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GENERAL REQUIREMENTS AND TESTING OF AC MOORING WINCHES (FOR SHIP BOARD USE)

(First Revision)

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

GENERAL REQUIREMENTS AND TESTING OF AC MOORING WINCHES (FOR SHIP BOARD USE)

(First Revision)

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Indian Standard

GENERAL REQUIREMENTS AND TESTING OF AC MOORING WINCHES (FOR SHIP BOARD USE)

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 February 1979, after the draft finalized by the Marine Engineering Sectional Committee had been approved by the Marine, Cargo Movement and Packaging Division Council.

0.2 This standard was first issued in 1969. The revision of this standard has been taken up to bring it in line with the current work by ISO/TC 8/ SC 10 on standardization of mooring winches and the experience gained by the manufacturers during these years.

0.3 The present day shipping practice is to use 3-phase ac induction motors of 440 volts, 60 Hz or 415 volts, 50 Hz to drive mooring winches. Speed control to obtain two or three speed changes is achieved by pole changing arrangement.

0.4 The warping drum for mooring purposes may be attached to winches and windlasses. The present day practice is to equip separate mooring winches to operate these warping drums and are fitted both at the aft-end and at the fore-end of the ship. The warping drum may be placed horizontally or in a vertical manner.

0.5 Generally electrical drive with pole changing squirrel cage induction motor is used for non-automatic mooring winches. For automatic mooring winches electrical drive with Ward-Leonard system and electro-hydraulic system are used.

0.6 Manufacturers have to keep in mind that winches and other deck machinery are subjected to very heavy stresses due to continuous handling by dock labour in different ports of the world and are also exposed to highly corrosive saline atmosphere.

0.7 The allowable design stress for maximum stalling load conditions is also indicated in this standard as a guide for the manufacturer.

0.8 Attention of manufacturers and users of mooring winches is particularly drawn to provisions of Chapter 8 'Loading and unloading machinery and gear' of Safety of Health in Dock Work issued by the International Labour Office.

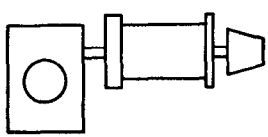
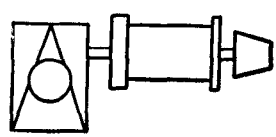
0.9 The information to be provided by the purchaser at the time of enquiry is given in Appendix A for guidance.

0.10 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers general requirements and method of testing of electrically operated automatic and non-automatic mooring winches fitted on-board ships for rated loads up to and including 40 tonnes.

1.1.1 The functions of mooring winches covered by this standard are scheduled in the following table :

Operation	*Mooring Winch (Non-automatic)*	*Mooring Winch (Automatic)*
		
Mooring	X On drum	X On drum
Rope storing	X On drum	X On drum
Tension maintaining through brake	X On drum	X On drum
Warping	Optional On warping end or on drum	Optional On warping end or on drum
Tension maintaining through automatic device	—	X On drum

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Nominal Size — The nominal size of a mooring winch corresponds to the holding load in tonnes at its nominal speed.

NOTE — The nominal sizes of mooring winches in Table 1 have been derived from R10 series of preferred numbers.

2.2 Drum Load (Rated Load, Hauling Load and Hoisting Load) — The maximum rope tension in kN, measured at the drum exit when the winch is hoisting or hauling in at the nominal speed with the rope wound on the drum in a single layer.

2.3 Holding Load (Brake Holding Load) — The maximum rope tension in kN, that can be maintained by the winch braking/locking system on the drum when the rope is led off the first layer.

2.4 Stalling Load — The maximum rope tension in kN measured at the drum exit when the drum ceases to rotate in the direction of haul, the prime mover being set for maximum torque and the rope being wound on the drum in a single layer.

2.5 Recovery Load — The maximum rope tension in kN, measured at the drum exit when the drum commences to rotate in the direction of haul, the prime mover being set for maximum torque and rope being wound on the drum in a single layer. This applies to automatic winches only.

2.6 Rendering Load — The maximum rope tension in kN, measured at the drum exit when the drum just commences to rotate in the opposite direction to the applied driving torque, the prime mover being set for maximum torque and the rope being wound on the drum in a single layer.

2.7 Nominal Speed — The maximum rope speed in metres per second that can be maintained by the winch when it is applying the drum load.

2.8 Light Line Speed — The maximum rope speed in metres per second that the winch can maintain with the rope wound on the drum in a single layer and with negligible tension on the rope.

2.9 Creep Speed — The minimum uniform rope speed in metres per second measured on the first layer that the winch can maintain under drum load.

2.10 Cable — The rope used for pulling the ship to the required position with the help of the mooring winch. Wire ropes, manila or sisal ropes or man-made fibre ropes may be used.

2.11 Warping Drum — A drum used for winding the cable when the ship is being moored.

2.12 Right-Hand and Left-Hand Mooring Winches

2.12.1 A winch is called a right-hand winch in relation to an observer situated on the side of the motor, power supply or controller (in the case of a symmetrical winch) when the reduction gear or the drive for the drum is on the right-hand side of the drum.

2.12.2 A winch is called a left-hand winch, in relation to an observer situated on the side of the motor, power supply or controller (in the case of a symmetrical winch) when the reduction gear or the drive for the drum is on the left-hand side of the drum.

The illustrations of mooring winch types given below represent right-hand models :

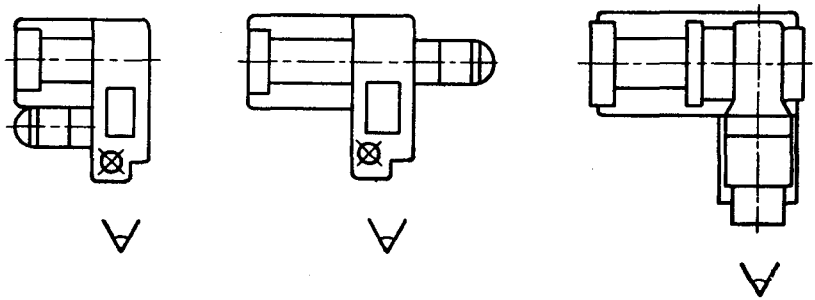


FIG. 1 RIGHT-HAND WINCHES

3. GENERAL REQUIREMENTS OF MOORING WINCH

3.1 The winch may be designed to handle the drum loads given in Table 1 with the provision of mechanical gear changing arrangement in conjunction with a 3-phase induction motor.

3.2 The drum load on winch shall not produce stresses greater than 0·4 times the 0·2-percent proof stress of the material, the allowable stress on any part of the winch being calculated on the basis of the simple elastic theory.

3.3 The maximum torque of the prime mover, under the most severe working conditions, shall be such that the allowable stresses in the affected parts shall not be greater than 0·9 times the 0·2-percent proof stress of the material.

3.4 The holding load of the winch shall be such that the allowable calculated stresses of the affected parts (including the base plate) shall not be greater than 0·90 times the 0·2-percent proof stress of the material.

3.5 Winch seats shall be of adequate strength. They may be in the form of a sealed box, but if of open construction, provision shall be made to prevent accummulation of water and to give adequate access for cleaning and painting of the structure. Decks in way of winch seats shall be adequately strengthened.

4. GENERAL REQUIREMENT OF MOORING WINCH MOTORS

4.1 The nominal size and drum load are indicated in Table 1.

4.2 The motor shall be capable of maintaining the rated power corresponding to S_2 duty cycle as given in **4.4** and be able to withstand an overload of 50 percent for 2 minutes.

4.3 The starting torque of the motor shall be approximately twice the rated torque of the motor.

4.4 The motor shall be of intermittent periodical duty conforming to duty type 'S_2' according to IS : 325-1970*.

4.5 When the reduction gear of the mooring winch is placed above deck, the motor shall be of the enclosed type conforming to degree of protection 'IP56' in accordance with IS : 4691-1960†.

4.6 When the reduction gear is placed below the deck, depending upon the location, the motor may be of the screen protected drip proof type conforming to degree of protection 'IP23' or totally enclosed fan cooled type conforming to degree of protection 'IP44' in accordance with IS : 4691-1960†.

5. WARPING DRUMS FOR MOORING WINCHES

5.1 Drum Diameter — The drum diameter shall not be less than 16 times the diameter of the design rope. The drum diameters to be used with different nominal size of mooring winches are given in Table 1.

5.2 Design Rope — The winch design shall be based on the use of wire rope complying with the requirements of IS : 2266-1977‡, tensile grade 1 770 N/mm², 6 × 36 I.W.R.C. The diameter of the rope shall be as given in Table 1.

NOTE — The above requirement does not preclude the use of other types of rope in service.

*Specification for three-phase induction motors (*third revision*).
†Degrees of protection provided by enclosures for rotating electrical machinery.
‡Specification for steel wire ropes for general engineering purposes (*second revision*).

5.3 Drum Capacity — The drums shall be of two capacities 'normal' and 'high'. The minimum length of design rope to be stored on normal capacity drum is given in Table 1. High capacity drums shall store twice the length of normal capacity drums.

5.4 Drum Length

5.4.1 The drum length of normal capacity drums shall be such that the total length of the design rope can be accommodated in not more than five layers evenly reeled.

5.4.2 The drum length of high capacity drums shall be such that the total length of the design rope can be accommodated in not more than 8 layers, evenly reeled.

5.4.3 When a split drum is used, the number of layers on the storage section may be increased.

NOTE — Attention of the users of the winch is drawn to the possibility of the damage occurring to the rope if large loads are applied while more than four layers of rope are reeled on the drum.

5.5 Drum Flange Height

5.5.1 When all the rope is reeled on normal capacity drum, the flange height shall project at least 2·5 times the rope diameter above the outer layer.

5.5.2 The flanged height of high capacity drums shall be such that the design rope may be fully stored without projecting beyond the flanges when wound with the layers superimposed directly upon each other.

5.6 The drum may be declutchable from the drive.

5.7 The cable end shall be fixed to the drum either by means of a special hook in accordance with IS : 5130-1969* or any other suitable arrangement.

5.8 The warping drums in accordance with IS : 5130-1969* may be fitted at either end, if required by the purchaser.

5.9 The admissible height of the warping drum above the deck shall be such that the operating personnel can easily handle the pulling rope.

6. GENERAL REQUIREMENTS FOR DIRECTION OF CONTROLS, BRAKE AND SAFETY DEVICES

6.1 Manual Controls

6.1.1 Manual control is that where the mooring winch is directly controlled by an operator and there is no facility for automatic control.

*Specification for drums fitted to cargo and mooring winches.

TABLE 1 STANDARD AUTOMATIC AND NON-AUTOMATIC MOORING WINCHES

(*Clauses* 3.1, 4.1, 5.1, 5.3, 7.1, 7.2.1 *and* 8.2.2.2)

Nominal Size	Drum Load	Nominal Speed, *Min*	Light Line Speed, *Min*	Creep Speed, *Max*	Design Rope Diameter	Breaking Strength of Rope, *Min*	Holding Load, *Min*	Recovery Load, *Min*	Rendering Load, *Max*	Theoretical Diameter of Drum and Warping End	Drum Capacity	
											Normal	Hight
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
tonnes	kN	m/s	m/s	m/s	mm	kN	kN	kN	kN	mm	m	m
5	50	0·25	0·5	0·125	18	181	150	25	90	288	180	360
8	80	0·25	0·5	0·125	22	271	220	40	135	352	200	400
12	125	0·20	0·4	0·100	26	378	310	60	189	416	200	400
16	160	0·20	0·4	0·100	32	573	470	80	286	512	250	500
20	200	0·16	0·32	0·080	36	725	590	100	362	576	250	500
25	250	0·16	0·32	0·080	40	895	730	125	447	640	250	500
32	315	0·13	0·26	0·065	44	1080	880	155	540	704	250	500
40	400	0·13	0·26	0·065	48	1290	1050	200	645	768	250	500

NOTE 1 — Col 9 and 10 apply only to automatic mooring winches.

NOTE 2 — Col 3, 4 and 5 apply only to manual control.

6.1.2 The direction of motion of the operating devices shall be such that the winch will haul in by clockwise movement of a hand wheel or crank handle, or alternatively movement of a hand lever towards the operator or to the right or downwards.

6.1.3 Any extensions to control handles or control pedals shall be securely fastened to the control lever or pedal and be of sufficient strength to reduce deflection and backlash to a minimum.

6.1.4 Long levers shall be counterbalanced.

6.1.5 All control handles and wheels shall be clearly and permanently marked with their purpose and mode of operations.

6.1.6 The direction of the rotation when hauling in shall be clearly and permanently marked on drums.

6.1.7 Gear levers shall be locked by click stops or by any other positive means in any gear or in neutral position.

6.1.8 The maximum travel of a control handle shall not exceed 600 mm in one direction or 300 mm each side of a central position.

6.2 Automatic and Remote Controls

6.2.1 Automatic control is that where a mooring winch is controlled within selectable limits without direct human intervention.

6.2.2 Remote control is that where the control position is at a distance from the mooring winch being controlled, the control position may be fixed or portable.

6.2.3 With remote controlled winches, the hauling in and paying out may be actuated by separate push-buttons or lever controls. These push-buttons or levers may be coloured in a suitable manner.

6.2.4 The push-buttons shall be depressed or lever actuated to operate the winch and when released shall cause the winch to be stopped and effectively braked.

6.2.5 Separate push-buttons, where fitted and when they are not associated with automatic sequential control, shall be provided for each motion of the winch that is one push button to haul in and a separate button to pay out.

6.3 Braking

6.3.1 All winches shall be provided with an automatic electrically actuated braking system which operates when bringing the operating device to the stop or to the braking position and also when the power supply is cut off.

6.3.2 The brake shall be capable of sustaining a load of 1·5 times the drum load and of stopping the rotation of the drum at its maximum speed without suffering damage.

6.3.3 *Drum Brake* — The drum shall be fitted with a brake capable of applying a braking torque sufficient to maintain the required holding load under the extreme condition when the drum is declutched from the winch drive mechanism.

6.3.3.1 Provision shall be made to minimise the possibility of accidental release of the brake.

6.3.3.2 The brake shall be capable of maintaining the holding load when the winch is unattended.

6.3.3.3 With hand operated brake, the force applied to the control grip shall not exceed 160 N, in order to exert a braking torque 25 percent in excess of the driving torque required to maintain the drum load.

6.3.3.4 With pedal operated brake, the force applied to the pedal shall not exceed 320 N, in order to exert a braking torque 25 percent in excess of the driving torque required to maintain the drum load.

6.3.3.5 The maximum travel of a foot pedal shall not exceed 250 mm.

6.3.3.6 The drum brake may be used as the control brake provided it is capable of fulfilling the requirements of **6.3.1** and **6.3.2**.

6.3.3.7 The clockwise movement at a hand-wheel or the movement of hand-lever to right or towards operator or upward shall apply the brake and reverse shall be applicable for releasing the brake.

6.3.4 *Emergency Stop* — The winch shall be fitted with a quick acting local emergency stop mechanism which when operated, removes power from the winch and applies the automatic braking system. The emergency stop shall be located in a clearly marked and accessible position close to a remotely controlled winch and adjacent to a manually controlled winch.

6.4 Speed Control

6.4.1 The speed of the winch shall be adjustable between light line speed and stop for hydraulic winches. It shall be possible to make the adjustment whilst the winch is working.

6.4.2 The speed control system shall be such that it is possible to move the controls from the full veer position to the full haul position or vice versa in less than 2 seconds.

6.4.2.1 The speed with which the controls are manipulated shall not have an adverse effect on either the winch machinery or the safety of the operator.

6.4.2.2 Winch response times shall be supplied by the manufacturer to the purchaser on request.

6.5 Location of Control — Irrespective of whether the driving gear is above the deck or below the deck, a starting control panel shall be placed above deck at a convenient height and position for easy operation. The position of the control panel shall be such that the operator has, at all times, a clear view of the movement of the winch drum and rope.

7. PERFORMANCE

7.1 The mooring winch shall be capable of exerting the drum, holding, recovery and rendering loads according to its nominal size, when performing at the design speeds specified in Table 1 and within the limitations specified in **7.1.1** to **7.1.4**.

7.1.1 *Drum load* — This shall not be greater than 0·33 times the breaking strength of the design rope when operating at the corresponding design speeds.

7.1.2 *Holding Load* — This shall not be less than 80 percent of the breaking strength of the design rope.

7.1.3 *Recovery Load* — This shall not be less than 50 percent of the drum load.

7.1.4 *Rendering Load* — This shall not be more than 50 percent of the breaking strength.

7.2 Speeds

7.2.1 *Nominal Speed* — The minimum speed for the respective nominal sizes of mooring winch shall be in accordance with that specified in Table 1.

7.2.2 *Light Line Speed* — The light line speed, measured on the first layer on the drum shall be twice the nominal speed.

7.2.3 *Creep Speed* — The creep speed shall not be more than 0·5 times the nominal speed nor more than 0·15 metres per second.

8. TESTING OF MOORING WINCHES

8.1 Testing of Motors and Electrical Controls

8.1.1 *Type and Routine Tests* — Type and routine tests shall be conducted at the manufacturer's premises and test certificate issued for winch motors in accordance with the relevant clauses of IS : 325-1970*.

8.1.1.1 Unless otherwise specified, the purchaser, if so desired by the manufacturer, shall accept as evidence of compliance of the motor with the requirements of type test, on a motor identical with the one purchased, together with routine tests on each motor.

8.1.1.2 When a batch of 20 or more similar motors is supplied to one order, type tests, as specified, one of these motors may be carried out in the manufacturer's premises, if the purchaser so requires.

8.1.1.3 The temperature shall be measured by thermometer or by electrical resistance method in accordance with IS : 325-1970* for a motor with S_2 duty cycle. The temperature-rise test need only be carried out on 8 and 4 pole steps.

8.1.2 *Control Panel Test* — All control panels supplied with the motors shall be tested for proper working of contactors, relays and insulation resistance.

8.2 Testing of Mechanical Drive

8.2.1 Tests shall be carried out at manufacturers' works, but where this is not possible the tests may be carried out at a place as agreed to between the manufacturer and the purchaser.

8.2.1.1 Tests given in **8.2.2.1** to **8.2.2.3** and **8.2.2.5** are not meant to assess the performance of the motor. Tests given in **8.2.2.4**, **8.2.2.6**, and **8.2.2.7** shall be carried out on the complete winch.

8.2.1.2 The result of the test carried out in accordance with **8.2.2** shall be stated in test certificate.

8.2.1.3 When a batch of 20 or more similar winches is supplied to one order, type tests, on one of these winches may be carried out in the manufacturer's premises or at a place agreed between the manufacturer and the purchaser if so required.

8.2.1.4 The type test may be replaced by a prototype test certificate if agreed to by the manufacturer and the purchaser.

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*Specification for three-phase induction motors (*third revision*).

8.2.1.5 Where tests are required in excess of the type test, these shall be agreed to between the manufacturer and the purchaser at the time of contract.

8.2.2 *Type Tests*

8.2.2.1 *Operation under no-load* — The winch shall be run for 30 minutes, 15 minutes continuously in each direction at light line speed. During this period the speed and noise shall be checked and the bearing lubrication shall be checked for proper operation. At the end of the test run, the temperature rise of all parts and oil-bath shall be checked and compared against the guaranteed values.

8.2.2.2 *Operation under load* — The drum load corresponding to the nominal size of the winch as given in Table 1 shall be raised and lowered through a height of 7 m for a period corresponding to S_2 duty cycle depending upon the rating of the motor with 20 seconds idling between one cycle and the next (lowering and hoisting). For higher sizes above 16 tonnes where it is not possible to carry out the load test on the manufacturer's works, it may be carried out on board ship, if agreed to between the manufacturer and the purchaser.

While testing the following shall be checked :

a) Presence of abnormal temperature of bearings,

b) Measurement of actual speed,

c) Presence of abnormal noise, and

d) Power consumption in watts.

8.2.2.3 *Holding test* — This test shall be carried out by applying the holding load to a rope led off the drum when the drum shall not rotate. This test may be carried out on board ship if agreed to between the purchaser and the manufacturer.

8.2.2.4 *Automatic brake system test* — This test shall satisfy the requirements of **6.3.1** and **6.3.2**. This test may be carried out on board ship if agreed to between the purchaser and the manufacturer.

8.2.2.5 *Open inspection test* — At the end of type test, the winch shall be opened and inspected for any defects on the following parts :

a) Worm shaft and bearings,

b) Gear wheel shafts and bearings,

c) Winding drum and bearings,

d) Thrust bearing,

e) Brake lining,

f) Worm and worm gear, and

g) Gear wheel and pinion.

In the case of gear wheels, the tooth faces shall be checked for proper meshing.

8.2.2.6 *Waterproofness test*

a) *Water spray test* — This test shall be conducted in accordance with IS : 4691-1968* to ascertain that the winch enclosure corresponds to the degree of protection type 'IP 56'.

b) *Insulation resistance test* — This test shall be carried out according to IS : 325-1970† both before and after the water spray test.

8.2.2.7 *Tilt test* — This test is to ascertain the proper functioning of the oil seals of the gear case and alignment of the gear train ensuring proper working of the winch and the motor even when the ship has a list up to 5° and a trim up to 2°. If facilities for conducting this test in the shop is not available, this may be conducted on board the ship, during sea trials, if agreed to between the manufacturer and the purchaser.

8.2.3 *Routine Test* — This test shall be carried out on every winch as follows.

8.2.3.1 *Test at no-load* — The mooring winch shall be run for 30 minutes (15 minutes in each direction) at no load.

While testing the following shall be checked :

a) Tightness against oil leakages,

b) Temperature of bearings,

c) Presence of abnormal noise,

d) Power input, and

e) Speed of rotation of drum which shall conform to the requirement of **7.2.2**.

8.2.3.2 *Correct operation of brake system* — This test shall satisfy the requirements of **6.3.1** and **6.3.2**.

8.3 On Board Acceptance Tests — It is recommended that these tests shall only be arranged for the following inspections, and tests to be carried out on board ship to ensure that the winch is fully operable. All tests shall be carried out under ship power.

8.3.1 The mooring winch shall be mounted on board ship in its appropriate position. The winch shall be run for a period of 10 minutes at light line speed (5 minutes continuously in each direction) so that all parts attain their equilibrium temperature.

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*Degrees of protection provided by enclosures for rotating electrical machinery.
†Specification for three-phase induction motors (*third revision*).

8.3.2 *Additional Tests* — Other tests may be requested by the purchaser at his own expense.

9. DESIGNATION

9.1 The designation of mooring winch shall indicate the following :

a) Nominal size in tonnes;

b) Whether the electrical motor is placed above deck AB or below deck BD;

c) Right-hand or left-hand model (R or L); and

d) Additional items shall be given where applicable, for example, current, voltage, frequency.

Designation of an electric ac mooring winch of nominal size 5, left-hand model with driving motor placed below deck 440 ac, frequency 60 Hz shall be :

WINCH 5L × BD 440/60 IS :.....

9.2 A rating plate shall be separately attached to the motor according to IS : 325-1970*.

10. MARKING

10.1 Winches shall be marked with a plate attached to it with the designation given in **9**.

10.1.1 Winches may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

*Specification for three-phase induction motors (*third revision*).

APPENDIX A

(*Clause* 0.9)

INFORMATION TO BE PROVIDED BY THE PURCHASER

A-1. The purchaser should provide the manufacturer of the mooring winch with the following information at the time of enquiry:

a) Nominal size;

b) Whether left-hand or right-hand;

c) Whether warping end is required, if only one, on which end;

d) Drum capacity rating;

e) If separate control brake is required;

f) If remote control or local control is required;

g) If variation is required for standard speed;

h) If additional test is to be performed;

j) Power source available;

k) Maximum attitude of ship if required to be in excess of 5° heel/or 2° trim; and

m) Whether the reduction gear of the mooring winch is to be placed below or above deck.

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Conversion
Force	newton	N	1 N = 0·101 972 kgf
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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