

Installation problems for balanced bellows safety valves

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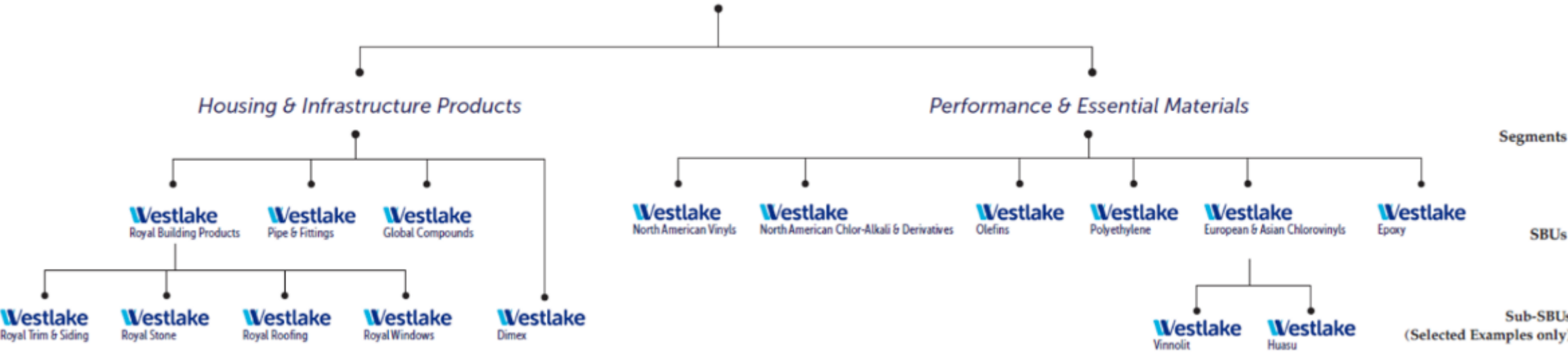
Superintendent - Process Safety, Europe and Asia

Westlake





Westlake Overview

A global producer of performance and essential materials and building products, HQ in Houston

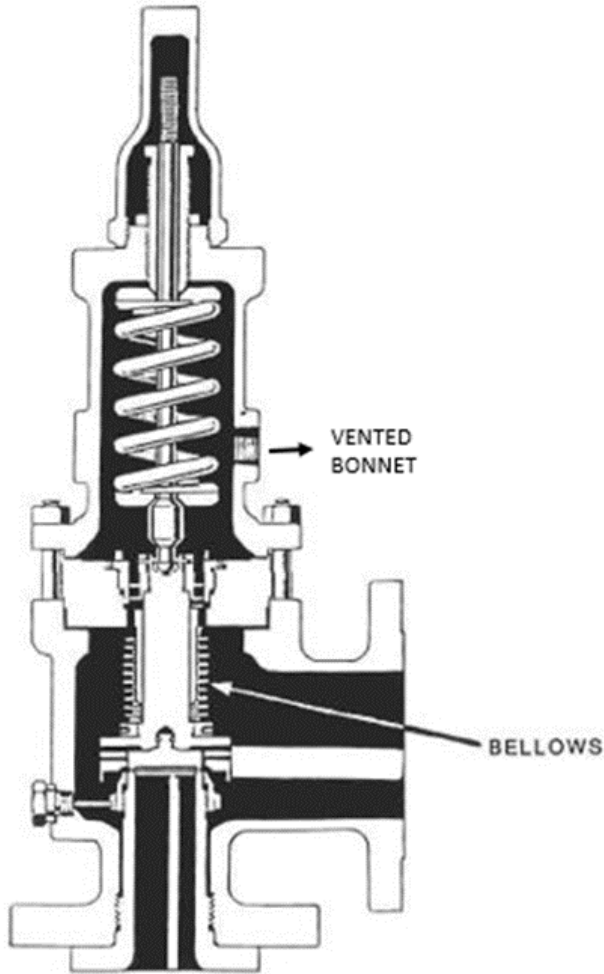
80+ Manufacturing Facilities	16,000 Employees	\$ 12.5 billion Sales 2023
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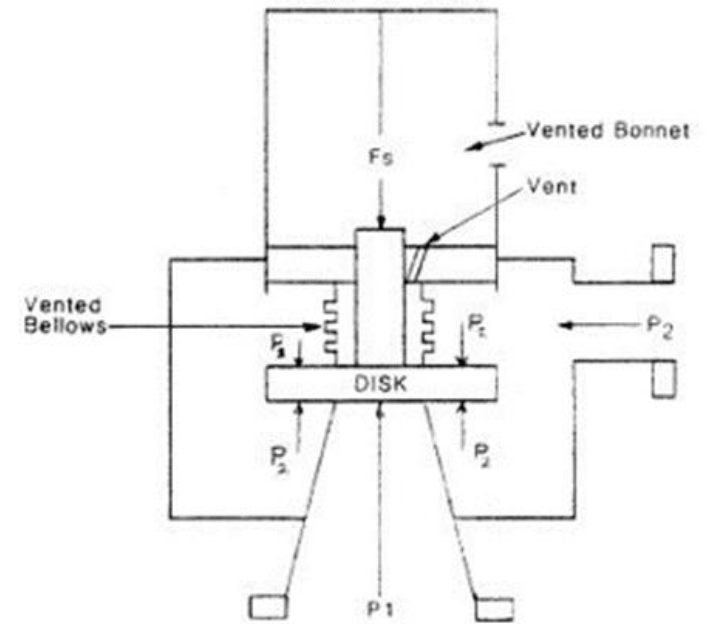
Applications

Product	End-use and Applications
<p>Polyethylene</p> 	<ul style="list-style-type: none">• Solar cell films• Personal care products• Sterile medical packaging• Food preservation
<p>PVC & Copolymers</p> 	<ul style="list-style-type: none">• Medical equipment, e.g. blood bags, pill blister packs• Vinyl flooring and wall covering• Consumer durables• Automotive applications• Credit card films• Vinyl records
<p>Epoxy Resins</p> 	<ul style="list-style-type: none">• Wind turbines• Automotive & aerospace composites• Electrification/semiconductor chips• Coatings for consumer applications• Adhesives and construction applications
<p>Housing & Infrastructure</p> 	<ul style="list-style-type: none">• Roofing• Windows• Siding, trim, moulding• Pipes and fittings• Decorative stone

What is a balanced bellows safety valve?



- This type of pressure safety valve (PSV) contains a bellows vented to atmosphere so that downstream blow off pressure does not affect the intended pressure set point.
- A bellows is installed so that any back-pressure acts both downward and upward on the same area of the disc. These forces always cancel, so do not affect the set point.
- Balanced bellows PSVs are normally used when there are long vent pipes, or where vent pipes are shared (in these circumstances, conventional PSVs are insufficient for handling the back pressure)



Challenges with balanced-bellows safety valves

- PSM audits were conducted at plants located in Bavaria, Germany.
- Audits revealed a number of the Leser balanced-bellows safety valves had been improperly installed and did not conform to the Leser installation instructions, which are based on API 520.
- According to Leser, varying from their installation instructions is only permissible after clearance by the operator's responsible regulatory authority.
- No documentation could be provided from the plants to demonstrate clearance by the responsible regulatory authority.
- The proper function of safety valves is a critical process safety concern; safety valves must function at intended set pressure to prevent over-pressurization.
- What follows will clarify the gaps and challenges identified, with example photos.

Plastic plug in vent port of bonnet

Leser balanced-bellows valves are shipped with a plastic plug in the vent port in the bonnet of the safety valve. Their warning sticker is attached above the port to remove the plastic plug.

In Leser installation instructions, they discuss the need to keep the port open → see next slide.



Leser: Installation instructions

For the proper function of a safety valve it must be guaranteed that the bonnet space above the bellows is only exposed to atmospheric pressure, respectively is never exposed to inadmissible overpressure.

It is recommended that the vent hole should generally remain open. In this way a constant pressure balance is guaranteed between bonnet space and environment. At the same time the vent hole serves to detect leakages due to a potentially defect bellows. This recommendation follows API 520-2, the only standard providing a statement concerning the vent hole.

The bonnets of balanced bellows pressure-relief valves must always be vented to ensure proper functioning of the valve.

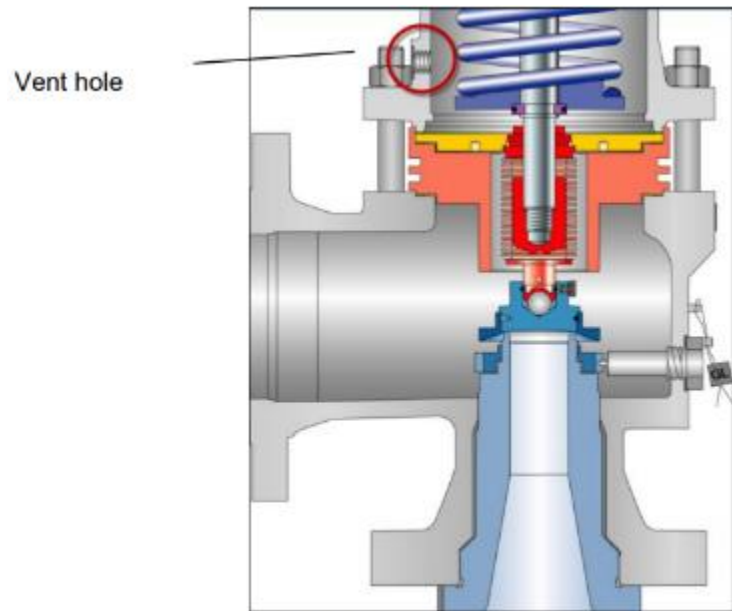


Figure 6.4.5-1: Safety valve with back pressure compensating bellows

<https://www.leser.com/de-de/dienstleistungen/engineering/>

Leser: Risks of a closed vent hole

When a vent hole is closed, the pressure in the bonnet can increase inadmissibly, which can cause a late opening of the safety valve and other unwanted impacts.

Reason for pressure increase in the bonnet	Caused by	Risks
Defect bellows	Superimposed back pressure	Set pressure increase of the safety valve by the amount of the superimposed back pressure
Defect bellows	Built-up back pressure	Function of the safety valve after actuating corresponds roughly to a safety valve without bellows. Consequently, there is the risk of chattering in case of inadmissibly high back pressure.
Thermal expansion of the air in the bonnet	e. g. solar radiation	Little increase of the set pressure (0,1 to 0,4 bar)

Table 6.4.5-1: Risks of pressure increase in the bonnet

Leser: Closing of the vent hole using a plug

In exceptional cases, the vent hole can be closed with a plug or with a screw.

This can be the case when e. g. due to operational experience in connection with regular maintenance (no defect bellows) ... an inadmissible pressure increase can be excluded without fail and when at the same time the risk of freezing of the bellows is considered as the higher risk.

In this case, the operator – if required **after clearance with the responsible regulatory organization** – can determine that the vent hole at the bonnet is closed.

In case of closing of the vent hole by means of a plug, there is the risk of a pressure increase in the bonnet due to thermal expansion of the air encased in the bonnet and consequently the risk of an inadmissible increase of the set pressure. The thermal expansion can be caused by e. g. solar radiation or heating of the valve during operation.

The operator must evaluate if a possible increase of the set pressure due to thermal expansion in the bonnet is a risk.

API 520-2

Sizing, Selection, and Installation of Pressure-relieving Devices

Part II—Installation

API STANDARD 520, PART II
SEVENTH EDITION, OCTOBER 2020



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10.3 Balanced Bellows Valves

10.3.1 General

Balanced bellows PRVs minimize the effect of backpressure on the set pressure and relieving capacity of the valve by reducing the effect of backpressure on the force balance around the disk (see API 520, Part I, Figure 8 and Figure 9). This requires that the bonnet operate at atmospheric pressure at all times.

10.3.2 Bonnet Vent for Bellows Valve Handling Non-hazardous Vapors

In non-hazardous vapor service, an elbow and bug screen, as shown in Figure 19, should be installed on the bonnet vent opening to prevent insects from entering the bonnet. This also reduces the likelihood of mistakenly installing a plug in the open bonnet vent hole.

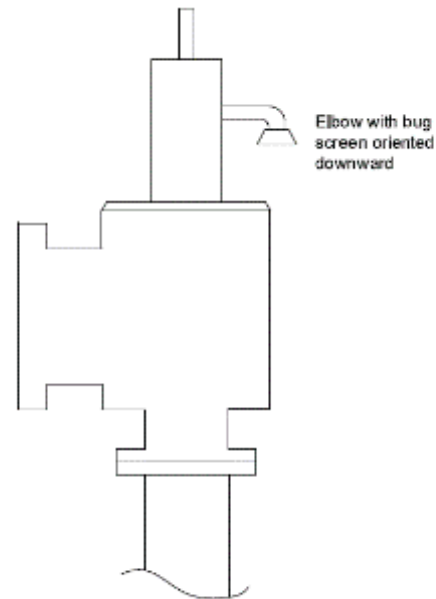


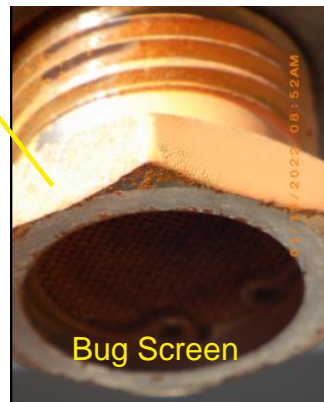
Figure 19—Bonnet Vent for Bellows Valves with Vent Located at the PRV

API 520-2



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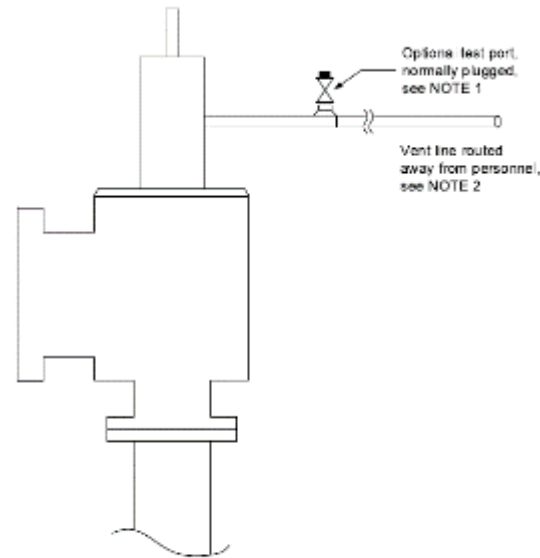


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10.3.3 Bonnet Vent for Bellows Valve Handling Hazardous Vapors

When the fluid in the process or discharge system contains hazardous vapors, the bonnet vent may need to be routed to a safe location. Dispersion analysis or other appropriate methods may be used to determine if a remote vent location is required. Figure 20 shows an example of a bonnet vent design for bellows valves handling vapor with remote vent location. When a remote vent location is required, the vent line should be arranged to prevent ingress of rainwater and should be free draining, away from the bonnet, and have no pocketed section. The end of the vent line should be equipped with a bug screen.



NOTE 1 A test port may be provided to check for bellows leakage or plugged vent line.
NOTE 2 See 10.3.3.

Figure 20—Bonnet Vent for Bellows Valves Handling Vapor with Remote Vent Location

This is not always necessary
if there is local leak detection

European Commission advice to Seveso inspectors

https://minerva.jrc.ec.europa.eu/en/shorturl/technical_working_group_2_seveso_inspections/seveso_inspection_series



seveso

common **INSPECTION** series

criteria

Pressure Relief Systems

This publication of the European community on Common Inspection Criteria is intended to share knowledge about technical measures and enforcement practices related to major hazard control and implementation of the Seveso Directive. The criteria have been developed by Seveso inspectors to aid in dissemination of good enforcement and risk management practices for the control of major industrial hazards in Europe and elsewhere.

Visual on-stream inspection (while the safety valve is in service) should ensure that ... Bellows vents are open and clear.

Examples

New safety valve
on a batch reactor



Examples

New safety valve on another batch reactor



Examples

These safety valves were checked by the local inspection authority, who have approved/tagged them.

The plugs and warning signs are still visible!



Examples



Sticker and plastic plug
have been painted over.

Examples



Just overhauled and tagged!



On another pressure vessel

Examples



Older safety valves on liquid monomer pipes

Follow up

- During the audit process, plant engineers were not able to produce documentary approval from an inspection body to justify keeping the vent ports blocked, and did not have a full understanding of the concerns.
- To correct the gaps, plant engineers removed the plugs and fitted downward-pointed bends. For affected safety valves located inside enclosed buildings, gas detectors are located close by and will alarm in the event of leaks to mitigate risks associated with leaking bellows.
- Companies at the same chemicals parks use similar PSVs, share the same testing facilities and are subject to the same inspection authority. Industry should be aware of and address the potential for common gaps/concerns across German chemical facilities/sites.
- Feedback from inspectors across Germany: *“The issue is a little bit more complex. A general removal of the plug is not recommended ... or it must be clarified beforehand that possible leaks from this opening are diverted to a safe place. It must also be prevented that harmful (e.g. corrosive) substances from the outside can get into the interior. Against this background, it is a case-by-case decision whether and how to proceed with each valve. However, it must be ensured that a significant pressure build-up in the cover is avoided.”*
- To ensure safe and functional operation of the safety valves, operators should follow manufacturer instructions, adhere to the EU advice to Seveso inspectors and comply with the API 520 technical recommendations.
- **Please check that your balanced-bellows safety valves are correctly installed!**

The logo features a stylized 'W' composed of two overlapping shapes: a light blue shape on the left and a dark blue shape on the right. To the right of this 'W' is the word 'estlake' in a dark blue, sans-serif font. The entire logo is centered horizontally on the page.

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