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Ships and marine technology — Pressure/vacuum valves for cargo tanks

Navires et technologie maritime — Robinets à pression/à vide pour citernes de chargement

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15364 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

This second edition cancels and replaces the first edition (ISO 15364:2000) which has been technically revised.

Ships and marine technology — Pressure/vacuum valves for cargo tanks

1 Scope

This international standard applies to pressure-vacuum relief valves protecting marine vessel systems, including cargo tanks, which may be subject to gas/vapour pressure or vacuum beyond the design parameters of the system/tank. This International Standard specifies the minimum requirements for performance and testing of pressure-vacuum relief valves, with emphasis on selection of materials, internal finish and surface requirements for pressure-vacuum valves installed on cargo tanks in tankers (see Annex A). This International Standard specifies design and in-service performance criteria, operational testing and maintenance requirements. Certification to this International Standard does not imply suitability for any given installation; it indicates that certain minimum requirements have been considered and that information necessary for determination of suitability is provided to the buyer of the equipment.

This International Standard does not cover all test procedures for devices that prevent the passage of flame, such as flame arresters. Such devices may be used in conjunction with pressure/vacuum valves.

NOTE Additional information for devices to prevent the passage of flame is found in the International Maritime Organization (IMO) “International Convention for the Safety of Life at Sea, 2002” (SOLAS), Chapter II-2, Regulation 4, and IMO Maritime Safety Committee (MSC) Circular No. 677 (MSC/Circ. 677), “Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers”, as amended by IMO MSC/Circ. 1009.

2 Normative references

The following referenced documents are indispensable for the application 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.

International Maritime Organization, Assembly Resolution A.746(18), *Survey Guidelines under the Harmonized System of Survey and Certification*

International Maritime Organization, *International Convention for the Safety of Life at Sea, 2002* (SOLAS), Chapter II-2, Regulation 4

3 Terms and definitions

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

3.1
administration
government of the state whose flag the ship is entitled to fly

3.2
flame arrester
device to prevent the passage of flame, designed and tested in accordance with a specified performance standard

NOTE Its flame-arresting unit is based on the principle of quenching.

3.3
full opening valve
design that opens fully at the set pressure

3.4
high velocity vent
device to prevent the passage of flame, consisting of a mechanical valve which adjusts the opening available for flow in accordance with the pressure at the inlet of the valve in such a way that the efflux velocity cannot be less than 30 m/s (98 ft/sec)

3.5
maximum experimental safe gap
MESG
property of the respective gas mixture being the maximum clearance of the joint between two parts of the interior chamber of a test apparatus which, when the internal gas mixture is ignited and under specified conditions, prevents ignition of the external gas mixture through a 25 mm (10 in) long joint, for all concentrations of the tested gas or vapour in air

NOTE IEC 60079-1 [1] standardizes the test apparatus and the test method.

3.6
maximum intended pressure drop
largest pressure drop generated over a valve for which the test laboratory verifies the corresponding flow capacity

3.7
modulating valve
design that opens proportionally with rise in pressure

3.8
pressure/vacuum valve
device designed to maintain pressure and vacuum in a closed container within preset limits

3.9
standard air
dry air at 21 °C (70 °F) and 1 013,25 hPa (29,92 in Hg) pressure

NOTE This is substantially equivalent to a density of 1,2 kg/m^3 (0,075 lb/ft^3). Specific heat of dry air = 1 004,8 J/(kg·K) [0,24 Btu/(lb·°R].

3.10
third party inspection body
organization designated by the administration which is independent from the manufacturer or user and which performs or witnesses the tests and inspections provided for by this International Standard

3.11
transition point valve
design where the valve characteristics change from modulating to full opening at a particular pressure

3.12
verified drawings and diagrams
drawings and diagrams certified to be authentic and complete by the test laboratory issuing the test report in accordance with this International Standard

3.13
verified flow chart
pressure versus flow volume presented in a chart certified by the test laboratory issuing the test report in accordance with this International Standard

4 Symbols and abbreviated terms

D nominal pipe diameter at device connection

D_{min} minimum diameter of the piping between the device and the tank allowed for non-oscillating performance

L_{max} maximum length of the piping between the device and the tank allowed for non-oscillating performance

L_1 pipe length between test tank and the device for flow testing

L_2 pipe length between test tank and the device during non-oscillation testing

$P_{closing}$ pressure drop over the valve corresponding to the minimum flow required to keep the valve partially open with no contact between the disc and the seat

P_{max} maximum pressure drop corresponding to the maximum flow volume (Q_3)

P_{set} set pressure, expressed as the calculated force applied to the disc versus the area on which tank pressure is applied

$P_{1\text{-tpv}}$ pressure at which a transition point valve changes from modulating to full opening

$Q_{1\text{-fov}}$ flow volume needed to open the valve

Q_2 flow volume needed for the valve to remain fully open

$Q_{2\text{-fov}}$ flow volume needed to maintain the valve fully open at P_{set}

$Q_{1\text{-mv}}$ flow volume needed to open the valve

$Q_{2\text{-mv}}$ flow volume needed to maintain the valve fully open

$Q_{1\text{-tpv}}$ flow volume at which a transition point valve changes from modulating to full opening

$Q_{2\text{-tpv}}$ flow volume needed to maintain a transition point valve fully open at $P_{1\text{-tpv}}$

Q_3 flow volume corresponding to the maximum intended pressure drop over the valve

Q_{close} minimum flow required to keep the valve partially open with no contact between the disc and the seat

V_{min} minimum volume of the tank allowed for non-oscillating performance

5 Materials

5.1 The device housing, and other parts or bolting used for pressure retention, shall be constructed of materials suitable for the intended service and listed in a recognised national/international standard.

Housings, discs, spindles, seats, springs, gaskets, seals, flame arresters (when included in the design) and all other integral parts, including parts with coatings to prevent corrosion, shall be made of materials resistant to attack by sea water and the liquids and vapours contained in the tank being protected (see Annex C).

Springs plated with corrosion resistant material are not acceptable.

5.2 Non-metallic materials, other than gaskets, seals and diaphragms as allowed by 6.11, shall not be used in the construction of pressure retaining components of the device.

Resilient seals may be installed only if the device is still capable of effectively performing its flame arresting function when the seals are partially or completely damaged or burned.

Non-metallic gaskets shall be made of non-combustible material and suitable for the service intended.

5.3 Materials for connecting pressure-vacuum valves to their respective piping systems should meet standards for physical characteristics similar to those of the piping systems to which they are connected.

5.4 The possibility of galvanic corrosion shall be considered in the selection of materials (see Annex C for additional considerations).

5.5 The verified drawings shall include a complete bill of materials showing conformity with this clause and any other material requirements listed in Clause 6.

6 Other requirements

6.1 The maximum gas leakage rate shall be provided and expressed as the volume in standard air that may leak from the valve at 80 % of the nominal setting.

6.2 Housings, elements, and seal gasket materials shall be capable of withstanding the maximum and minimum pressures and temperatures to which the device may be exposed under normal operating conditions.

6.3 Where welded construction is used for pressure retaining components, welded joint design details, welding and non-destructive testing shall be in accordance with national or international standards. Welders and weld procedures shall be qualified by a recognised organization to ensure consistent quality production of weld joints that are sound and of proper strength, in accordance with recognised national/international standards.

6.4 End-of-line pressure-vacuum valves shall be designed such that condensed vapour and water in the pressure-retaining zone drain from the device into the tank and do not impair the efficiency of the device. The design shall also prevent the accumulation of water inside the device and subsequent blockage due to freezing. Internal components, channels and inner walls to be drained shall be sloped.

6.5 All fasteners essential to the operation of the device shall be protected against loosening.

6.6 Devices shall be designed and constructed to minimize the effect of fouling under normal operating conditions. The design shall be such that the device can be examined for any build-up of residue due to vapour condensation. For certain cargoes that crystallize, heating arrangements may be necessary.

6.7 Devices shall be capable of operating over the full range of ambient air temperatures anticipated. Devices shall be capable of operating in freezing conditions (such as may cause blockage by freezing cargo vapours or by icing in bad weather) and when covered by a layer of ice, the allowed thickness of which shall be stated by the manufacturer in the instruction manual. Devices shall also be capable of operating at whatever surface temperature is developed by heating arrangements.

6.8 End-of-line devices are required to direct the efflux vertically upward (see SOLAS 2002, Ch. II-2 Regulation 4, 5.3.4.1.1.2) and the minimum average velocity of air through a cross section of the valve's outlet to atmosphere shall not be less than 30 m/s for all flow rates.

6.9 A manual means shall be provided to verify that any valve disc and other moving elements lift freely and fully and cannot remain in the open position. The design shall be such that the device is verified not to be inoperable due to corrosion, residue build-up or icing, when the aforementioned manual means is used in combination with the manufacturer's requirements for visual inspection.

6.10 Valve discs and other moving parts shall be guided by a suitable means to prevent binding and ensure proper self-closing (seating), taking into account the possible build-up of condensed vapours passing through the valve during loading, when maintenance is carried out in accordance with the manufacturer's requirements. Valve discs shall normally close against the valve seat by metal to metal contact. Resilient seating seals may be provided if the design is such that the disc closes tight against the seat in case the seals are destroyed, damaged or are otherwise carried away.

Valve discs may be solid or made hollow so that weight material may be added to vary the lifting pressure. If hollow discs are employed, a watertight bolted cover shall be fitted to encase the weight material. The set pressure shall not be varied by personnel other than the manufacturer without prior approval by the Administration. A clear indication, visible from the outside of the valve, shall be employed to indicate the position of the valve disc(s). The indicator shall be visible from below and from the side of the valve at deck level.

6.11 Valves may be actuated by non-metallic diaphragms except where failure would result in unrestricted flow of tank vapours to the atmosphere or in an increase in the pressure or vacuum at which the valve normally releases.

6.12 Relief pressure adjusting mechanisms shall be permanently secured by lockwire, locknuts or other suitable means to prevent devices from becoming misadjusted due to handling, installation or vibration.

7 Approval tests

7.1 Type approval tests shall be conducted by a laboratory acceptable to the administration. The manufacturer, in choosing a laboratory, shall ensure that the laboratory is qualified (by the administration or by a certifying entity designated by the administration) to conduct the tests provided for by this International Standard, and that the laboratory has (or has access to) the apparatus, facilities, personnel and calibrated instruments necessary for the tests. Alternatively, the tests provided for by this International Standard may be conducted by the manufacturer when the tests are witnessed by a third party inspection body designated by the administration, who can certify that the tests are conducted properly.

7.2 One of each model device and each size shall be tested. A change of material that negatively affects the corrosion resistance shall be considered a change of model for the purpose of this paragraph. A change of design or construction shall be considered a change of model for the purpose of this paragraph. Each size of each model should be submitted for type approval. Devices should have the same dimensions and most unfavourable clearances expected in the production model. If a device is modified during the test programme, or at a later date, such that the function of the valve or its performance characteristics are affected, the administration shall be informed and an acceptable test related to the modified part required by a third party inspection body.

A corrosion test shall be conducted. In this test, a complete device, including a section of pipe similar to that to which it will be fitted, shall be exposed to a 5 % sodium chloride solution spray at a temperature of 25 °C (77 °F) for a period of 240 h, and allowed to dry for 48 h. Following this exposure, all movable parts shall operate properly and there shall be no corrosion deposits that cannot be washed off.

The pressure retaining boundary of the device shall be subjected to a hydrostatic pressure test of at least 150 % of maximum rated pressure or a minimum pressure of 3 450 hPa gauge (50 psig) [1)], whichever is greater, for 10 min without rupturing, leaking or showing permanent distortion. For the purposes of this test, the disc may be gagged or blocked.

Performance characteristics as declared by the manufacturer, such as flow rates under both positive and negative pressure, operating sensitivity, flow resistance and velocity, shall be verified by laboratory tests.

An external ice test shall be conducted to verify the allowable accumulation of an external layer of ice at which the valve will still operate. In this test, a complete device, including a section of the pipe similar to which the device will be fitted, shall be exposed to a temperature of –10 °C (14 °F) for a period of 24 h. Following this initial exposure, 1 l (1,7 pints) of water at no more than 2 °C (35,6 °F) shall be sprayed every 10 min on to the outside of the valve until the specified ice thickness is achieved. Proper operation of the valve shall be verified.

1) 1 psig = 1 lbf/in^2 gauge.

7.3 A test report for each prototype shall be prepared by the laboratory. This shall include:

— verified detail drawings of the device and its components;

— the types of test conducted and results obtained, with such recorded data to allow verification of the tests;

— specific advice on approved attachments;

— drawings of the test rig, to include a description of the inlet and outlet piping attached;

— a record of all markings found on the tested device;

— an instruction manual (provided by manufacturer);

— a report number.

8 Inspections

8.1 The manufacturer shall afford the purchaser's representative all reasonable facilities necessary to satisfy him that the material is being furnished in accordance with this International Standard. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All examinations and inspections shall be made at the place of manufacture, unless otherwise agreed upon.

8.2 Each finished device shall be visually and dimensionally checked to ensure that the device complies with this International Standard, including the specification information in Annex E, the certification and the markings in Clause 12. Special attention shall be given to the adequacy of welds and the proper fit-up of joints.

8.3 Each finished device shall be leakage tested using air to verify the maximum leakage rate specified according to 6.1.

9 Flow and velocity tests

9.1 Determination of capacity

The capacity of pressure/vacuum valves shall be established by flow testing at least one production model of every type and size of venting device under the conditions listed in 9.2 to 9.4.

9.2 Capacity data

The following requirements shall be met when establishing capacity data:

— the pipes, as well as the connections between the pipes and the device, shall be without obstructions causing additional turbulence;

— the nominal diameter of the test pipe shall be of the same or larger size as the device being tested;

— all pressure measuring points shall be arranged normal to the pipe axis and shall not influence the flow;

— the test medium shall be air at ambient conditions; ambient pressure and temperature shall be recorded to convert flow rate to normal conditions;

— all measuring instruments shall be calibrated.

9.3 Test apparatus

The test apparatus is shown in Figure 1. The dimensions of the tank (key 3) shall be sufficient to allow a mean flow velocity of less than 0,5 m/s in the tank. All tank pressure data shall be recorded under these conditions.

The test pipe L_1 shall have a length of no more than 10 × D and no less than 1,5 × D of the test specimen. The tank penetration should be at a location of the tank where it is essentially flat and the rounding of the penetration shall be in accordance with a recognised national or international standard to provide uniform pressure drop influence.

Vacuum valves shall have the flow direction reversed.

CAUTION — It should be observed that the blower or fan may cause oscillation in the system if the fan wings are not aligned or damaged. This should be avoided.

9.4 Flow measurements

9.4.1 Flow measurements for pressure/vacuum valves shall be made using the lowest and highest setting for the specific model. Flow charts for in-between settings may be interpolated.

NOTE If the setting can be changed without making any changes to the form and shape of the valve housing and the physical appearance of any component (e.g. by changing the magnet power, spring compression, etc.), this does not constitute a change of model. The spring wire diameter need not be taken into consideration.

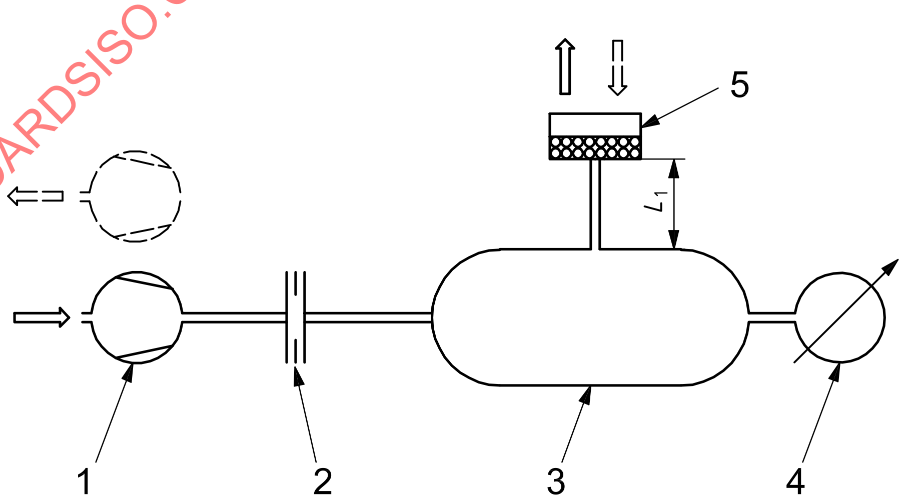
9.4.2 The pressure at which the valve opens shall be established using a flow rate resulting in a pressure rise no greater than 0,01 N/mm^2/min (10 kPa/min or 0,295 3 in Hg). The set-pressure is designated as P_{set} which shall be within ± 3 % of the calculated set-pressure expressed as the correlation between the closing force and the area of the disc against which tank pressure is projected.

9.4.3 Depending on valve type, the flow measurement shall consist of the steps described in Annex B. See Annex F for corresponding examples of flow diagrams.

For high velocity vents, during each of the measuring periods in accordance with Annex B, the average velocity of air through a cross section of the valve's outlet to atmosphere shall be recorded.

9.4.4 Flow graphs shall be drawn showing the readings from the steps described by Annex B, and in the appropriate format given in Annex F.

9.4.5 Flow testing shall be conducted adhering to the test rig provided in Figure 1. All instrumentation shall be calibrated and have an uncertainty of no more than ± 5 %.



Key

1 blower or fan
2 flowmeter
3 tank
4 pressure measuring device
5 pressure/vacuum valve
L_1 length of connection pipe

Figure 1 — Flow test rig

10 Undamped oscillation tests

High velocity vents shall be tested for undamped oscillations. The test apparatus is shown in Figure 2. All instrumentation shall be calibrated.

This test shall be carried out with the lowest and the highest opening setting available for the particular model without a change of setting constituting a modification as defined in the note in 9.4.1.

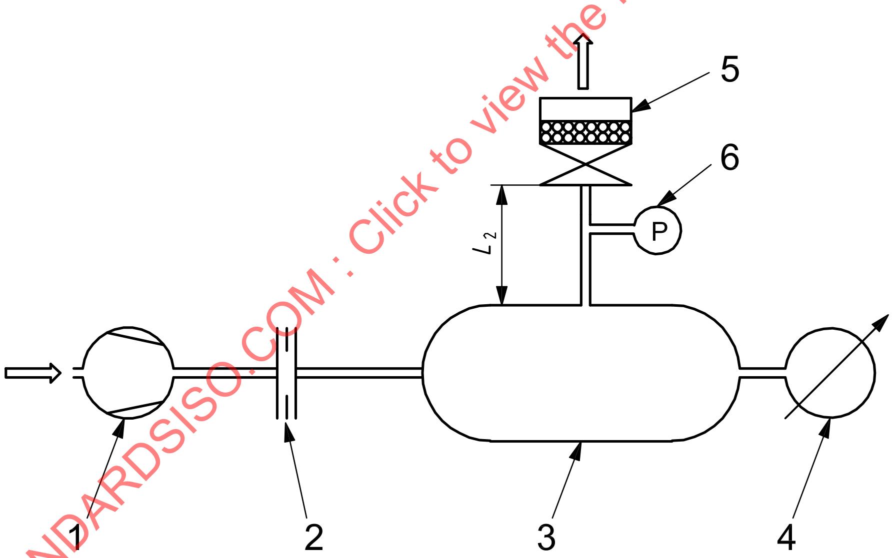
The length and diameter of the pipe, L_2, and the volume of the tank shall be requested by the manufacturer. The tests shall be carried out for 3 min each at ten about-equally spaced flow rates starting at 0,2 × Q_{close} and using this rate as the step width (maximum flow in this test: 2 × Q_{close}).

NOTE Some valve designs will perform open/close cycles that will cause periodic changes on the flowmeter reading (Figure 2). In these cases, the average flow recorded in the 3 min span shall reflect the step-value in question.

If the disc location sensor indicates contact with either seat or upper stops with a frequency of more than 0,5 Hz, the pipe length, L_2, shall be shortened until this value is not exceeded. That length shall be recorded as L_{max} and the diameter of the piping as D_{min} while the tank volume is recorded as V_{min}.

The use shall be limited to pipe length on the protected side not exceeding L_{max} and the diameter shall not be less than D_{min}, while the minimum pre-volume available at any time in the tank protected (ullage space) shall not be less than V_{min}.

For modulating valves, where there is no flow volume at the closing pressure, the first step shall start at 10 % of the flow volume, at which the valve is fully open.



Key

1 blower or fan
2 flowmeter
3 tank
4 pressure measuring device
5 high velocity vent valve
6 pressure sensor
L_2 length of vent pipe

Figure 2 — Test rig for undamped oscillations

11 Documentation

11.1 General

An instruction manual shall be provided. The instruction manual shall include the items described in Table 1 and 11.2.

Table 1 — Product data relevant for the specification information according to Annex E to be included in the instruction manual

Specification information	Purpose	A. Data location B. Description of test data/application note
1. Nominal pipe size, configuration of piping, and pipe length	Compliance with design parameters for tank pressure limits, and for high velocity vents, compliance with non-hammering conditions.	A: Type approval certificate. B: For high velocity vents: test records indicating piping limitations for safe, non-hammering performance (minimum diameter and maximum length from valve to ullage/buffer volume).
2. Maximum gas density considered	Compliance with design parameters for tank pressure limits.	B: Convert to standard air.
3. Lowest MESG	Suitability for the application.	A: Type approval certificate. B: The lowest MESG of the IEC explosion group allowed.
4. Set opening points for pressure and vacuum	Suitability for the application.	A: Type approval certificate. B: The upper and lower values applied during flow testing shall not be exceeded.
5. Maximum pressure drop	Compliance with design parameters for tank pressure limits and the selected opening setting of the device.	A: Certified flow charts. B: The flow chart format shall show the maximum pressure drop over the valve for any flow volume. This value is essential for pressure drop calculations.
5a. Pressure drop at maximum flow	Compliance with design parameters for tank pressure limits and the selected opening setting of the device.	A: Certified flow charts. B: The flow chart shall show the pressure drop over the valve at the maximum required flow rate to be established.
6. Minimum reseating pressure	Suitability for the application with regard to minimizing the loss of cargo vapour.	A: Certified flow charts. B: The flow chart format shall indicate the reseating pressure.
7. Maximum and minimum ambient temperature	Suitability for the application.	A: Instruction manual. B: The manufacturer's recommendations shall not be exceeded.
8. Materials of construction	Suitability for the application.	A: Verified drawing. B: The combination of materials chosen may not have lower corrosion resistance than the version tested. The drawing shall include a bill of materials in accordance with Clause 5.
9. Surface treatment and coating	Suitability for the application.	A: Instruction manual. B: The surface treatment and coating, if any, shall be decided by the buyer with due consideration to Annex D.
10. Maximum gas flow in standard air, pressure drop of the piping system, and maximum tank pressure	Suitability for the application and compliance with design parameters for tank pressure limits, alarms, liquid-filled breakers, filling limitations for high density cargoes.	A: Certified flow chart. B: The maximum tank pressure allowed in normal operations less an appropriate fouling factor and margin for alarm and breaker settings, etc., shall not be exceeded when calculating the combined pressure caused by the valve and the pressure drop over the piping system.
11. Maximum outer ice layer thickness	Suitability for the application.	A. Type approval certificate. B. Due consideration shall be given to vessel service conditions and facilities available for on-deck de-icing before cargo operations and during voyage.
12. For high velocity vents: the minimum average velocity required for cross section of the valve's outlet to atmosphere	Suitability for the application.	A: Recorded in test report. B: The ability to disperse gas above deck relates to the velocity through the cross section of the valve's outlet to atmosphere.
13. Maximum air leakage rate	Suitability for the application.	A: Instruction manual. B: The verified product data shall state the maximum leakage rate expressed in air of a new valve at 80 % of the nominal setting.

11.2 Installation instructions

11.2.1 Operating instructions, including any service restrictions imposed for safe functioning of the device.

11.2.2 Maintenance requirements, including information on maintenance of any corrosion prevention system (see Annex D).

11.2.3 Instructions on when cleaning is required due to the inside build-up of residue. The instruction manual shall also describe the method for cleaning using a diagram.

11.2.4 Verified exploded view drawings with indication for each component as to the order of disassembling and re-assembling for inspection, cleaning, repair or removal of internal elements for replacement. The design shall not allow the valve to be incorrectly reassembled following inspection, cleaning or repair, be it due to wrong order of parts or missing parts. Information on sizes for all components shall be included on the drawings to ensure that the specified gas-tightness is achieved, and for the valve to be restored to the original, as-purchased condition with regard to set pressure and flow rate.

11.2.5 Full work descriptions, including drawings, on how replacement of wearing parts is achieved in-service without removing the valve.

11.2.6 Instructions for the user to check valve lift prior to each cargo loading and cargo unloading operation in order to:

— verify unobstructed movement of the moving parts and

— ensure that fouling conditions are controlled to establish safe operation and full capacity.

A diagram shall be included which shows the parts either moved or cleared when the check-lift is operated.

11.2.7 The test reports.

12 Marking

Each device shall be permanently marked indicating:

a) manufacturer's name or trademark;

b) style, type, model or other manufacturer's designation for the device, which shall form a unique identification of the approved device;

c) size of the inlet (and outlet, if applicable);

d) serial number;

e) direction of flow through the device;

f) test laboratory and report number(s);

g) pressure and vacuum setting;

h) ISO designation of this standard, i.e., ISO 15364:2007.

NOTE If the set-pressure is changed, the marking shall be updated accordingly.

13 Quality assurance

13.1 Devices shall be designed, manufactured and tested in a manner that ensures they meet the characteristics of the prototype tested in accordance with this International Standard. No changes or modifications are allowed without adhering to 7.2.

13.2 The device manufacturer shall maintain the quality of the devices that are designed, tested and marked in accordance with this International Standard. At no time shall a device be delivered with this standard designation that does not meet the requirements herein.

Annex A
(normative)

Installation requirements for ships subject to the International Convention for the Safety of Life at Sea, 2002 (SOLAS)

A.1 General

For the purpose of arrangement and installation of cargo tank venting systems on board ships, the International Convention for the Safety of Life at Sea, 2002 (SOLAS), Chapter II-2, Regulation 4, shall be applied.

A.2 Examination of cargo tank pressure/vacuum valves on board ships

For the purpose of examination of cargo tank pressure-vacuum relief valves on ships, the International Maritime Organization Assembly Resolution A.746 (18), paragraph 6.2.3.3, shall be applied.

A.3 Access arrangements for examining pressure/vacuum valves

For the purpose of ensuring that any pressure/vacuum relief valve lifts easily and cannot remain in the open position (as per manufacturer's instructions) appropriate access arrangements to the valve to facilitate this operation, such as a stand or platform at deck level, should be fitted when necessary, with provisions allowing for inspection of inside accumulation of cargo residue and parts replacement. The instruction manual for the device shall include diagrams showing the weight of all parts over 10 kg (22 lb) that need be dismounted for inspection, cleaning and replacement of wearing parts, so that precautions for crane support can be allocated if necessary, and appropriate working schedules be prepared.

Annex B
(normative)

Flow test measurements

B.1 General

Depending on valve type, the flow measurement shall consist of the following steps (see Annex F for corresponding diagrams).

B.2 Transition point valves

1) The opening phase from shut to the transition point where the valve characteristics change from modulating to full open.

2) The flow rate, for which the pressure does not rise above the minimum level required for the valve to remain fully open.

3) The maximum intended pressure drop over the valve.

4) The closing phase from fully open at the maximum intended pressure drop to shut.

Step 1:

The flow measurement is made to establish the maximum pressure drop of the valve and the corresponding flow rate, at which the valve characteristics change from modulating to full open (transition point). This intersection is designated as $P_{1\text{-tpv}}$ and $Q_{1\text{-tpv}}$. Ten equally spaced pressure measurements between zero capacity and $Q_{1\text{-tpv}}$ shall be recorded. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

Step 2:

The flow measurement is made to establish the flow rate needed for the valve to remain fully open at $P_{1\text{-tpv}}$. This intersection is designated $Q_{2\text{-tpv}}$. On the flow chart representation a horizontal line shall be drawn from $Q_{1\text{-tpv}}$ to $Q_{2\text{-tpv}}$.

Step 3:

The flow measurement is made to establish the flow rate corresponding to the maximum intended pressure drop over the valve. This is designated P_{max} and Q_3. Ten equally spaced flow measurements between $Q_{2\text{-tpv}}$ and Q_3 shall be recorded. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

Step 4:

The flow measurement is made to establish the closing pressure of the device, $P_{closing}$. The flow range between Q_3 and the flow value corresponding to $P_{closing}$ shall be divided into ten equally spaced flow rates. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

B.3 Full opening valves

1) The opening phase from shut to where the valve is constantly fully open.

2) The maximum intended pressure drop over the valve.

3) The closing phase from fully open at the maximum intended pressure drop to shut.

Step 1:

The flow rate needed to open the valve, $Q_{1\text{-fov}}$, shall be ignored for the purpose of the flow chart. The flow measurement is done to establish the flow rate needed for the valve to remain fully open at P_{set}. This intersection is designated $Q_{2\text{-fov}}$. On the flow chart representation a horizontal line shall be drawn from $Q_{1\text{-fov}}$ to $Q_{2\text{-fov}}$ horizontally from P_{set}.

Step 2:

The flow measurement is made to establish the flow rate corresponding to the maximum intended pressure drop over the valve. This is designated P_{max} and Q_3. Ten equally spaced flow measurements between $Q_{2\text{-fov}}$ and Q_3 shall be recorded. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

Step 3:

The flow measurement is made to establish the closing pressure of the device, $P_{closing}$. The flow range between Q_3 and the flow value corresponding to $P_{closing}$ shall be divided into ten equally spaced flow rates. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

B.4 Modulating valves

1) The opening phase from shut to the maximum intended pressure drop over the valve.

2) The closing phase from fully open at the maximum intended pressure drop to shut.

Step 1:

The flow rate needed to open the valve, $Q_{1\text{-mv}}$, and the flow rate needed for the valve to remain fully open, $Q_{2\text{-mv}}$, shall be ignored for the purpose of the flow chart. The flow measurement is made to establish the flow rate corresponding to the maximum intended pressure drop over the valve. This is designated P_{max} and Q_3. Ten equally spaced flow measurements between zero capacity and Q_3 shall be recorded. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

Step 2:

The flow measurement is made to establish the closing pressure of the device, $P_{closing}$. The flow range between Q_3 and the flow value corresponding to $P_{closing}$ shall be divided into ten equally spaced flow rates. Each flow increment shall be maintained under stabilized conditions for at least 5 s with logged flow and corresponding pressure readings at least 10 times per second.

Annex C
(informative)

Materials selection guidelines

C.1 General

The purpose of these guidelines is to recommend general criteria for the selection, application and maintenance of materials used in the pressure/vacuum relief valves within the scope of this International Standard.

These guidelines are not intended to replace the technical aspects of any specific design or type of equipment that is under the responsibility of ship owners, manufacturers and shipyards. The selection of equipment is based on the specification information provided by the buyer in accordance with Annex D.

The manufacturer shall provide details to the buyer on the necessary system to ensure an adequate level of corrosion protection of the pressure/vacuum valves.

C.2 Selection of materials

The materials chosen for the construction of pressure/vacuum valves shall reflect the expected working conditions and environment in terms of being subjected to various cargoes and their vapours. Depending on application (e.g. end-of-line or in-line installation and type of cargoes), cast iron, ductile iron, bronze and different grades of stainless steel may be used. Refer to Clause 5 for allowed use of non-metallic parts.

For wearing parts, such as seats and discs, material selection should reflect the expected working conditions associated with the predicted functional characteristics of the particular valve design.

The working conditions may negatively influence the lifetime of the wearing parts as a consequence of frequent seat and disc contact due to:

— oversizing, which prevents the valve from opening fully during normal operation;

— excessive maximum pressure drop over the valve, which keeps the lift of the disc reduced at low filling rates;

— inadvertent relation between the venting rate during normal operations and the valve's transition point, where it becomes fully open.

Annex D
(informative)

Corrosion protection guidelines

D.1 Corrosion protection systems

The grade of surface preparation, design features, expected working conditions, maintenance scheme, and desired protection time should be taken into account for the selection of suitable corrosion protection systems.

Available methods for corrosion protection are hard coatings, soft coatings with optional corrosion inhibitors, and powder treatments.

When repairs are necessary due to corrosion, maintenance coatings should be carried out with the same coating system originally used, provided the surface treatment and working conditions required for a satisfactorily result are obtainable. The valve manufacturer shall furnish, with the instruction manual, instructions for carrying out repair works on the corrosion protection system including details on surface treatment, procedures, and type of coatings allowed.

D.2 Selection of corrosion protection system

In selecting the corrosion protection system, the parties involved should consider the current situation, foreseeable service conditions and planned maintenance programme.

The following aspects should be considered:

— current surface condition;

— possible surface preparation;

— valve design and intended service;

— required surface cleanliness and dryness;

— required ambient conditions during preparation;

— frequency of loading operations causing the valve to be subjected to aggressive compounds and their temperatures;

— aspired durability;

— maintenance features.

D.3 Coatings

The durability of coatings applied for corrosion protection is influenced by factors such as surface conditions, surface penetration, coating selection, application and maintenance.

Common types of coating used for surface protection are:

— epoxy formulations for high surface protection;

— combinations of natural or synthetic oils and grease formulations containing corrosion inhibitors.

Observing the coating process and in-service inspection is best served by using a light-coloured coating.

The provided technical product data sheet and job specification should be carefully followed, including required ambient and working conditions.

A record of the ambient and working conditions during the coating application process should be entered.

D.4 Surface preparation

The performance of a coating system is highly affected by the condition of the treated surface.

Over time, the grade of surface preparation has a direct influence on the selection of protective coatings and their performance.

Recognised national or international standards for good practice concerning methods for surface preparation should be observed along with the manufacturer's recommendations.

Possible surface preparation methods include:

— blast cleaning;

— hand and power tool cleaning;

— flame cleaning;

— high pressure water blasting;

— electrolytic cleaning.

The method chosen should take into consideration the necessary requirements for cleanliness, humidity and grade of surface preparation.

Remaining particles such as blasting abrasives, dust, rust flakes and water should be removed as appropriate.

A record of the result of the surface preparation should be entered.

D.5 Application

The application of a coating should be carried out in accordance with the manufacturer's recommendations.

Coatings, liquid or powders may be applied by spraying under documented working conditions. Additional repair work, if required, should be applied by brush or roller.

Each coating layer should have the maximum/minimum thickness required in accordance with the job specification. Eighty percent of all measurements should be higher than or equal to the nominal coat thickness, and none of the balance should be below 80 % of the required nominal thickness.

Depending on the type of coating, the thickness may be measured either on wet or dry surfaces.

Instructions should indicate the dry-to-recoat periods and limits of ambient conditions during the application process.

D.6 Testing

Destructive testing should be avoided.

Coat thickness testing should be carried out after each coat layer is applied, by means of appropriate thickness gauges.

D.7 Inspection

Surface preparation and coating application should be inspected as relevant in accordance with prior agreement between the parties involved. Inspections should be logged in an agreed format to be signed at the conclusion of each stage of the process.

Items to be inspected may include:

— working conditions;

— ambient conditions, i.e. temperature and humidity;

— surface preparation processes;

— coating application equipment;

— thickness of layers drying period for the different layers;

— final drying time;

— coating repairs.

During inspection, defective areas should be marked and appropriately repaired.

D.8 Maintenance

D.8.1 A corrosion protection system should be maintained throughout the lifetime of the valves.

Maintenance should be in accordance with the manufacturer's recommendations for the most effective way to preserve the efficiency of the corrosion protection system.

D.8.2 The type of cargo carried should be taken into consideration when deciding for the appropriate maintenance schedule. Factors that may influence the frequency of maintenance are:

— chemical aggressiveness of the cargoes and tendency of cargo vapour to crystallize;

— valve design features allowing condensate to accumulate;