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TESTING OF THE ANCHORING INSTALLATION FOR SEAGOING SHIPS

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ABSTRACT

The anchoring installation is one of the most important deck systems, ensuring the safe temporary positioning of a ship in roads, coastal areas or inland waters. Although its configuration may differ from one vessel to another, the design and testing procedures are strongly standardised by the rules of classification societies. This paper presents an overview of the construction and operation of ship anchoring systems and describes the main requirements for testing anchor windlasses, chain stoppers, anchors and associated equipment. The methodology includes factory acceptance tests of the windlass, verification of the electrical drive according to IEC 60034-1, on-board commissioning and sea trial procedures. Particular attention is paid to the performance criteria requested by class rules, such as continuous pulling capacity, short-time overload, hoisting speed, braking capacity and structural integrity of the chain stopper. A practical example of testing a multi-purpose anchor-mooring windlass built by a Romanian manufacturer is discussed, highlighting the measurement of torque, temperatures, rotational speeds and brake performance. The paper underlines the role of proper planning, documentation and coordination between shipyard, equipment manufacturer, Owner and Classification Society to achieve a safe and reliable anchoring installation.

Keywords: anchoring installation, anchor windlass, chain stopper, class rules, testing, commissioning

1. INTRODUCTION

From the earliest floating craft, seafarers have needed a means to hold a vessel in a fixed position under the action of wind, waves and currents. This led to the development of the naval anchor, which evolved from simple pierced stones to modern high holding power (HHP) and very high holding power (VHHP) designs used on today's ships and offshore structures.

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On board seagoing ships, the anchoring installation provides a flexible connection between the hull and the seabed and may also assist in manoeuvres such as turning in restricted waters, auxiliary safety when moored, or refloating grounded vessels. Because failure of this system may have severe consequences for the ship, crew and environment, classification societies impose detailed requirements both for design and for testing during construction and trials.

The aim of this paper is to present the main elements of a ship anchoring installation and to describe the testing procedures from factory acceptance to sea trials, based on current class rules and on shipyard practice.

2. ANCHORING INSTALLATION OF SEAGOING SHIPS

2.1. Function and general arrangement

The anchoring installation is part of the deck equipment and ensures the safe stationing of the ship in harbors, roads, fairways and open sea up to a specified depth. It generally consists of one or more bow anchoring systems and, for some ship types, an additional stern system. The installation must allow rapid lowering of the anchor with controlled chain speed, reliable holding on the seabed under environmental loads, and safe hoisting or emergency letting-go of the chain when it becomes jammed in rocky ground.

For modern seagoing ships, the anchoring equipment is usually dimensioned statistically according to the unified requirements of IACS. The equipment number or equipment characteristic is calculated as:

$$C_d = \Delta^{2/3} + 2hB + \frac{A}{10} \tag{1}$$

where Δ is the displacement at full load, h is the height from full-load waterline to the highest continuous deck wider than $B/4$, B is the breadth and A is the projected lateral area above the waterline. The resulting value is used to select the number and mass of anchors, chain diameter and total chain length from class tables.

2.2. Main components

The main components of a typical bow anchoring system are:

- Chain locker and chain pipes, including the mud box and perforated gratings which allow water and sediments to drain while storing the chain in a conical heap.
- Chain securing device inside the locker, consisting of a strong point with a hook or lug and a screw-operated locking pin, allowing emergency release of the inboard end of the chain.
- Chain pipes and deck hawse pipes, fitted with reinforced rings and brackets and sometimes with washing nozzles connected to the fire-fighting system to clean the chain when recovered from muddy seabeds.
- Anchor windlass, mounted on a reinforced deck foundation and driven electrically or hydraulically. Depending on the ship, the windlass may be combined with mooring drums.
- Chain stopper, installed between the windlass and the hawse pipe, transmitting the chain load to the hull structure and relieving the windlass when the ship is at anchor.
- Anchors and chain cables, selected according to the equipment characteristic and class tables.

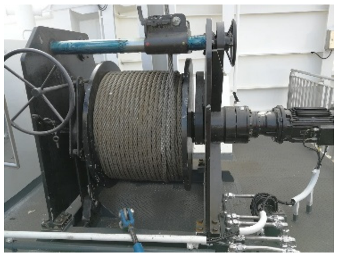

Fig.1. Anchor winch: view onboard (personal collection)

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The figure 1 illustrates an anchor winch mounted onboard of a 70 m passenger ferry.

3. CLASS RULES AND TESTING METHODOLOGY

3.1. Requirements for the anchor windlass and chain stopper

Classification societies specify minimum performance for anchor windlasses in terms of:

- Continuous pulling capacity: the main motor and gearing must provide a rated pull on the wildcat for at least 30 minutes, determined as a function of chain diameter and steel grade.
- Short-time overload: the windlass must withstand 150 % of the rated continuous pull for 2 minutes, sufficient to break out the anchor from the seabed.
- Hoisting speed: the mean speed when hoisting must be at least 0.15 m/s, verified over two shackles of chain during tests with the anchor suspended.
- Brake capacity: where no chain stopper is fitted, the brake must withstand 0.8 times the breaking load of the chain without slipping; if a chain stopper is provided, the brake must hold at least 0.45 of the chain breaking load. In all cases it must safely hold 1.3 times the rated pull under static conditions with the drive disconnected or without power.

Chain stoppers must support a static load equal to 80 % of the chain breaking strength without permanent deformation of the stressed parts. Type approval may be granted based on bench tests on representative specimens and documented calculations.

Anchors are also subject to mass tolerances and, for HHP and VHHP types, to comparative holding tests on several seabed types (soft mud, sand or gravel, hard clay or equivalent). The holding power must be at least twice that of a conventional stockless anchor of the same mass for HHP, and four times for VHHP anchors.

3.2. Factory acceptance tests of the windlass

Anchor windlasses are normally tested on the manufacturer's test bench in the presence of the designer, the class surveyor, a representative of the Owner and, when applicable, the commissioning engineer. The test programme typically includes:

- no-load running test in both directions;
- pulling tests at 30 %, 70 % and 100 % of the rated load, with hoisting and lowering of the chain;
- brake test at 1.5 times the rated pull, verifying that the wildcat does not rotate under static load.

During the tests, temperatures of bearings and gear wheels, oil level and oil temperature in the gearbox (limited to about 75 °C), vibration and noise levels are monitored. Pull is measured by a calibrated dynamometer, and drum or chain speed and motor data are recorded. An example test table for a combined anchor-mooring windlass built by a Romanian manufacturer is presented, with a rated pull of 120 kN and corresponding brake test at $1.5xF_{nom}$.

Table 1. Factory test for an anchor winch

No.	Description of the Work Task	Barbotine Load Force / (kN) Rated	Electric Motor Speed	Time (min)	Remarks
1	No-load operation	-	1180	10	
2	Load operation	30% / 36 70% / 84 100% / 120	1180	15 15 30	Lifting and lowering the load
3	Brake test	$1.5*F_{nom}$ / 180	-	2	Static test, the barbotine must not rotate

3.3. Verification of electric motors

Electric motors driving the windlass are tested according to IEC 60034-1, either under class survey or based on manufacturer's certificates, depending on the power rating. Tests include temperature rise at rated power, overload capability, no-load running at rated voltage and frequency, vibration and bearing lubrication checks, as well as visual inspection of the machine.

3.4. On-board commissioning and sea trials

Commissioning of the anchoring installation on board involves checking that all components have been installed according to the approved drawings and that they perform as required. A standard commissioning protocol typically covers:

- inspection of the foundation, alignment and bolting of the windlass;
- verification of chain path, chain locker arrangement and securing device;
- functional checks of brakes, clutches, local and remote controls, limit switches and safety devices;
- measurements of currents, voltages, pressures and temperatures during trial operation with the ship's power system;
- demonstration of emergency procedures, including manual release of the chain securing device and use of the chain stopper.

During sea trials, anchor handling operations are performed in the presence of the Owner and class surveyor, and the commissioning report is completed and signed. Any remarks are recorded in a dedicated list of observations to be closed before delivery of the vessel.

4. CONCLUSIONS

The paper has reviewed the main elements of ship anchoring installations and the standardized procedures for their testing, from factory acceptance to sea trials. The following conclusions can be drawn:

The design of anchoring equipment is largely governed by unified class rules based on an equipment characteristic which relates ship size and windage to anchor and chain parameters.

Anchor windlasses and chain stoppers must satisfy stringent performance criteria regarding continuous pull, overload capacity, hoisting speed and braking force, all verified by bench tests under class supervision.

Proper testing of electrical motors and control systems, in line with IEC standards, is essential for reliable operation of the anchoring installation.

On-board commissioning and sea trials represent a critical interface between shipyard, equipment manufacturer, Owner and Classification Society; comprehensive protocols and observation lists are required to ensure that all issues are identified and resolved before delivery.

Continuous investment in testing equipment and personnel training is necessary for shipyards and manufacturers to maintain high quality and safety standards in the field of ship anchoring installations.

Future work may focus on integrating digital monitoring and data logging during anchor handling operations, allowing better assessment of in-service loads and optimization of maintenance intervals.

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