A3 Anchor Windlass Design and Testing

A3 (June 2017)

1. General

1.1 Application

A windlass used for handling anchors, suitable for the size of chain cable and complying with the following criteria is to be fitted to the ship.

1.2 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.

The following are examples of standards recognized:

SNAME T & R Bulletin 3-15 - Guide to the Design and Testing of Anchor Windlasses for Merchant Ships
ISO 7825 Deck machinery general requirements
ISO 4568 Shipbuilding - Sea-going vessels - Windlasses and anchor capstans
JIS F6714 Windlasses
BS MA35 Specifications for Ship Deck Machinery Windlass

1.3 Plans and Particulars to be Submitted

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

- Windlass design specifications; anchor and chain cable particulars; anchorage depth; performance criteria; standard of compliance.

Note:

1. This UR is to be uniformly implemented by IACS Societies:

   i) when an application for certification of an anchor windlass is dated on or after 1 July 2018; or

   ii) installed in new ships for which the date of contract for construction is on or after 1 July 2018.

2. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.

3. Windlass foundation structure (incl. under deck supporting structures) is not addressed in this UR. Holding down arrangements are to be per 4.2 of UR S27, as applicable.

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- 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 system, to include:

  i) piping diagram along with system design pressure,

  ii) safety valves arrangement and settings,

  iii) material specifications for pipes and equipment,

  iv) typical pipe joints, as applicable, and

  v) technical data and details for hydraulic motors.

- Electric one line diagram along 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.

- Plans and data for windlass electric motors including associated gears rated 100 kW 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 4ii).

- Operation and maintenance procedures for the anchor windlass are to be incorporated in the vessel operations manual.

2. Materials and Fabrication

2.1 Materials

Materials used in the construction of torque-transmitting and load-bearing parts of windlasses are to comply with Rules of the class society 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.

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2.2 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 the requirements of the class society. Welding consumables are to be type-approved by the class society. The degree of non-destructive examination of welds and post-weld heat treatment, if any, are to be specified and submitted for consideration.

3. Design

Along with and notwithstanding 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.

3.1 Mechanical Design

3.1.1 Design Loads

(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, 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.

(b) Inertia Loads

The design of the drive train, including prime mover, reduction gears, bearings, clutches, shafts, cable lifter 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.

3.1.2 Continuous Duty Pull

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 corresponding to S2-30 min. of IEC 60034-1), Z_{cont1}, corresponding to the grade and diameter, d, of the chain cables as follows:

Grade of chain	Z_{cont1}	
	N	*kgf*
1	$37.5d^2$	$3.82d^2$
2	$42.5d^2$	$4.33d^2$
3	$47.5d^2$	$4.84d^2$
Unit of d	*mm*	*mm*

The values of the above table are applicable when using ordinary stockless anchors for anchorage depth down to 82.5 m.

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For anchorage depth deeper than 82.5 m, a continuous duty pull Z_{cont2} is:

$Z_{cont2}[N] = Z_{cont1}[N] + (D – 82.5) \times 0.27d^2$

or

$Z_{cont2}[kgf] = Z_{cont1}[kgf] + (D – 82.5) \times 0.0275d^2$

where

D is the anchor depth, in metres.

The anchor masses are assumed to be the masses as given in UR A1 and Recommendation 10. Also, 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.

3.1.3 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. The speed in this period may be lower than normal.

3.1.4 Hoisting Speed

The mean speed of the chain cable during hoisting of the anchor and cable is to be at least 0.15 m/sec. For testing purposes, the speed is to be measured over two shots of chain cable and initially with at least three shots of chain (82.5 m or 45 fathoms in length) and the anchor submerged and hanging free.

3.1.5 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.

3.1.6 Chain Cable Stopper

Chain cable stopper, if fitted, 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.

3.1.7 Support Structure

For hull supporting structures of windlass and chain cable stoppers, refer to A1.7 of UR A1.

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3.2 Hydraulic Systems

Hydraulic systems where employed for driving windlasses are to comply with the provisions of the class society.

3.3 Electrical Systems

3.3.1 Electric Motors

Electric motors are to meet the requirements of the class society and those rated 100 kW and over are to be certified. Motors exposed to weather are to have enclosures suitable for their location as provided for in the requirements of the class society. Where gears are fitted, they are to meet the requirements of the class society and those rated 100 kW and over are to be certified.

3.3.2 Electrical Circuits

Motor branch circuits are to be protected in accordance with the provisions of the class society and cable sizing is to be in accordance with the requirements of the class society. Electrical cables installed in locations subjected to the sea are to be provided with effective mechanical protection.

3.4 Protection of Mechanical Components

To protect mechanical parts including component housings, a suitable protection system is to be fitted to limit the speed and torque at the prime mover. Consideration is to be given to a means to contain debris consequent to a severe damage of the prime mover due to over-speed in the event of uncontrolled rendering of the cable, particularly when an axial piston type hydraulic motor forms the prime mover.

3.5 Couplings

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

4. 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 specified 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 3.1 can be attained.

Where the manufacturing works does not have adequate facilities, these tests, including the adjustment of the overload protection, can be carried out on board ship. In these cases, functional testing in the manufacturer's works is to be performed under no-load conditions.

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

5. On-board 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 cable 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 3.1.4, 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.

6. Marking

Windlass shall be permanently marked with the following information:

(a) Nominal size of chain (e.g. 100/3/45 means chain dia./grade/breaking load)

(b) Maximum anchorage depth, in metres.

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