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

Navires et technologie maritime — Soupapes de pression/dépression pour citernes à cargaison

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Foreword

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

This third edition cancels and replaces the second edition (ISO 15364:2007), which has been technically revised.

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

1 Scope

This International Standard is applicable 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. Design or manufacturing in accordance with 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 can be used in conjunction with pressure/vacuum valves.

NOTE 1 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, 2009" (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.

NOTE 2 In addition to providing pressure relief, high velocity vent valves are devices that prevent the passage of flame. Where high velocity vent valves are installed on the pressure relief system and the vacuum relief valve is protected by a flame arrester, the standards of IMO MSC/Circ. 677, as amended, are applicable. ISO 16852 is also an acceptable test standard for devices to prevent the passage of flame.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 (SOLAS)*, 2002, Chapter II-2, Regulation 4

International Maritime Organization (IMO), *International Convention for the Safety of Life at Sea (SOLAS)*, 2009

3 Terms and definitions

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

3.1
flame arrester
device to prevent the passage of flame, designed and tested in accordance with a specified performance standard

Note 1 to entry: Its flame-arresting unit is based on the principle of quenching.

3.2
dual nozzle valve
pressure relief valve that features two high velocity vents with different opening settings integrated into one valve, the flow characteristics of which may be one or more of the types defined below

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
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 (1 in) long joint, for all concentrations of the tested gas or vapour in air

Note 1 to entry: IEC 60079-20-1 standardizes the test apparatus and the test method.

3.6
maximum verified 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/or 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 1 to entry: 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 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 recognized 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 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 worn down, 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 D for additional considerations).

5.5 The verified drawings shall include a complete bill of materials showing conformity with this subclause 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 75 % of the nominal setting as determined by the manufacturer. See Annex I for suggested leakage rates.

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. Welding procedures should be in accordance with the ISO 15607 series. Welders should be qualified according to the ISO 9606 series. Non-destructive testing should comply with ISO 5817.

Alternative equivalent National/International Standards may be used.

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. The design shall prevent pockets of water or product from accumulating.

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.

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). Devices shall also be capable of operating at whatever surface temperature is developed by heating arrangements.

Where a valve is intended to be fitted in a ship that will be operated in climate conditions that might hamper its operation, e.g. seawater icing, the instruction manual should contain appropriate information to ensure continued operation.

6.8 End-of-line devices are required to direct the efflux vertically upward (see SOLAS 2009, 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 (e.g. check-lift) 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 and other moving parts shall close against the valve seat by metal to metal contact. Where the valve closes against a metal seat and a resilient seal is added to reduce gas leakage, the valve's performance in terms of flow shall not be affected if the seal is destroyed, damaged or is 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. 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.

6.13 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 solidify, heating arrangements may be necessary.

7 Type tests

7.1 Type tests shall be conducted by a laboratory acceptable to a third party inspection body. The laboratory should be qualified 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 who can certify that the tests are conducted in accordance with this International Standard.

7.2 One of each model device and each size shall be tested in accordance with Clauses 7, 8 and 9. A change of material or coating system 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 testing. 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 functions of the valve or its performance characteristics are affected, the third party inspection body shall be informed. An appropriate test related to the modified part may be required by the third party inspection body.

7.2.1 A corrosion test shall be conducted. In this test, a complete device 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.

7.2.2 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.

7.2.3 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.

7.2.4 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 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. After achieving the specified thickness, proper operation of the valve check-lift shall be verified. The maximum ice thickness at which the valve check-lift will operate properly shall be noted in the instruction manual (see Clause 11).

7.3 A test report with documentation for each prototype test shall be prepared by the laboratory. Further to the requirements given in ISO/IEC 17025:2005, 5.10.3, the test report shall as a minimum, include:

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

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

— an instruction manual provided.

8 Flow and velocity tests

8.1 Determination of capacity

The capacity of pressure and/or 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 8.2 to 8.4.

Where a pressure or vacuum valve is used with a flame arrester, the capacity of the overall assembly will be different than the capacity of a standalone valve. The capacity test may be conducted on the combined assembly or may be done separately.

8.2 Capacity data

The following requirements shall be met when establishing capacity data:

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

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

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

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

e) all measuring instruments shall be calibrated.

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

8.3 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 $5 \cdot D$ and a length no less than $1{,}5 \cdot D$ 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 recognized 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.

8.4 Flow measurements

8.4.1 Flow measurements for pressure and/or 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.

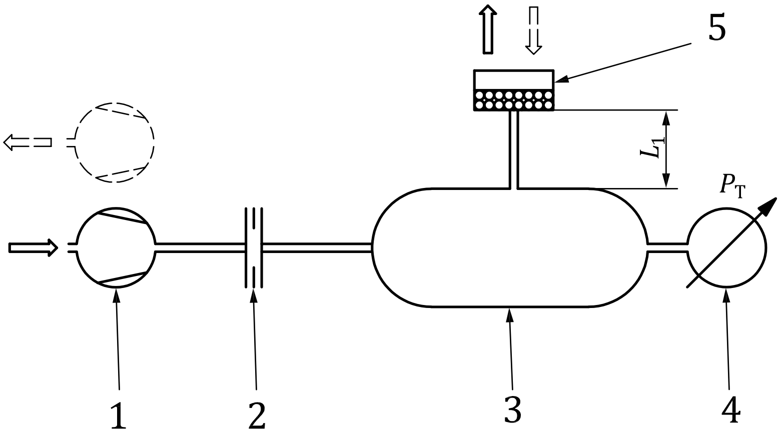
8.4.2 The pressure at which the valve opens shall be established using a flow rate resulting in a pressure rise no greater than 0,01 N/mm^2/min (10 kPa/min or 0,2953 in Hg). The set-pressure is designated as P_{set}, which shall be within ±3 % of the calculated set-pressure expressed as the correlation between the closing force and the area of the disc against which tank pressure is projected.

8.4.3 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.

NOTE Manufacturers may choose to provide information regarding the dispersion of the discharged gas.

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

8.4.5 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 flow meter

3 tank

4 pressure measurement

5 pressure/vacuum valve

L_1 length of connection pipe

NOTE Blower or fan flow is reversible depending on pressure or vacuum test.

Figure 1 — Flow test rig

9 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 8.4.1.

If a closing pressure value is established to be satisfactory, valves of the same model with higher set pressure but the same closing pressure need not be tested.

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 $0{,}2 \cdot Q_{close}$ and using this rate as the step width (maximum flow in this test: $2 \cdot Q_{close}$).

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}.

