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Ships and marine technology — Jacking system appliances on self-elevating unit — General requirements

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Foreword

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This document was prepared by Technical Committee 8, *Ships and marine technology*, Subcommittee 4, *Outfitting and deck machinery*.

Ships and marine technology — Jacking system appliances on self-elevating unit — General requirements

1 Scope

This document specifies general requirements for the jacking system appliances on self-elevating unit, especially for the rack and pinion jacking system and yoke and pin jacking system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3828, *Shipbuilding and marine structures — Deck machinery — Vocabulary and symbols*

ISO 7825, *Shipbuilding — Deck machinery — General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3828 and the following apply.

3.1
jacking system
the system used to raise and lower a self-elevating unit or legs and transfer the load between the unit and the legs

Note 1 to entry: The common types of the jacking system include *hydraulic yoke and pin jacking system*(see 3.2) and *rack and pinion jacking system*(see 3.3).

3.2
hydraulic yoke and pin jacking system
jacking system(see 3.1) used to raise, lower and hold a self-elevating unit when the legs are in standing state or to elevate, lower and hold legs when the unit is in floating state by applying the force of the yokes and pins driven by the hydraulic cylinder to holes on the unit legs

3.3
rack and pinion jacking system
jacking system(see 3.1) used to raise, lower and hold a self-elevating unit when the legs are in standing state or to elevate, lower and hold legs when the unit is in floating state by engagement of the climbing gear with the transmission rack on the unit leg driven by hydraulic or electric motors through a gearbox

3.4
hull jacking speed
ratio of the displacement to the unit time during raising or lowering of the self-elevating unit when the legs are in standing state

Note 1 to entry: For calculation of hull jacking speed for the hydraulic yoke and pin jacking system, the time required for jacking and retracting the hydraulic cylinder as well as inserting and extracting pins shall be taken into account.

3.5
leg jacking speed
ratio of displacement during raising or lowering of legs to the unit time when the self-elevating unit is in floating state

Note 1 to entry: For calculation of leg jacking speed for the hydraulic yoke and pin jacking system, the time required for jacking and retracting the hydraulic cylinder as well as inserting and extracting pins shall be taken into account.

3.6
hull jacking condition
working state of a self-elevating unit during raising or lowering by means of *jacking system*(see 3.1) under the allowable environmental condition

3.7
leg jacking condition
working state of legs during elevating or lowering by means of *jacking system*(see 3.1) under the allowable environmental condition

3.8
pre-load condition
state in which the bearable load of the pile reaches or exceeds the maximum load of the hull through compaction of the foundation layer at the bottom of the footing by the *jacking system*(see 3.1) under the allowable environmental condition

3.9
normal holding condition
state of normal operation under the allowable environmental condition

3.10
leg pulling condition
state in which the legs are pulled from the foundation layer, such as mud and deposits under the allowable environmental condition

3.11
storm holding condition
state in which the self-elevating hull cannot continue operation but can achieve certain safety by adjusting variable loads or abandoning partial loads as well as other measures under the extreme environmental condition that is designed for

3.12
afloat condition
state of the self-elevating unit during transit

3.13
normal jacking loadings
load borne by the jacking system under the *hull jacking condition*(see 3.6)

3.14
pre-load loadings
load borne by the jacking system under the *pre-load condition*(see 3.8)

3.15
normal holding condition
load borne by the jacking system under the *normal holding condition*(see 3.9)

3.16
storm loadings
load borne by the *jacking system*(see 3.1) under the storm condition

3.17
pulling loadings
load borne by the *jacking system*(see 3.1) under the *leg pulling condition*(see 3.10)ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC electropedia: available at https://www.electropedia.org/

— ISO online browsing platform: available at https://www.iso.org/obp

4 Design

4.1 General

4.1.1 Failure Mode and Effects Analysis (FMEA) shall be conducted for design and manufacturing of the jacking system to ensure certain redundancy, and prevent the single failure of any component or part from affecting the safety of the hull, so that the hull is capable of emergency jacking operation or being supported at a certain position. The jacking system shall be designed and manufactured in such a manner that in case of loss of power, such as electrical, hydraulic or pneumatic pressure, the elevation of the leg relative to the unit can be safely maintained.

4.1.2 The calibrated safety factors with respect to the yield strength of load bearing/ torque transmitting components in the direct load path of the jacking system are specified in Table 1.

Table 1 — safety factors with respect to the yield strength of main structures of the jacking system

Types of stress	Static loadings	Combined loadings
Axial or bending stress	1,67	1,25
Shear stress	2,50	1,88
Equivalent stress	1,43	1,11
Yield stress	1,67	1,25

NOTE 1 the safety factor is the ratio of yield strength to allowable stress.

NOTE 2 static loadings of jacking system are the maximum value in normal jacking condition, pre-load jacking condition and normal holding condition.

NOTE 3 combined loadings of jacking system is the maximum value in storm holding condition,afloat condition and pre-load holding condition.

4.1.3 The jacking system shall be provided with necessary monitor, alarm and control devices, at least including indication of unit inclination, hydraulic system pressure, oil tank liquid level, motor running status, as well as overload alarm and availability indication of applicable power sources, if appropriate.

4.1.4 A indicator shall be placed at a manned position to display the inclination of the self-elevating unit during jacking and to give audible and visual alarm signals when the inclination exceeds the maximum allowable value.

4.1.5 The jacking system shall be provided with remote and local control units, between which there is a switching device to switch the operation and a two-way communication.

4.1.6 the remote and local control units shall be provided with emergency cut-out switch to stop the operation of the jacking system. The switch shall be conspicuously marked in red and attached by nameplate descriptions.

4.1.7 The strength analysis of the jacking system shall at least include the maximum loads of the following loads: normal jacking loadings, pre-load loadings, normal holding loading, pulling loadings and storm loadings, as applicable.

4.1.8 Each hydraulic power unit shall at least be provided with two separate power oil pumps, so that when any of the pumps stops running, other oil pumps or pump sets shall be capable of meeting the requirements of the jacking system.

4.2 Design requirements for rack and pinion jacking system

4.2.1 Brakes are to be designed to engage automatically in the event of failure of power supply to the motor (fail-safe type). When holding systems are not fitted out for self-elevating unit, the brake holding capacity is to be at least equal to 1,2 times the pre-load condition required brake torque. When holding systems are fitted out for self-elevating unit, the brake holding capacity is to be at least equal to 1,2 times the storm holding condition required brake torque. If the rotation speed of pinion exceed 1,1 times the maximum value of rated speed, the brakes should come to braking state automatically to prevent platform from uncontrolled descent.

4.2.2 In selecting prime movers of the jacking system, various factors shall be taken into account, such as rack and pinion friction, friction between legs and guides, as well as uneven distribution of loads among racks and pinions.

4.2.3 The minimum safety factor of the pinion tooth root bending stress shall be 1,5 for the closed drive gear, and the minimum safety factor of the pinion tooth surface contact stress shall be 1,0.

4.2.4 The design of climbing pinions shall be specially considered and meet the following requirements:

a) Hardness of pinion materials shall generally be not less than that of rack materials;

b) The root bending safety factor shall be not less than 1,5 under the static or dynamic load condition;

c) Ultimate strength (breaking load) of the root shall be not less than 1,1 times that of the rack.

4.2.5 The newly designed pinion gearing shall be prototype tested at the manufacturer. The test load shall be not less than 1,5 times designed normal jacking loadings or 1,1 times the maximum static holding loadings, whichever is greater. By no more than hull jacking speed, the pinion runs one complete revolution. After the test, all major components shall be checked and inspected for cracks when they are dismantled.

4.3 Design requirements for hydraulic yoke and pin jacking system

4.3.1 Hydraulic yoke and pin jacking system shall be provided with holding mechanism, such as setting up a locking device to bear the maximum load of a single leg. The strength of the locking device shall meet requirements in 4.1.2. if a plurality of holding mechanism are set up to bear the maximum load of single leg, each locking device can bear the maximum load of 1/2 single leg at least, and the strength check also needs to meet requirements in 4.1.2.

4.3.2 The failure analysis shall be carried out under the condition of system design and use and the result must meet requirements in 4.1.1. When a load-part or a load-subassembly is failure, the safety factor of the structural strength of the load-part or the load-subassembly shall be checked according to the yield strength of the material.

5 Acceptance tests

5.1 General

5.1.1 The jacking system shall be factory tested prior to delivery. The factory test includes but is not limited to the following contents.

5.1.2 The test items specified in 5.2~5.4 may be conducted before or after shipment. The test items specified in 5.5~5.8 shall be conducted only after shipment.

5.2 Hydraulic power unit (if any)

The factory test for each hydraulic power unit shall include at least the following test items:

a) Hydraulic test before assembly of components (the test pressure shall be not less than 1,5 times the design pressure).

b) Rated flow output measurement under different output pressure conditions.

c) Check and calibration of relief valves, overflow valves, counterbalance valves and reducing valves.

d) Check of adjustment of other adjusting valves, such as speed control valves, proportional valves and servo valves.

e) Check of monitor, display and alarm sensors supplied with the hydraulic power unit as well as their settings.

f) Demonstration of functions and capabilities of failure handling and emergency control.

5.3 Electrical control unit

The factory test for each electrical control unit shall include at least the following test items:

a) Appearance check.

b) Functional test (control, alarm and display functions of the jacking system under different conditions).

c) Measurement of insulation resistance.

5.4 Security test

Security functions of the jacking system shall meet the requirement specified in 4.1.1, and include at least the following items:

a) Leg limit alarm.

NOTE Leg limit alarm refers to the alarm when the jacking system has reach the extreme ends of the upper or lower limit of any leg.

b) Power status alarm.

c) Unit inclination alarm.

d) Jacking system overload alarm.

e) Rack phase differential (RPD)alarm . (Only for rack and pinion jacking system)

5.5 Leg jacking test

The jacking test shall be carried out for legs when the unit is in floating state, the leg jacking test stroke of legs shall be not less than 2 m (for hydraulic yoke and pin jacking systems, the stroke shall be not less than the pitch between two leg holes). Checks shall be conducted during the test as follows:

a) There are no abnormalities of the jacking system during the test.

b) The leg jacking speed meets the design requirement.

5.6 Pre-load test

Pre-load test shall be carried out for the unit when legs are in standing state, with the preloading time not less than 30 min. Checks shall be conducted during the test as follows:

a) Record test loadings.

b) No abnormalities of the jacking system during the test.

5.7 Hull jacking test

The hull jacking test shall be carried out for the hull when legs are in standing state, with the jacking stroke of the hull not less than 2 m(for hydraulic yoke and pin jacking system, the stroke shall be not less than the pitch between two leg holes). Checks shall be conducted during the test as follows:

a) The test load is no less than the normal jacking load required in the design.

b) No abnormalities of the jacking system during the test.

c) Hull jacking speed meets the design required speed.

5.8 Pulling leg test

The pulling leg test shall be carried out in afloat condition. Checks shall be conducted during the test as follows:

a) The test loadings are no less than the designed required pulling leg loadings.

b) No abnormalities of the jacking system during the test.

5.9 Full stroke jacking test

According to the state of test sea area, the hull can be jack up to the limit position of leg. Or the hull can lower leg to the limit position of leg.

a) No abnormalities of the jacking system during the test.

b) Entire leg travels through guides and that all leg components will mesh with jacking system properly.

6 Nameplate, packing, transport and storage

6.1 Nameplate

The jacking system shall be provided with a nameplate at its conspicuous position. The nameplate shall include the following items:

a) name of manufacturer.

b) product name and model.