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Ships and marine technology — Marine cranes — Design requirements for low temperature operation

Navires et technologie maritime — Grues marines — Exigences de conception pour une exploitation à basses températures

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Foreword

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The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 4, *Outfitting and deck machinery*.

Ships and marine technology — Marine cranes — Design requirements for low temperature operation

1 Scope

This document specifies the requirements for design, construction, safety, performance, acceptance test and operation of marine cranes for low temperature operation.

This document is applicable to marine cranes of the following types, which are exposed to and operated in low temperatures:

— deck cranes mounted on ships for handling cargo or containers in harbour or sheltered water conditions;

— floating cranes or grab cranes mounted on barges or pontoons for operating in harbour conditions or sheltered water conditions;

— engine room cranes and provision cranes, etc. mounted on ships (including floating docks) for handling equipment and stores in harbour conditions.

This document is not applicable to the following:

— minimum ambient operating temperatures no less than −20 °C;

— maximum ambient operating temperatures above +45 °C;

— transport, assembly, dismantling and decommissioning of cranes;

— lifting accessories, i.e. any item between the crane and the load;

— lifting operations involving more than one crane;

— hand powered cranes;

— emergency rescue operations;

— shore-side cargo handling cranes;

— portable cranes on board;

— lifting appliances for lifeboats, liferafts accommodation ladders and pilot ladders;

— launching appliances for survival craft and rescue boats;

— gangways, accommodation and pilot ladders and their handling 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 19354, *Ships and marine technology — Marine cranes — General requirements*

ISO 19355, *Ships and marine technology — Marine cranes — Structural requirements*

ISO 19356, *Ships and marine technology — Marine cranes — Test specification and procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4306-1, ISO 3828 and the following apply.

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

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

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

3.1
mean daily low temperature
MDLT
mean value of the daily low temperature for each day of the year over a minimum of ten-year period

Note 1 to entry: A data set acceptable to the administration may be used if ten years of data is not available.

3.2
polar service temperature
PST
temperature specified for a ship which is intended to operate in low air temperature, which shall be set at least 10 °C below the lowest *MDLT* (3.1) for the intended area and season of operation in polar waters

3.3
marine crane intend to operate in low temperature
crane which is intended to work in the areas where the lowest *mean daily low temperature (MDLT)* (3.1) is below −10 °C

3.4
design service temperature
DST
temperature specified for a ship which is intended to judge the performance of material, machinery and system in low air temperature

Note 1 to entry: Note1 to entry: It is usually decided by the ship-owner according to the use and service condition of the ship. It shall be set at least 10 °C below the lowest *MDLT* (3.1) for the intended area and season of operation in polar waters.

Note 2 to entry: Design service temperature (DST) equal to *polar service temperature (PST)* (3.2).

4 Design parameters of cranes

4.1 Design classification grade

The classification grade of low temperature operating cranes may be in accordance with ISO regulations on common marine cranes.

4.2 Design temperature

Design temperature would decide the steel grade. Hydraulic, electric and lubrication system should be reliable for cranes operated at design temperature and the cranes should stay undamaged at the minimum anticipated temperature.

Design temperature of cranes for low temperature operation is equal to the polar service temperature (PST) of the intended ship.

PST should be decided by ship-owner or ship designer according to mean daily low temperature (MDLT) of the intended operation area. PST would be obtained with reliable temperature records excluding those which occurred at a rate below 2,5 %.

Minimum anticipated temperature should be confirmed by ship-owner or ship designer. If the minimum anticipated temperature data could not be achieved, it should be at least 10 °C below the PST.

5 Force and load

5.1 General

Force and load shall be in accordance with ISO 19354. Snow and ice loads shall be taken into account at the storage condition.

5.2 Snow load

For movable parts, maximum surface area that can occur shall be taken into account for calculation of snow load. Snow load shall be calculated with 3 kg/m^2.

Only the upper surface or equal cast shadow shall be considered for calculation.

NOTE Both two type snow loads might exist at the same time.

5.3 Ice load

The whole surface area of the crane shall be taken into account with ice coverage. Ice load shall be calculated with 30 kg/m^2.

5.4 Other load

Ice breaking vibration load should be taken into consideration at the storage condition and effective fixation should be designed for the movable components.

6 Selection of materials

6.1 Rolled steel

6.1.1 General

Mechanical property, chemical composition, deoxidization, heat treatment process and inspection method of rolled steel shall be in accordance with related requirements of common marine cranes.

6.1.2 Impact properties

Requirements for impact test temperatures of materials shall be determined according to design temperature (T_D) and the material thickness (t). Impact test temperatures of steel are given in Table 1 for welded structure.

Table 1 — Impact test temperatures

Material thickness (t) mm	**Design temperature** (T_D) °C					
	−23 ~ −27	**−28 ~ −32**	**−33 ~ −38**	**−39 ~ −48**	**−49 ~ −58**	**−59 ~ −68**
$t \leq 10$	+20	+20	0	−20	−20	−40
$10 < t \leq 20$	0	0	−20	−20	−40	−40
$20 < t \leq 30$	0	−20	−20	−40	−40	−60
$30 < t \leq 40$	−20	−20	−40	−40	−60	−60
$40 < t \leq 45$	−20	−20	−40	−60	−60	—
$45 < t \leq 50$	−40	−40	−40	−60	−60	—

The steel grade of materials shall be determined according to design temperature (T_D) and the material thickness (t), as required in Table 2.

Table 2 — Steel grade requirements

Material thickness (t) mm	**Design temperature** (°C)											
	−23 ~ −27		**−28 ~ −32**		**−33 ~ −38**		**−39 ~ −48**		**−49 ~ −58**		**−59 ~ −68**	
	MS	**HT**	**MS**	**HT**	**MS**	**HT**	**MS**	**HT**	**MS**	**HT**	**MS**	**HT**
$t \leq 10$	A	AH	A	AH	B	AH	D	DH	D	DH	E	EH
$10 < t \leq 20$	B	AH	B	AH	D	DH	D	DH	E	EH	E	EH
$20 < t \leq 30$	B	AH	D	DH	D	DH	E	EH	E	EH	—	FH
$30 < t \leq 40$	D	DH	D	DH	E	EH	E	EH	—	FH	—	FH
$40 < t \leq 45$	D	DH	D	DH	E	EH	—	FH	—	FH	—	—
$45 < t \leq 50$	E	EH	E	EH	E	EH	—	FH	—	FH	—	—
MS — Mild Steel HT — High Tensile												

6.1.3 Others

For members which bearing tensile stress in thickness direction, Z-grade material should be selected with thickness above 50 mm.

6.2 Forgings

6.2.1 General

All forgings used by low temperature operating cranes shall be made from fully deoxidization steel.

Heat treatment, test, inspection and defect repair of forgings should be carried out in accordance with related requirements of common marine cranes.

Impact test temperatures of forgings are given in Table 3.

Table 3 — Impact test temperatures

Design temperature (°C)			
−23 ~ −27	−28 ~ −32	−33 ~ −38	−39 ~ −48
−20	−20	−40	Special consideration

For steel with yield stress below 305 N/mm^2, minimum average Akv should be no less than 27 J. For steel with yield stress above 305 N/mm^2, minimum average Akv should be no less than 34 J.

6.2.2 Slewing ring

The slewing ring shall be made of forgings. The impact test temperatures of material shall comply with the specification of Table 3 while the impact energy (J) should comply with the Table 4.

Table 4 — Performance requirements of slewing ring

Impact energy (J)	**Average**	≥42
	Single minimum	≥27

6.2.3 Connecting bolt of slewing support

Connecting bolts of slewing support shall be in accordance with ISO 19355.

Requirements in 6.2.1 should be adopted.

6.2.4 Hook, ring, shackle, chain, shaft and pin

Forgings of hooks, rings, shackles, chains, shafts and pins shall be made from fully deoxidization steel and fine-grain treated non-ageing steel. Mechanical properties of such steel forgings shall comply with the specification in Table 5 while the impact test temperatures shall comply with Table 3.

Table 5 — Impact requirements (longitudinal value) for hooks, rings, shackles, chains, shafts and pins

Yield strength (N/mm^2)		$235 \le R_{eH} < 300$	$300 \le R_{eH} < 355$	$355 \le R_{eH} < 500$	$500 \le R_{eH} < 690$	$R_{eH} \ge 690$
Tensile strength (N/mm^2)		400 to 560	≤620	≤770	≤940	>940
Yield strength to tensile strength ratio			≤0,85	≤0,85	≤0,9	
Elongation (%)		≥22	≥20	≥16	≥14	
Reduction in area (%)		≥40	≥35	≥35	≥35	
Impact energy (J)	Average	≥42	≥42	≥42	≥42	≥42
	Minimum value	≥27	≥27	≥27	≥27	≥27

6.3 Castings

For main stressed structures of ice operating cranes, steel castings shall not be used.

For non-main stressed parts, steel which made of fully deoxidization steel castings can be used.

6.4 Welding materials

6.4.1 Selection of welding materials

6.4.1.1 Toughness requirements of main welds shall be considered for important stressed components and the low-hydrogen basic welding materials should be selected.

NOTE Important stressed components means components which could determine the structural safety and evaluation for safe operation of crane, including jib, post, slewing ring, eye plate, etc.

6.4.1.2 Welding material matching for welding structures is, in principle, equal matching. When welding steels with different steel grades and strength grades, overmatching is applicable to Grades 235 to 345 (including Grade 235) and undermatching is, in principle, applicable to the grade above Grade 345.

6.5 Hydraulic sealing materials

Hydraulic seals such as oil seal and O-ring shall use the components with low flexibility and good brittlement in cold condition.

6.6 Low-freezing grease

6.6.1 Hydraulic oil

Hydraulic oil shall be selected according to extreme low temperatures in the route and the minimum start-up oil temperature of the system, while considering the maximum design working oil temperature of the system. It shall meet the following requirements.

a) Freezing points of hydraulic oil shall be lower than the extreme low temperature in the route.

b) Viscosity of hydraulic oil for the minimum oil temperature of the system shall be less than the allowable start-up range of the system and components.

6.6.2 Gear oil

For closed gear oil, appropriate lubricating oil shall be selected according to the features of drive gear. It shall meet the following requirements.

a) The pour point of gear oil shall be lower than extreme low temperature in the route.

b) Features of gear oil such as little moisture, low frothiness and small growth rate of viscosity ensure that viscosity within the allowable working temperature range of the crane can meet the working requirements of the gear.

c) For open gear oil, the lubricating oil with viscosity index meeting the requirements shall be selected, with the high temperature in the navigation zone during the ship navigation taken into account.

6.6.3 Lubricating grease

For lubricating grease, low-freezing and extreme pressure lubricating grease shall be selected.

7 Structure design

Structure design shall be in accordance with ISO 19355. Fatigue analysis should be carried out.

8 Design of power plant, mechanism and operating system

8.1 General

Power plants, mechanisms and operating devices shall be arranged in a well-closed tower body structure and cabin to the maximum extent. If some mechanisms are unable to be arranged in the house or cab, a proper means of insulation shall be provided.

Power plants, mechanisms and operating devices need not to comply with the crane design temperature. Effective heating device is essential. However, these parts should stay in good condition at the design temperature or min anticipated temperature.

8.2 Power unit

The power system shall be designed such that the features in a low temperature condition are taken into full account; for the hydraulic system, features of hydraulic oil shall be taken into full account and low speed high torque hydraulic components shall be preferred.

The hydraulic oil tank shall be enlarged appropriately in the design, with the volume change rate considered.

8.3 Mechanical unit

Mechanical units include actuating mechanisms with hoisting, pitching and slewing operations. Unless otherwise specified herein, the design may be conducted in accordance with common marine cranes.

8.4 Electric control unit

Electric components, including cables and lights, shall be selected such that they have the capacity of withstanding extreme low temperatures in the navigation zone.

9 Design of safety and protection system

9.1 Safety protection of marine crane

Safety protection shall be in accordance with the relevant parts in ISO 19354.

9.2 System heating and insulation protection

9.2.1 Insulation protection of tower body structure

The insulation protection of the tower body structure shall meet the following conditions.

a) Under the minimum working conditions, the heat transfer of the tower body structure shall be no more than the heat produced by the system during the idle running of the crane.

b) The insulating material attached onto the tower body structure shall have good adhesion and can effectively endure ship swaying and vibration generated on icebreaking route.

c) The insulating material shall meet the requirements for environmental protection, in addition to safe, environment-friendly, non-toxic, strong flame-retardant, low water absorption, and low dimensional change rate.

d) The insulating material shall have a certain resistance to salt spray and corrosion, and not have chemical reaction with possible contact media (such as hydraulic oil, gear oil, etc.).

9.2.2 Protection of cabin

For the insulation protection of cabin, the insulating material shall have the same requirements as that of the tower body structure. In addition, comfortability of the operating environment shall be taken into full account.

The glass of the cabin shall be resistant to extremely low temperature in the navigating area, and have anti-fogging function.

9.2.3 Protection against moisture in navigation

Electrical appliances, such as electric motor, control cabinet, etc., shall be provided with a heater.

9.2.4 Heating before working

The tower body structure inside shall be equipped with a heater, which is required to have such abillity that can raise the temperature of the tower body structure from the minimum operating ambient temperature to the temperature at which the hydraulic system can start up and operate.

9.3 Surface protection at low temperature

The surface of marine ice operating cranes, especially the external surface exposed to the air, shall have the ability to resist extremely low temperature in the navigating area.

9.4 Platform and passage

Considering the low temperature, platform and passage should be skid-proof. People need to stay or pass the platform and passage conveniently with warm wear.

10 Rope and removable parts

10.1 Rope

The rope of cranes for low temperature operation should be in accordance with related requirements of common marine cranes. However, the lubrication should have a special consideration.

10.2 Sheave (pulley block)

10.2.1 Material of sheave

For the sheave used in cranes for low temperature operation, especially the material of the wire rope sheave, it is preferred to use steel but not cast iron material other than ferrous casting ductile (FCD) which should be complied with the temperature requirement.

10.2.2 Bearing and lubrication

The sheave can use self-lubricating bearing.

If grease lubrication bearing is selected, the lubrication cavity shall be designed to have a leak tight structure and the lubrication at low temperature in ice shall be taken into full consideration.

11 Inspection and acceptance

11.1 General

Manufacturers and purchasers may reach an agreement regarding the required shop test. Before the first actual use of the crane, an overall test and inspection shall be carried out. Ice and snow should be swept out before test, if necessary.

Repeated tests shall be also done regularly after the crane is put into service.

11.2 Functional and performance tests

Functional and performance tests shall be in accordance with ISO 19356.

By means of simulation test, the effect of the insulating device in the cabin should be confirmed.

11.3 Visual and surface protective inspection

After the functional and performance test, check stressed structure and weld of the crane.

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