

Australian Transport Council

National Standard
for
Commercial Vessels

PART C
DESIGN AND CONSTRUCTION

SUBSECTION 7D
ANCHORING SYSTEMS

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FOREWORD

This Subsection of the National Standard for Commercial Vessels (NSCV) was developed following a review of the Uniform Shipping Laws (USL) Code Section 13 (Miscellaneous Equipment) Appendix H (Anchors and Cables) and Appendix I (Sea Anchors).

In reviewing the USL Code and preparing this Subsection, consideration was given to a number of factors including:

- a) The National Marine Safety Strategy.
- b) Current designs, practices and materials.
- c) Relevant national and international standards.
- d) Provisions no longer used.
- e) Current survey practice, both formal and informal.
- f) Discretionary requirements which rely on Authority approval.
- g) Current technical standards format and style.

This Subsection of the NSCV should be read in conjunction with Part B— General Requirements and Part E— Operational practices of the NSCV. It should also be read in conjunction with Part A— Safety Obligations of the NSCV.

This Subsection of the NSCV was drafted by the NMSC Secretariat in consultation with a reference group comprising of representatives from the various State and Territory marine authorities, manufacturers, designers, academics and operators.

The NMSC accepted the recommendations of the reference group which met on 4 July 2007 and the draft subsection and RIS were revised accordingly. The Office of Best Practice Regulation approved the Final RIS on 2 August 2007.

Edition 1 was later subject to a correction amendment. Amendment 1 to Clauses 1.3, 3.1, 3.2, 3.5, 3.7 and 4.2.1 was endorsed by NMSC on 5 October 2010 and published in October 2010.

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CHAPTER 1 PRELIMINARY

1.1 SCOPE

This Subsection of NSCV specifies minimum requirements for design, selection and testing of anchoring systems for commercial vessels.

This Standard recognises anchoring systems as safety equipment.

NOTE: For particular operational needs additional equipment may be required.

This Subsection shall be read in conjunction with Part B (General Requirements) and Part E (Operational Practices) of the National Standard for Commercial Vessels.

1.2 OBJECTIVE

The objective of this subsection is to provide a method of determining a suitable anchoring system to prevent a vessel getting into a dangerous situation that may threaten life, property or environment.

1.3 APPLICATION

The anchoring systems specified in this Subsection are suitable only for use in reasonably sheltered conditions or in emergencies such as equipment failure.

NOTE: Where a vessel is to anchor frequently or in extreme conditions, anchoring systems of greater holding power, robustness and performance may need to be provided to fulfil the broader safety obligations specified in Part A of this Standard.

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This Subsection applies to all vessels other than Special Vessels provided for in NSCV Part F of this standard, unless NSCV Part F specifies otherwise.

This Standard does not apply vessels operating on cables (vessel-in-chain).

1.4 REFERENCED DOCUMENTS

The following documents are referred to in this Subsection of the NSCV. Any documents referenced in this Subsection shall be considered to be the latest revision of the document, including amendments and supplements.

AUSTRALIAN TRANSPORT COUNCIL

National Standard for Commercial Vessels

Part B—General Requirements

Part E—Operational Practices

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

AS 2321: Short-link chain for lifting purposes

AS 2759: Steel wire rope – Use, operation and maintenance

AS 3569: Steel wire ropes

AS 4142.1: Fibre ropes – Care and safe usage

AS 4142.2: Fibre ropes – Three strand hawser-laid and eight-strand plaited

AS 4143.1: Methods of test for fibre ropes – Dimensions, linear density, breaking force and elongation

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO 1704: Ships and marine technology – Stud-link anchor chains

1.5 DEFINITIONS

For the purpose of this Subsection of NSCV, the definitions provided in Part B of the NSCV and those in this Clause shall apply unless otherwise indicated.

anchor—

a device designed to engage the bottom of a waterway or sea, as part of an anchoring system, in order to maintain a vessel's position through its resistance to drag.

anchoring system—

an anchoring system consists of an anchor and its attachment to the vessel.

high holding power anchor—

an anchor with a minimum holding ratio of 6.

holding power—

the force needed to break out an anchor embedded in the seabed, expressed in newtons.

holding ratio—

the ratio of anchor holding power to anchor weight.

safe haven—

as defined in NSCV Part B.

sea anchor—

a device attached to a vessel and deployed underwater that is designed to produce drag to stabilise the motion or reduce drift and enhance control.

super high holding power anchor—

an anchor with a minimum holding ratio of 12.

setting the anchor—

embedding the anchor in the seabed.

standard anchor—

an anchor with a minimum holding ratio of 3.

1.6 OPERATING PROFILES AND CONSIDERATIONS IN DETERMINING MINIMUM ANCHORING EQUIPMENT

The purpose of developing an operating profile for a vessel is to assess the risk to the vessel if either environmental factors or a problem aboard the vessel affect its safety where the response requires anchoring the vessel temporarily.

When determining the minimum requirements for anchoring equipment the following are to be considered:

- a) The distance in nautical miles that the vessel will travel from a suitable safe haven.
- b) The size of the vessel taking into consideration displacement, length, beam, frontal area and profile area.
- c) The vessel's maximum speed at full load displacement.

- d) The significant wave height of the intended area of operation.
- e) The maximum wind speed in which the vessel intends to operate. The maximum wind speed is assumed to be 1.4 times the mean wind speed. The mean wind speed is taken to be the 10 min average wind speed.
- f) The type or types of seabed in the area of operation.

NOTE: The distance from the area of operation to the safe haven is measured by the shortest navigable route.

CHAPTER 2 ANCHORING SYSTEM OUTCOMES AND SOLUTIONS

2.1 SCOPE

This Chapter specifies required outcomes and anchoring system solutions applicable to vessels.

2.2 REQUIRED OUTCOMES

2.2.1 Type and quantity

A vessel must be provided with an anchoring system of type and quantity appropriate to control to acceptable levels the risks associated with the operation of the vessel, taking into account its area of operation and the number of persons on board as well as other risk factors that might be relevant.

2.2.2 Performance

Anchoring systems must be designed and arranged to function so as to significantly enhance the probability of survival in the event of an incident.

2.2.3 Availability

Anchoring systems must be readily available for safe and effective deployment.

2.2.4 Reliability

Anchoring systems must be designed, constructed, arranged and maintained so as to function reliably at time of need.

2.2.5 Operating instructions

Adequate operating instructions must be available for the safe and effective use of anchoring systems.

2.3 DEEMED-TO-SATISFY SOLUTIONS

2.3.1 Compliance

For the purpose of this National Standard, anchoring systems shall be deemed to satisfy the required outcomes in Clauses 2.2.1 to 2.2.5, if they comply with Clauses 2.3.2 and 2.3.3 as applicable.

2.3.2 Type and quantity

A vessel shall carry anchoring systems of type and quantity appropriate to its category of service in accordance with this Subsection of NSCV.

2.3.3 Standards for anchoring systems

2.3.3.1 Specification

The components of anchoring systems shall comply with the applicable Chapters of this Subsection of NSCV.

2.3.3.2 Assessment and verification

The components of anchoring systems shall be assessed and verified as meeting the applicable specification by one or more of the following methods:

- a) Tested and specifically listed for the purpose by a recognised testing and listing organisation in Australia.
- b) Certified by a JAS-ANZ accredited product certification body.
- c) Type approved by a ship classification society recognised by the Australian Maritime Safety Authority (AMSA).
- d) Certified by an AMSA-recognised Notified Body in accordance with the EU Marine Equipment Directive, Module B (MED-B).

Testing and listing, certification or type approval in the foregoing manner shall be deemed to be proof of compliance with the relevant standard.

NOTE: A listing of safety equipment that has been recognised as complying with the NSCV is available on the Register of Compliance Equipment published by the National Marine Safety Committee at www.nmsc.gov.au.

2.4 EQUIVALENT SOLUTIONS

Assessment methods for equivalent solutions applicable to anchoring systems shall comply with Part B of this National Standard. Equivalent solutions shall be verified in a manner appropriate to the risks that would arise should the safety system fail to perform at the time of need.

CHAPTER 3 DEEMED-TO-SATISFY SOLUTION FOR ANCHORING SYSTEM

3.1 A1 | MINIMUM ANCHOR MASS

3.1.1 Vessels more than 24 m in measured length

The minimum mass per anchor for a vessel more than 24 m in measured length shall be determined by calculating the equipment number as specified in Clause 3.2.

3.1.2 Vessels up to 24 m in measured length

The minimum mass per anchor for a vessel up to 24 m in measured length shall be the lesser value determined by—

- e) applying the values specified in Tables 3.1 to 3.4, for vessels up to 24m length only; or
- f) calculating the mass from the equipment number as specified in Clause 3.2.

3.2 EQUIPMENT NUMBER

Equipment number is a function of displacement, frontal area and profile area. It shall be calculated by the following equation:

$$EN = \{(\Delta^{2/3} \cdot f_h) + 2(B \cdot a + \sum b \cdot h \cdot \cos\theta_f) + 0.1(A_h + A_{ss} \cdot \cos\theta_p)\} f_o \dots\dots\dots (3.1)$$

where

- EN = equipment number
- Δ = vessel displacement, in tonnes
- B = moulded breadth, in metres
- a = Freeboard, in metres
- b = breadth of deckhouse tier if greater than B/4, in metres
- h = height of deckhouse tier if greater than B/4, in metres
- A_h = the hull profile above waterline, in square metres
- A_{ss} = superstructure profile area, in square metres
- θ_f = slope of superstructure front to the vertical, in degrees
- θ_p = slope of superstructure side to the vertical, in degrees
- f_h = factor for hull type:
 - 1.0 for monohulls
 - 1.26 for catamarans
 - 1.33 for trimarans
- f_o = factor for operational area:
 - 1.0 for area A, B and C

A1 |

0.8 for area D

0.54 for area E

3.3 HOLDING POWER

The holding power (force) of an anchor is related to the equipment number by the following equation:

$$P_h = 3 (0.002 EN^2 + 2.3 EN + 9) \times 9.81 \dots\dots\dots (3.2)$$

where

P_h = holding power (force), in newtons

EN = equipment number

3.4 ANCHOR MASS

The required anchor mass is related to the anchor holding power by the following equation:

$$M_a = P_h / (F_t \times 9.81) \dots\dots\dots (3.3)$$

where

M_a = required anchor mass, in kilograms

P_h = holding power (force), in newtons

F_t = factor for anchor type:

3.00 for standard anchors

4.29 for high holding power anchors

5.45 for super high holding power anchors

3.5 CABLE LENGTH AND DIAMETER

The required cable length and diameter is related to the equipment number by the following equation:

$$L_c = 1 \times 10^{-6} \cdot EN^3 - 1.4 \times 10^{-3} \cdot EN^2 + 0.75 \times EN + 55 \dots\dots\dots (3.4)$$

$$D_c = -6 \times 10^{-5} \cdot EN^2 + 0.095 \times EN + 8 \dots\dots\dots (3.5)$$

where

L_c = length of cable, in metres

D_c = diameter of cable, in millimeters

EN = equipment number

The length of anchor cable should be dependent on the area of operation of the vessel.

NOTES:

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1. For vessels operating in shallow water, local equivalent solution should apply.
2. The length of anchor cable attached to an anchor should be sufficient to achieve a scope of 7 to 1 or 45 m, whichever is longer.
3. Vessels operating in Class A, B or C waters should carry at least 150 m of anchor cable and those operating in class D waters should carry at least 100 m of anchor cable.
4. Vessels operating in class E waters should carry at least 45 m of anchor cable.

Additional requirements for anchor cables are specified in Clause 4.2.

3.6 LIGHT CRAFT

A vessel is considered a light craft if it has a maximum speed

$$V_m \geq 7.16 \Delta^{0.1667} \dots\dots\dots (3.6)$$

where

V_m = maximum speed, in knots

Δ = The craft displacement corresponding to the design waterline, in tonnes

3.7 DETERMINING ANCHOR MASS BY TABLES

Tables 3.1, 3.2, 3.3 and 3.4 provide the mass of standard anchors for vessels with displacement hulls. If the parameters of the vessel fall between the values as shown in the Tables, the anchor mass should be calculated by interpolation. In the event of the non-availability of an anchor having the calculated mass, the next higher size anchor should be selected.

The mass of a single anchor shall be determined from the following formula:

$$M_A = M_T f_V f_A \dots\dots\dots (3.7)$$

where

M_A = mass of a single anchor, in kilograms

M_T = tabular mass of anchor from Tables 3.1 to 3.4

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f_V = speed factor:

= 1 if not a light craft as defined by Clause 3.6

= 0.75 a light craft as defined by Clause 3.6

f_A = 1 for standard anchors

= 0.7 for high holding power anchors

= 0.55 for extra high holding power anchors

3.8 NUMBER OF ANCHORS

The number of anchors required to be carried by a vessel shall depend on its operating profile. The operating profile affects the risk of encountering an emergency situation.

Where a vessel is required to carry two anchors, each anchor shall be capable of providing the required holding power. The primary anchoring system shall be ready at all times. The secondary anchoring system shall be ready to deploy within 15 min.

All vessels shall carry two anchors if their equipment number is more than 10 or they are located below the double line in Tables 3.1 to 3.4.

Unless carrying dangerous goods, a vessel shall be allowed to carry one anchor if all of the following risk mitigating measures are in place:

- a) The vessel has complete redundancy with respect to main propulsion which means twin screw, independent and separate engine support systems (i.e. fuel, cooling water, electronic and electrical controls, shafting, and steering).
- b) The vessel operates within 30 NM radius of a safe haven and able to return to the safe haven from any point within 2 hours.
- c) The vessel carries communications equipment in accordance with NSCV Part C Section 7, Subsection 7B and has a safety management plan as per NSCV Part E (including procedures in the event of breakdown).

Excluding vessels carrying dangerous goods, any vessel less than 24m which operates solely in sheltered waters (Class D and E) shall be exempted from the requirement to carry a second anchor.

NOTE: A vessel may require more than one anchor for the following reasons:

- i) Operational requirements.
- ii) Anchoring in different types of sea beds.
- iii) Local Authority requirements.

Table 3.1 – Anchor mass in kg for Class A & B vessels

H L	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
3														
4			8	11										
5		8	12	13.5	16									
6	8	11	14	16	18.5	21								
7	10	13	16	18.5	21	<u>24</u>	26							
8	12	15	18.5	21	<u>24.5</u>	27	31	35						
9	14	17	21	<u>24</u>	28	32	36	41	46					
10	16	19	<u>23.5</u>	27	32	37	42	47	52	59				
11	18	22	26	31	37	42	48	54	61	67.5	75			
12	20	<u>24.5</u>	29	35	41	48	54	62	69.5	77	87	96		
13	22	27	33	40	46.5	53.5	62	70	80.5	90	99.5	110	121	
14	<u>24</u>	30.5	37.5	45	52	61	70	81	91	102	113	125	138	148
15	27	35	42	50	59	69	79	91	102	115	128	141	154	168
16	31	39	47	56	66	77	90	102	115	129	142	156	171	186
17	35	43	52	63	74	87	100	114	129	143	158	174	190	206
18	39	48	58	70	83	97	111	127	142	158	175	191	210	226
19	43	53	65	78	93	108	124	140	156	175	192	211	228	246
20	48	59	72	87.5	103	120	137	154	173	191	211	229	248	268
21	53	66	80	97	114	132	149	169	189	208	228	248	270	291
22	59	73	90	107	126	145	164	185	206	226	247	270	292	318
23	65	82	100	118	138	158	180	201	223	244	268	291	318	347
24	72	90	109	130	150	172	195	218	240	264	289	318	344	388

Above == 1 anchor required

H is height in metres

Below == 2 anchors required

L is measured length in metres

Table 3.2 – Anchor mass in kg for Class C vessels

H L	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
3														
4			7	10										
5		7	10	12	14									
6	7	10	12	13	15	18								
7	9	11	14	16	18	20	<u>22.5</u>							
8	10	12.5	15	17.5	20	<u>22.5</u>	25	30						
9	12	15	17.5	20	<u>22.5</u>	27.5	30	35	40					
10	14	17	20	<u>22.5</u>	27.5	30	35	40	45	50				
11	15	20	<u>22.5</u>	25	30	35	40	45	50	55	60			
12	17	<u>20</u>	25	30	35	40	45	50	57.5	65	72.5	80		
13	20	25	30	35	40	45	50	60	67.5	75	82.5	90	100	
14	20	25	32.5	37.5	45	50	57.5	67.5	75	85	95	105	115	125
15	<u>22.5</u>	30	35	42.5	50	57.5	65	75	85	95	110	120	130	140
16	25	32.5	40	47.5	55	65	75	85	97.5	110	120	130	140	155
17	30	37.5	45	52.5	62.5	72.5	85	95	110	120	130	145	160	175
18	32.5	40	50	60	70	80	92.5	105	120	130	145	160	175	190
19	35	45	55	65	77.5	90	105	120	130	145	160	175	190	205
20	40	50	60	72.5	85	100	115	130	145	160	175	190	205	225
21	45	55	67.5	80	95	110	125	140	160	175	190	210	225	245
22	50	60	75	90	105	120	135	155	175	190	205	225	245	265
23	55	70	85	100	115	130	150	170	190	205	225	245	265	290
24	60	75	90	110	125	145	165	180	200	220	240	260	285	320

Above == 1 anchor required

H is height in metres

Below == 2 anchors required

L is measured length in metres

Table 3.3 – Anchor mass in kg for Class D vessels

H L	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
3														
4			6	8										
5		6	8	9.5	11									
6	6	8	9.5	11	12.5	14								
7	7	9	11	12.5	14.5	16	18							
8	8	10.5	12.5	14.5	16.5	18.5	21	23.5						
9	9.5	12	14	16.5	18.5	21.5	24.5	28	31					
10	11	13	16	18.5	21.5	25	28.5	32	35	40				
11	12.5	15	18	21	24.5	28.5	32.5	36	41	45.5	50			
12	13	16.5	20	23.5	28	32.5	36.5	42	46	52	58	64		
13	15	18.5	22.5	27	31.5	36	42	47	53	60	66	73	81.5	
14	17	20.5	25	30.5	35	41.5	47	53	60.5	68	74.5	84.5	<u>92</u>	<u>99</u>
15	19	23	29	33.5	40	46	53	60.5	68	77	86	<u>94</u>	103	112
16	21	26	32	37.5	44.5	51.5	59.5	68	77	87	<u>95.5</u>	105	115	125
17	23	30.5	35	42.5	49	58	66.5	76	87	<u>95.5</u>	106	117	117	138
18	26.5	32.5	39	47	55.5	64.5	74.5	85.5	<u>96</u>	106	117	129	140	152
19	29	36	44	52	62	72	83.5	<u>96</u>	106	117	129	141	153	165
20	32.5	40	48	58.5	68.5	81	<u>92</u>	105	116	128	141	154	166	180
21	35.5	44.5	53.5	64.5	76	88.5	100	114	127	138	153	167	181	195
22	40	49	60	71.5	85	<u>96.5</u>	111	124	138	152	166	181	196	212
23	44	54	66.5	79	<u>93</u>	107	120	135	150	164	180	196	211	230
24	48	60.5	73	<u>88</u>	101	116	131	146	162	175	196	210	229	250

Above == 1 anchor required

H is height in metres

Below == 2 anchors required

L is measured length in metres

Table 3.4 – Anchor mass in kg for Class E vessels

L H	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
3														
4			4	5										
5		4	5	6	7									
6	4	5	6	7	8	9								
7	4.5	6	7	8	9.5	11	12							
8	5.5	6.5	8	9.5	11	12.5	14	15.5						
9	6	7.5	9	11	12.5	14.5	16	18.5	21					
10	7	8.5	11	12.5	14.5	16.5	19	21.5	24	26.5				
11	8	10	12	14.5	16	19	22	24.5	27.5	31	34.5			
12	9	11	14	15.5	18.5	22	25	28	31.5	35.5	39.5	43		
13	10	12.5	15	18	21.5	24.5	28	32	36	40.5	45	50	54.5	
14	11.5	14	17	20.5	24	27.5	32	36.5	41	46.5	51	56.5	62	67
15	12.5	15.5	19	23	27	31	36	41	46	52	57.5	63.5	69.5	75
16	14	17.5	21.5	25.5	30	35	40.5	46	52	58	64	70	76.5	83
17	15.5	19.5	24	28.5	34	39.5	45	51.5	58	64	71	77.5	85	92
18	17.5	22	26.5	32	38	43.5	50.5	57.5	64	71	78	86	93.5	102
19	19.5	24.5	29.5	35.5	41.5	49	56	63	70.5	78	86	94.5	103	111
20	22	27	33	39.5	46.5	54	62	70	77	85.5	94.5	104	113	<u>121</u>
21	24.5	30	36.5	43.5	51.5	59	67.5	75.5	84	94	103	113	<u>122</u>	133
22	27	33.5	40.5	47	57	65	73.5	82.5	92	102	112	<u>122</u>	133	144
23	29.5	37	45	53	62	71	80	90	100	111	<u>121</u>	132	145	158
24	33	40.5	49.5	58.5	68	77	87	98	109	<u>119</u>	131	144	157	171

Above == 1 anchor required

H is height in metres

Below == 2 anchors required

L is measured length in metres

3.9 MATERIALS AND CONSTRUCTION

3.9.1 General requirements

Anchors shall comply with the following requirements:

- a) The anchor as constructed shall be able to withstand the design loads without bending, shearing or failing in any way.
- b) The materials, or combination of materials, shall be protected from corrosion that is likely to cause failure of the anchor in service. Corrosion protection may be inherent to the material or applied externally.
- c) The method of construction or assembly process shall minimise the variation in strength from one anchor to the next.

NOTE: The components of an anchor may be cast, forged or fabricated from plate materials.

3.9.2 Certificate for fabricated components

For fabricated anchor components, certificates relating to the chemical composition and material properties shall be obtained from the material manufacturer.

3.9.3 Certificate for cast or forged components

For cast or forged anchor components the anchor manufacturer shall be responsible for the provision of certificates relating to chemical composition and material properties.

3.9.4 Record of treatment processes

Anchor manufacturers shall record details of any heat treatment, cold working or other process, which may affect either the material properties, or corrosion resistance of the anchor.

3.9.5 Type and size approved

Details relating to anchor materials shall be supplied to the assessment body for obtaining a certificate of approval for type and size.

3.10 TESTING

Anchors shall be tested in accordance with Annex A to ensure that they are capable of providing the specified holding power when deployed.

CHAPTER 4 REQUIREMENT FOR COMPONENTS

4.1 ANCHOR SHACKLE

The anchor shackle provides the link between the anchor and the anchor cable. The basic requirements of the anchor shackle are:

The strength of the anchor shackle shall be equal to or more than that of the anchor cable it is connected to.

NOTE: As the shape of the anchor shackle is inherently weaker than stud-link anchor cable this will require a larger diameter for the shackle leg and pin.

The proof load for the anchor shackle shall be greater than the certified holding power of the anchor it is connected to.

4.2 ANCHOR CABLE

4.2.1 Cable type

A1

The anchor cable shall be of stud-link chain, short-link chain, wire rope or fibre rope, subject to the requirements of this Chapter.

4.2.2 Design requirements

The anchor cable shall be designed such that the following applies:

- a) It provides a connection between the anchor and the vessel of sufficient length so that the anchor is able to provide maximum holding power.
- b) It provides a measure of elasticity to reduce the response loads on the vessel and anchor caused by the variation in the applied loads on the vessel due to wind, wave and current forces.

To satisfy the design requirements, the anchor cable shall have a working strength greater than the holding power of the anchor to be used. The anchor cable shall be able to absorb the design accelerations without exceeding the holding power of the anchor. This may be achieved by the use of mass, the elastic properties of the anchor cable, cable length or some combination of these characteristics.

4.2.3 Steel chain

The diameter of the chain shall be as per Clause 3.5 or Table 4.1.

Chain shall be manufactured, tested and certified in accordance with one of the following:

- a) ISO 1704 or equivalent National or International Standard.
- b) AS 2321 or equivalent National or International Standard.
- c) Ship Classification Society recognised by AMSA.

4.2.4 Steel wire rope

It is permitted to replace chain by steel wire rope where the equivalent anchor mass does not exceed that of a 130 kg standard anchor and the breaking load of the steel wire rope is at least equal to that of chain cable. The minimum length of chain at the end of wire rope shall be as per Table 4.1.

Wire ropes shall be manufactured, tested and certified in accordance with one of the following:

- a) AS 3569 or equivalent National or International Standard.

NOTE: For information on the operation and maintenance of steel wire ropes, refer to AS 2759.

- b) The requirements of a Ship Classification Society recognised by AMSA.

4.2.5 Fibre rope

Fibre rope is allowed for any anchor excepting anchors on vessels operating in A, B and C Class waters where the equivalent anchor mass exceeds that of a 130 kg standard anchor. The minimum breaking load of the fibre rope shall be equal to or more than that of a chain cable. The rope shall be in good condition, free from sunlight damage, abrasions, and hockles. The minimum length of chain at the end of fibre rope shall be as per Table 4.1.

NOTE: For guidance, rope diameters are given in Table 4.1.

The fibre ropes shall be manufactured as per AS 4142.2 or equivalent National or International Standard and tested as per AS 4143.1 or equivalent National or International Standard.

NOTE: For information on care and safe usage of fibre ropes, refer to AS 4142.1.

Fibre ropes that have been certified by AMSA recognised Ship Classification Society shall be deemed to comply with this National Standard.

Table 4.1 – Dimensions of anchor cable

Cable material	Standard anchor mass Kg	Short-link chain	Manila	Poly-propylene	Nylon	Poly-ethylene	+ Chain length
Chain, wire rope or fibre rope	Under 8	8	14	12	10	14	3 m chain of table size shackled between rope and anchor
	8 – 13	8	16	12	10	14	
	13 – 18	8	18	14	11	16	
	18 – 25	8	20	16	12	18	
Chain, wire rope or fibre rope	25 – 32	10	24	16	14	20	6 m chain of table size shackled between rope and anchor
	32 – 38	10	24	18	14	22	
	38 – 44	10	24	22	16	24	
	44 – 51	13	30	24	18	28	
	51 – 76	14	34	28	20	32	
	76 – 89	14	38	32	22	36	
	89 – 100	15	40	34	24	36	
	100 – 130	15	48	40	30	44	
Fibre rope permitted for vessels operating in partially smooth water and smooth water	130 – 178	16					9 m chain of table size shackled between rope and anchor
	178 – 226	17					
	226 – 274	19					
	274 – 322	20					
	322 – 370	21					
	370 – 432	21					

4.2.6 Windlass, capstan or winch

Mechanical lifting devices shall be fitted if the combined mass of anchor and one third of the cable exceeds the local Occupational Health and Safety (OHS) requirements for manual lifting. Cable stoppers, claws or similar fastenings shall be provided as necessary between the windlass or capstan and the hawse pipe. The windlass or capstan shall be designed for immediate dropping of the anchor and shall have an efficient brake.

Means shall be provided to secure the cable at the required length. The means shall be of strength sufficient to withstand loads not less than the breaking strength of the cable, including shock loading.

The bitter end of the cable shall be permanently secured to the vessel by an attachment of strength sufficient to withstand loads not less than the breaking strength of the cable.

For an anchor mass of less than 50 kg, the windlass or capstan may be hand operated provided that the applied effort shall not exceed 155 N when lifting the anchor and total length of cable fitted.

For an anchor mass of 50 kg and above, a power operated windlass or capstan shall be provided. It shall be capable of lifting one anchor and 35 m of its cable plus a 20 per cent overload at a speed of not less than 7.5 metres per minute.

Where a windlass or capstan is suitable for operation by hand and power, the manual drive shall not be operational in power mode.

CHAPTER 5 SEA ANCHORS

5.1 GENERAL

Class B and Class C vessels of measured length up to 10 m shall carry a sea anchor unless the vessel is capable of anchoring in deep water.

A typical sea anchor is a conical canvas bag open at both ends with a mouth opening eight times the size of the tail. Other dimensions of a typical sea anchor are:

- a) Diameter of mouth of circular sea anchor: 700 mm
- b) Length of each side of mouth of non-circular sea anchor: 600 mm
- c) Length of canvas bag: 1200 mm
- d) Diameter of hawser: 24 mm
- e) Diameter of tripping line: 16 mm

The fabric used in the construction of sea anchor shall be porous and rotproof, and shall allow a water penetration of between 100 L/s/m² when tested in accordance with Paragraph B4.4.

Alternative designs that meet the requirements of this Subsection may be accepted.

5.2 TESTING

Sea anchor shall be tested in accordance with Annex B.

ANNEX A ANCHOR TESTING

A1 SCOPE OF ANNEX

This Annex specifies the requirements and procedures for testing the anchors.

This Annex forms a normative part of this Subsection.

A2 APPLICATION

This Annex applies to all anchors except sea anchors.

A3 REQUIRED OUTCOME

The anchor shall be able of withstanding the forces induced in operation according to its specified holding power.

A4 TYPE OF ANCHOR TESTING

Anchor testing shall be in two parts, as follows:

- a) Determining the load the anchor is capable of generating.
- b) Determining the structural strength of the anchor.

A5 ANCHOR TESTING — LOADS

A5.1 General

Anchors are tested in various seabed types to determine the holding power, in kilograms force or kilonewtons; and from that, the holding ratio.

NOTE: The use of scopes less than 5 will result in reduced holding power and increased drag prior to embedment.

Allowable anchor holding power and holding ratios are based on the level of testing carried out, thus:

- a) Generic stockless and fishermen's stocked anchors of less than 75 kg mass shall have an assumed holding ratio of 3 times the anchor's mass and need not be tested.

NOTE: These anchors may also be known by trade names such as "Navy Stockless", "Dreadnought", and "Old-fashioned", "Fishermen's" or "Admiralty".

- b) All other anchors shall be tested in accordance with A5.2 to A5.3. The actual holding ratio derived from the test shall be permitted to be used but shall be limited to a maximum value of 12.

NOTE: Where the testing has been carried out in accordance with the requirements of a recognised Classification Society the type approval from the Classification Society of "Standard", "High Holding Power" or "Super High Holding Power", (SHHP) will be accepted. In such instances the holding ratios are assumed to be 3, 6 and 12 respectively.

A5.2 Test conditions

Anchors shall be assessed for holding capacity, as follows:

- a) All anchors shall be designed to take up an effective hold of the seabed irrespective of the angle or position at which they first settle on the seabed after dropping from a normal type of hawser pipe or bow roller. In case of doubt a demonstration of these abilities may be required.

- b) If approval is sought for a range of anchor sizes, at least two sizes are to be tested. The mass of the larger anchor to be tested is not to be less than one-half (1/2) of that of the largest anchor for which approval is sought. The smaller of the two anchors to be tested is to have a mass not less than one-half (1/2) of that of the larger.
- c) Each test is to comprise a comparison between at least two anchors, one, which has previously been tested and approved, and the anchor for which approval is sought. The masses of the anchors are to be as equal as possible.
- d) The tests are normally to be carried out by means of a tug or land based equipment. The pull is to be measured by means of a load cell.
- e) The test shall be witnessed by a representative of the Assessment Body.
- f) An accurate record of the test program shall be signed by the representative of the Assessment Body who witnessed the tests. The record shall include the following:
 - i) Date or dates and times of tests.
 - ii) Name of person responsible for carrying out the test and their relationship, if any, with the anchor manufacturer.
 - iii) Name of person representing the Assessment Body in the capacity of witness.
 - iv) Details of the equipment used.
 - v) Weather conditions at time of test, including wind speed and direction, and significant wave height.
 - vi) Water depth at anchor location for each test.
 - vii) Anchor details including, manufacturer, and number for certificate of approval, mass and general description.
 - viii) Anchor cable details including, cable size, type and length.
 - ix) Details of the seabed type; mud, sand, rock, sand and mud, seaweed and mud, or clay.
 - x) Any other details that may be relevant or likely to affect the outcome of the tests.

A5.3 Test Procedure

The tests are to be conducted on a sandy bed with little weed, and in addition on all bottom types for which approval is sought, on the basis that the following applies:

- a) The holding power as found for the system as tested shall only apply to the system and seabed on which it was tested or where it may reasonably be assumed that the seabed type would offer an improved holding power to that tested.
- b) Determination of where it may be “reasonably assumed” lies with the Authority and will be based on information relating to tests using similar anchors.
- c) Certificates of approval for type and size shall include details of seabed types tested.
- d) At least three test pulls shall be performed on any sea bed type for which approval is sought.

e) A test is to consist of the placement and the test pull of the anchor over the sea bed. The placement should resemble the deployment in service and it should not favour the embedment of the anchor.

f) The anchor shall embed in a distance from the start of pull as given below:

$$L_e = 6 + 0.15M$$

where

L_e = embedment distance, in metres

M = mass of anchor, in kilograms

g) For each test an adequate length of pull shall be used to enable a reliable average to be obtained. For a test conducted using a vessel or on a beach, the minimum recommended pull distance is as shown below:

$$P = 20 + M \quad \text{for standard anchors}$$

$$P = 20 + 1.5M \quad \text{for anchors with holding ratio more than three}$$

where

P = entire distance of pull in metres

M = mass of anchor in kg

h) The tension during the entire pull from rest shall be recorded. The average holding force during a test should be determined from the entire pull less the embedment distance (that is from $P - L_e$).

NOTE: Where the maximum holding power may exceed the intended maximum holding power for that anchor, the average results of 5 pulls of length sufficient to effectively engage the flukes may be used to determine the holding power. The embedment distance should comply with A5.3 f).

i) The holding power of anchors will be affected by the type, size and length of the attached anchor cable. The test should be arranged to represent a cable length of 10 times the depth of water but under no circumstances is to be less than 6 times the depth of water.

j) The test program should be designed to provide as much confidence in the results as is reasonably possible. To enable this:

i) Where at least three (3) but less than six (6) tests are carried out on the same or similar bottom types, the allowable holding power is not to exceed the lesser of—

A) the minimum recorded holding power; or

B) the average recorded holding power less two times its standard deviation.

ii) Where at least six (6) tests are carried out on the same or similar bottom types the allowable holding power is not to exceed two (2) standard deviations less than the average holding power recorded by the tests.

iii) The maximum applied load is not to exceed the proof load for the anchor. Where the proof load is not known it may be assumed to be as determined in A6.4a).

iv) The results from any test where the anchor or cable is damaged are not to be included in the overall test results and anchors or cables so damaged are not to be repaired except where such repairs do not impair the expected life of the anchor or cable had it not been damaged.

A6 ANCHOR TESTING— STRUCTURAL**A6.1 General**

The purpose of structural anchor testing is to ensure that the anchor does not fail in service. The test process shall ensure that the anchor is loaded in such a way that service conditions are matched as closely as possible.

The design process for the anchor will indicate in which mode and where on the structure failure is most likely to occur and under what conditions. The testing of the anchor shall confirm the design strength.

Representative samples of each anchor design shall be structurally tested in accordance with this Annex.

Certificates for structural testing shall be issued by an independent assessment body. Test certificates and original design specifications shall be retained by the manufacturer and made available for inspection on request.

Manufacturers that have been issued with a test certificate from an independent Assessment Body for a particular type anchor shall then provide a certificate with each anchor so certified that has been proof tested.

The anchor certificate issued by the manufacturer shall contain:

- a) The number of the certificate of approval from the Assessing Body.
- b) The manufacturer's trading name.
- c) The month and year of manufacture.
- d) The anchor model number.
- e) The anchor mass in kilograms.
- f) The proof load in either kilonewtons or kilograms.
- g) The proven holding power in kilonewtons, if applicable.

Where a particular anchor is being produced for the generic categories of "Standard", "High Holding Power" or "Super High Holding Power" the proof load shall be determined in accordance with A6.5.

A6.2 Test conditions

The following test set-ups are to be applied as appropriate to the anchor type to determine the proof load:

- a) Where the anchor shank is fixed in the horizontal plane the test load is to be applied at an angle of 30 degrees from original axis of the shank in the horizontal plane.
- b) Where the anchor shank can rotate in the horizontal plane the test load is to be applied at an angle of 30 degrees greater than the maximum angle of rotation in the horizontal plane.
- c) Where the anchor shank is fixed in the vertical plane the test load is to be applied at an angle of 45 degrees from the original axis of the shank in the vertical plane.
- d) Where the anchor shank can rotate in the vertical plane the test load is to be applied at an angle of 45 degrees greater than the maximum angle of rotation in the vertical plane.

- e) If the design of the anchor could lead to a condition which would place a higher load on the anchor than the test methods outlined in a) to d) above then such a test shall be carried out on the anchor.
- f) Anchors that fail or yield during testing shall be discarded after the test and shall not be repaired and used.

NOTES:

1. The yield strength of the anchor being tested is assumed to occur at the minimum load, which causes permanent bending, or in the case of tensile or shear failure that does not immediately lead to separation of anchor components.
2. The ultimate strength of the anchor occurs at the minimum applied load where separation of anchor components occurs. Testing shall be stopped when the ultimate strength is reached.

A6.3 Testing procedure

The structural testing of anchors shall be carried out as follows:

- a) The load is to be applied to the anchor shackle while the flukes are held similar to the way in which the anchor would be set.
- b) Loads are to be applied in both the horizontal and vertical planes simultaneously and in accordance with A6.2.
- c) For multiple fluke anchors testing is to be carried out on each fluke.

Failure of an anchor being tested is deemed to have occurred if any part of the anchor suffers permanent bending, buckling, tensile or shear failure.

A6.4 Proof Load

The proof load is to be determined as follows:

- a) Where the mass of an anchor is less than 50 kg and it does not have a certificate of approval the proof load shall be determined from the holding power. In no case shall an anchor without a certificate of approval for size and type have a proof load, in kilograms, that exceeds three (3) times the anchor mass for traditional stockless and stocked types or six (6) times the anchor mass for High Holding Power types.
- b) Where less than three (3) anchors of one size and type are tested in accordance with A6.2 to A6.3 the proof load is not to exceed one-half (1/2) of the minimum tested yield strength.
- c) Where a minimum of three (3) anchors of one size and type are tested in accordance with A6.2 to A6.3 the proof load is not to exceed two-thirds (2/3) of the minimum tested yield strength.
- d) Where at least six (6) anchors are tested in accordance with A6.2 to A6.3 the proof load for an anchor is not to exceed the average yield strength recorded minus three (3) standard deviations.
- e) Where a series of anchors are tested across a range of sizes in accordance with A6.2 to A6.3 the proof load for an anchor is not to exceed three (3) standard deviations less than the average yield strength recorded for each size.

NOTES:

1. The greater the number of anchors tested the greater the certainty that the actual anchor yield and ultimate strengths recorded will reflect the actual yield and ultimate strengths of anchors in normal production and therefore reduce the risk of failure due to a higher working load as a proportion of the yield strength.

2. Statistically three standard deviations below the average yield strength will ensure that approximately 99 per cent of anchors have yield strengths greater than the proof load.
3. For holding ratios of 12 or less, the proof load may be determined in accordance with the rules of a recognised Classification Society or in accordance with A6.5.

A6.5 Proof Load - Classification Society Designations

Where a particular size and type of anchor is being produced in accordance with the requirements of a recognised Classification Society the following shall apply with regard to the proof load:

- a) For holding ratios of 12 or less and equivalent “Standard” anchor masses of less than 50 kg proof testing shall not be required.
- b) The proof test shall be as given in Table A1, dependent on the mass of equivalent anchor, defined as follows:
 - i) 1 times the total mass for Standard anchors.
 - ii) 4/3 times the total mass for High Holding Power anchors.
 - iii) 2 times the mass for Super High Holding Power anchors.

NOTE: For intermediate values of mass the test load is to be determined by linear interpolation.

- c) The proof load shall be applied on the arm or on the palm at a distance from the extremity of the bill equal to 1/3 of the distance between it and the centre of the crown. The shackle shall be tested with the anchor.
- d) For stockless anchors, both arms shall be tested simultaneously, first on one side of the shank and then on the other side.
- e) For stocked anchors, each arm shall be tested individually.
- f) The anchors shall withstand the specified proof load without showing signs of defects.

Table A1 Proof test load for anchors

Mass of anchor kg	Proof test load kN	Mass of anchor kg	Proof test load kN	Mass of anchor kg	Proof test load kN	Mass of anchor kg	Proof test load kN
50	23.2	120	44.3	325	84.2	600	132
55	25.2	140	49.1	350	88.8	650	140
60	27.1	160	53.3	375	93.4	700	149
65	28.9	180	57.4	400	97.9	750	158
70	30.7	200	61.3	425	103	800	166
75	32.4	225	66.8	450	107	850	175
80	33.9	250	70.4	475	112	900	182
90	36.3	275	74.9	500	116	950	191
100	39.1	300	79.6	550	125	1000	199

A7 CONFORMITY ASSESSMENT

Structural tests of anchors for a certificate of approval for type and size shall be witnessed by an authorised representative of the Assessment Body.

NOTE: Manufacturers that have experience in testing anchors in conjunction with a Classification Society may be permitted to provide test data without requiring an independent witness. In such cases the managing director may sign the test record.

Records of structural anchor tests for certificates of approval for type shall be signed by the authorised representative of the Assessment Body and shall be kept by the manufacturer.

Tests carried out by the manufacturer and accepted by a recognised Classification Society may be accepted in lieu of the tests required by this paragraph (A7).

Test records for certificates of approval shall include the following:

- a) The test date.
- b) Details of the anchor being tested, including; materials, construction method, mass, and plan and profile views with dimensions.
- c) Details of the test equipment, including method of applying the load and method of holding anchor in place while being tested.
- d) The rate at which the load was applied.
- e) Photographic or other evidence showing where and the extent of failure at yield.

The certified holding power as determined in A5 for an anchor shall not exceed the proof load.

NOTE: The Authority may apply additional conditions in relation to the structural testing of anchors where novel designs are presented for approval.

ANNEX B TESTS FOR SEA ANCHORS

A8 SCOPE

This Annex specifies the requirements and procedure for testing sea anchors.

This Annex forms a normative part of this Subsection.

A9 APPLICATION

This Annex applies to sea anchors only.

A10 REQUIRED OUTCOME

The anchor shall be able to withstand forces according to its specified holding power.

A11 TESTING

B4.1 Deployment

A sea anchor with its full length of 30m line shall be thrown into a swimming pool or from a jetty into the sea. The reinforced ringed entrance of the sea anchor shall open up immediately.

B4.2 Towing

A fully streamed sea anchor shall be towed over a distance of 500m at a range of 1 to 6 knots. The sea anchor shall be carefully observed throughout the tow and shall remain completely stable, not breaking through the surface of the water. On completion, the sea anchor and attachments shall be examined and shall not show any signs of deterioration or damage.

With a dynamometer fitted in the tow line the sea anchor shall again be towed over a distance of 500m and the tensile force in the line recorded at speeds of 1.5, 3 and 6 knots. If there is a tide running, the force shall be recorded in each direction and the mean taken. The forces recorded shall be in the range—

- a) 15 kg \pm 10% at a speed of 1.5 knots; or
- b) 40 kg \pm 10% at a speed of 3 knots; or
- c) 100 kg \pm 10% at a speed of 6.0 knots.

B4.3 Strength

To demonstrate the strength of the sea anchor and its attachments to the shroud and towing line the anchor shall be uniformly loaded internally with a weight of 100 kg. The sea anchor shall then be suspended by at least 2m of towing line for a period of 6 hours. On completion the anchor, shroud lines and all attachments shall be carefully examined and there shall not be any visible signs of any deterioration or damage.

B4.4 Porosity

The material used in the manufacture of the sea anchor shall be tested for porosity by attaching it to the open end of a 50 mm internal diameter pipe as shown in Figure B1.

Water shall be supplied to the apparatus at a rate of 0.24 L/s. The test shall be carried out over at least 10 s and repeated 5 times using a different sample of material each time, the average value being taken as the flow rate. An accuracy of $\pm 10\%$ shall be acceptable.

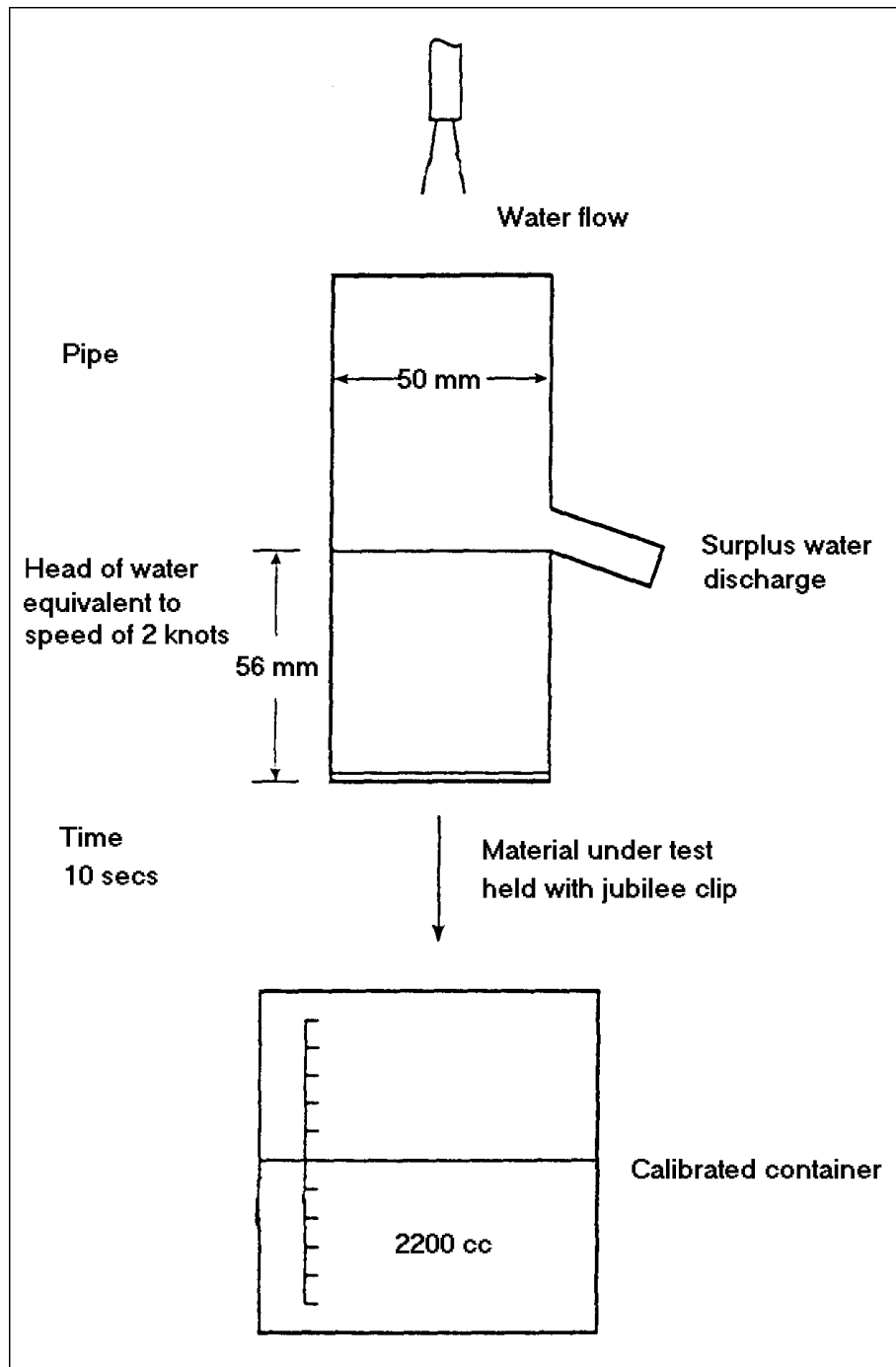


Figure B.1 — Test to determine porosity of sea anchor material