IGV IndustrieGase Verband e.V.

Position Paper §

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Adjusting and examination of safety valves

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1. Introduction

Safety valves are used to protect against excessive pressure and are the ultimate safety for a container or piping system. A safety valve opens automatically, unassisted by any energy other than that of the medium and allows enough medium to flow out to prevent a predefined pressure from being exceeded. A safety valve closes when normal operating conditions prevail again. Safety valves must be state of the art and suitable for the intended use. The basis for the development of safety valves is ISO 4126.

A safety valve is a piece of equipment with a safety function to protect pressure equipment when the permissible limits are exceeded and thus falls under Directive 2014/68/EU (Pressure Equipment Directive) of the European Parliament and of the Council Article 2. section 4.

To ensure functional readiness, safety valves require special attention during installation and maintenance.

2. Scope

The position paper provides a recommendation for the definition of measures for setting and testing safety valves.

3. Terms and Definitions according to ISO 4126-1

3.1 Set pressure

Predetermined pressure at which a safety valve under operating conditions commences to open.

3.2 Cold differential pressure

Value of the inlet static pressure at which the disc re-establishes contact with the seat or at which the lift becomes zero The valve manufacturer (HEROSE) defines the method as "first audible opening".

3.3 Overpressure

Pressure increases over the set pressure.

ISO 4126-1 makes no distinction regarding the opening characteristic. The German standard "AD 2000 – Merkblatt A2" divides safety valves according to their opening characteristics into:

- Normal-lift safety valves
- Full-lift safety valves
- Proportional safety valves

3.4 Reseating pressure

Value of the inlet static pressure at which the disc re-establishes contact with the seat or at which the lift becomes zero (tightness is not discussed here!).

4. Allowable tolerances

a) Sei pressure: ±3 % of set pressure or ±0,1 bar, whereby the larger value applies.

b) Overpressure:

- Normal lift safety valves open within a pressure increase of maximum 10 % of the set pressure. At pressures < 1 bar, the pressure increase can be a maximum of 0.1 bar.
- Full-lift safety valves open almost abruptly within a pressure increase of maximum 5 % of the set pressure.
- Proportional safety valves open almost continuously depending on the pressure rise within a maximum pressure rise of 10 %.

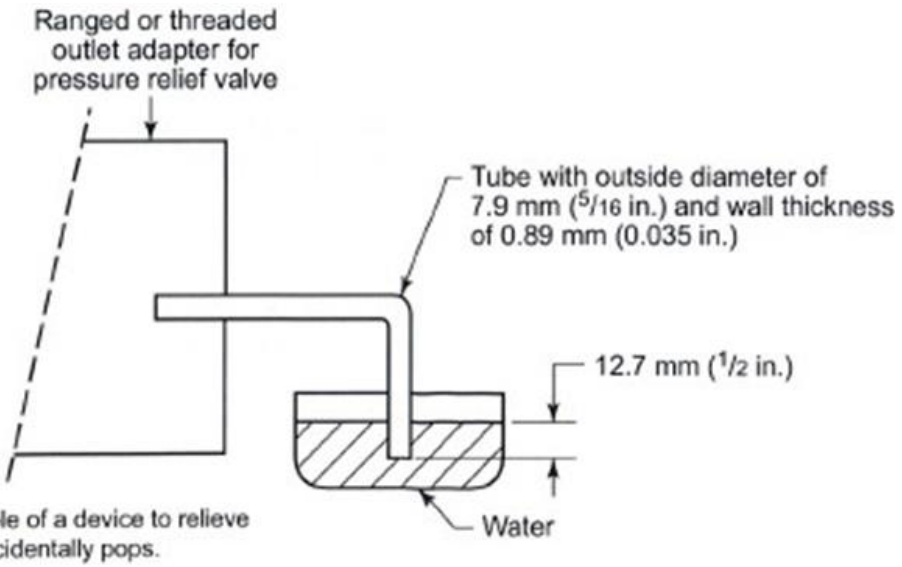
c) Reseating pressure:

- for compressible media:10 % of set pressure, below 3 bar 0.3 bar difference applies, both according to "AD 2000-Merkblatt A2" (at least 2 %, at most 15 % or 0.3 bar, whichever is greater, according to ISO 4126-1)
- for non-compressible media: 20 % of the set pressure, below 3 bar 0.6 bar difference applies, both according to "AD 2000-Merkblatt A2" (minimum 2.5 % maxima 20 % or 0.6 bar, whichever is greater, according to ISO 4126-1)

5. Testing of safety valves

Safety valves are tested for seat tightness at the factory after the set pressure or cold set pressure has been adjusted. The leakage rate and the test procedure are to be agreed between the manufacturer and the purchaser. API 527 can be used for this purpose.

Test setup according to API 527:



NOTE See Figure 2 for an example of a device to relieve body pressure in case the valve accidentally pops.

Figure 1—Apparatus to Test Seat Tightness with Air

Before the leak test, the set pressure should be verified, and all valve body connections and fittings should be checked with a suitable solution to ensure that all connections are tight.

Before counting bubbles, apply the test pressure for at least one minute to a valve whose nominal pipe size is 50 mm (2 in.) or smaller, two minutes to a valve with a nominal pipe size of 65 mm, 80 mm or 100 mm (21/2 in.) and five minutes to a valve with a nominal pipe size of 150 mm (6 in.) or larger. The valve must then be observed for leakage for at least one minute.

Acceptance criteria:

For a metal-to-metal seated valve, the leakage rate in bubbles per minute may correspond to the values in Table 1. For a soft-seated valve, there must be no leakage for one minute (0 bubbles/min).

Table 1—Maximum Seat Leakage Rates for Metal-Seated Pressure Relief Valves

Set Pressure at 15.6 °C (60 °F) kPa (psig)	Orifice Diameter Less Than or Equal to 18 mm (0.700 in)		Orifice Diameter Greater Than 18 mm (0.700 in)	
	Leakage Rate (Bubbles/min)	Approximate Leakage/24 hr Standard m^3 (ft^3)	Leakage Rate (Bubbles/min)	Approximate Leakage/24 hr Standard m^3 (ft^3)
13 to 6896 (15 to 1000)	40	0.017 (0.60)	20	0.0085 (0.30)
10,300 (1500)	60	0.026 (0.90)	30	0.013 (0.45)
13,800 (2000)	80	0.034 (1.20)	40	0.017 (0.60)
17,200 (2500)	100	0.043 (1.50)	50	0.021 (0.75)
20,700 (3000)	100	0.043 (1.50)	60	0.026 (0.90)
27,600 (4000)	100	0.043 (1.50)	80	0.034 (1.20)
34,400 (5000)	100	0.043 (1.50)	100	0.043 (1.50)
41,400 (6000)	100	0.043 (1.50)	100	0.043 (1.50)

6. Type tests of safety valves according to DIN EN ISO 4126-1

The definition of the maximum occurring mass flow that must be released by the safety valve for overpressure protection of the tank is carried out in accordance with the calculations according to ISO 21013-3.

The manufacturer guarantees that a safety valve is capable of discharging the required mass flow by carrying out functional and performance tests on approved test equipment. The exact test procedure and scope is described in detail in ISO 4126-1.

The discharge coefficient Kd determined during the performance test is reduced by a factor of 0.9. This now results in the reduced outflow coefficient Kdr, which must be marked on the safety valve.

Compliance with the standard requirements must be confirmed by a notified body (e.g. TÜV) in accordance with the Pressure Equipment Directive (2014/68/EU). The confirmation is usually made by an EU type examination.

Plants or tanks are protected by calculating a maximum blow-off capacity and selecting a safety valve for this incident. For this purpose, a type test according to ISO 4126-1 can be carried out.

During the type examination, the safety valve to be tested is functionally tested on the test bench over all spring ranges, both in the lower and upper pressure ranges. The measured values are used to determine the smallest stroke, the so-called nominal stroke, at which the safety valve opens. For the flow test, the valve to be tested is set with the nominal stroke. After determining the outflow coefficient Kd, a reduced outflow coefficient Kdr is assigned to the valve. This value is 90 % of the determined value.

7. Adjustment of safety valves

Safety valves are secured against unauthorised adjustment (e.g. lead sealing).

Adjustments to safety valves may only be carried out by specialist personnel authorised by the manufacturer. The documents provided for this purpose must be followed.

8. Examination of safety valves

Safety valves are divided into soft-sealing and metal-t-metal sealing depending on the sealing.

8.1 Examination before first commissioning

If soft-seated safety valves are installed in a system, it is recommended to check the set pressure before initial commissioning. Due to storage of the safety valves in a depressurised state or unforeseen events that occur during transport of the equipped tank or system to the installation site (impacts, shocks, environmental influences...), the finely machined sealing surfaces on the valve seat and disc can adhere due to adhesion forces and lead to an increased set pressure. The inspection may only be carried out by competent, authorised and instructed employees or by other contractors with comparable qualifications who are suitable for carrying out the inspection work (BetrSichV §10, Para. 2).

When using soft-sealing, liftable safety valves, it is sufficient to check the lift ability. However, it must be ensured that at least 80 % of the set pressure is present in the inlet of the safety valve.

Carry out the set pressure test:

Before testing, it is recommended to check the marking on the safety valve with the information on the associated documents or to compare it with the maximum permitted pressure of the tank. If the changeover or divertor valve is connected upstream, the test can be carried out in the installed state. A calibrated pressure gauge of accuracy class 0.6 must be connected to the test connection. The test pressure is slowly increased under the safety valve until the safety valve audibly begins to open. The test pressure gauge is to be observed closely during this process. At the end of the test, the excess pressure is released via a bypass valve.

If metal-to-metal seated safety valves are stored properly according to the manufacturer's instructions, it is not absolutely necessary to check the set pressure before the first commissioning. Due to the metallic seal, it cannot be assumed that the set pressure will increase during storage in the non-pressurised state.

Minor leaks may occur even before the set response pressure (see para. 5. Seat tightness test). This applies to both soft-seated and metal-seated safety valves and does not count as set pressure.

8.2 Periodic inspections

For safety valves with lifting device (lever or screw), the test for the free movement of the moving parts can be used by lifting, whereby a pressure of at least 85 % of the set pressure must be maintained under the valve seat (see ISO 4126-1 §3.3 and "AD 2000-Merkblatt A2 §4.3.1"). Safety valves without lifting device are tested for free movement of the moving parts by increasing the pressure under the valve seat to the set pressure and accompanied by an exhaust noise.

The level of the set pressure as well as the control of the free movement of all moving parts shall be checked at regular intervals. The employer determines these intervals of the periodic inspections according to the operating conditions. Recommendations of the manufacturer and the responsible independent body serve as a basis for this. These intervals can be adjusted within the framework of the risk assessment. The latest time is the external or internal inspection of the associated pressure vessel ("AD 2000-Merkblatt A2 § 4.7" or "BetrSichV Annex 2, section 4, 2.2.").

The functional tests of the safety valves can be carried out by a qualified person, provided that suitable test equipment is made available by the employer.

Functional tests as part of maintenance measures, on the other hand, can also be carried out by qualified, authorised or instructed persons. [6]

The functional test must always be documented.

9. Bibliography

[1] ISO 4126-1, Safety devices for protection against excessive pressure
[2] API 527, Seal tightness of pressure relief valves
[3] AD 2000-Merkblatt A2, Safety devices against excess pressure - Safety valves
[4] Directive 2014/68/EU
[5] ISO 21013-3, Crygenic vessels – Pressure-relief accessories for cryogenic service – Part 3 Sizing and capacity determination
[6] DIN 31051 Basics of maintenance