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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — A-frame launch and recovery system

1 Scope

This document specifies the design, operation, performance and acceptance test of A-frame launch and recovery systems (hereinafter referred to as “A-frame LARS”) for underwater applications excluding lifesaving appliances.

This document is applicable to the design, manufacturing, testing and acceptance of A-frame LARS for underwater applications excluding lifesaving appliances.

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*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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

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

3.1
A-frame launch and recovery system
A-frame LARS
system installed at the stern of ship deck or side-launched, which mainly consists of the structural members, and *associated winches* (3.3) and loose gear, used to achieve the hoisting, towing and recovery of the equipment

3.2
A-frame
mechanism that mainly consists of the main structure, oil cylinder, transverse travel trolley (if any), retractable rack (used for anti-swinging, if any) and pulley block and associated winch used to hoist, traverse, lower and recovery of the equipment in a coordinated way

Note 1 to entry: The rope can be centered through traverse of transverse travel trolley (if any); the sway of the hoisted can be reduced by buffering of the retractable rack (if any) and cylinder.

3.3
associated winch
winch used to fulfill the function of hoisting and launch of subsea equipment as well as towing of subsea equipment in the sea together with the *A-frame* (3.2), by hauling in and paying out steel wire ropes

Note 1 to entry: The associated winch may also act as a functional winch such as a cable winch, to fulfill the function of launching and recovery of operating equipment such as subsea equipment in combination with the A-frame.

3.4
safe working load
SWL
maximum static load the properly installed lifting appliance is capable of sustaining under the design operating condition

3.5
operating condition
condition under which the *safe working load* (3.4) of an *A-frame launch and recovery system* (3.1) is ascertained

Note 1 to entry: The vibration and shock that can be withstood by the equipment during the normal operation of the ship are ascertained according to the maximum angles of heel, trim, roll and pitch of the ship required by the user.

3.6
duty factor
factor that makes allowances for the frequency and state of loading for which an *A-frame launch and recovery system* (3.1) considers in design

3.7
design stress
maximum stress permitted to which any component part of an *A-frame* (3.2) and towing winch may be subjected under *safe working load* (3.4)

Note 1 to entry: When the equipment is subjected to the factor load, both the specified lateral and wind loads are taken into account.

3.8
minimum hoisting speed
minimum load hoisting speed at which the load does not collide with the hull after the load is lifted away from the ship

Note 1 to entry: The minimum load hoisting speeds to avoid re-contact for various sea conditions are given in Formula (A.3).

4 Operation and functional requirements

4.1 Operating position

4.1.1 The main control panel is mounted on the position from which the working status of the equipment is visible. Except for the main control panel, there shall be a portable control box, by which short distance operation may be available beside the A-frame LARS.

4.1.2 The main control panel and portable control box shall be provided with emergency recovery and quick release buttons.

4.1.3 Other control functions shall be determined by the buyer and seller.

4.2 Constant tension setting

Under towing conditions, the winch of the A-frame LARS shall have the function of wire rope constant tension to prevent blockage from damaging equipment during towing. For example, when the wire rope is blocked at the other end of the seafloor, the instantaneous tension on the wire rope is greater than the constant tension of the winch, and the winch will release the rope to prevent damage to winch structure.

4.3 Load measuring device

The A-frame LARS should be fitted with a load measuring device, which can measure the load of wire rope and record the maximum tension at any time. The system shall also be fitted with an overload alarm indicator which makes indication on the control panel of the cab.

4.4 Emergency release

The A-frame LARS shall be designed to have the capacity of emergency release. The emergency release load shall be not more than 80 % of the breaking load of the rope. The system shall be capable of normal operation right after emergency release, while the prime mover of the system shall not operate again automatically after emergency release. The emergency release control shall require at least two separate actions to minimise the risk of inadvertent or incorrect operation.

4.5 Wire rope design

The wire rope shall be anti-corrosion and anti-rotating, and the nominal tensile strength of each strand of the wire rope shall not be less than 1 420 MPa and not more than 2 200 MPa. The length of the wire rope shall be determined according to the design requirements of the user. The safety factor of steel wire rope shall be obtained according to Formulae (1) and (2):

$$\eta = \frac{10\ 000}{0{,}004\ F_{SWL} + 1\ 910}\text{, but shall not be greater than 5,0 regardless of the safe working load} \quad (1)$$

where F_{SWL} is the safe working load.

or

$$\eta = 2{,}25 \times \phi_h \quad (2)$$

where ϕ_h is the hoisting factor (see Annex A) and shall not be less than 3,0.

4.6 Cylinder protection

The proper anti-corrosion coating shall be painted on the surface of the cylinder piston rod to protect the piston rod against the corrosion by seawater and salt fog at sea. When the equipment is out of service, the piston rod shall retract to the cylinder to extend the life of anti-corrosion coating.

4.7 Loose gear

All chains, rings, hooks, links, shackles, swivels, and blocks of lifting appliance shall be tested with a proof load at least equal to the following value in Table 1.

Table 1 — Test load for loose gear

Article of gear	Proof load [a]
Chain, ring, hook, link, shackle or swivel	200 % of the SWL
Pulley blocks	
Single sheave hook block	200 % of the SWL[b]
Multiple sheave block and container spreader with SWL up to and including 196 kN	200 % of the SWL
Multiple sheave block and container spreader with SWL over 196 kN up to and including 392 kN	196 kN more than the SWL
Multiple sheave block and spreader with SWL over 392 kN	150 % of the SWL

[a] Alternatively, the proof tests as recommended in Reference [7] may be accepted where the items of gear are manufactured or tested or both in accordance with Reference [7].

[b] The SWL shall be marked on a single sheave.

5 Design

5.1 General

The A-frame LARS is a kind of offshore crane which is, during hoisting, subjected to various loads, such as live load, deadweight, wind load and hull inclination load. The design conditions shall include conditions without wind specified in 5.2 and conditions with wind specified in 5.3.

5.2 Conditions without wind

Conditions without wind is the main case of loading and includes the loads that necessarily occur under normal operation:

a) Principal loads

— the loads due to deadweight of the components (F_G)

— the loads due to working load (F_L)

b) Vertical loads due to operational motions

The vertical loads due to operational motions shall be taken into account by multiplying the working load by a hoisting factor, ϕ_h , which covers inertia forces and shock.

c) Horizontal loads due to operational motions

The horizontal loads (F_H) due to operational motions are:

— inertia forces due to acceleration or deceleration of horizontal motions

— forces transverse to rail resulting from reeling and skew motion.

Conditions without wind may be calculated as per Formula (3):

$$F_G + \phi_h \times F_L + F_H \quad (3)$$

5.3 Conditions with wind

Conditions with wind include the same loads as conditions without wind, with the addition of loads (F_W) due to working wind:

$$F_G + \phi_h \times F_L + F_H + F_W \tag{4}$$

F_W shall be determined by Formulae (5) and (6):

$$F_W = A \times p \times C \times \sin\alpha \tag{5}$$

$$p = \rho \times \frac{{v_W}^2}{2} \tag{6}$$

where

F_W	is the wind force, in N;
A	is the exposed area, in m^2;
p	is the air velocity pressure;
ρ	is the mass density of the air, which is 1,225 kg/m^3;
v_W	is the wind velocity, in m/s;
C	is the average pressure coefficient for the exposed surface;
α	is the angle between the wind direction and the exposed surface.

5.4 Allowable stress for A-frame structure member

5.4.1 The allowable stress for the structure member is given by Formula (7):

$$[\sigma] = \frac{\sigma_s}{n} \tag{7}$$

where

σ_s	is the yield strength of steel, in MPa;
n	is the safety factor, see Table 2.

Table 2 — Safety factor, *n*

Conditions	Without wind	With wind
Safety factor, *n*	1,5	1,33
NOTE *n* is the safety factor under von Mises stress.		

5.4.2 For members made of structural steel, the requirements for the various cases of loading are given.

With reference to the method of analysis and method of verification of safety given in Table 2, σ_s is the yield strength. If σ_s is higher than 0,8 times the ultimate strength σ_u used in this connection $0{,}8 \cdot \sigma_u$ instead of σ_s.

5.5 Fatigue

The fatigue analysis is conducted according to the cyclic data provided by the buyer to determine that fatigue life of the current design meets expectations.

5.6 Fracture toughness requirements for critical and main load bearing members

5.6.1 General requirement

5.6.1.1 Requirements in 5.6 are applicable for launch and recovery systems with a design temperature of −10 °C or colder.

5.6.1.2 For launch and recovery systems with a design temperature warmer than −10 °C, the critical and main load bearing members should have a fracture toughness suitable for the intended application.

5.6.2 Steels up to and including 41 kg/mm² yield strength

Steels up to and including 41 kg/mm² (58 000 psi) the yield strength shall meet the following longitudinal Charpy V-notch (CVN) requirements in Table 3.

Table 3 — Longitudinal CVN requirements for steels up to and including 41 kg/mm² yield strength

Yield strength	CVN (Longitudinal)	Test temperature
MPa	J	10 °C (18 °F) below design service temperature
240 to 310	28	

5.6.3 Extra high strength steels above 41 kg/mm² yield strength

Steels in the 42 kg/mm² to 70 kg/mm² yield strength range shall meet the following longitudinal CVN impact requirements in Table 4.

Table 4 — Longitudinal CVN impact requirements for steels in the 42 kg/mm² to 70 kg/mm² yield strength

Design service temperature	Test temperature	CVN at test temperature J
−10 °C (+14 °F)	−40 °C (−40 °F)	35
−20 °C (−4 °F)	−40 °C (−40 °F)	35
−30 °C (−22 °F)	−50 °C (−58 °F)	35

5.6.4 Alternative requirements

As an alternative to the requirements in Table 3 and Table 4, one of the following may be complied with:

a) For transverse specimens, the CVN energy is 2/3 of longitudinal specimens.

b) For longitudinal specimens, lateral expansion shall not to be less than 0,5 mm (0,02 in.). For transverse specimens, lateral expansion shall not to be less than 0,38 mm (0,015 in.).

c) Nil-ductility temperature (NDT) as determined by drop weight tests shall be 5 °C (9 °F) below the test temperature specified in Table 3 and Table 4.

d) Other means of fracture toughness testing, such as crack opening displacement (COD) testing, will be specially considered.

6 Acceptance tests and inspection

6.1 General

6.1.1 For the first or modified product critical structure members shall be selected for the heavy hoisting test to demonstrate the design method.

6.1.2 For follow-up products, the equipment shall only meet the requirements of factory acceptance test before delivery.

6.2 Heavy hoisting test and inspection

6.2.1 In the heavy hoisting test, the equipment shall hoist 2,0 times the safe working load. The test load and structure length shall be selected to produce the maximum stress level on all critical structure components. After the hoisting, the A-frame structure shall be completely disassembled, and the following appropriate non-destructive testing method(s) shall be selected according to components for its applicability assessment:

a) dye penetration;

b) magnetic particle;

c) radiography;

d) ultrasonic.

6.2.2 There shall be no plastic deformation, indentation or cracks on critical parts, in particular the position of welded joints. Accurate measurement and inspection are required before and after the test to verify the condition of the launch and recovery system.

6.3 Factory acceptance test and inspection

6.3.1 The factory acceptance test includes, but is not limited to, the following contents:

a) no-load test to check equipment state and functions;

b) load test to test hoisting and slewing speeds;

c) overload test (1,25 times the SWL), or test as specified by the buyer;

d) functional test of the hydraulic system.

6.3.2 The test shall be conducted with the certified test load hanging from the hook or spreader. The load shall remain suspended for at least 5 min after being hoisted. After the overload test, the operation test shall be conducted under the safe working load. The operating speeds for hoisting, slewing and luffing shall be tested at all speeds to show that the operation, overload efficiency, load indicators and limiters are in satisfactory condition. The comprehensive check shall be made after the test to verify whether the equipment has any deformation or other defects.

6.3.3 For the first set of equipment or first modified equipment, the endurance test shall be carried out continuously for at least 8 h.

7 Installation testing and inspection

7.1 General

The A-frame launch and recovery system shall be load tested as part of the factory acceptance test and after it has been installed at its operational location:

a) before being taken into use at the first time;

b) after any substantial alteration or renewal, or after repair of any stress bearing part;

c) at least once every five years (preferably at regular five-year intervals after the date on which the appliance was first taken into use).

7.2 Test loads

7.2.1 The test load applied to a lifting appliance shall exceed the SWL of the appliance as in Table 5.

Table 5 — Test loads

Safe working load (SWL)[a]	Test load
Up to 20 tonnes	25 % in excess of the SWL
Exceeding 20, but not exceeding 50 tonnes	5 tonnes in excess of the SWL
Above 50 tonnes	10 % in excess of the SWL

[a] Where φ_h exceeds 1,33, the reference SWL in the table shall be taken as 0,75 × φ_h × F_{SWL}.

7.2.2 For hydraulic A-frame LARS, where, due to the limitation of hydraulic oil pressure by the safety valve, it is not possible to lift a test load in accordance with Table 5, it suffices to lift the greatest possible load. Generally, this should not be less than 10 % in excess of the SWL. It is then assumed that the structure is load tested with a load reflecting the overload based on the reference SWL by means of other methods.

7.3 Examination after testing

7.3.1 After testing, A-frame LARS shall be examined thoroughly to observe whether any part has been damaged or permanently deformed by the test. Dismantling and/or non-destructive testing may be required if deemed necessary by the surveyor.

7.3.2 Any overload protection system and automatic safe load indicators that may have been disconnected during load testing shall be reconnected. Accordingly, safety valves and/ or electrical circuit breakers shall be adjusted. Set points shall be verified and sealed by the surveyor.

