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1 Purpose

The purpose of this LESER information document (LID) is to provide valve repair shops with a guideline and the necessary assessment criteria to test LESER safety valves after assembly. It is valid for all LESER safety valves except the Clean Service “Easy to Maintain” configuration. Please refer to LGS 0201 and 0202 for those valves.

2 Overview

This document describes the tests that need to be done for every new or repaired LESER safety valve after the valve is assembled. It is written with external service partners, like LESER partners, LARCs or Assemblers, in mind. Therefore, no explanation for certain procedures or acceptance criteria is given. Please consult the referenced documents for detailed information. The image below shows what tests are required for gas tight and non-gas tight valves and in what chapter of this document the testing procedures can be found.

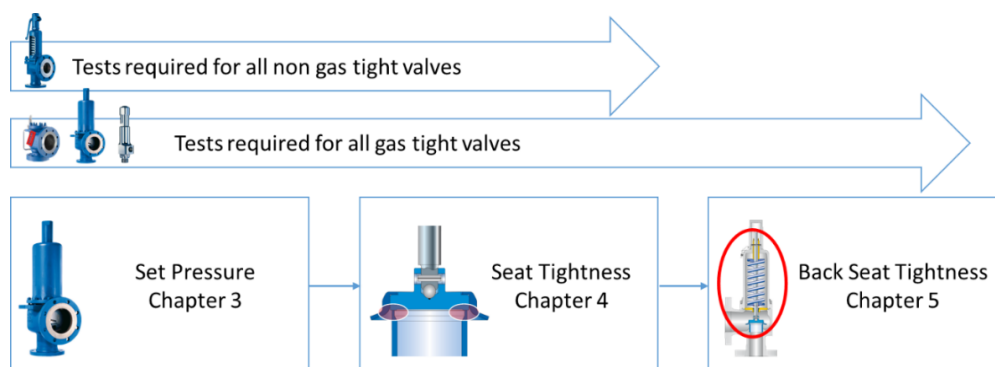


Figure 1: Required tests for gas tight and non-gas tight valves.

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3 Cold differential set pressure test

Each safety valve shall be adjusted to its designated set or cold differential test pressure (hereafter CDTP). The purpose of this test is to ensure that all the safety valves meet the requirements for which they have been designed. CDTP is used if correction of set pressure of safety valves according to deviation of service conditions is necessary (temperatures and superimposed constant back pressure). The test medium is used according to the below table, if not otherwise specified by the customer.

Table 1: Medium of operation vs test medium

Medium of Operation	Test medium for valves with CE (PED)	Test medium for valves with UV (ASME)
Gas	Air at room temperature	Air at room temperature
Liquid	Air at room temperature	Water at room temperature
Steam	Air at room temperature	Steam (see ASME UG-136(d)(4) for exemption)

Each safety valve will be pressurized and the set pressure will be determined at the cold differential test pressure. The set pressure tolerances for LESER valves are as per below table:

Table 2: Set pressure tolerances

Set Pressure P_{set}	Tolerance
$P_{set} \leq 1,65 \text{ barg (24 psig)}$	+ 0,05 barg (1 psig)
$1,65 \text{ barg (24 psig)} < P_{set} < 3,96 \text{ barg (58 psig)}$	+ 0,1 barg (2 psig)
$P_{set} \geq 3,96 \text{ barg (58 psig)}$	+ 3%

For evaluation of actual set pressure 3 single serial values have to be within a repeat accuracy of 1%. The average value of these 3 single values is the determined actual set pressure, which has to be within the above specified allowable tolerance. See the below sample graphic for 10 barg.

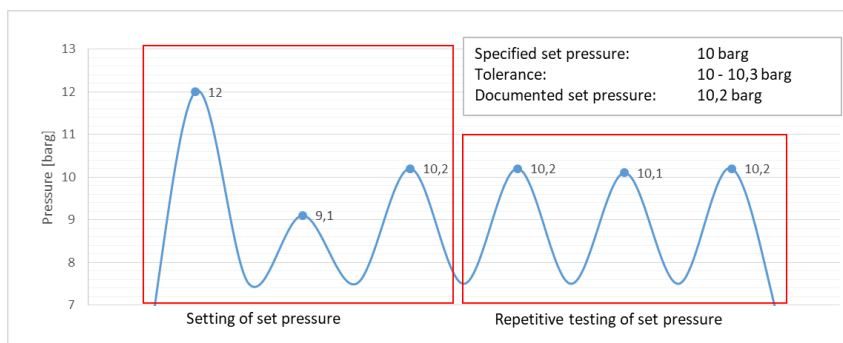


Figure 2: Exemplary set pressure test for 10 barg

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3.1 CDTP Correction

The CDTP-correction is the correction of set pressure at test bench condition to achieve the correct set pressure at service condition. For calculating the CDTP, the below formula applies:

LESER datasheet of CDTP (Cold differential test pressure)	
$P_{CDTP} = (P_{set} - P_a) * k_T$	$P_{CDTP} = (P_{set} * k_{af}) * k_T$ (Type 459/462 w. bellows only)
P_{CDTP} : cold differential test pressure [psig or barg] P_{set} : set pressure at service conditions [psig or barg] P_a : constant superimposed back pressure [psig or barg] k_T : correction factor for CDTP, temperature influence [-] k_{af} : correction factor for type 459 / 462 w. bellows, deviating effective area influence [-]	

The correction factors for k_T and k_{af} can be found in the two following tables, where missing values can be interpolated using the below formula:

$$y = y_0 + (x - x_0) * \frac{y_1 - y_0}{x_1 - x_0} \quad ; \text{ with } y: k_T / k_{af} \text{ and } x: ^\circ C / ^\circ F$$

Table 3: CDTP correction factor k_T calculation

°C	°F	Conventional		Balanced Bellows or Inconel spring			
		Open Bonnet	Closed Bonnet	Open Bonnet	Closed Bonnet		
550	1022	Limitation at 427°C	Limitation at 350°C	1,049	1,049		
500	932			1,032	1,032		
450	842			1,021	1,021		
400	752	1,049		1,013	1,013		
350	662	1,032	1,049	1,007	1,007		
300	572	1,021	1,032				
250	482	1,013	1,021				
200	392	1,007	1,013				
150	302		1,007				
100	212	No influence of service condition on CDTP, correction factor: 1,000					
-250	-418						

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Table 4: Deviating effective area correction factor k_{af} for 459/462

$P_a/P_{set} * 100$ [%]	k_{af}		$P_a/P_{set} * 100$ [%]	k_{af}	
	$d_0 = 9$ [mm]	$d_0 = 17,5$ [mm]		$d_0 = 9$ [mm]	$d_0 = 17,5$ [mm]
0,0	0,999	0,998	14,0	1,048	0,904
1,0	1,001	0,990	16,0	1,059	0,893
2,0	1,003	0,983	18,0	1,070	0,882
3,0	1,005	0,975	20,0	1,083	0,872
4,0	1,008	0,968	22,0	1,097	0,863
5,0	1,011	0,961	24,0	1,111	0,855
6,0	1,014	0,954	26,0	1,126	0,847
7,0	1,018	0,947	28,0	1,143	0,840
8,0	1,021	0,940	30,0	1,160	0,833
9,0	1,025	0,934	32,0	1,178	0,827
10,0	1,029	0,927	34,0	1,197	0,822
12,0	1,038	0,915	35,0	1,207	0,819

3.2 Set Pressure Definitions

LESER's set pressure definitions are as following:

Test Procedure	Set Pressure Definition	Additional Notes
Air	Initial Audible Discharge	Simmer point (Not pop)
Water	First Steady Stream	Water streaming steadily and perpendicularly (90°) from the outlet
Steam	Initial Audible Discharge	Valve seat to be heated to min. 50° C (122° F)

For all testing media: during the interval starting at 90% of the set pressure, the rate of pressure increase shall not exceed 2.0 psi/sec [0.15bar/sec.] or whatever lesser rate of increase is necessary for the accurate and repeatable reading of the pressure.

3.3 Test Procedure for Air

After assembly the safety valve will be pressurized and adjusted via adjusting screw to the given set pressure. The procedure of setting and testing of cold differential test pressure with air is described exactly for each valve type in the working instructions (assembly / installation documentation). The set pressure is reached when the first discharge of air is audible. A saturated opening with clear clicking noise or crack shall be reached. A slow response is not allowed.

3.4 Test Procedure for Water

The valve is first set on air to the desired cold differential test pressure. Then it is mounted on the water test bench and the inlet body is filled with water, without an air cushion. This is ensured by increase of pressure to the safety valve until the first water flow drains off. After the air cushion was removed from the inlet the pressure must be reduced to 0 bar (psig). Then, the set pressure is set with water. The set pressure of the valves is reached when you see the first continuous water flow, the first steady stream.

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3.5 Test Procedure for Steam

The safety valves are initially set and tested on air. The assembly and pressure preset on air of safety valves with pressure setting to steam is carried out the same way as for safety valves on air. The steam generator and the steam test bench are started up in accordance with the instruction manual. The test bench is warmed up at approx. 90 % of CDTP until the test temperature has been reached.

Each safety valve then has to be opened min. 3 times to warm up the valve seat and the valve disk to min. 50°C (above 50°C no condensation will occur below the seat).

Alternatively, the valve may be opened using a mechanical lifting device so that the valve reaches the required test temperature.

The set pressure of the valve is reached when the discharge of steam is audible (swooshing or roaring hiss sound). It is important to ensure that the audible sound is indicating the start of the opening of the valve (equilibrium of pressure induced force and spring force is reached) and not just the beginning of leakage between the disc and seat caused by system pressure approaching set pressure (slight hissing sound).

3.6 Differences in the procedure for POSVs

In case where a special pilot test bench is available the pilot control should be set to cold differential set pressure, together with the blow down for pop action pilots, on its own. After setting the pilot and performing the leak test, the complete POSV is assembled. Each complete POSV is then tested for its definite cold set pressure. If this has been achieved by setting the pilot, then no other settings are necessary. However, if there are deviations from the specified cold set pressure, then they will be corrected by resetting the pilot.

If no special pilot test bench is available the whole pilot operated safety valve is assembled first and then set pressure testing and leakage test are performed on the valve as a whole, using the procedures for flanged safety valves.

After setting the POSV on water the assembly must be cleared of any water residue. Therefore, the pilot assembly shall be actuated two times at the test-bench with air. Then, the plug of the pilot (Item 20) shall be removed to release the water. Compressed air is then used to blow dry the return spring area. The plug shall be re-assembled after this. Next, the pilot and manifold block will be detached from the main valve. The manifold block shall be dried with compressed air and assembled again.

4 Seat Tightness Test

All LESER safety valves have to be tested on tightness. The tightness test is set up to ensure that each safety valve fulfils the requirements for which they have been design without suffering from leakage of pressurized parts or seals. The tightness test is standard practiced at LESER after the set pressure is demonstrated. The leakage rates shall be documented. The test medium for determining the seat tightness, air, steam or water, shall be the same as that used for determining the set pressure of the valve. For dual- service valves, the test medium, air, steam or water, shall be the same as the primary relieving

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medium. As a standard technique, the minimum or maximum temperature shall not be below 5°C (40°F) nor above 50°C (122°F) during the test.

The test pressure, procedures and acceptance criteria for each medium are described in the following subchapters.

4.1 Test Pressure for all mediums

Set Pressure / CDTP, p_0	Test pressure, p_{test}
$0,1 < p_0 < 0,7$ (bar) $1,45 < p_0 < 10,15$ (psi)	$0,5 * p_0$
$0,7 \leq p_0 \leq 3,5$ (bar) $10,15 \leq p_0 \leq 50,8$ (psi)	$p_0 - 0,35$ (bar) $p_0 - 5,08$ (psi)
$p_0 > 3,5$ (bar) $p_0 > 507,6$ (psi)	$0,9 * p_0$

4.2 Seat Tightness Test on Air

4.2.1 Testing on air for gas tight safety valves

4.2.1.1 Procedure

Testing on air is done according to and with the specified equipment in the API 527. The valve shall be vertically mounted on the test stand, and the test apparatus shall be attached to the valve outlet. All openings-including but not limited to caps, drain holes, vents, and outlets-shall be closed.

The valve shall then reach set pressure once and afterwards the inlet pressure is decreased to the test pressure. The water shall then be observed for 1 minute at the test pressure and the number of bubbles counted.

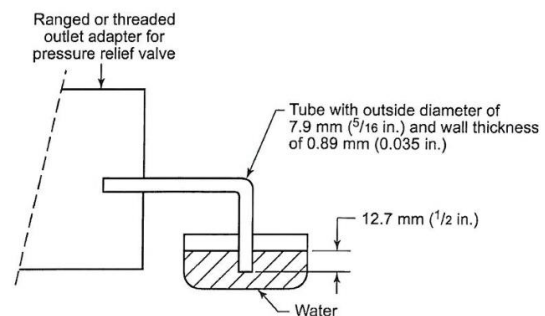


Figure 3: Apparatus to test seat tightness with air. (API 527)

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4.2.1.2 Acceptance Criteria

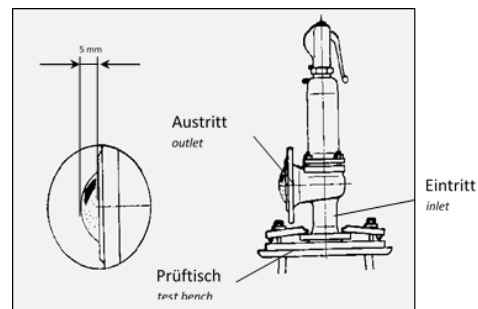
Seal type	Set pressure p_0 (related to 16°C)			Allowed Number of Bubbles [Bubbles / min]	
	[bar-g]	[kPa-g]	[psi-g]	$d_0 \leq 18 \text{ mm}$	$d_0 > 18 \text{ mm}$
Metal-to-metal sealing	$0,1 \leq p_0 \leq 69$	$10 \leq p_0 \leq 6.900$	$1.45 \leq p_0 \leq 1.000$	40	20
	$69 < p_0 \leq 103$	$6.900 < p_0 \leq 10.300$	$1.000 < p_0 \leq 1.500$	60	30
	$103 < p_0 \leq 850$	$10.300 < p_0 \leq 85.000$	$1.500 < p_0 \leq 12.328$	80	40
Soft sealing plate	$0,1 \leq p_0 \leq 850 \text{ bar}$	$10 \leq p_0 \leq 85.000$	$1.45 \leq p_0 \leq 12.328$	20	10
Soft sealing O-Ring or disc with vulcanized soft sealing	$0,1 \leq p_0 \leq 850 \text{ bar}$	$10 \leq p_0 \leq 85.000$	$1.45 \leq p_0 \leq 12.328$	0	0

4.2.2 Testing on air for non-gas tight safety

4.2.2.1 Procedure

The safety valves are mounted via clamping jaw vertically at the inlet flange on the test bench. For the sealing a rubber pad is laid down under the inlet flange of the safety valve.

After setting of the safety valve the seat leakage test is carried out. A foamy lotion is drawn over the outlet orifice. The extension under pressure and the leakage volume is then observed at the outlet for 1 minute at test pressure.



4.2.2.2 Acceptance Criteria

The sealing between seat and disc fulfils the tightness requirements, if the bubble extends not more than 5 mm.

4.3 Seat Tightness Test on Water

4.3.1 Procedure

Before starting the seat tightness test the inlet body bowl shall be filled with water, which shall be allowed to stabilize with no visible flow from the valve outlet. The inlet pressure shall then be increased to the test pressure. The valve shall then be observed for 1 minute at test pressure.

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4.3.2 Acceptance Criteria

	Nominal Inlet Size DN and NPS	10	15	20	25	40	50	80	100	125	150	200	250	300	400	
		3/8"	1/2"	3/4"	1"	1 1/2"	2"	3"	4"	5"	6"	8"	10"	12"	16"	
Allowable number of water drops per inlet size	Metal seated	1				2	3	5	6	8	10	13	16	20	26	
	Soft seated	No visible leakage														

4.4 Seat Tightness Test on Steam

4.4.1 Procedure

Any condensate in the body bowl shall be removed before the seat tightness test. Air (or nitrogen) may be used to dry condensate. After any condensate has been removed, the inlet pressure shall be increased to the test pressure and be held for at least three minutes to heat up the valve. Tightness is then checked visually using a black background. The valve shall be observed for leakage for at least one minute.

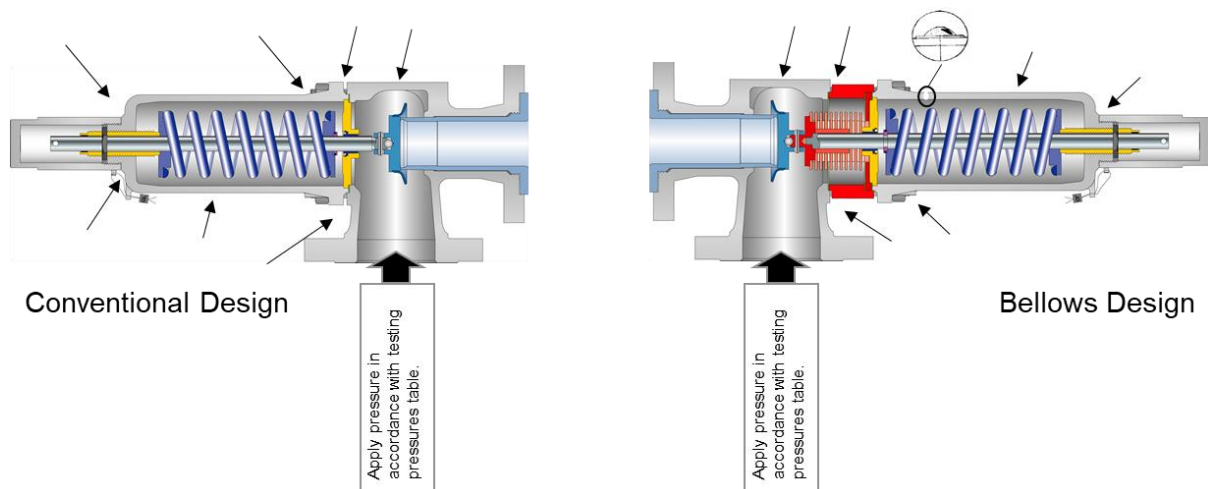
4.4.2 Acceptance Criteria

No recognized or visible leakage.

5 Back seat tightness (Outlet tightness)

5.1.1 Procedure

The tightness test of the back sealing, LESER named it tightness outwards, is carried out for all LESER's safety valves in gastight design and for all POSVs. After testing of the seat leakage and the test pressure the safety valve will be tightened (outlet) on the test bench and admitted with pressure. Reaching the test pressure, the safety valves will be sprayed at the connections and the outlet area with a non- volatile and viscous test fluid. In case of a balanced bellows design the test fluid is drawn over the drainage whole in the bonnet.



The below testing times and test pressures apply.

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Table 5: Testing pressures and times for back seat tightness test

Nominal Size	Minimum test time [s]	Test pressure P_{test} Normal		Test pressure P_{test} PFTE / Elamstomer components			
				$p0 < 3$ bar		$p0 \geq 3$ bar	
		bar	psi	bar	psi	bar	psi
		\leq DN 50 (2")	15	6	87	0.15	0.15
DN 65 (3") - DN 150 (6")	60	6	87	x	x	2	28
\geq DN 200 (8")	60	2,5	36	P0	P0		

5.1.2 Acceptance Criteria

The acceptance criteria is that no foam appears on the tested area and the fluid film over the drainage whole does not have a bubble.

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