signify that the anchor, chain, windlass and support structure of the vessel is in compliance with the requirements contained in this Guide addressing deep water anchoring. The mass per anchor of bower anchors, given in Section 1, Table 1, is for anchors of equal mass. The mass of individual anchors may vary 7% plus or minus from the tabular mass, provided that the combined mass of all anchors is not less than that required for anchors of equal mass. The total length of chain required to be carried onboard, as given in Section 1, Table 1 is to be reasonably divided between the two bower anchors.

Chains which are intended to form part of the equipment are not to be used as check chains when the vessel is launched. The inboard ends of the chains of the bower anchors are to be secured by efficient means. Two bower anchors and their chains are to be connected and positioned, ready for use. Where three anchors are given in Section 1, Table 1, the third anchor is intended as a spare bower anchor and is listed for guidance only; it is not required as a condition of classification. Means are to be provided for stopping each chain as it is paid out and the windlass should be capable of heaving in either chain. Suitable arrangements are to be provided for securing the anchors and stowing the chains.

The typical requirements in the ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* cover temporary mooring of a vessel in a harbor or other sheltered water depth up to 64 m. The requirements herein are intended for temporary mooring of a vessel outside a harbor or similar areas of sheltered water with water depth up to 120 m (394 ft) and generally up to conditions 1.54 m/s (3 knots) current, 14 m/s (27 knots) wind (normally developed at Beaufort 6), and 3 m (10 ft) wave (normally developed at Beaufort 6).

3 Deep Water Equipment Number

Anchors and chains are to be in accordance with Section 1, Table 1 and the numbers, mass and sizes of these are to be regulated by the Deep Water Equipment Number (*DE*) obtained from the following equation:

$$DE = 0.628\left[\alpha\left(\frac{E}{0.628}\right)^{1/2.3} + (1-\alpha)\beta\right]^{2.3}$$

where

α = $cL^3 \times 10^{-7} + dL^2 \times 10^{-5} + eL \times 10^{-3} + f$

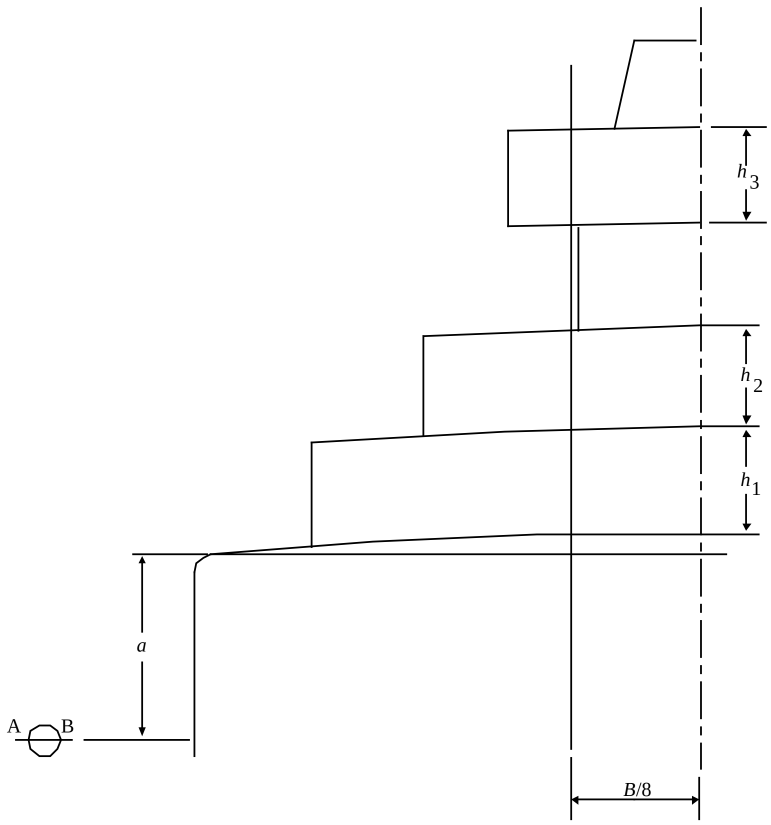
c = 0.0183 (0.0183, 0.000518)

d = 0.209 (0.209, 0.0194)

e = –0.621 (–0.621, –0.189)

f	=	0.0866
β	=	sL + 8.372
s	=	0.156 (0.156, 0.0475)
L	=	length of vessel, in m (ft), as defined in 3-1-1/3.1 of the *Steel Vessel Rules*
E	=	$k\Delta^{2/3} + mBh + nA$
k	=	1.0 (1.0, 1.012)
m	=	2 (2, 0.186)
n	=	0.1 (0.1, 0.00929)
Δ	=	molded displacement, as defined in 3-1-1/11.1 of the *Steel Vessel Rules*
B	=	molded breadth, in m (ft), as defined in 3-1-1/5 of the *Steel Vessel Rules*
h	=	$a + h_1 + h_2 + h_3 + \ldots$, as shown in Section 1, Figure 1. In the calculation of h, sheer, camber, and trim may be neglected
a	=	freeboard, in m (ft), from the summer load waterline amidships
$h_1, h_2, h_3\ldots$	=	height, in m (ft), on the centerline of each tier of houses having a breadth greater than B/4
A	=	profile area, in m^2 (ft^2), of the hull, superstructure and houses above the summer load waterline which are within the Rule length. Superstructures or deck houses having a breadth at any point no greater than 0.25B may be excluded. Screens and bulwarks more than 1.5 m (4.9 ft) in height are to be regarded as parts of houses when calculating h and A

FIGURE 1
Effective Heights of Deck Houses



5 Anchors

5.1 Anchor Types

High holding power is required in deep water up to 120 m (394 ft) in open seas. Therefore anchors are to be of the stockless High Holding Power (HHP) type with holding power at least twice that of an ordinary stockless anchor of the same mass. The mass of the head of a stockless anchor, including pins and fittings, is not to be less than three-fifths of the total mass of the anchor.

7 Anchor Chain

7.1 Chain Type

Due to high tension loads experienced with deep water anchoring, high strength and extra-high strength chains are required for this notation, as specified as follows.

Strength Level	*Grade*	*Method of Manufacture*
High Strength	2a 2b	Flash Butt-welded or Drop-forged Cast Steel
Extra-high Strength	3a 3b	Flash Butt-welded or Drop-forged Cast Steel

Steel chain made by processes or to requirements differing from those shown in 2-2-2/Table 1 of the ABS *Rules for Materials and Welding (Part 2)* and certain types of drop-forged chain will be subject to special consideration.

7.3 Chain Size

Due to the complex behaviors of vessels when anchored in deep water, vessels will need larger chain. Generally the chain size increases with the size of the vessel. However, for deep water anchoring, some smaller oil tankers and bulk carriers may require larger chain similar to larger vessels of the same type since the wave-induced dynamic loads for the vessel-mooring system is greater for smaller oil tankers and bulk carriers than larger vessels of the same type.

7.5 Chain Length

The required chain lengths are based on direct calculations of the vessel-mooring system under the combined loads from wind 14 m/s (27 knots), current 1.54 m/s (3 knots) and wave height 3 m at water depth of 120 m (394 ft). The direct calculations show that the length of chain needed for water depth of 120 m (394 ft) is of scope* 3 to 4.

* *Note:* Scope is the ratio of length of chain paid out to the water depth.

9 Tests

Tests are to be in accordance with the requirements of Chapter 2 of the ABS *Rules for Materials and Welding (Part 2)* for respective sizes of anchors and chains, see Sections 2-2-1 and 2-2-2 of the ABS *Rules for Materials and Welding (Part 2)*.

11 Environmental Loads

11.1 General

Environmental loads that are important to mooring design include current, wind and wave loads. Wave-induced loads dominate over wind and current loads on moored vessels sited in unsheltered, high energy environments. As the mooring site is moved into sheltered areas, these loads diminish and the wind and current loads begin to dominate. In open seas, waves often exert significant dynamic loads on moored vessels and mooring elements that are to be accounted for in the design.

13 Windlass Support Structure and Cable Stopper

13.1 General

Construction and installation of all windlasses used for anchoring are to be carried out in accordance with 4-1-1/5 of the *Steel Vessel Rules* and Section 2 of this Guide. Where fitted, an independent chain stopper and its components are to be adequate for the load imposed. The arrangements and details of the cable stopper are to be submitted for review.

The windlass supporting structures are to meet the requirements in 1/13.3. Where the mooring winch is integral with the windlass, it is to be considered as a part of the windlass.

13.3 Support Structure

The windlass is to be bolted down to a substantial foundation, which is to meet the following load cases and associated criteria.

13.3.1 Operating Loads

13.3.1(a) Load on Windlass Support Structure. The following load is to be applied in the direction of the chain.

With cable stopper not attached to windlass:	45% of B.S.
With cable stopper attached to windlass:	80% of B.S.
Without cable stopper:	80% of B.S.

B.S. = minimum breaking strength of the chain, as indicated in 2-2-2/Tables 2 and 3 of the ABS *Rules for Materials and Welding (Part 2)*.

13.3.1(b) Load on Cable Stopper and Support Structure. A load of 80% of B.S. is to be applied in the direction of the chain.

13.3.1(c) Allowable Stress. The stresses in the structures supporting the windlass and cable stopper are not to exceed the yield point.

13.3.2 Sea Loads

13.3.2(a) Pressures. Noting the exposed location of the anchor windlass and the potential impact on the windlass, the following pressures and associated areas are to be applied (see Section 1, Figure 2):

- 200 kN/m^2 (20.4 tf/m^2, 4178 lbf/ft^2) normal to the shaft axis and away from the forward perpendicular, over the projected area in this direction
- 150 kN/m^2 (15.3 tf/m^2, 3133 lbf/ft^2) parallel to the shaft axis and acting both inboard and outboard separately, over the multiple of f times the projected area in this direction

  where f is defined as:

  f = $1 + B/H$, f need not be taken as greater than 2.5

  B = width of windlass measured parallel to the shaft axis

  H = overall height of windlass.

13.3.2(b) Forces. Forces in the bolts, chocks and stoppers securing the windlass to the deck are to be calculated. The windlass is supported by N groups of bolts, each containing one or more bolts, see Section 1, Figure 2.

i) *Axial Forces.* The aggregate axial force R_i in respective group of bolts (or bolt) i, positive in tension, may be calculated from the following equations:

$$R_{xi} = P_x \, hx_i \, A_i / I_x$$

$$R_{yi} = P_y \, hy_i \, A_i / I_y$$

and

$$R_i = R_{xi} + R_{yi} - R_{si}$$

where

P_x = force, kN (tf, lbf), acting normal to the shaft axis

P_y = force, kN (tf, lbf), acting parallel to the shaft axis, either inboard or outboard, whichever gives the greater force in bolt group *i*

h = shaft height above the windlass mounting, cm (in.)

x_i, y_i = *x* and *y* coordinates of bolt group *i* from the centroid of all *N* bolt groups, positive in the direction opposite to that of the applied force, cm (in.)

A_i = cross-sectional area of all bolts in group *i*, cm^2 (in^2)

I_x = $A_i\, x_i^2$ for *N* bolt groups

I_y = $A_i\, y_i^2$ for *N* bolt groups

R_{si} = static reaction at bolt group *i*, due to weight of windlass.

ii) *Shear Forces.* Aggregated shear forces, F_{xi}, F_{yi}, applied to the respective bolt group, *i*, of bolts, and the resultant combined force, F_i, may be calculated from:

$$F_{xi} = (P_x - \alpha g M)/N$$

$$F_{yi} = (P_y - \alpha g M)/N$$

and

$$F_i = (F_{xi}^2 + F_{yi}^2)^{0.5}$$

where:

α = coefficient of friction (0.5)

M = mass of windlass, in tonnes (Ltons)

g = gravity: 9.81 m/sec^2 (32.2 ft/sec^2)

N = number of groups of bolts

The axial tensile/compressive and lateral forces from the above equations are also to be considered in the design of the supporting structure.

13.3.2(c) Stresses in Bolts. Tensile stresses in the individual bolts in each group of bolts *i* are to be calculated. The horizontal forces, F_{xi} and F_{yi}, are normally to be reacted by shear chocks. Where "fitted" bolts are designed to support these shear forces in one or both directions, the equivalent von Mises stresses in the individual "fitted" bolts are to be calculated and compared to the stress under proof load. Where pourable resins are incorporated in the holding down arrangements, due account is to be taken in the calculations.

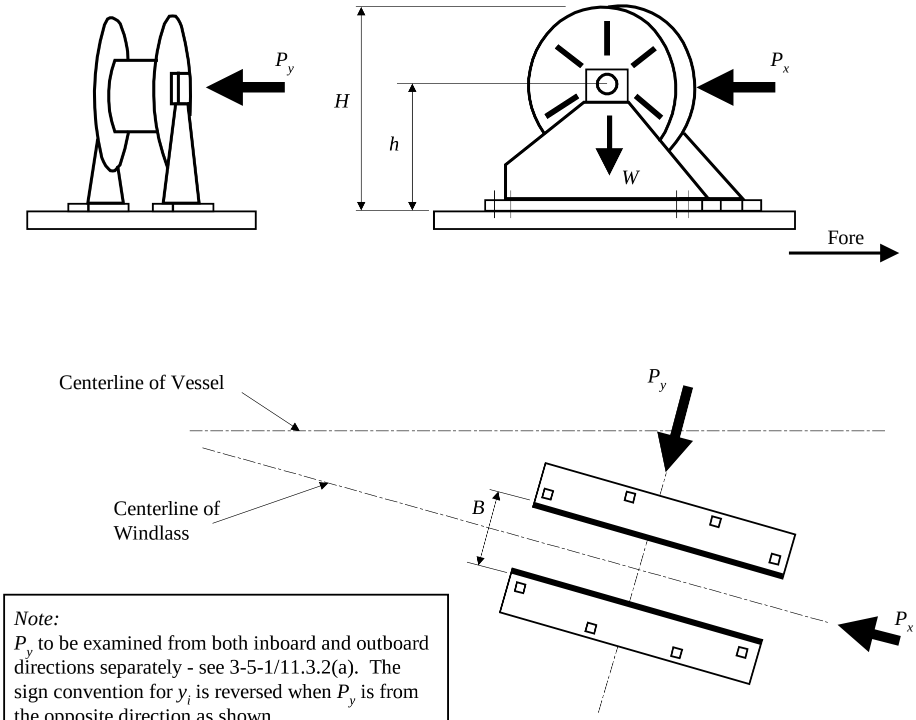
13.3.2(d) Allowable Stress

i) *Bolts.* The safety factor against bolt proof strength is to be not less than 2.0.

ii) *Supporting Structures.* The stresses in the above deck framing and the hull structure supporting the windlass are not to exceed the following values.

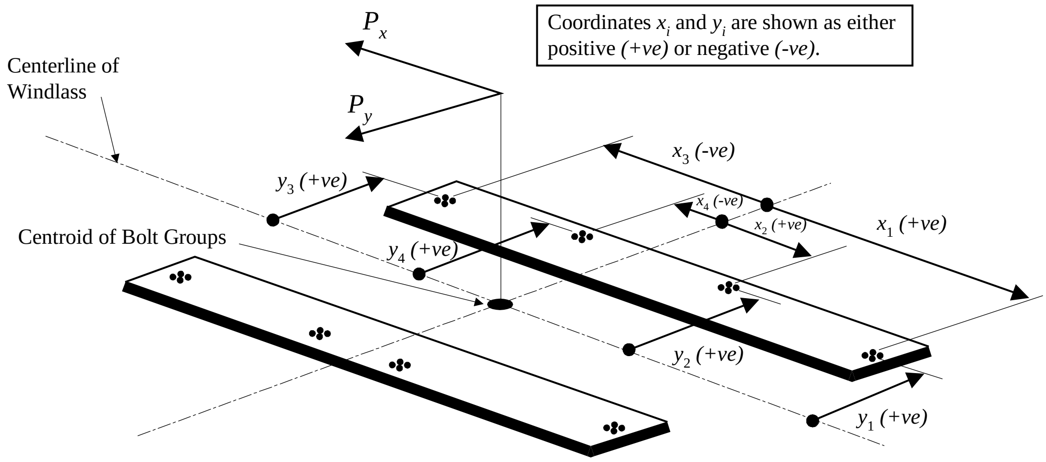
- Bending Stress 85% of the yield strength of the material
- Shearing Stress 60% of the yield strength of the material

FIGURE 2
Direction of Forces and Weight



Note:
P_y to be examined from both inboard and outboard directions separately - see 3-5-1/11.3.2(a). The sign convention for y_i is reversed when P_y is from the opposite direction as shown.

FIGURE 3
Sign Convention



15 Vessel Support Structure

15.1 General

As indicated in 1/13.3.2(d)ii), the hull structure supporting the windlass and chain stopper are to be sufficient to accommodate the loads from the anchoring equipment.

15.1.1 Arrangement

Reinforced structural members (e.g., girders, beams, brackets, and carling) are to be arranged to effectively distribute the loads from the anchoring equipment, chain locker and hawse pipe to the surrounding vessel structure.

15.1.2 Allowable stresses

Allowable stresses under design load conditions are as follows:

- Normal stress: 85% of the specified minimum yield point of the material
- Shearing stress: 60% of the specified minimum yield point of the material

No stress concentration factors need to be taken into account. Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress.

15.3 Scantlings

15.3.1 Net Scantlings

The net minimum scantlings of the supporting hull structure are to comply with the requirements given in 1/15.1. The net thicknesses, t_{net}, are the member thicknesses necessary to obtain the above required minimum net scantlings. The required gross thicknesses are obtained by adding the total corrosion additions, t_c, given in 1/15.3.2, to t_{net}.

15.3.2 Corrosion Addition

The total corrosion addition, t_c, in mm (in.), for both sides of the hull supporting structure is not to be less than the following values:

- Ships covered by Common Structural Rules (CSR) for bulk carriers and CSR for double hull oil tankers: Total corrosion additions defined in these rules
- Other ships: 2.0 mm (0.08 in)

17 Chain Lockers

17.1 General

Chain lockers and chain pipes are to be made watertight up to the weather deck. The arrangements are to be such that accidental flooding of the chain locker cannot result in damage to auxiliaries or equipment necessary for the proper operation of the vessel nor in successive flooding into other spaces. Bulkheads between separate chain lockers not forming a part of subdivision bulkhead (see Section 1, Figure 4A below), or bulkheads which form a common boundary of chain lockers (see Section 1, Figure 4B below), need not be watertight.

Where means of access into chain lockers are provided, they are to be closed by a substantial cover secured by closely spaced bolts. Doors are not permitted.

Where a means of access to chain lockers is located below the weather deck, the access cover and its securing arrangements are to be in accordance with recognized standards (such as ISO 5894-1999), or equivalent for watertight manhole covers. Butterfly nuts and/or hinged bolts are prohibited as the securing mechanism for the access cover.

The arrangements on vessels that are not subject to the International Convention on Load Lines or its Protocol may be specially considered.

FIGURE 4A

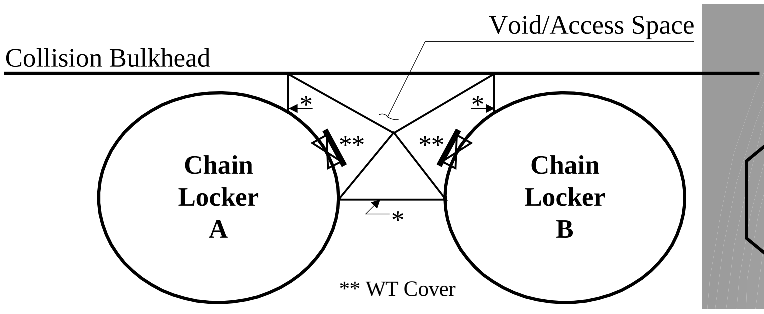
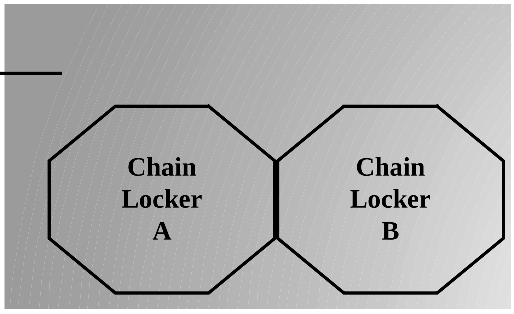


FIGURE 4B



Bulkheads between separate chain lockers not forming a part of subdivision bulkhead

17.3 Chain Pipe opening

Chain pipes through which anchor cables are led are to be provided with permanently attached closing appliances to minimize the ingress of water. A canvas cover with appropriate lashing arrangement may be acceptable for this purpose. A cement and wire mesh arrangement is not permitted.

19 Hawse Pipes

Hawse pipes are to be of ample size and strength. They are to have full rounded flanges and the least possible lead, in order to minimize the nip on the cables. They are to be securely attached to thick doubling or insert plates by continuous welds the size of which are to be in accordance with Section 3-2-19 of the *Steel Vessel Rules* for the plating thickness and type of joint selected. When in position, they are to be thoroughly tested for watertightness by means of a hose in which the water pressure is not to be less than 2.06 bar (2.1 kgf/cm^2, 30 psi). Hawse pipes for stockless anchors are to provide ample clearances. The anchors are to be shipped and unshipped so that the Surveyor may be satisfied that there is no risk of the anchor jamming in the hawse pipe. Care is to be taken to ensure a fair lead for the chain from the windlass to the hawse pipes and to the chain pipes.

TABLE 1
Equipment for Self-propelled Ocean-going Oil Tankers and Bulk Carriers

Deep Water Equipment Numeral	*Deep Water Equipment Number (DE)**	*High Holding Power Stockless Bower Anchors*			*Chain Cable Stud Link Bower Chain*					
							Diameter			
		Number	*Mass per Anchor kg (lb)*		*Length, m (fathoms)*		*High- Strength Steel (Grade 2), mm (in.)*		*Extra High-Strength Steel (Grade 3), mm (in.)*	
D31	1670	3	14150	31130	1017.5	556	105	(4 1/8)	84	(3 5/16)
D32	1790	3	14400	31680	990	541	105	(4 1/8)	84	(3 5/16)
D33	1930	3	14800	32560	990	541	105	(4 1/8)	84	(3 5/16)
D34	2080	3	15200	33440	990	541	105	(4 1/8)	84	(3 5/16)
D35	2230	3	15600	34320	990	541	105	(4 1/8)	84	(3 5/16)
D36	2380	3	16000	35200	990	541	105	(4 1/8)	84	(3 5/16)
D37	2530	3	16300	35860	990	541	105	(4 1/8	84	(3 5/16)
D38	2700	3	16700	36740	990	541	105	(4 1/8)	84	(3 5/16)
D39	2870	3	17000	37400	990	541	105	(4 1/8)	84	(3 5/16)
D40	3040	3	17600	38720	990	541	105	(4 1/8)	84	(3 5/16)
D41	3210	3	18000	39600	990	541	105	(4 1/8)	84	(3 5/16)
D42	3400	3	18300	40260	990	541	105.5	(4 7/32)	84	(3 5/16)
D43	3600	3	19000	41800	990	541	106.5	(4 7/32)	85	(3 5/16)
D44	3800	3	19700	43340	962.5	537	107.6	(4 7/32)	87	(3 13/32)
D45	4000	3	20300	44660	962.5	531	111	(4 13/32)	90	(3 1/2)
D46	4200	3	21100	46442	962.5	529	114	(4 1/2)	92	(3 19/32)
D47	4400	3	22000	48400	962.5	526	117	(4 19/32)	95	(3 23/32)
D48	4600	3	22900	50380	962.5	526	119.3	(4 23/32)	97	(3 13/16)
D49	4800	3	23500	51700	962.5	525	121.7	(4 13/16)	99	(3 29/32)
D50	5000	3	24000	52800	935	521	125.2	(4 29/32)	101.5	(4)
D51	5200	3	24500	53900	907.5	509	130	(5 1/8)	105	(4 1/8)
D52	5500	3	25000	55000	907.5	496	132.9	(5 7/322)	107.3	(4 7/32)
D53	5800	3	25500	56100	880	489	137	(5 13/32)	111	(4 13/32)
D54	6100	3	25700	56540	880	481	140	(5 1/2)	112.7	(4 13/32)
D55	6500	3	26000	57200	852.5	474	142.8	(5 19/32)	115.3	(4 1/2)
D56	6900	3	26500	58300	852.5	466	147	(5 13/16)	117.5	(4 19/32)
D57	7400	3	27000	59400	825	459	152	(6)	120.7	(4 13/16)
D58	7900	3	27500	60500	825	451	154.1	(6 1/8)	123.3	(4 29/32)
D59	8400	3	28000	61600	797.5	436	157.9	(6 7/32)	127	(5)
D60	8900	3	28900	63690	770	422	162	(6 13/32)	132	(5 7/32)
D61	9400	3	29400	64680	770	421	—		135	(5 5/16)
D62	10000	3	29900	65846	770	421	—		138.7	(5 1/2)
D63	10700	3	30600	67386	770	421	—		142.5	(5 19/32)
D64	11500	3	31500	69344	770	421	—		147	(5 13/16)
D65	12400	3	33200	73062	770	421	—		152	(6)
D66	13400	3	35000	77198	770	421	—		157	(6 7/32)
D67	14600	3	38000	83600	770	421	—		162	(6 13/32)

* For intermediate values of Deep Water Equipment Number, use equipment complement in sizes and weights given for the lower equipment number in the table.

SECTION 2 Anchor Windlass

1 General

1.1 Application

The provisions of Section 2 apply to windlasses used for handling anchors and chains required by this Guide.

1.3 Standards of Compliance

The design, construction and testing of windlasses are to conform to an acceptable standard or code of practice. To be considered acceptable, the standard or code of practice is to specify criteria for stresses, performance and testing.

See of 4-5-1/1.3 of the *Steel Vessel Rules* for examples of standards presently recognized by ABS.

1.5 Plans and Particulars

The following plans showing the design specifications, the standard of compliance, engineering analyses and details of construction, as applicable, are to be submitted to ABS for evaluation:

- Windlass design specifications; anchor and chain cable particulars; performance criteria; standard of compliance
- Windlass arrangement plan showing all of the components of the anchoring/mooring system such as the prime mover, shafting, cable lifter, anchors and chain cables; mooring winches, wires and fairleads, if they form part of the windlass machinery; brakes; controls; etc.
- Dimensions, materials, welding details, as applicable, of all torque-transmitting (shafts, gears, clutches, couplings, coupling bolts, etc.) and all load bearing (shaft bearings, cable lifter, sheaves, drums, bed-frames, etc.) components of the windlass and of the winch, where applicable, including brakes, chain stopper (if fitted) and foundation
- Hydraulic piping system diagram together with system design pressure, relief valve setting, bill of materials, typical pipe joints, as applicable
- Electric one line diagram together with cable specification and size; motor controller; protective device rating or setting; as applicable
- Control, monitoring and instrumentation arrangements
- Engineering analyses for torque-transmitting and load-bearing components demonstrating their compliance with recognized standards or codes of practice. Analyses for gears are to be in accordance with a recognized standard
- Windlass foundation structure, including under deck supporting structures and holding down arrangements
- Plans and data for windlass electric motors including associated gears rated 100 kW (135 hp) and over
- Calculations demonstrating that the windlass prime mover is capable of attaining the hoisting speed, the required continuous duty pull and the overload capacity are to be submitted if the “load testing” including “overload” capacity of the entire windlass unit is not carried out at the shop, see 2/7ii)

3 Materials and Fabrication

3.1 Materials

Materials entered into the construction of torque-transmitting and load-bearing parts of windlasses are to comply with material specifications in Part 2, Chapter 3 of the ABS *Rules for Materials and Welding* or of a national or international material standard. The proposed materials are to be indicated in the construction plans and are to be approved in connection with the design. All such materials are to be certified by the material manufacturers and are to be traceable to the manufacturers' certificates.

3.3 Welded Fabrication

Weld joint designs are to be shown in the construction plans and are to be approved in association with the approval of the windlass design. Welding procedures and welders are to be qualified in accordance with Part 2, Chapter 4 of the ABS *Rules for Materials and Welding*. Welding consumables are to be type-approved by ABS or are to be of a type acceptable to the Surveyor. The degree of nondestructive examination of welds and post-weld heat treatment, if any, are to be specified and submitted for consideration.

5 Design

Together with and not withstanding the requirements of the chosen standard of compliance, the following requirements are also to be complied with. In lieu of conducting engineering analyses and submitting them for review, approval of the windlass mechanical design may be based on a type test, in which case the testing procedure is to be submitted for consideration. At the option of the manufacturers, windlass designs may be approved based on the Type Approval Program [see 1-1-A3/5 of the ABS *Rules for Conditions of Classification (Part 1)*].

5.1 Mechanical Design

5.1.1 Design Loads

5.1.1(a) Holding Loads. Calculations are to be made to show that, in the holding condition (single anchor, brake fully applied and chain cable lifter declutched), and under a load equal to 80% of the specified minimum breaking strength of the chain cable [see 2-2-2/Tables 2 and 3 of the ABS *Rules for Materials and Welding (Part 2)*], the maximum stress in each load bearing component will not exceed yield strength (or 0.2% proof stress) of the material. For installations fitted with a chain cable stopper, 45% of the specified minimum breaking strength of the chain cable may instead be used for the calculation.

5.1.1(b) Inertia Loads. The design of the drive train, including prime mover, reduction gears, bearings, clutches, shafts, wildcat and bolting is to consider the dynamic effects of sudden stopping and starting of the prime mover or chain cable so as to limit inertial load.

5.1.2 Continuous Duty Pull

The value of Z_{cont} is based on the hoisting of one anchor at a time, and that the effects of buoyancy and hawse pipe efficiency (assumed to be 70%) have been accounted for. In general, stresses in each torque-transmitting component are not to exceed 40% of yield strength (or 0.2% proof stress) of the material under these loading conditions. The continuous duty pull *Zcont* value is for the assumed depth of anchorage up to 120 m (394 ft).

The windlass prime mover is to be able to exert for at least 30 minutes a continuous duty pull (e.g., 30-minute short time rating as per 4-8-3/3.3.2 and 4-8-3/Table 4 of the *Steel Vessel Rules*; or corresponding to S2-30 min. of IEC 60034-1 *Rotating electrical machines Part 1: Rating and performance*).

The load Z_{cont}, corresponding to the grade 2 and 3 (see Section 1, Table 1) and diameter, *d*, of the chain cables as follows:

Grade of Chain	Z_{cont}		
	N	*kgf*	*lbf*
2	$50.53d^2$	$5.15d^2$	$7310.9d^2$
3	$55.53d^2$	$5.66d^2$	$8034.4d^2$
Unit of *d*	mm	mm	in.

5.1.3 Overload Capability

The windlass prime mover is to be able to provide the necessary temporary overload capacity for breaking out the anchor. This temporary overload capacity or "short term pull" is to be at least 1.5 times the continuous duty pull applied for at least 2 minutes.

5.1.4 Hoisting Speed

The mean speed of the chain cable during hoisting of the anchor and cable is to be at least 9 m/min (29.5 ft/min). For testing purposes, the speed is to be measured over three shots (82.5 m, 45 fathoms) of chain cable and initially with at least 120 m of chain (65.5 fathoms in length) and the anchor submerged and hanging free. However, the mean speed of the chain cable hoisting anchor from the depth of 120 m (394 ft) to the depth of 82.5 m (271 ft) is to be at least 4.5 m/min (15 ft/min).

5.1.5 Brake Capacity

The capacity of the windlass brake is to be sufficient to stop the anchor and chain cable when paying out the chain cable. Where a chain cable stopper is not fitted, the brake is to produce a torque capable of withstanding a pull equal to 80% of the specified minimum breaking strength of the chain cable without any permanent deformation of strength members and without brake slip. Where a chain cable stopper is fitted, 45% of the breaking strength may instead be applied.

5.1.6 Chain Cable Stopper

Chain cable stopper is to be provided and along with its attachments is to be designed to withstand, without any permanent deformation, 80% of the specified minimum breaking strength of the chain cable.

5.1.7 Support Structure

See Subsection 1/13 of this Guide.

5.3 Hydraulic Systems

Hydraulic systems where employed for driving windlasses are to comply with the provisions of 4-6-7/3 of the *Steel Vessel Rules*.

5.5 Electrical Systems

5.5.1 Electric Motors

Electric motors are to meet the requirements of 4-8-3/3 of the *Steel Vessel Rules* and those rated 100 kW and over are to be certified by ABS. Electrical motors installed in the weather are to have enclosures suitable for their location as provided for in 4-8-3/1.11 of the *Steel Vessel Rules*. Where gears are fitted, they are to meet the requirements of Section 4-3-1 of the *Steel Vessel Rules* and those rated 100 kW (135 hp) and over are to be certified by ABS. The Surveyor's presence for material tests referred to in 4-3-1/3.1.2 and 4-3-1/3.3 of the *Steel Vessel Rules* is not required, subject to compliance with 2/3.1.

5.5.2 Electrical Circuits

Motor branch circuits are to be protected in accordance with the provisions of 4-8-2/9.17 of the *Steel Vessel Rules* and cable sizing is to be in accordance with 4-8-2/7.7.6 of the *Steel Vessel Rules*. Electrical cables installed in locations subjected to the sea are to be provided with effective mechanical protection as provided for in 4-8-4/21.15 of the *Steel Vessel Rules*.

5.7 Protection of mechanical components

To protect mechanical parts of the windlass in the event of excessive loading, an overload protection such as slip coupling or relief valve is to be fitted to limit the maximum torque, see 2/5.1.3, of the windlass prime mover.

5.9 Coupling

Windlasses are to be fitted with couplings which are capable of disengaging between the wildcat (cable lifter) and the drive shaft. Hydraulically or electrically operated couplings are to be capable of being disengaged manually.

7 Shop Inspection and Testing

Windlasses are to be inspected during fabrication at the manufacturers' facilities by a Surveyor for conformance with the approved plans. Acceptance tests, as relevant in the specified standard of compliance, are to be witnessed by the Surveyor and include the following tests, as a minimum.

i) *No-load test.* The windlass is to be run without load at nominal speed in each direction for a total of 30 minutes. If the windlass is provided with a gear change, additional run in each direction for 5 minutes at each gear change is required.

ii) *Load test.* The windlass is to be tested to verify that the continuous duty pull, overload capacity and hoisting speed as specified in 2/5.1 can be attained.

Where the required "load testing" including "overload" capacity of the entire windlass unit at the shop is not possible or practical, the manufacturer may submit powering calculations demonstrating that the windlass prime mover is capable of attaining the hoisting speed, the required continuous duty pull and the overload capacity. These calculations are to be validated through testing of an anchor windlass unit. Once these calculations are validated, they may be used in place of the load tests within the scope of the calculations. Further, in addition to other testing requirements, each prime mover is to be tested at the shop to verify its ability to meet the calculated power requirements. Where the prime mover is a hydraulic motor, in addition to the hydraulic motor, the hydraulic pump is also to be tested at the shop. During the testing, the input/output torque, speed, delivery pressures and flow rates of the pump and the hydraulic motor are to be measured, as appropriate.

iii) *Brake capacity test.* The holding power of the brake is to be verified either through testing or by calculation.

At the option of the manufacturers, windlass designs and the manufacturing facilities may be approved under the Type Approval Program [see Appendix 1-1-A3 of the ABS *Rules for Conditions of Classification (Part 1)*].

9 Onboard Tests

Each windlass is to be tested under working conditions after installation onboard to demonstrate satisfactory operation. Each unit is to be independently tested for braking, clutch functioning, lowering and hoisting of chain cable and anchor, proper riding of the chain over the chain lifter, proper transit of the chain through the hawse pipe and the chain pipe, and effecting proper stowage of the chain and the anchor. It is to be confirmed that anchors properly seat in the stored position and that chain stoppers function as designed if fitted. The mean hoisting speed, as specified in 2/5.1.4, is to be measured and verified. The braking capacity is to be tested by intermittently paying out and holding the chain cable by means of the application of the brake. Where the available water depth is insufficient, the proposed test method will be specially considered.

SECTION 3 Surveys after Construction

1 Anchoring System Annual Surveys

Anchors and chain cables, anchor windlass including foundation, prime mover, shafting, wildcats, brakes, controls, chain stoppers and supporting vessel structure are to be examined, as far as possible.

Each windlass is to be operated, as far as possible, for braking, clutch functioning, lowering and hoisting of chain cable and anchor, proper riding of the chain over the wildcat, proper transit of the chain through the hawse pipe and chain pipe, and effecting proper stowage of the chain and anchor.

3 Anchoring System Special Periodical Surveys

In addition to the requirements of the Anchoring System Annual Survey, the Anchoring System Special Periodical Survey is to include sufficient examination, tests and checks carried out by the Surveyors to satisfy themselves that the anchoring systems are in or are placed in satisfactory condition and are considered adequate for the new period of class of five (5) years to be assigned, subject to proper maintenance and operation and to periodic surveys being carried out at the due dates. Anchoring System Special Periodical Survey is to include the following:

The anchors and chain cables are to be ranged, examined and the required complement and condition confirmed. The chain locker, holdfasts, hawse pipes and chain stoppers are to be examined and pumping arrangements of the chain locker operationally tested.

At Anchoring System Special Periodical Survey No. 2 and subsequent Anchoring System Special Periodical Surveys, chain cables are to be gauged and renewed in cases where their mean diameter is 12% or more below the original required nominal size. Where structural alterations to the vessel have resulted in a higher equipment numeral, the original chain cables may be used until their mean diameter has been reduced to 12% below the nominal diameter of the larger cable required by the higher equipment numeral.