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**Ships and marine technology —
Design and test requirements for steel
doors using electrical trace heating**

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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 SC 8, *Ship design*.

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 — Design and test requirements for steel doors using electrical trace heating

1 Scope

This document specifies the design, materials, quality of manufacture, test and designation of electrical trace heating for steel doors onboard vessels sailing in a low temperature environment (below $-10\text{ }^{\circ}\text{C}$).

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 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

heated steel door

door made of steel installed onboard vessels sailing in a *low temperature environment* (3.4) enabling people to open normally by adding heat through the *trace heater cable* (3.3)

3.2

trace heater

device designed for the purpose of producing heat on the principle of electrical resistance and typically composed of one or more metallic conductors or an electrically conductive material, suitably electrically insulated and protected

Note 1 to entry: This can be in the form of a *trace heater cable* (3.3), heater panel or heated pad.

[SOURCE: IEC 60519-10:2013, 3.115]

3.3

trace heater cable

circular to flattened cable shaped construction with one or more discrete or continuous electrically insulated heating elements

Note 1 to entry: This cable is able to self-regulate its heating output power due to ambient temperature.

[SOURCE: IEC 60519-10:2013, 3.116]

3.4 low temperature environment

water with the lowest mean daily low temperature below $-10\text{ }^{\circ}\text{C}$, such as the Arctic Ocean, St. Francis Bay, North Baltic, Okhotsk, Bohai and North Yellow Sea

Note 1 to entry: In general, these waters are covered by regional sea ice during winter.

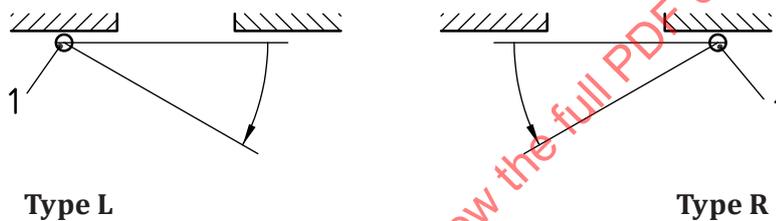
[SOURCE: IMO MSC.385 (94), 1.2.12, modified]

4 Design

4.1 Opening direction

Depending on the opening direction^[1], heated steel doors shall be classified into the following two types (see Figure 1):

- a) Type L: left-hand heated steel door (the hinge stays left when the door opens towards the observer);
- b) Type R: right-hand heated steel door (the hinge stays right when the door opens towards the observer).



- Key**
- 1 hinge
 - L left-hand
 - R right-hand

Figure 1 — Opening direction

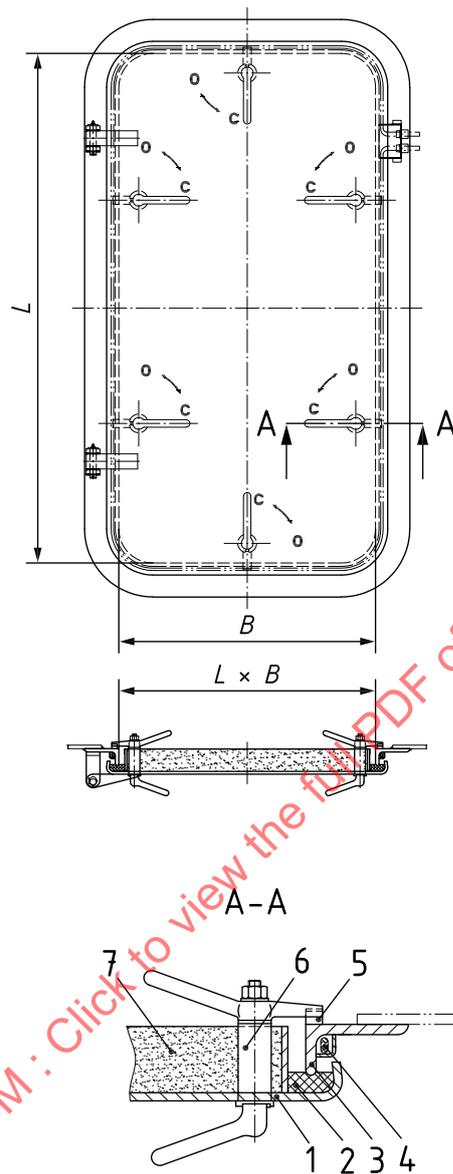
4.2 Structure

4.2.1 Types of heated steel doors

The heated steel doors are classified into three types, as shown in Table 1, Figure 2 and Figure 3.

Table 1 — Types of heated steel doors

Type	Definition
M	heated steel door whose locking mode is multi-buckle open
H	heated steel door whose locking mode is single handle linkage open
W	heated steel door whose locking mode is hand wheel linkage open



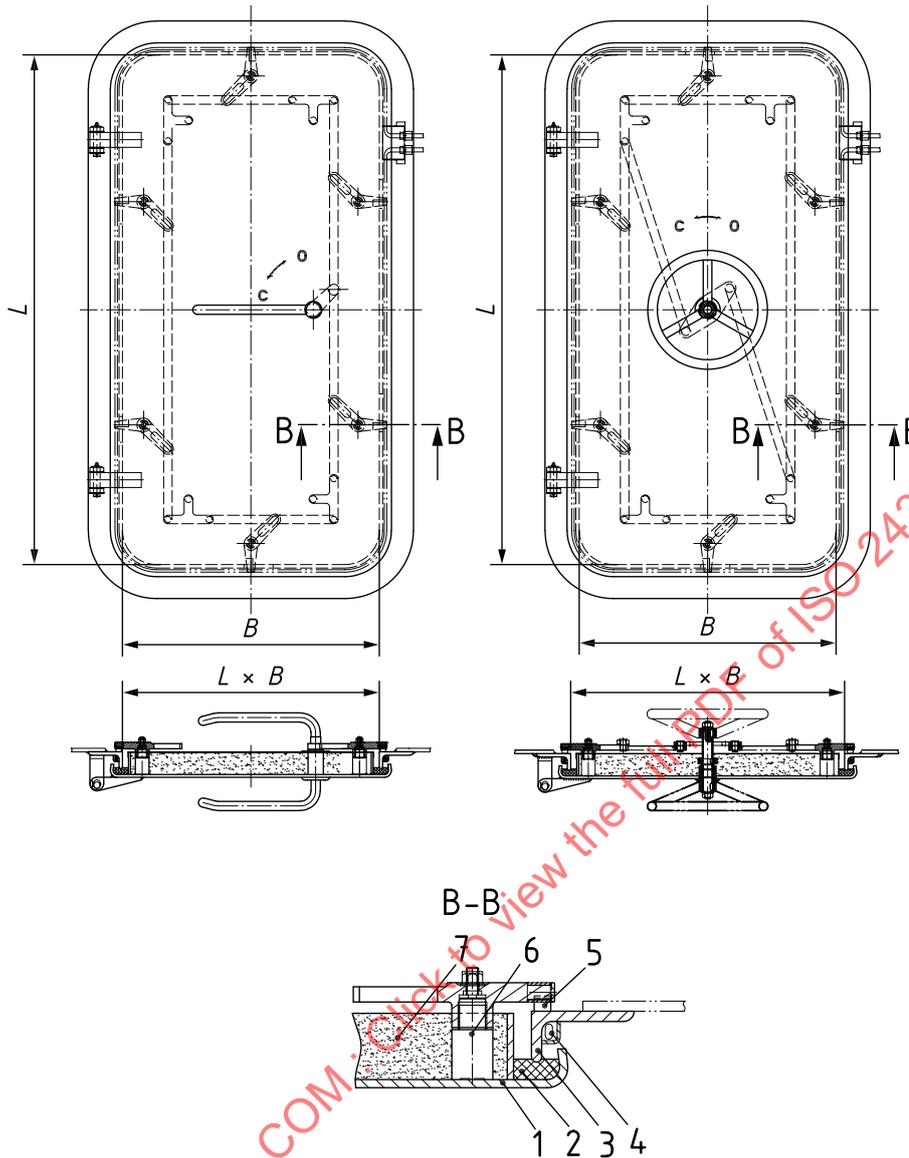
Key

- | | |
|-------------------------|-------------------------------|
| 1 door plate | 6 sleeve |
| 2 sealing rubber stripe | 7 thermal insulation material |
| 3 door frame | <i>B</i> width |
| 4 trace heater cable | <i>L</i> length |
| 5 wedge | |

NOTE 1 When the width *B* of the heated steel door is greater than or equal to 900 mm, two buckles are installed respectively at the top and bottom, with a distance of 300 mm.

NOTE 2 The figure shown is of a left-hand type heated steel door; the structure of the right-hand type heated steel door is symmetrical to the left one.

Figure 2 — Type M



Key

- | | |
|-------------------------|-------------------------------|
| 1 door plate | 6 sleeve |
| 2 sealing rubber stripe | 7 thermal insulation material |
| 3 door frame | <i>B</i> width |
| 4 trace heater cable | <i>L</i> length |
| 5 wedge | |

NOTE 1 When the width *B* of the heated steel door is greater than or equal to 900 mm, two buckles are installed respectively at the top and bottom, with a distance of 300 mm.

NOTE 2 The figure shown is of a left-hand type heated steel door; the structure of the right-hand type heated steel door is symmetrical to the left one.

Figure 3 — Type H and type W

4.2.2 Sealing rubber stripe

The section dimension of sealing rubber stripe is 45 mm × 20 mm (see [Figure 4](#)), and allowable initial compression is 2 mm.

The sealing rubber stripe shall be installed on the cover plate as shown in [Figure 2](#), fixed with a baffle and shall be glued on the cover plate with marine glue.

Ensure that there is a metal load-bearing plate on or near the centre line of each closing device, and the compression of the sealing rubber stripe is less than 4 mm.

Dimensions in millimetres

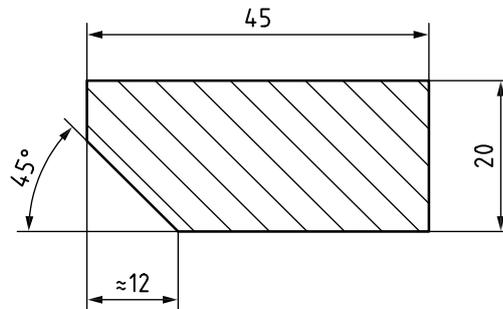


Figure 4 — Cross-section dimension of sealing rubber stripe

4.3 Performance

4.3.1 Weather-tightness

The heated steel door shall be weather-tight.

4.3.2 Anti-icing

The heated steel door shall be anti-icing for the door frame and shall be opened in low temperature.

5 Materials

5.1 Steel door

The steel door plate and door frames shall be made of weldable steel with minimum tensile strength of 235 N/mm² or marine steel of the same strength. The low temperature performance of the material shall conform to the specifications or shall not be lower than the material grade of the hull at the installation position.

Weldable low carbon steel with minimum tensile strength of 235 N/mm² shall be used for rubber stripe block, buckle, wedge and hinge. The low temperature performance of the material shall meet the specifications or shall not be lower than that of the material grade of the hull at the installation position.

Bolts and pins shall be made of corrosion resistant materials with minimum tensile strength of 235 N/mm², which can work normally in a low temperature environment.

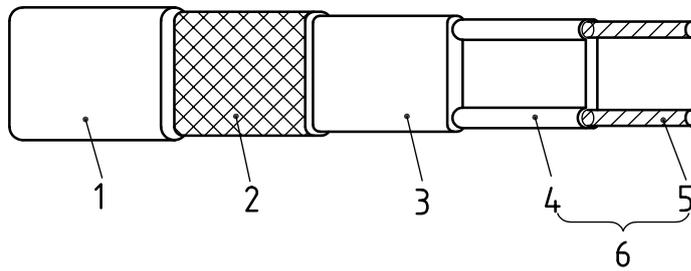
The elastic material of sealing rubber stripe shall meet the requirements of a low temperature environment. The sealing rubber stripe shall work normally in the normal temperature and low temperature alternating cycle environment, and provide effective and lasting sealing and re-sealing performance when the heated steel door is tightened.

Neutral lubricating grease is applied to the movable part of steel doors, and it shall work normally in a low temperature environment.

Steel door plate can be filled inside with insulating material according to the actual condition. The insulating material should operate normally in a low temperature environment.

5.2 Trace heater cable

The structure of trace heater cable^[2] is shown in Figure 5.



Key

- 1 outer sheath
- 2 metal shielding layer
- 3 insulating layer
- 4 thermal resistor
- 5 conductor
- 6 core tape

Figure 5 — Structure of trace heater cable

The trace heater cable is made up of conductor, thermal resistor, insulating layers and metal shielding layer that is covered with outer sheath (non-metallic).

The core tape consists of thermal resistor and conductor, and conductor is made of multiple twisted or braided tinning or nickel-copper wire, and the section shape of core tape is dumbbell or flat circle.

The insulating layer may be high density polyethylene (HDPE), fluorinated ethylene propylene (FEP), perfluoroalkoxy alkane (PFA), or other proven materials.

The metal shielding layers shall be braided with galvanized copper wire or other wire material. The braiding layer shall be evenly and smoothly covered with the insulating layer.

The outer sheath may be HDPE, FEP, PFA, or other proven materials.

6 Quality of manufacture

6.1 Appearance

There should be no burrs, sharp edges, scratches and indentation on the surface of steel door; the weld should be smooth without defects such as blowhole, crack, slag inclusion, flying edge and unfused.

6.2 Anti-rust and surface treatment

Steel door plate and frames shall not be deformed. The grade of rust-removing shall be Sa2.5 or St3 in accordance with ISO 8501-1. A layer of anti-rust primer shall be applied to prevent subsequent corrosion. The movable parts should be coated with neutral lubricating grease. The stainless-steel parts should be passivated, and the treated surface should always be silver-white.

6.3 Installation of trace heater cable

In order to gain the good heating conductivity, the installed trace heater cable shall fit closely to the heated steel door over the whole length.

The trace heater cable shall not be cut until it has been fastened on the heated steel door, so that the specific heating power is not affected by cutting the wrong length on site. After cutting, the ends shall be effectively protected against moisture (e.g. by self-adhesive tape or a blanking cap).

The installation radius of trace heater cable should be according to the minimum bending radii which shall be given by the supplier^[2].

7 Test

7.1 Weather-tight test

7.1.1 Indentation test

On the sealing filler of the door, apply white powder evenly, close the door, open it, and check the edge of the sealing filler and the door frame. The indentation depth of the sealing filler should be continuous, depth and width well-distributed, and the width should not be less than 5 mm.

7.1.2 Flushing test

The heated steel door should be installed on the simulated deck, and the flushing test should be carried out. The pressure at the nozzle outlet should not be less than 0,2 MPa. The distance between the nozzle and the test site should not be less than 1,5 m. The diameter of the nozzle should not be less than 12 mm, and the flushing time should not be less than 3 min. The inner surface shall be free of water stains or droplets.

7.2 Anti-icing test

7.2.1 Test purpose

The purpose of the test is to evaluate whether the heated steel door is capable of preventing formation of icing and operate (open or close) properly when subjected to low temperature operating conditions.

7.2.2 Test device

Test devices include an insulation meter (500 V megohmmeter), adjustable low temperature laboratory, blower with constant wind speed, steel door for test, temperature sensor and wind speed sensor.

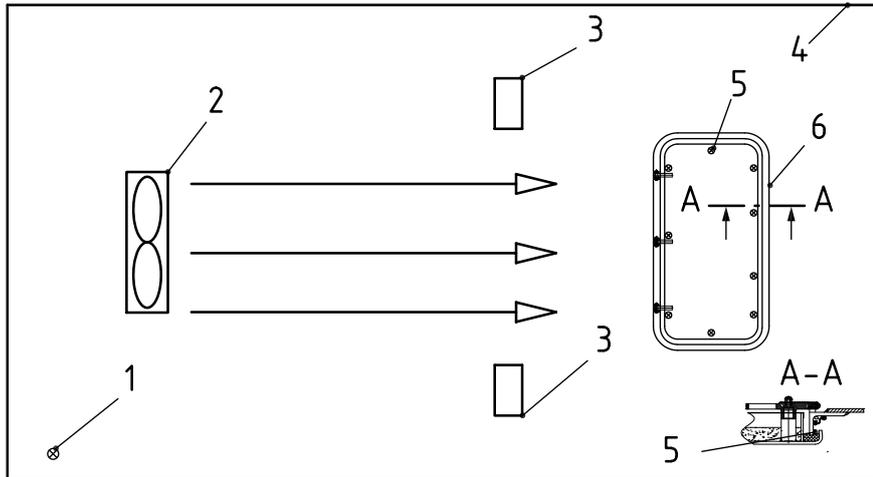
7.2.3 Test condition

The temperature stabilization shall be guaranteed:

- a) Ambient temperature: When the temperature is between -10 °C and -25 °C , the temperature should be kept constant during the test. Once the constant range is within $\pm 2\text{ °C}$ over a period of 30 min, it shall be considered as stabilized. When the temperature reduces to -25 °C , the range can be extended to $\pm 3\text{ °C}$;
- b) Specimen temperature: Once the temperature does not change by $\pm 2\text{ °C}$ over a period of 60 min, it shall be considered as stabilized.

The temperature sensor should be evenly arranged on the steel door coaming away from trace heating unexposed to the air. See [Figure 6](#) for details. And the number of temperature sensors should not be less than 9.

The wind speed sensor should be installed within 10 cm in front of the steel door and within 10 cm above and below. See [Figure 6](#) for details.



Key

- 1 temperature sensor in laboratory
- 2 blower
- 3 wind speed sensor
- 4 low temperature laboratory
- 5 temperature sensors on door coaming
- 6 heated steel door

Figure 6 — State diagram of in-lab anti-icing test

7.2.4 Test procedure

- a) After the installation of heated steel door is complete, the insulation state of the trace heater cable shall be measured by an insulating meter. Generally, the measured value should not be less than 20 MΩ^[3].
- b) Check whether the heated steel door is ready according to 7.2.3. Especially, the temperature sensors on door coaming shall be installed on the windward side.
- c) Turn on the refrigerator in the room and open the blower. When the temperature is below 0 °C, turn on the electric resistance trace heating power supply and heat the steel door.
- d) When the ambient temperature of the laboratory reaches the set temperature (which is determined by both the manufacturer and the buyer), record the ambient temperature at this time and the door temperature which keeps constant within 1 min.
- e) Record the observed data according to Table 2.
- f) Repeat steps a) to e) above three times.
- g) After test is complete, the insulation state of the trace heater cable shall be measured by an insulating meter. Generally, the measured value should not be less than 20 MΩ^[3].

Table 2 — Test data record of heated steel door

Test	Power	Type	Ambient temperature	Temperature									Test duration
				Sensor									
				1	2	3	4	5	6	7	8	9	
First test													
Second test													
Third test													

7.2.5 Pass/fail criteria

Stabilized specimen temperature value excluding minimum and maximum values from 9 sample points shall be constantly stable above 0 °C. If all three times tests are passed, then it can prove that the heated steel door can achieve the function of anti-icing.

8 Designation

The heated steel door conforming to this document should be designated as follows, in the order given:

- denomination: heated steel door;
- code number of this document: ISO 24316;
- type: M, H or W;
- mark of trace heater cable: E;
- nominal dimension, as specified in [Table A.1](#);
- ambient temperature, as specified in [Table B.1](#);
- opening direction: left-hand (L) or right-hand (R).

EXAMPLE The designation for type H heated steel door whose nominal dimension is 1 600 mm × 600 mm, and the ambient temperature is -10 °C, with a left-hand opening direction is as follows.

Heated steel door **ISO 24316-HE-1 600 × 600(-10 °C)-L**

Annex A (informative)

Nominal dimension and installation position of heated steel door

Dimensions and installation positions are listed in [Table A.1](#).

Table A.1 — Dimension and installation position

Dimensions in millimetres

Nominal dimension <i>L × B</i>	Application in accordance with ICLL 1966 ^[5] in position(s)
1 200 × 600	1 and 2
1 400 × 600	
1 400 × 750	
1 400 × 900	
1 500 × 600	2 only
1 500 × 750	
1 500 × 900	
1 600 × 600	
1 600 × 750	
1 600 × 900	
1 700 × 600	
1 700 × 750	
1 700 × 900	
1 800 × 600	
1 800 × 750	
1 800 × 900	