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Safety devices for protection against excessive pressure —

Part 11: Performance testing

Dispositifs de sécurité pour protection contre les pressions excessives —

Partie 11: Essais de performance

ICS: 13.240

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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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 whom 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.

ISO 4126-11 was prepared by Technical Committee ISO/TC 185, Safety devices for protection against excessive pressure

ISO 4126 consists of the following parts, under the general title *Safety devices for protection against excessive pressure*:

— *Part 1: Safety valves*

— *Part 2: Bursting disc safety devices*

— *Part 3: Safety valves and bursting disc safety devices in combination*

— *Part 4: Pilot operated safety valves*

— *Part 5: Controlled safety pressure relief system (CSPRS)*

— *Part 6: Bursting disc safety devices – Application, selection and installation*

— *Part 7: Common Data*

— *Part 9 : Application and installation of safety devices excluding stand-alone bursting disc safety devices*

— *Part 10 : Sizing of safety valves and connected inlet and outlet lines for gas/liquid two-phase flow*

The following parts are under preparation

— *Part 11: Performance testing*

Introduction

The objective of this standard is to provide test procedures to determine the operating and flow characteristics of the safety device under test in such a way that the test rig has no influence on the results. It should be noted however that actual performance of the safety device in service may be influenced by a variety of installation, process and environmental factors.

ISO 4126-1, 4 and 5 highlight the effects of back pressure on valve performance. In order to account for these effects, methods for testing under built-up and superimposed back pressure conditions are also included in Annex C .

1. Scope

The purpose of this International Standard is to define the testing procedures to be applied for carrying out performance tests on closing, non-reclosing and combined safety devices for protection against excessive pressure as specified in ISO 4126 Parts 1, to 7, with particular reference to type testing

The objective of this standard is to provide test procedures to determine the performance of the safety device under test in such a way that the test rig has no influence on the results.

For reclosing devices specified in ISO 4126 Part 1, 4 and 5, the objective of the tests is to determine the performance of the safety device when operating with compressible non-condensing fluids and non-flashing liquids.

For non-reclosing devices covered in ISO 4126 part 2, the objectives of the tests are to establish the bursting pressure, the opening characteristics and the device resistance to flow when opened under compressible or incompressible fluid conditions.

In the case of testing with liquids the temperature of the liquid at the safety device inlet shall be limited in accordance to the following: in the case of water the maximum temperature at the inlet shall be 50 ^{O}C to avoid the risk of flashing; in case of other liquids, the maximum vapor pressure shall be 0,125 bar absolute.

NOTE Flow capacity measurements obtained using test procedures detailed in this standard are valid only for ideal gasses and vapors (as real gas effects are not considered). An ideal gas behavior can generally be assumed as long as the real compressibility factor (Z) of the test gas at inlet and nozzle conditions is within the range of 0,95 and 1,05. As an example, air and nitrogen at ambient temperature may be considered as ideal gas up to a pressure of 150 bar. Under real gas conditions or pressures above 250 bar the measurement devices and accuracies shall be modified to the current state of technology and in the sense of this standard.

NOTE It should be noted that actual performance of the safety device in service may be influenced by a variety of installation, process and environmental factors.

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.

— ISO 4126 Parts 1 to 9

3. Terms and definitions

For the purposes of this document, in addition to the terms and definitions given in ISO 4126 parts 1 to 9 each one considered in its application field (i.e., regarding the specific device), the following apply.

3.1
back pressure ratio (BPR)
the back pressure ratio is the ratio of back pressure and inlet pressure, usually expressed as a percentage

NOTE: BPR can be based on gauge or absolute pressures. Both can be used for the purpose of tracing the curve of discharge coefficient vs. BPR

3.1.1
BPRA

is defined as the ratio of absolute back pressure to absolute inlet pressure. The value of BPRA is always equal to 100% when the back pressure equals the inlet pressure

3.1.2
BPRG
is defined as the ratio of back pressure to inlet pressure, both expressed as gauge, BPRG is always zero under atmospheric back pressure conditions and equals 100% when the back pressure equals the inlet pressure

3.2
inlet pressure
the stagnation pressure acting at the safety device inlet section

3.3
operator
the person who supervises and manages the test

NOTE The operator shall have specific background and formal education in technical subjects including fluid mechanics, thermodynamics and related measurement equipment. Moreover, the technical staff qualified for test management and supervision shall have practical experience, as certified by laboratory training records.

3.4
performance
the combined operating and flow characteristics of the safety device

3.5
safety device (SD)
all safety devices for the protection against excessive pressure addressed in ISO 4126 part 1 to part 5

3.6
sample
a safety device for the protection against excessive pressure, ready to be tested in the adjusted condition as specified by its manufacturer, and identified by a serial number or other code uniquely identifying the device to be tested and its parts

4. Preliminary agreements

Parties involved in tests shall make preliminary agreements about laboratory methods and procedures.

If any of the items listed here below are changed, then the safety device under test shall be identified as a new test sample.

4.1. When submitting a reclosing sample

Parties submitting a reclosing sample (all SD except bursting disc devices) for testing should at least specify to the laboratory the following items prior to conducting the test.

a) name and address of manufacturer;

b) serial number or other code uniquely identifying the sample to be tested and/or its parts (e.g. spring);

c) applicable parts of ISO 4126;

d) fluid to be used for testing;

e) inlet and outlet size and connection types;

f) declared flow area or flow diameter (Note: the actual measured value shall be used for the evaluation of the discharge coefficient);

g) method to be applied for set pressure detection;

h) method to be applied for reseating pressure detection;

i) marked set pressure;

j) cold differential test pressure (if applicable);

k) overpressure;

l) test conditions including;

1. atmospheric back pressure
2. built-up back pressure (if requested)
3. superimposed back pressure (if requested)

m) Main expected operational characteristics, at least including:

1. expected reseating pressure;
2. expected disc lift at overpressure;

3. expected discharge coefficient;
4. built-up back pressure range (if requested);
5. superimposed back pressure range (if requested).

4.2. When submitting a CSPRS sample

Parties submitting a CSPRS sample for testing should, in addition to those listed in 4.1, at least specify to the laboratory the following items prior to conducting the test.

a) opening sensing pressure and closing sensing pressure;

b) functional times (opening and reseating times, opening and reseating dead times);

c) measurement of the control unit flow capacity, if applicable;

4.3. When submitting a non-reclosing sample

Parties submitting a non-reclosing sample for testing should at least specify to the laboratory the following items prior to conducting the test:

a) Name and address of manufacturer;

b) lot number or other code uniquely identifying the sample to be tested;

c) model or type designation of bursting disc and corresponding holder;

d) applicable parts of ISO 4126;

e) inlet and outlet size and connection types;

f) declared minimum net flow area;

g) specified bursting pressure, coincident temperature and performance tolerance;

h) fluid to be used for testing;

i) test method:

1. discharge capacity or coefficient

2. flow resistance

For flow resistance testing also include:

j) one size or three size method;

k) requested K_R type:

1. K_{RG}, - all bursting discs are opened with gas

2. K_{RL} - all bursting discs are opened with liquid

3. K_{RGL} - one disc of each size is opened with liquid, the others with gas

l)

4.4. When submitting a safety valve and a bursting disc in combination

For combination flow capacity testing also include:

a) safety valve information as listed in 4.1, at least including items a, b, d, e, f, h, j, k,l,

b) bursting disc information as listed in 4.3, at least including items a, b, c, e, g,

c) one size or three size method as specified in IS0 4126-3

5. General requirements for test rigs and instrumentation

5.2. Test rigs

This section applies to all reclosing SD (all SD except bursting disc devices)

It is assumed that the test facility has adequate capacity and sufficient pressure to conduct the tests. The test rig and instrumentation shall allow for the determination, at least, of the valve operating and flow characteristics under atmospheric backpressure conditions.

The data acquisition and measurement system (including supply lines) shall be sufficiently responsive to accurately capture the test system and safety device performance characteristics applicable to the time scale of the phenomena under analysis. In order to improve the frequency response of the pressure measurement, particular care must be taken to reduce the length and capacity of the pressure lines and the volume of the cavities connecting the pressure tapping to the pressure transducers.

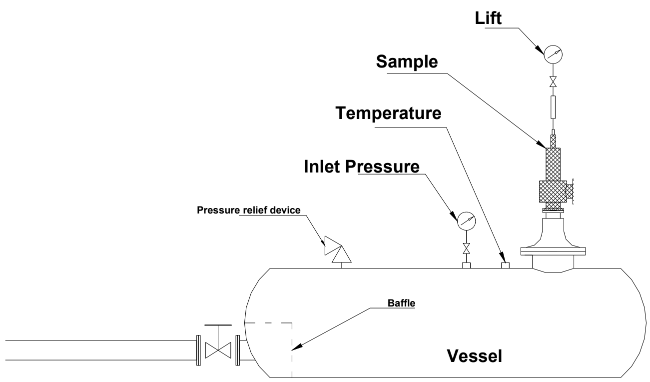

Figure 1 (informative): functional sketch of test rig for reclosing safety devices. Flow rate meter section is not shown.

Users of this standard must consider the effects of testing samples characterized by a slow response times (e.g. related to the presence of large volumes in the valve pressure chamber in the case pilot operated safety valves, long sensing lines, functional and dead times in the case of CSPRS) compared to the time variation of the inlet pressure. When testing pilot operated safety valves or CSPRS, the inlet pressure ramp should be evaluated before testing in order to avoid that a too steep inlet pressure ramp can influence the evaluation of the sample performance. As a general feature, inlet pressure at the beginning of the test and the pressure increasing/decreasing rate shall be related to the valve size and type (direct, pilot operated and CSPRS).

When testing with liquids particular care must be taken to evaluate the absence of pressure fluctuations superimposed to the inlet pressure ramp capable to influence sample performance (e.g., water hammer or acoustic pressure waves due to sudden changes of the inlet pressure, fast valve openings in the supplying system, etc.)

A generic informative functional sketch of the plant is shown in Figure 1, which is not intended to imply any particular arrangement of test equipment.

Since inlet pressure is used for the calculation of the theoretical flow capacity (q_m), and q_m is used for discharge coefficient calculation, particular attention must be given to the cross section of the vessel, to the location of the pressure tapping in the vessel, and to the contours of the inlet connections. The inlet pressure may be measured in the vessel or in the feed pipe between the vessel and the safety device. It is permitted to determine the inlet pressure by measuring the static pressure if the vessel or the feed pipe cross-section is greater or equal to 10 times the valve flow area or it shall be demonstrated that the accuracy of the measurement quantities are not affected. If this is not the case, the inlet pressure shall be determined by the application of a properly oriented stagnation pressure probe located immediately upstream of the safety device inlet section. The stagnation pressure drop between the inlet pressure measuring section and the valve inlet should not exceed 1% of set pressure. If a higher pressure drop occurs, a correction on the inlet pressure reading shall be performed in order to properly evaluate the stagnation pressure acting at the valve inlet. In any case the stagnation pressure drop shall not exceed 3%.

NOTE: in order to limit the inlet total pressure loss, a general good practice is to avoid too sharp edges on the connection(s) between the vessel and the sample.

In test rigs for liquids, where pumps are used to deliver fluid to the test valve, particular care shall be taken so that the amplitude of the pressure pulsations does not affect the operating and flow characteristics of the safety valve, pressure measurement as well as flow capacity measurements. The use of a damper can be considered in order to limit pressure fluctuations.

The general test arrangement for operating and flow capacity testing with steam is similar to the one required for testing with other compressible fluids, with the following points also being considered:

a) when testing with saturated steam, the steam quality shall be measured by suitable devices such as a throttling calorimeter: the reference condition should be dry saturated steam with limits of 98% minimum quality and maximum 10 ˚C of superheat;

b) tests may be performed on superheated steam if required by particular application;

c) test systems should be suitably insulated, and warmed up before test;

d) performance testing should take into account the need to bring the pressure relief device up to operating temperature, and acknowledge that additional set pressure and blowdown test cycles may be needed to achieve stable operating characteristics. For large valves, temperature measurements may be needed to verify the valve is at working temperature;

e) during flow capacity measurements on steam, suitable methods must be employed to account for condensation in the test vessel of steam that has been measured as passing through the flow measurement device;

f) For timed weight condensate systems, the back pressure on the valve shall be measured and controlled.

This may not cover all elements of steam testing.

5.3. Instrumentation

All instruments used during performance testing shall be periodically calibrated in accordance to the laboratory quality standards requirements and shall be directly or non-directly referable to certified primary instruments of lower uncertainty.

The laboratory shall define a procedure for the evaluation of the expanded measurement uncertainty of direct and non-direct quantities; the method will be defined by the application of an international standard (e.g. ISO 21748:2010, ISO/IEC Guide 98-1:2009 Part 1, ISO/IEC Guide 98-3:2009), or by other referable and verified methods based e.g. on propagation error theory or Monte Carlo Method (e.g.: ISO/IEC Guide 98-3:2008/Suppl 1:2008).

Pressure and lift measurement shall be characterized by a frequency response sufficient to follow the dynamic of the test such as to allow the accurate measurement of overpressure, blow down and discharge coefficient/flow rate

5.3.1. Pressure measurements

The uncertainty of pressure measurement shall be within ± 0,5% of measured values.

Pressure taps should have an aspect ratio (length / diameter) of not lower than 2,5 with a minimum diameter of 2 millimeters. Edge of hole should be clean and sharp or slightly rounded free from burrs, wire edges or other irregularities. In no case can any fitting protrude inside the pipe.

Flow measurement details for steam should include references concerning temperature protection of the pressure measurement equipment with suitable water seals (condensation pots).

