



System control: Maintain a stable Pressure regulation

Swagelok®



Paul Krouwels & Dick van Camp

26 Mei 2026

Introduction Swagelok



Paul Krouwels

Sales Engineer & Trainer



Dick van Camp

Field Engineer

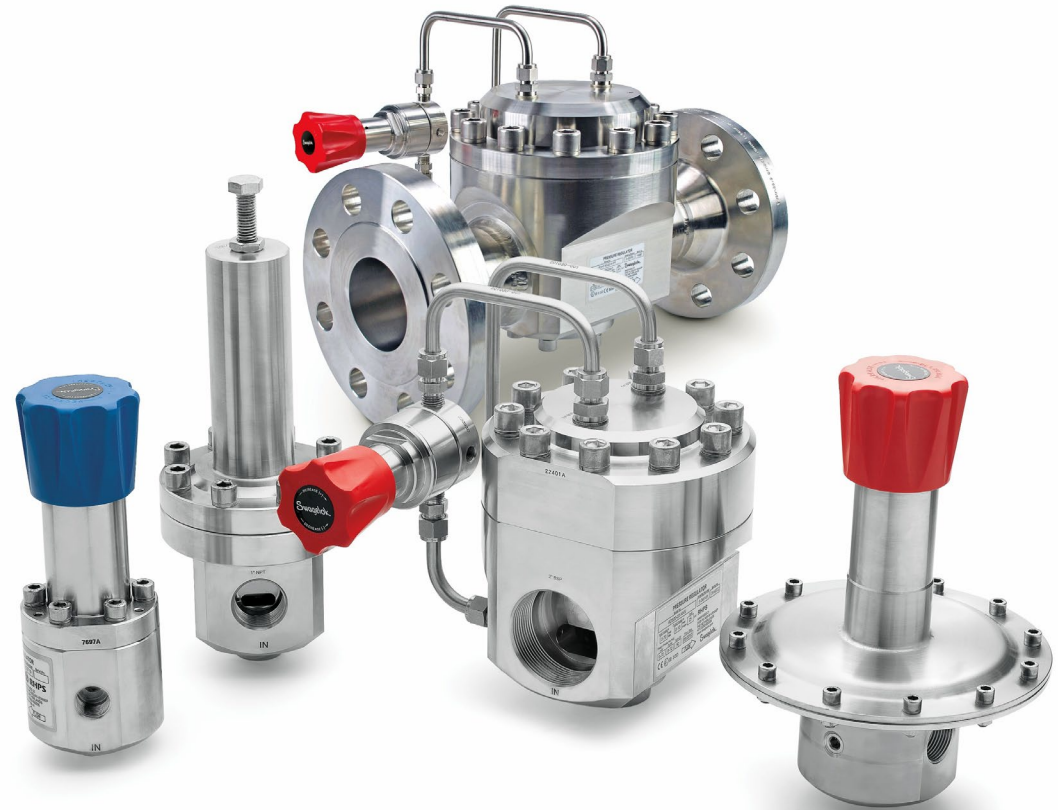
Why this TechTalk?

Swagelok



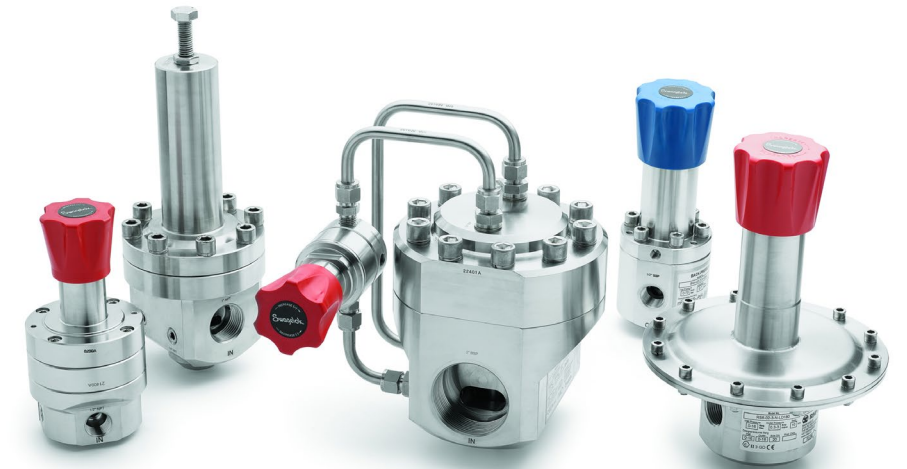
Agenda

- Regulators Basics (reducing & back pressure, components)
- Variables for sizing a Regulator
- How to use flow curves
- Regulator Series
- Process Regulators
- Maintenance and failure



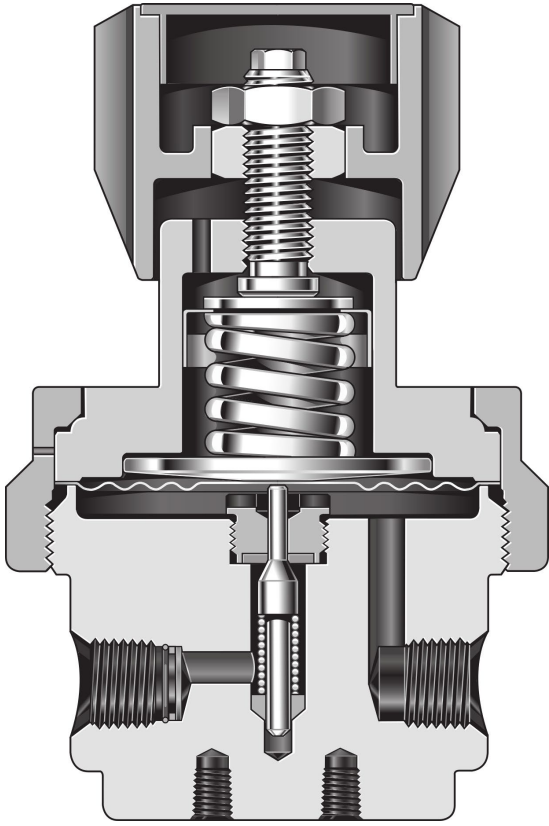
Regulator Basics

- **Pressure-Reducing**
 - Spring-Loaded
 - Dome-Loaded
- **Back Pressure Regulators**
 - Spring-Loaded
 - Dome-Loaded
- **Specialty**
 - Vaporizing regulators
 - Automatic switching regulators
 - Tank-blanketing regulators



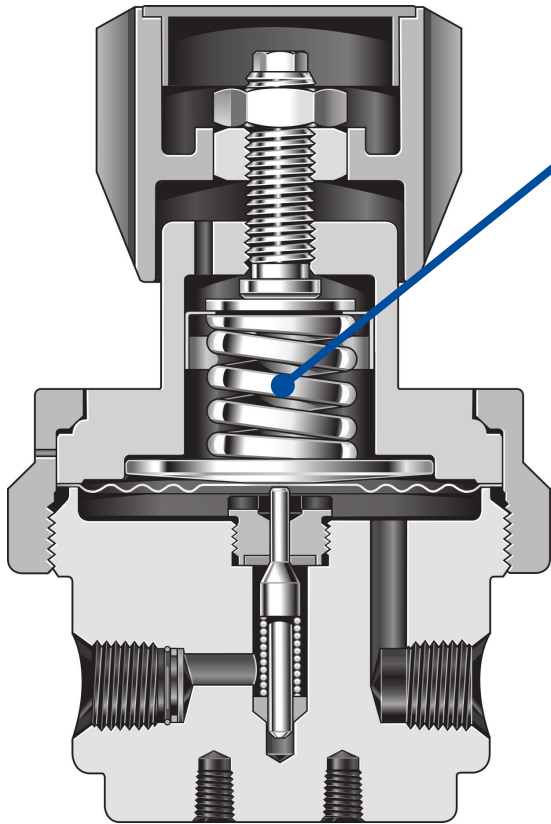
Regulator Basics – Main Components

Understanding a regulator's functionality begins with familiarity of its component parts:



Regulator Basics – Main Components

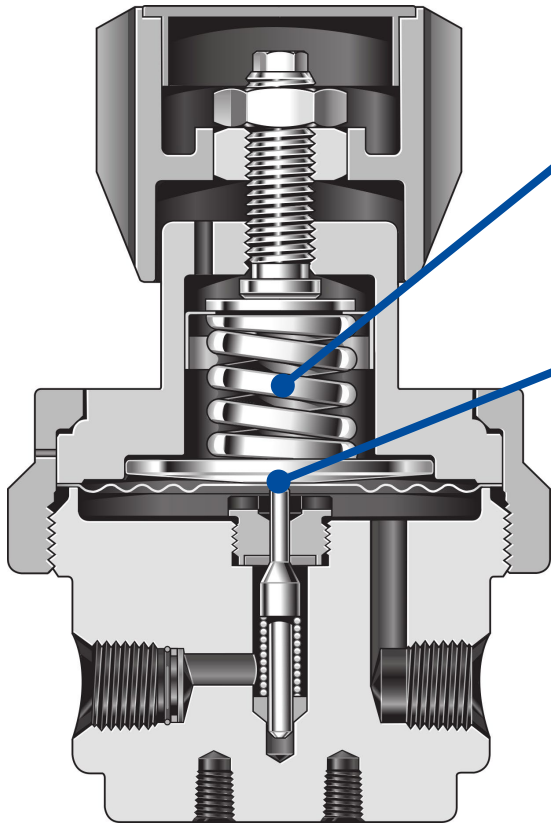
Understanding a regulator's functionality begins with familiarity of its component parts:



A loading element. Regulators may be spring-loaded or dome-loaded. The loading element applies a downward, balancing force on top of the diaphragm.

Regulator Basics – Main Components

Understanding a regulator's functionality begins with familiarity of its component parts:

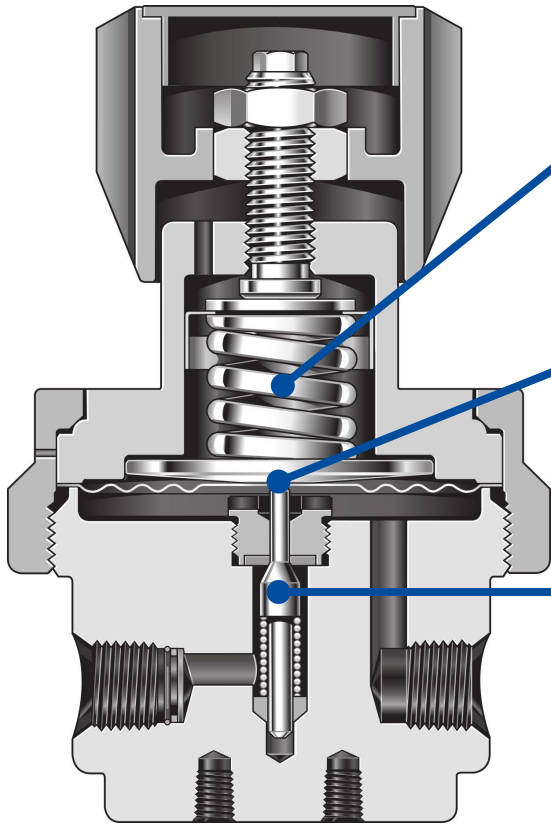


A loading element. Regulators may be spring-loaded or dome-loaded. The loading element applies a downward, balancing force on top of the diaphragm.

A sensing element, typically a diaphragm or piston. The sensing element allows the poppet to rise and fall in the seat, controlling inlet or outlet pressure.

Regulator Basics – Main Components

Understanding a regulator's functionality begins with familiarity of its component parts:

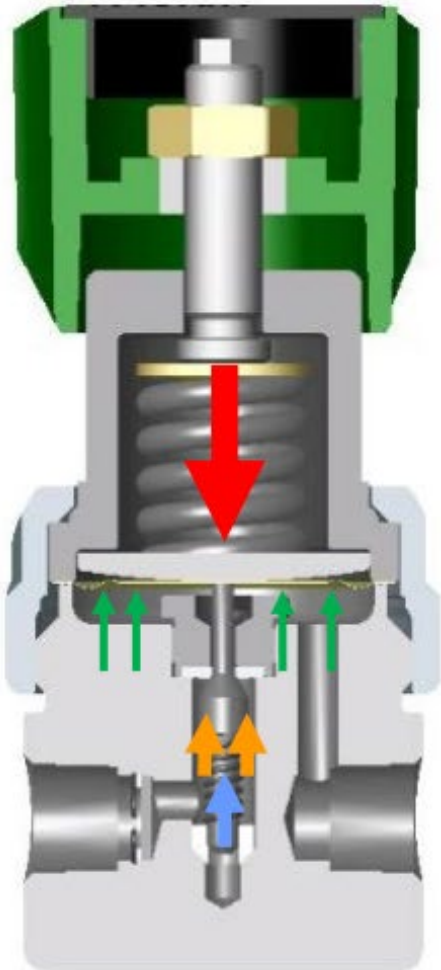


A loading element. Regulators may be spring-loaded or dome-loaded. The loading element applies a downward, balancing force on top of the diaphragm.

A sensing element, typically a diaphragm or piston. The sensing element allows the poppet to rise and fall in the seat, controlling inlet or outlet pressure.

A control element, including a seat and poppet. The seat contains pressure and prevents fluid from leaking to the opposite side of the regulator when flow is closed. Together with the seat, the poppet regulates pressure by maintaining a fine gap between the two while a system is flowing.

Regulator Basics - Forces



F_1 = Loading Force

F_2 = Poppet Spring Force

F_3 = Outlet Pressure Force

F_4 = Inlet Pressure Force

Force from Set Spring

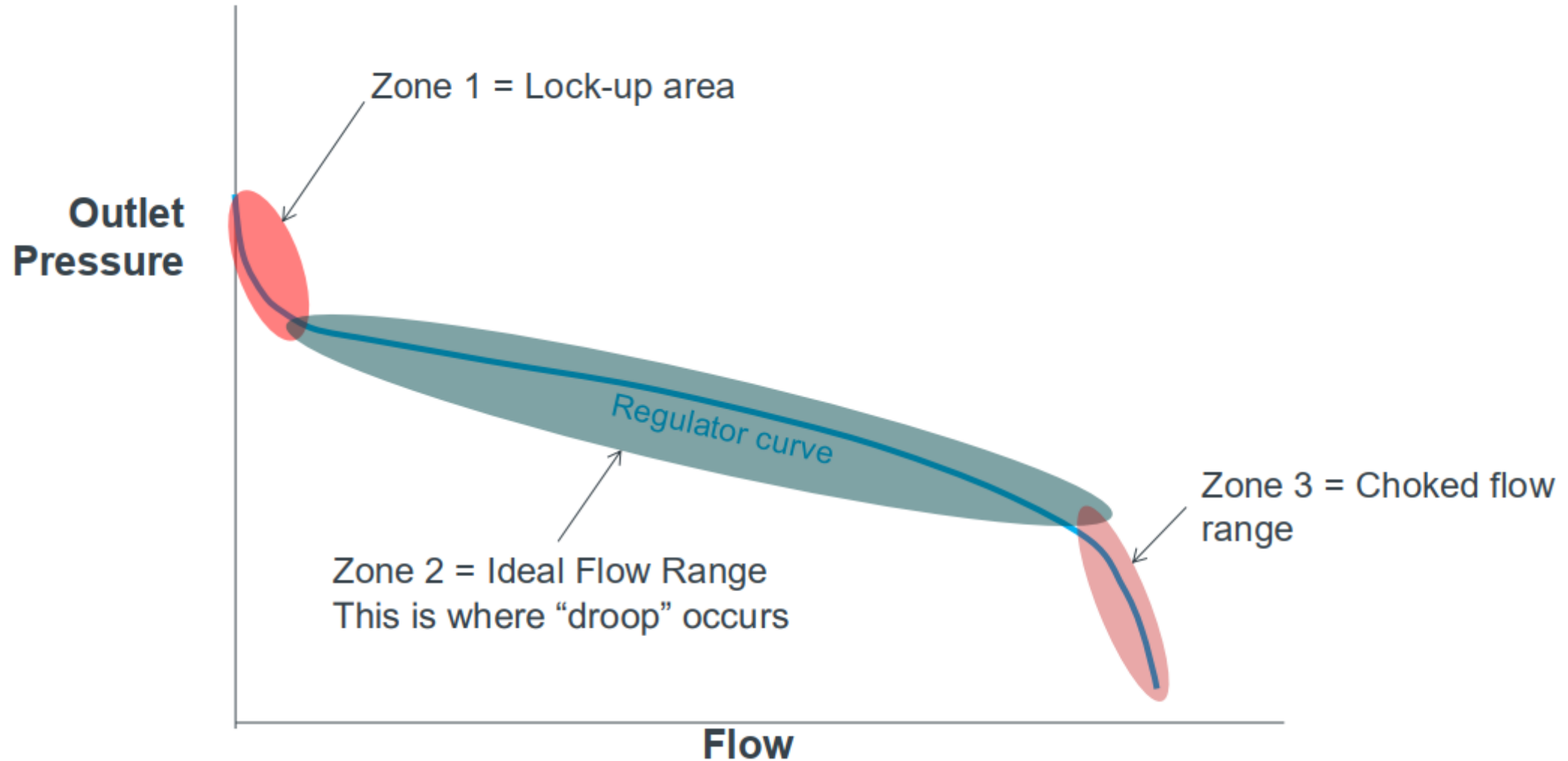
Force from Poppet Spring

System Pressure

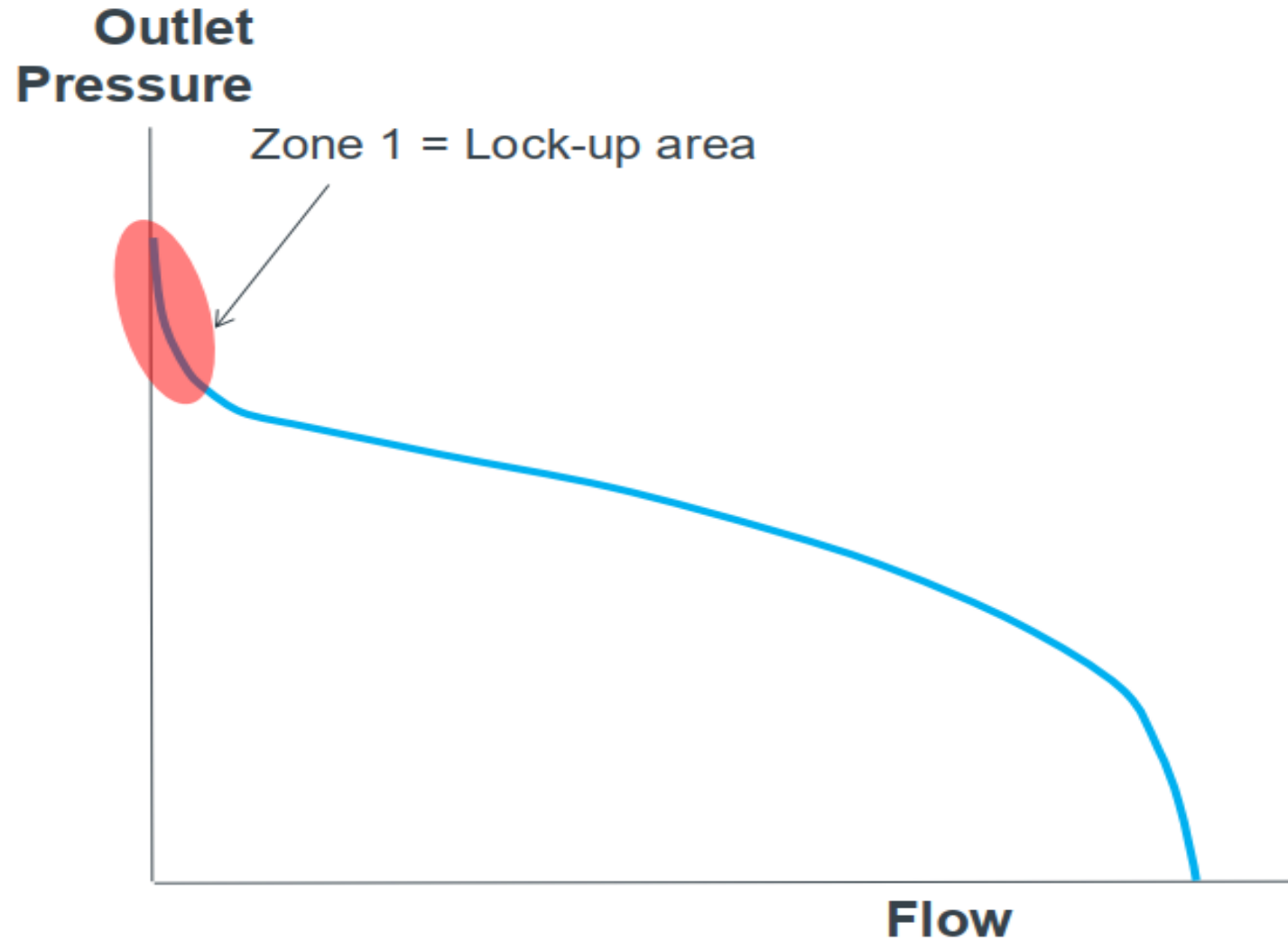
Supply Pressure

$$F_1 = F_2 + F_3 + F_4$$

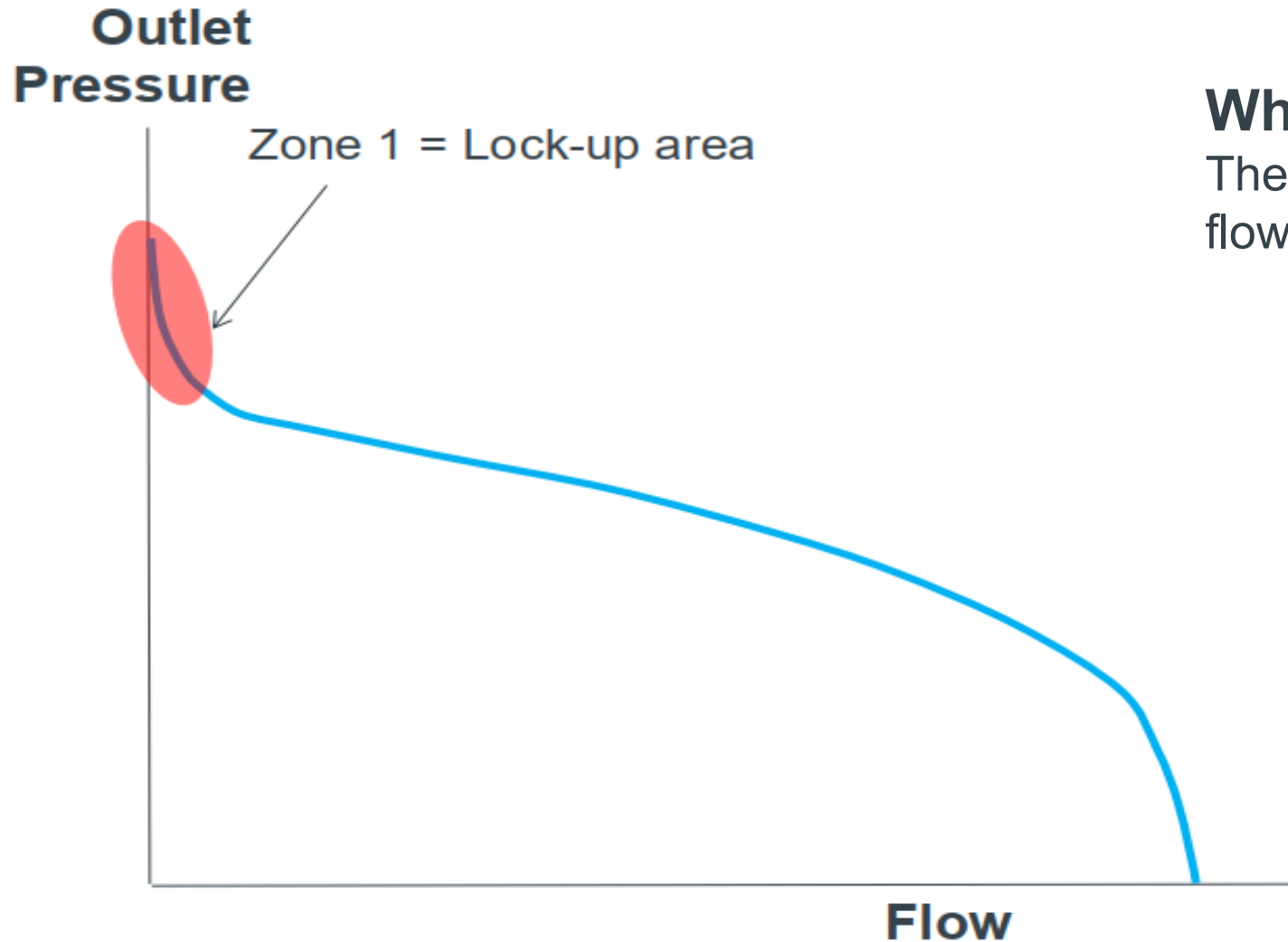
Regulator Basics – Flow Curve



Regulator Basics – Flow Curve, Lock-up



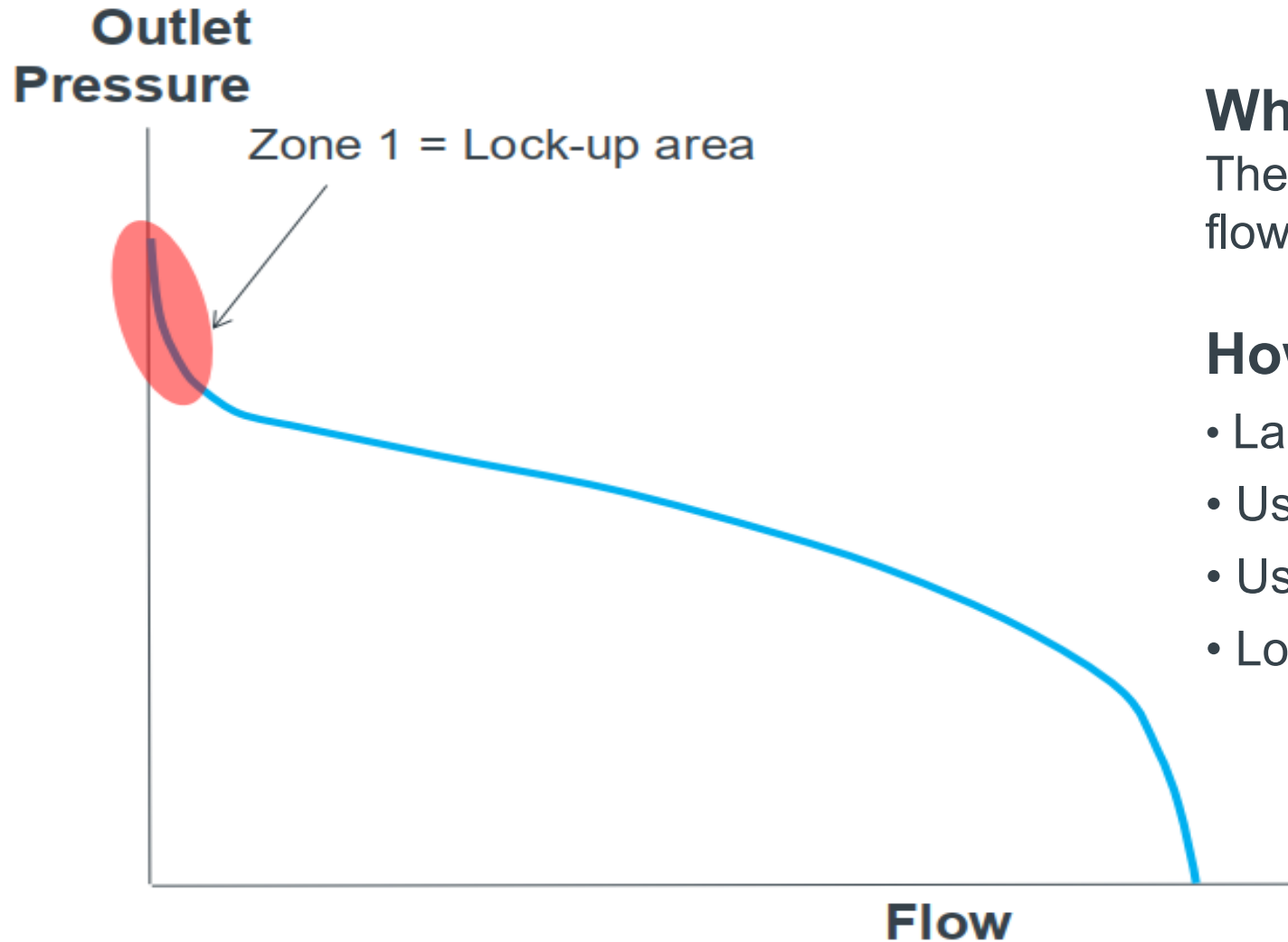
Regulator Basics – Flow Curve, Lock-up



What is Lock-up?

The difference in Outlet Pressure between a flowing and non-flowing condition.

Regulator Basics – Flow Curve, Lock-up



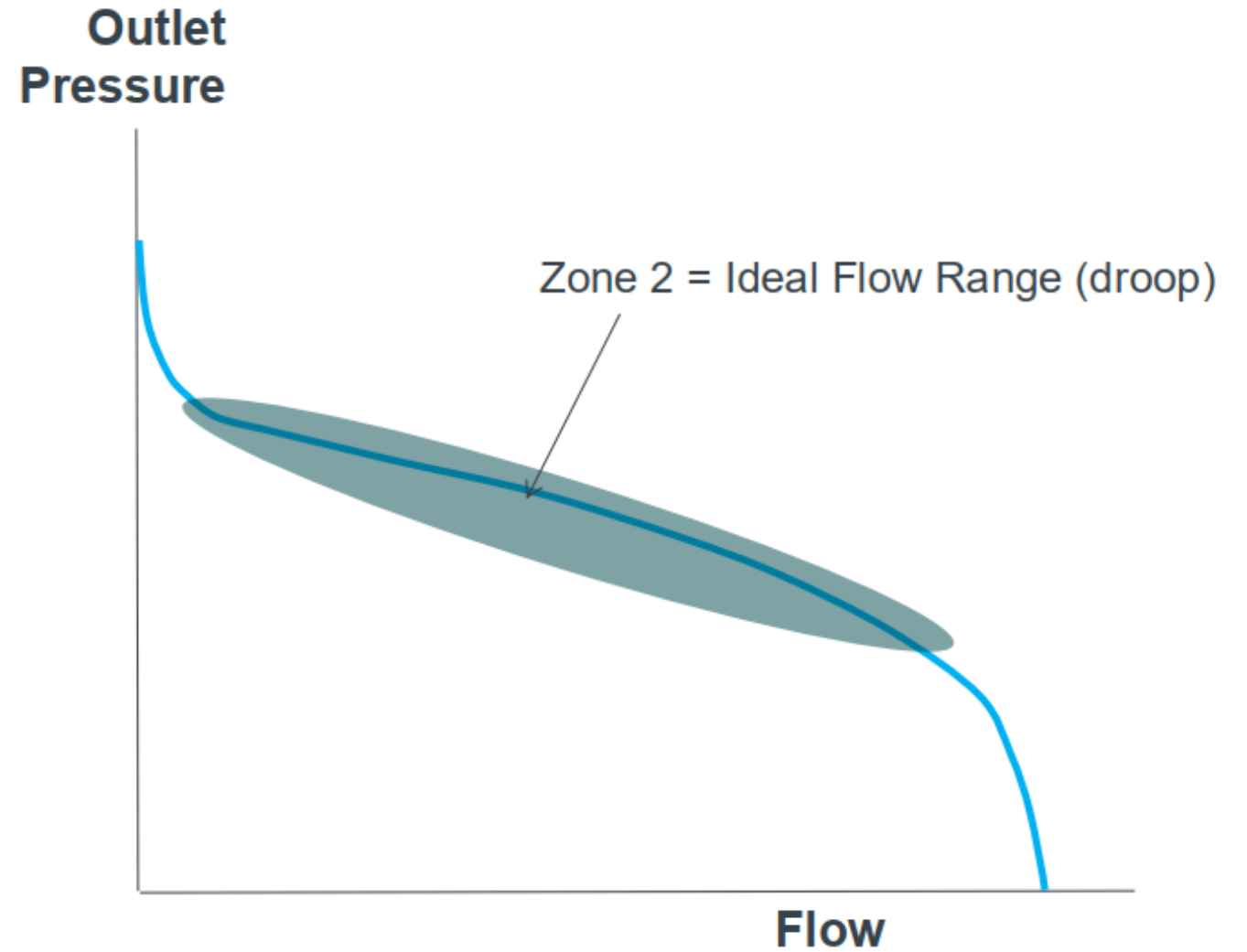
What is Lock-up?

The difference in Outlet Pressure between a flowing and non-flowing condition.

How to reduce Lock-up?

- Large sensing area (Piston or diaphragm)
- Use smallest Cv for the application
- Use soft sealing material
- Lower differential pressure over the seat

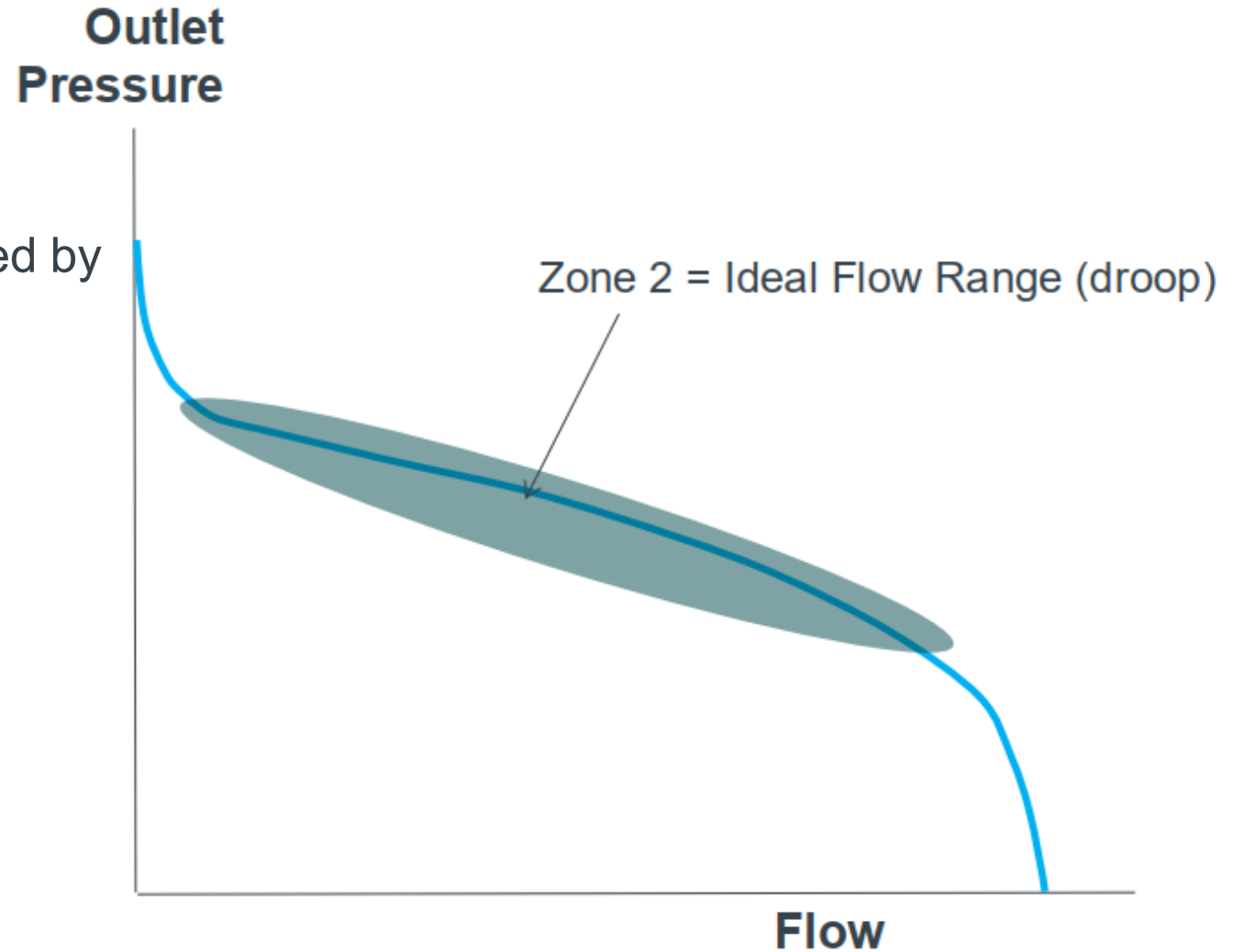
Regulator Basics – Flow Curve, Droop



Regulator Basics – Flow Curve, Droop

What is Droop?

The reduction of Outlet Pressure experienced by Pressure Reducing Regulators as flow increases.



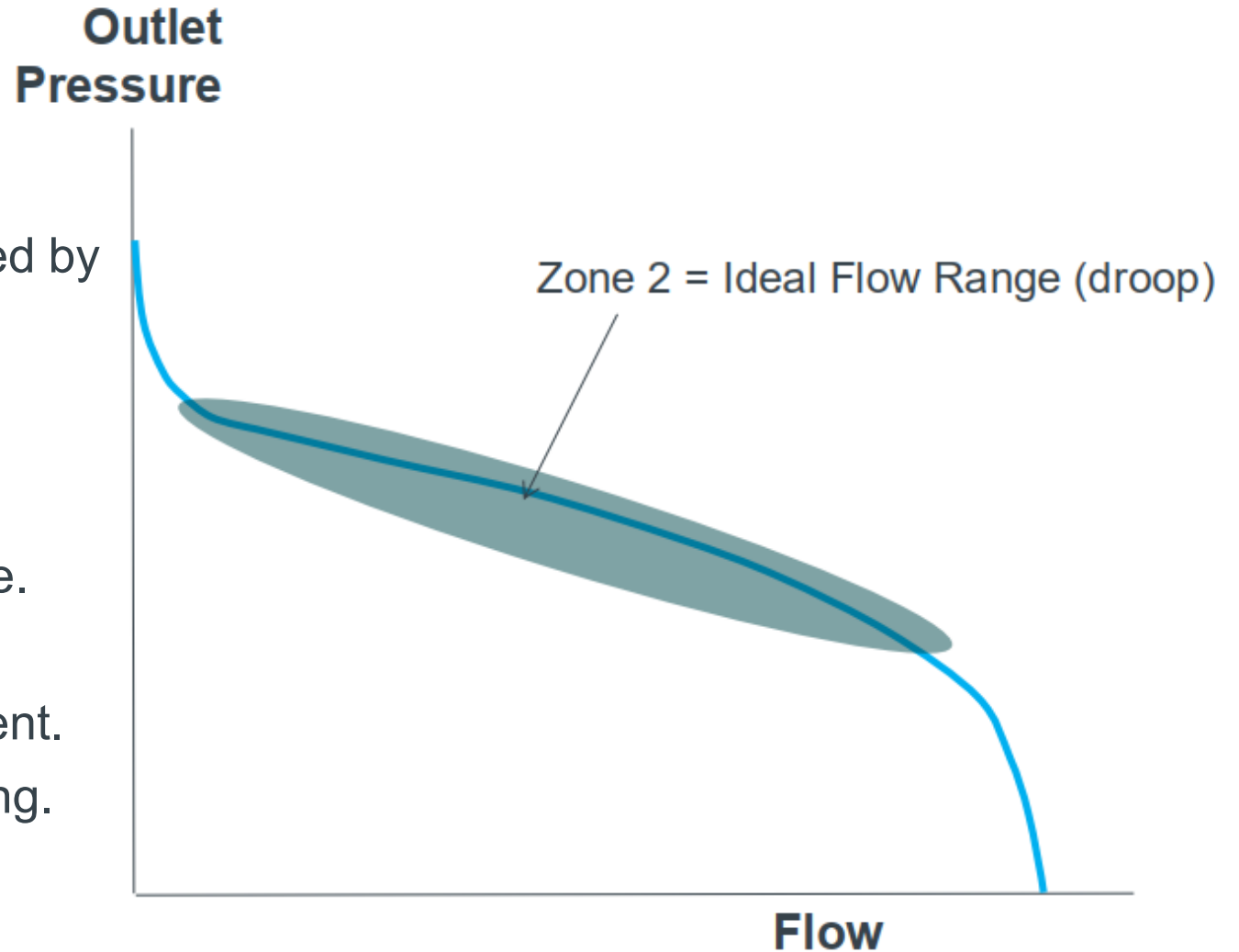
Regulator Basics – Flow Curve, Droop

What is Droop?

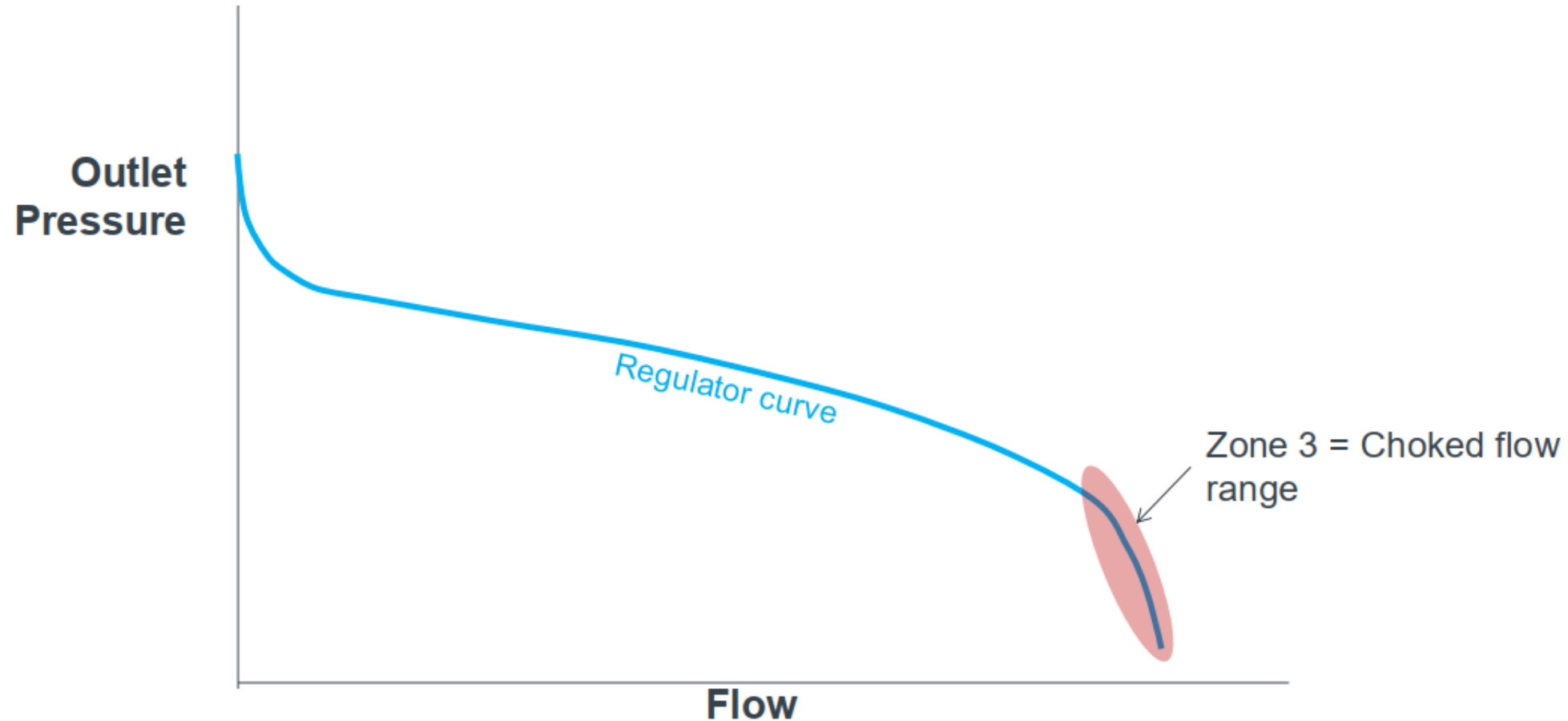
The reduction of Outlet Pressure experienced by Pressure Reducing Regulators as flow increases.

How can Droop be reduced?

- Select appropriate Pressure Control Range.
- Use a longer Spring.
- Select Regulator with larger sensing element.
- Use Dome-loading instead of Spring-loading.



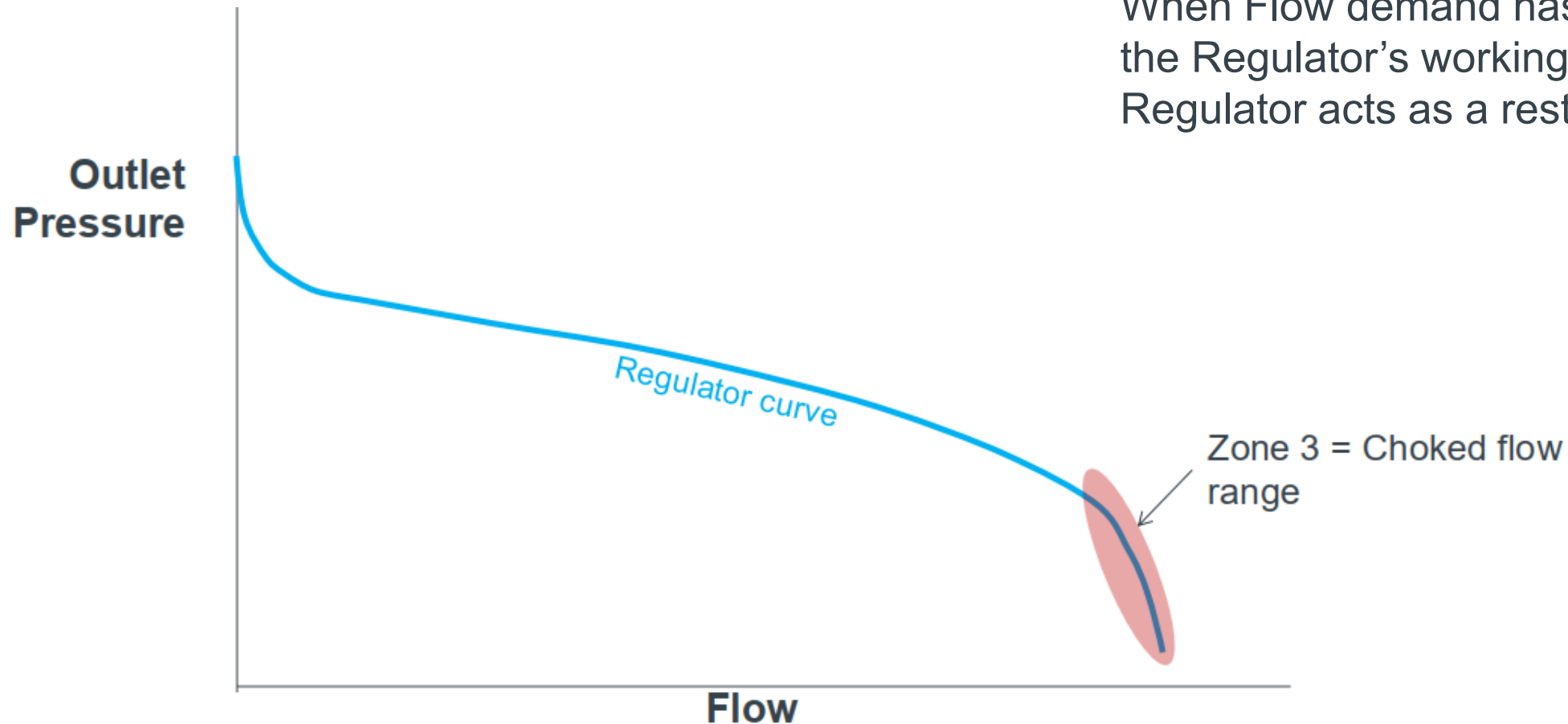
Regulator Basics – Flow Curve, Choked Flow



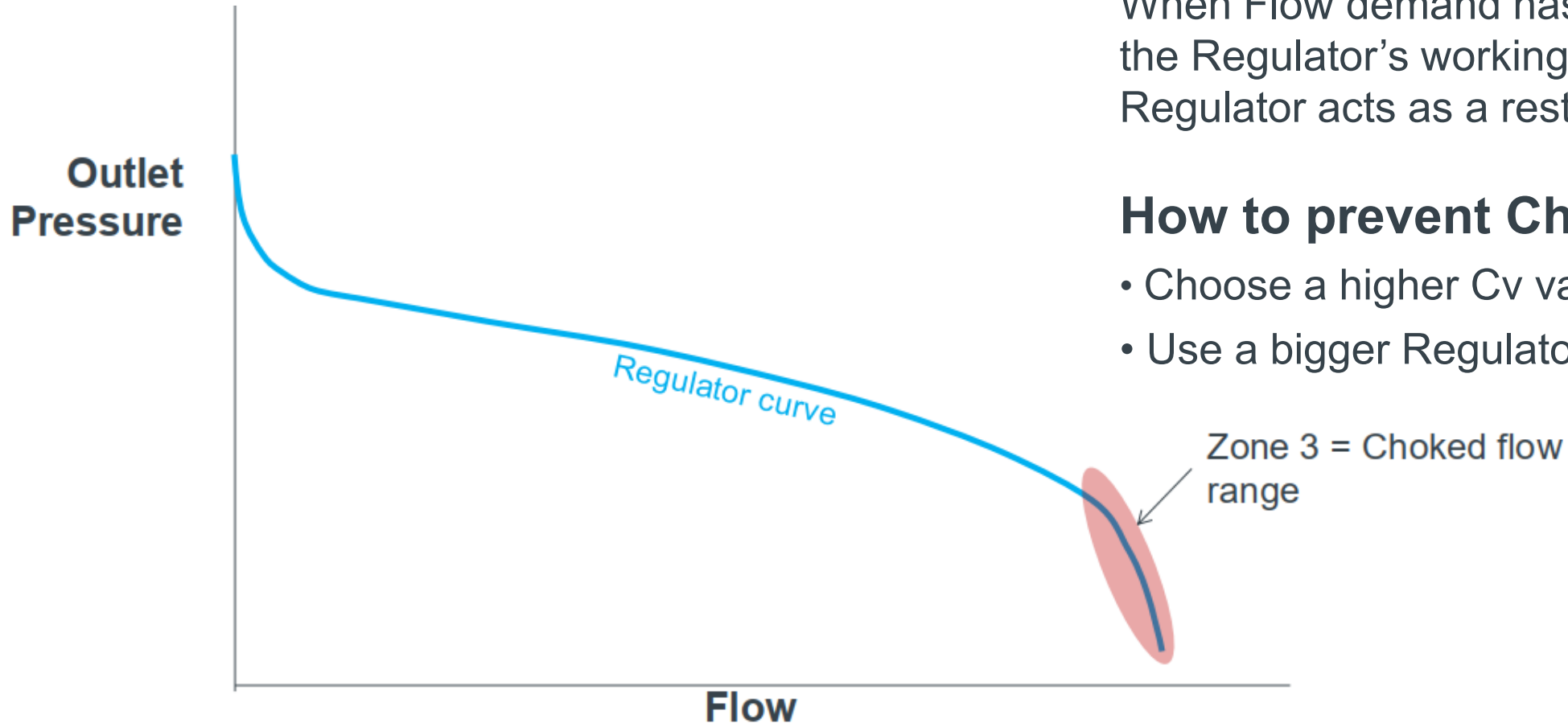
Regulator Basics – Flow Curve, Choked Flow

What is Choked Flow?

When Flow demand has increased beyond the Regulator's working capability, and the Regulator acts as a restricting orifice.



Regulator Basics – Flow Curve, Choked Flow



What is Choked Flow?

When Flow demand has increased beyond the Regulator's working capability, and the Regulator acts as a restricting orifice.

How to prevent Choked Flow?

- Choose a higher Cv value.
- Use a bigger Regulator.

Regulator Variables

Required Information

- Inlet Pressure (max-min)
- Set Pressure (control range)
- Flow (nominal-max)
- Temperature
- Media (gas / liquid)
- Pressure source
- Line size

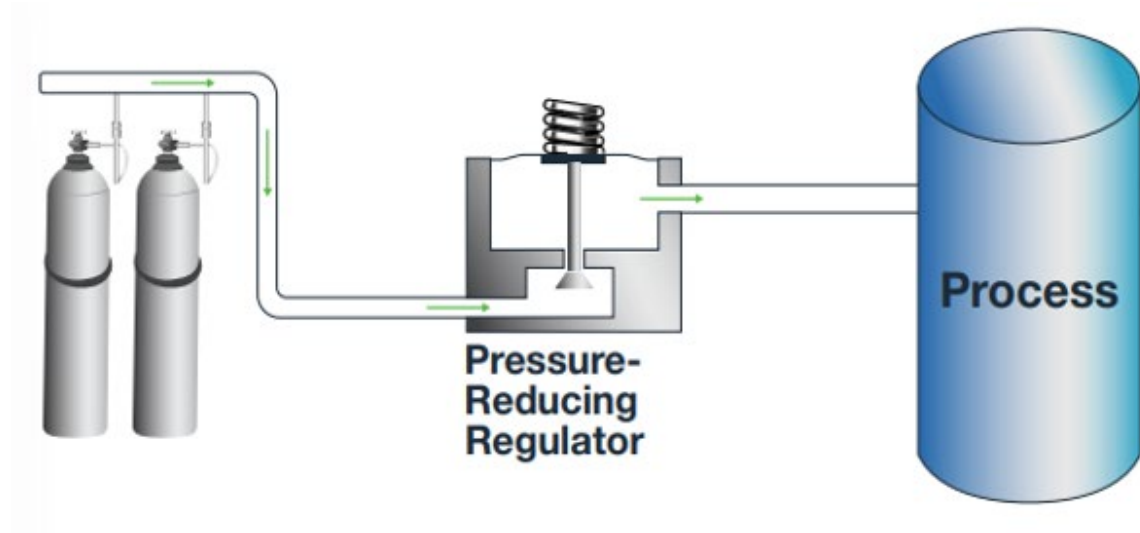


Regulator Variables – Supply Pressure Effect (SPE)

What is the Supply Pressure Effect? (SPE)

The increase in Set Pressure (Outlet Pressure) of a Regulator as the inlet pressure decreases (or vice-versa).

(Defined as a % of the Inlet Pressure change)



Regulator Variables – Supply Pressure Effect (SPE)

What is the Supply Pressure Effect? (SPE)

The increase in Set Pressure (Outlet Pressure) of a Regulator as the inlet pressure decreases (or vice-versa).

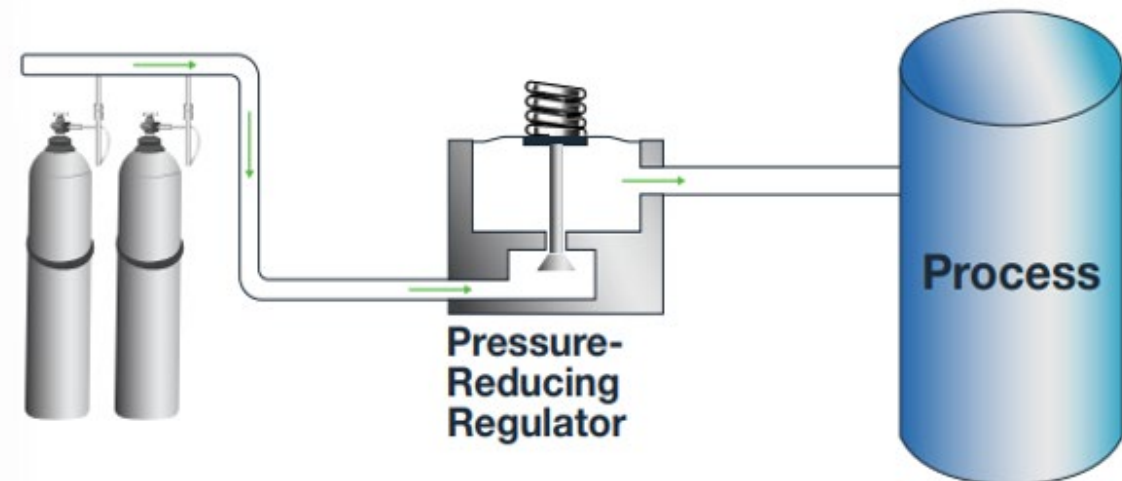
(Defined as a % of the Inlet Pressure change)

Example

As Inlet pressure drops from 200 bar to 100 bar (100 bar drop)

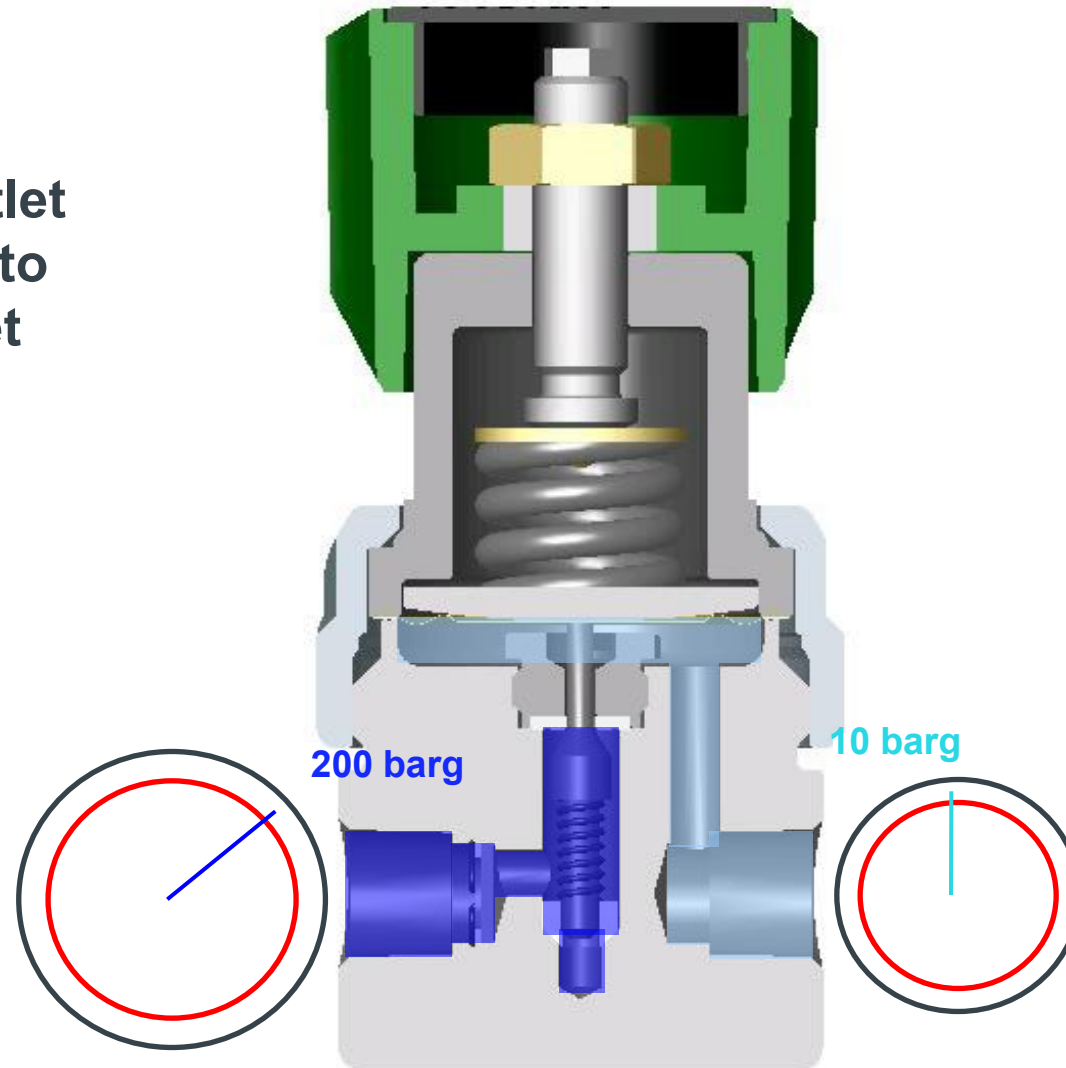
Outlet pressure increases from 10 bar to 11 bar (1 bar increase)

$SPE = 1\% \text{ van } 100 \text{ bar} = 1 \text{ bar}$



Regulator Variables – Supply Pressure Effect (SPE)

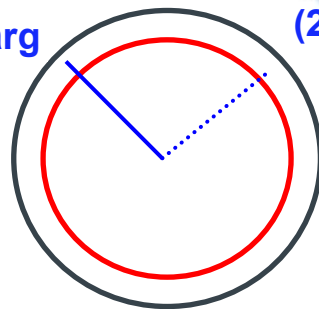
Change in outlet pressure due to change in inlet pressure



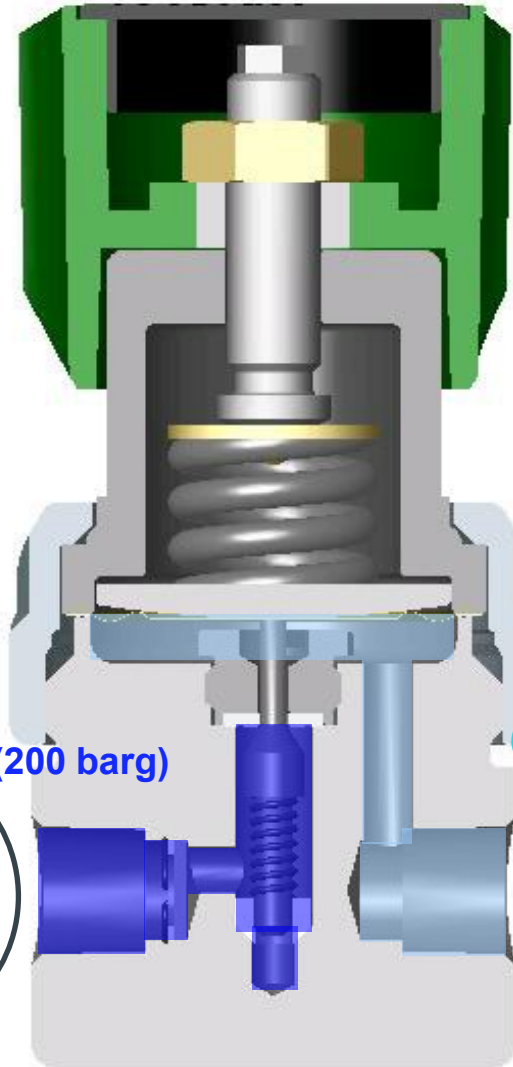
Regulator Variables – Supply Pressure Effect (SPE)

1. Upstream pressure decreases as cylinder is depleted

100 barg



(200 barg)

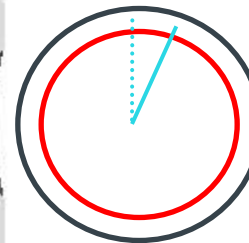


P_{inlet} decreases from 200 to 100 = 100 bar

1% of 100 bar = 1 bar

P_{outlet} increases 1 bar

(10 barg) 11 barg

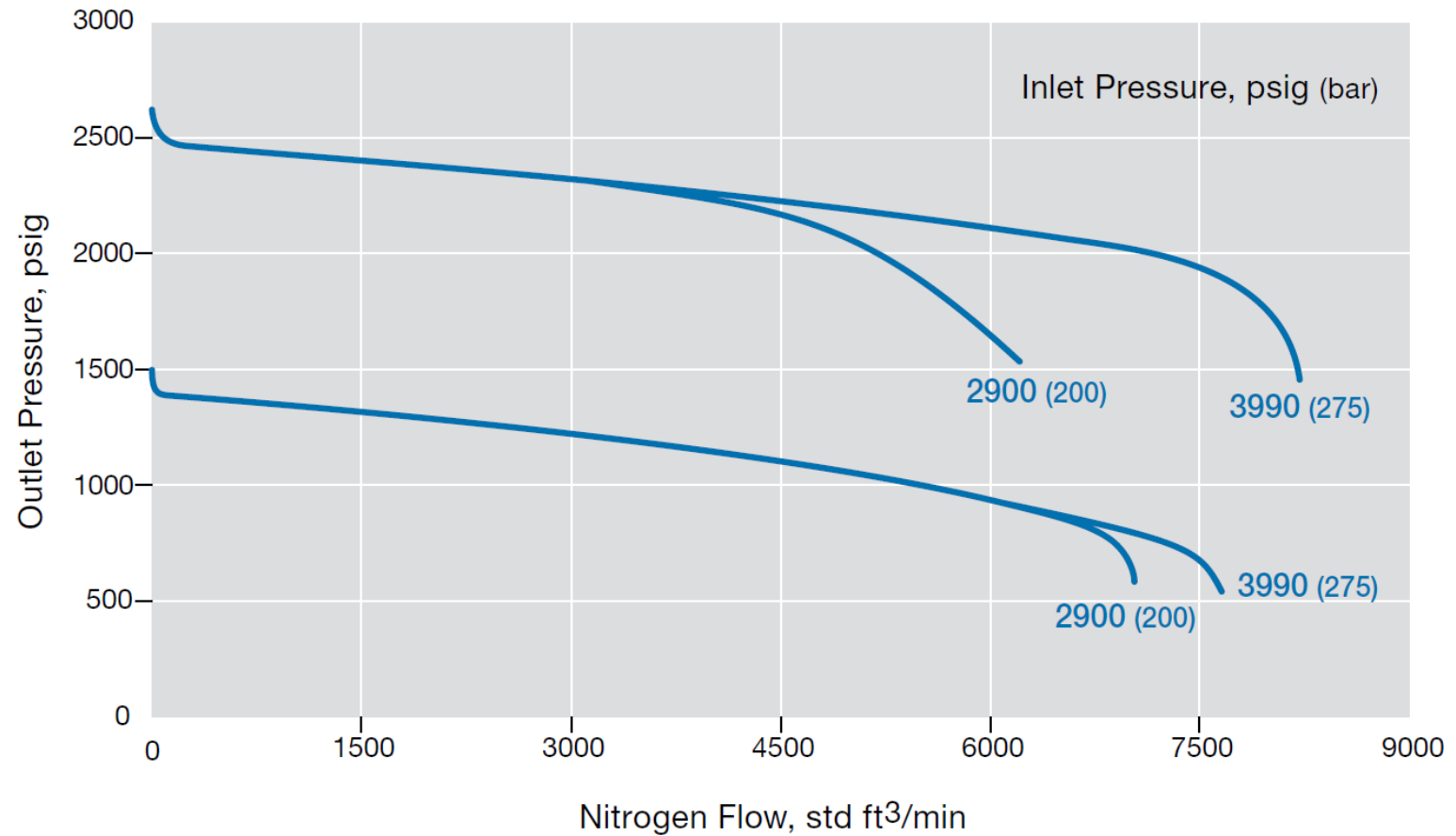


2. Downstream pressure increases 1% of the inlet decrease

How to use Flow Curves

Flow Curves demonstrate Regulator Performance of how Outlet pressure changes as Flow is increased.

For each Curve, Inlet Pressure and Set Pressure are fixed.



How to use Flow Curves

Flow Curves demonstrate Regulator Performance of how Outlet pressure changes as Flow is increased.

For each Curve, Inlet Pressure and Set Pressure are fixed.

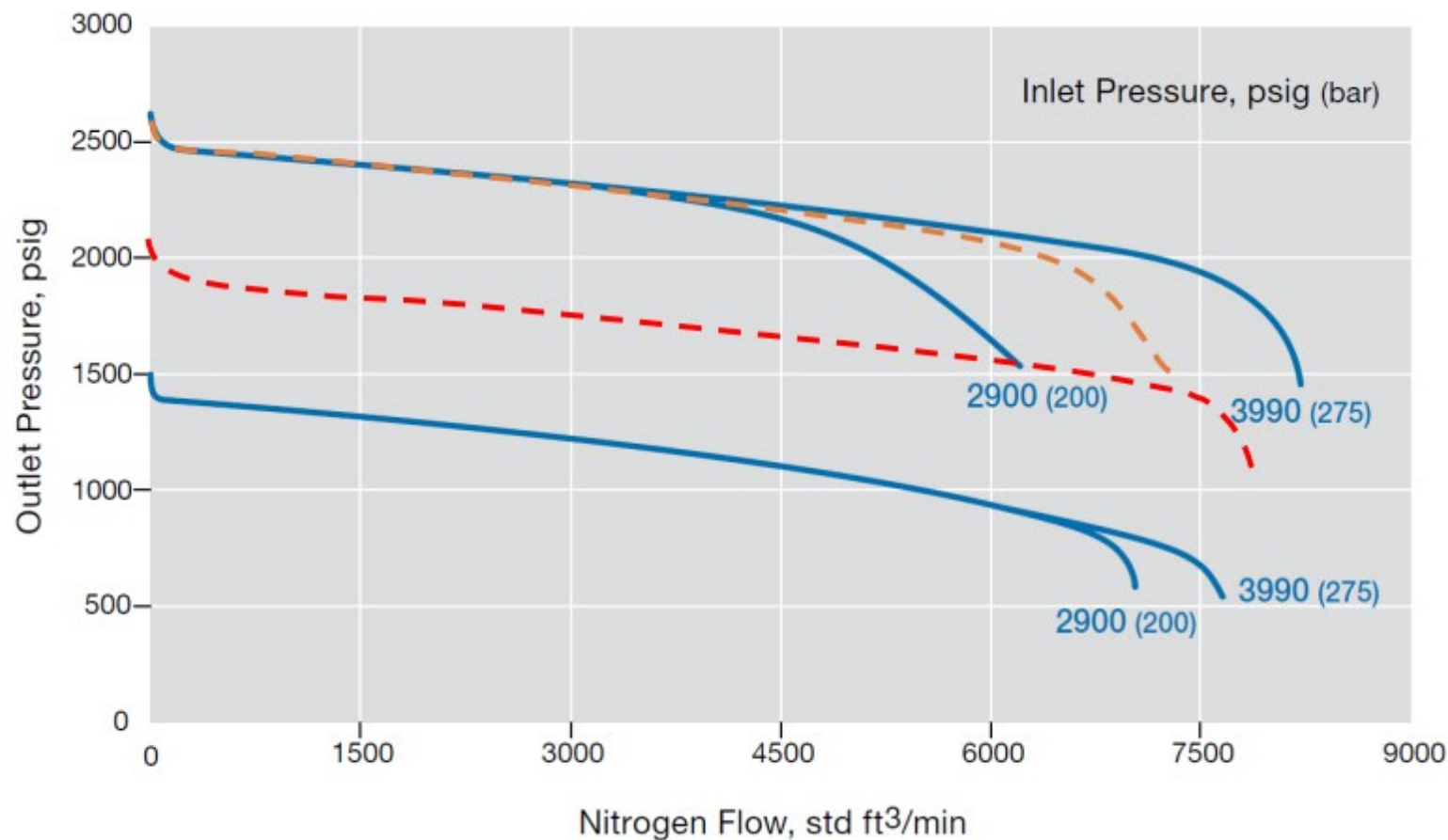
Flow Curves can be interpolated:

Example 1

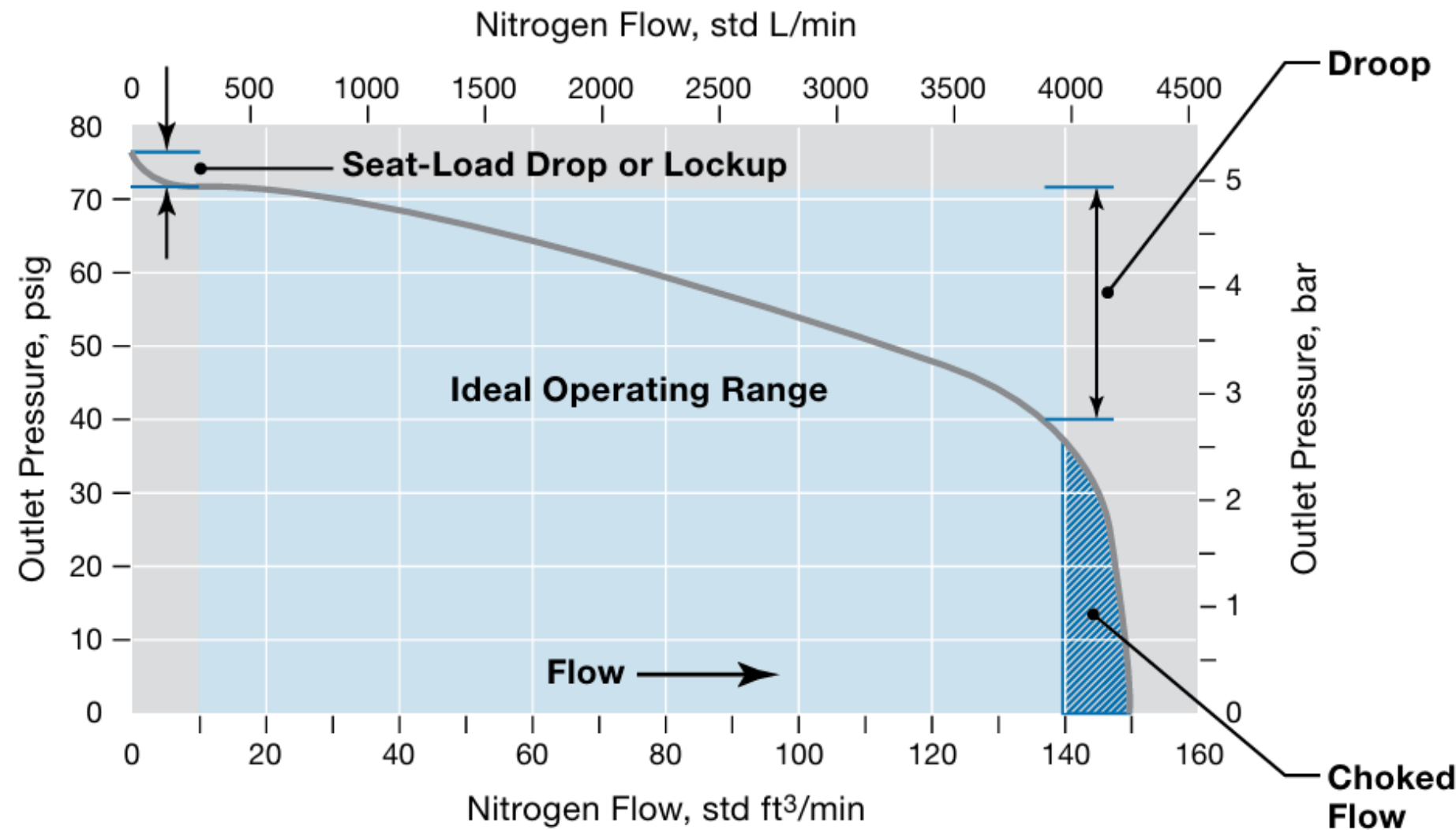
3500 psig inlet, 2500 psig set pressure

Example 2

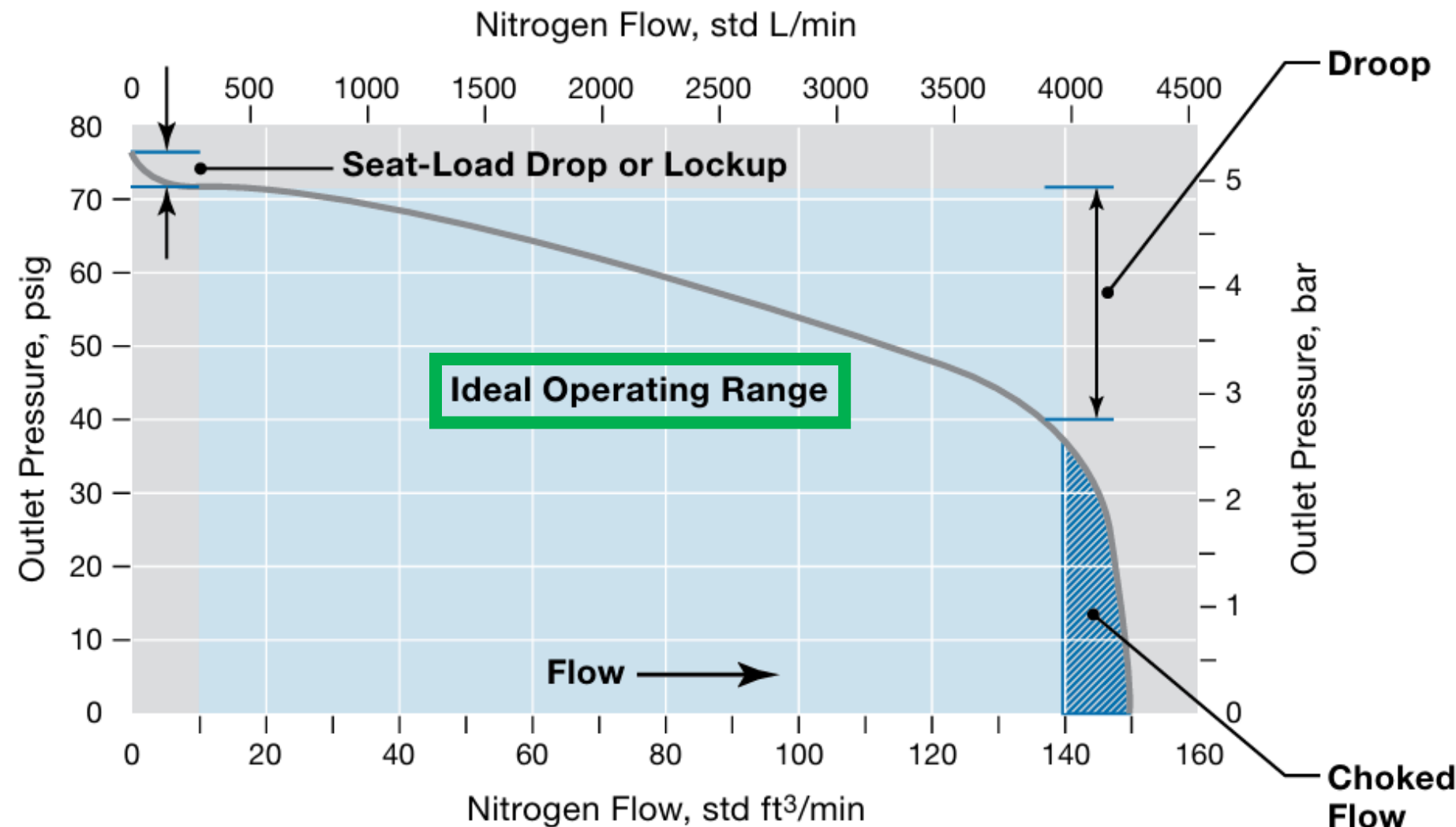
3990 psig inlet, 2000 psig set pressure



How to use Flow Curves



How to use Flow Curves



Regulator Series – K-Series (instrumentation)



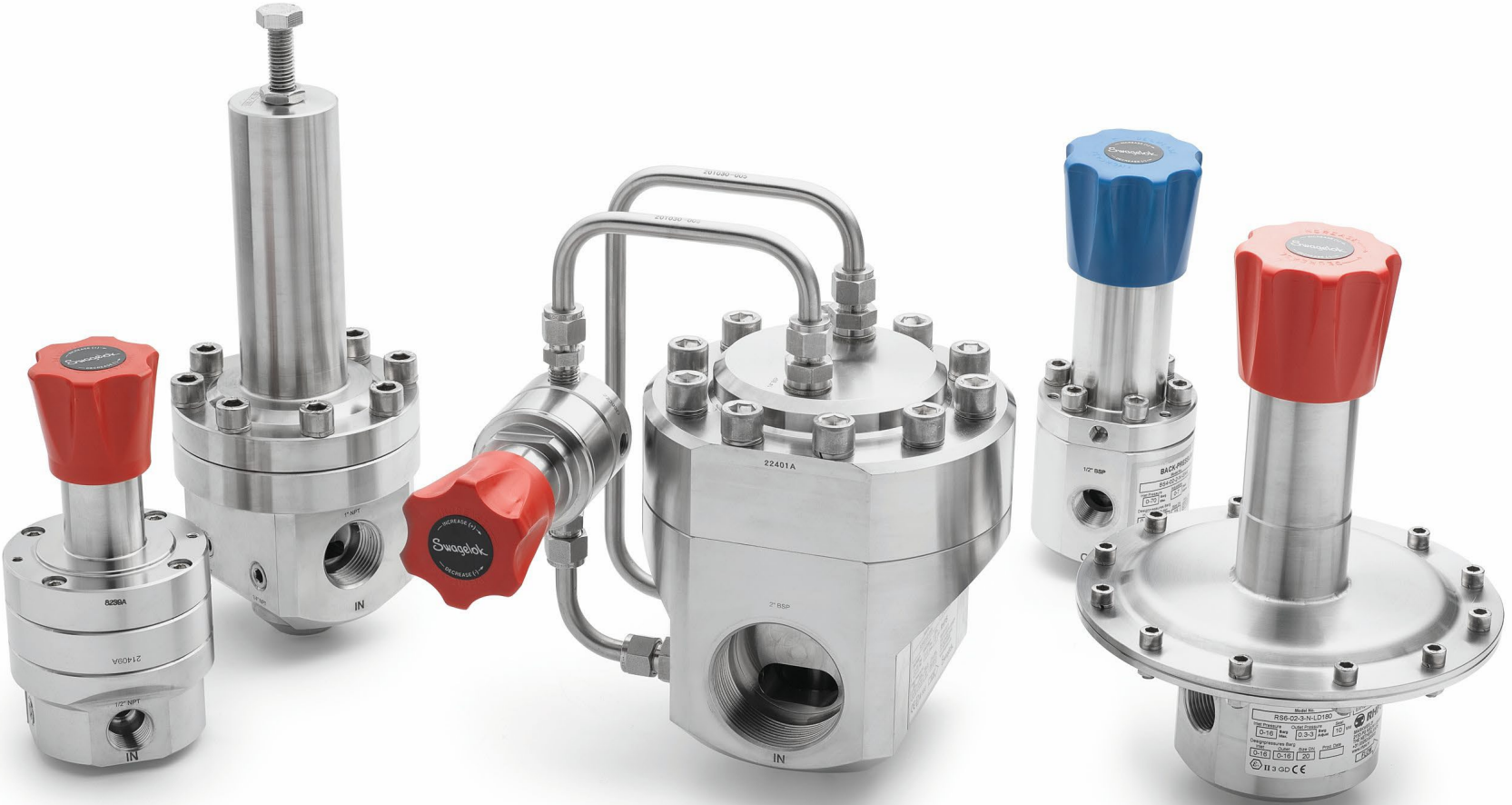
Regulator Series – K-Series (instrumentation)

Applications

- Laboratory
- Dosing
- Sampling Systems
- Gas Distribution



Regulator Series – Process Series

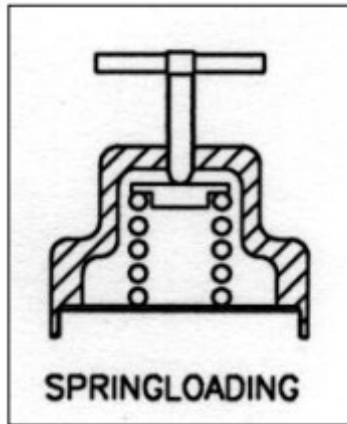


Regulator Series – Process Series

Loading Mechanism: 4 types

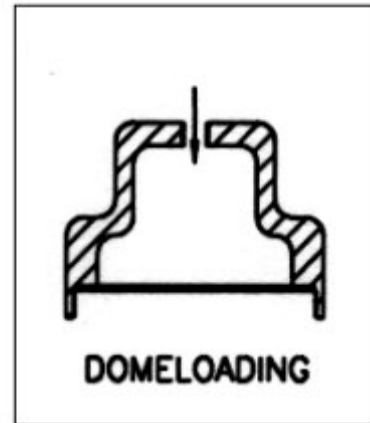
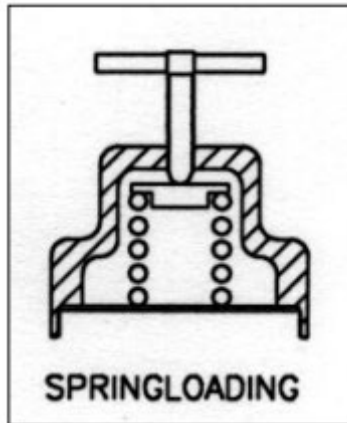
Regulator Series – Process Series

Loading Mechanism: 4 types



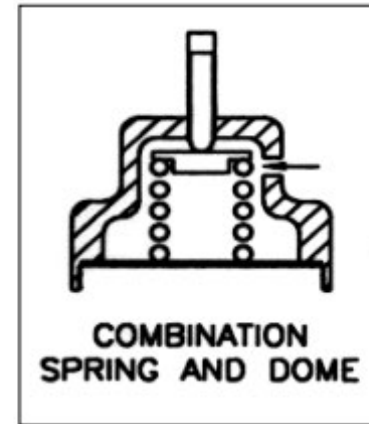
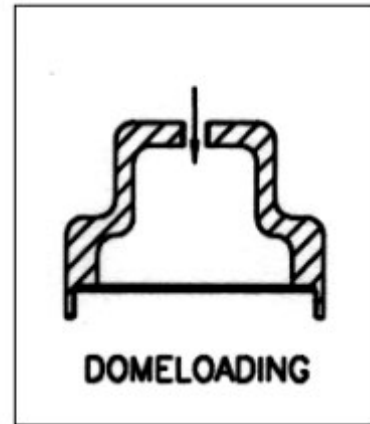
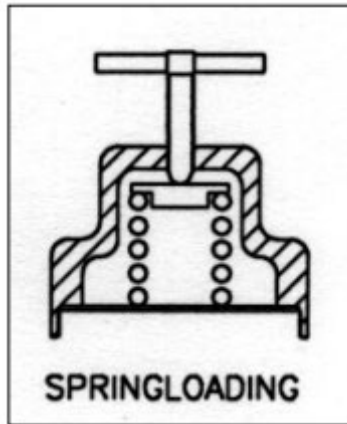
Regulator Series – Process Series

Loading Mechanism: 4 types



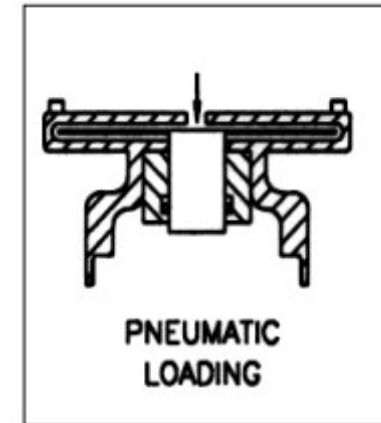
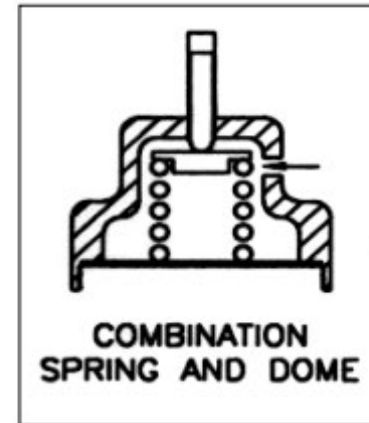
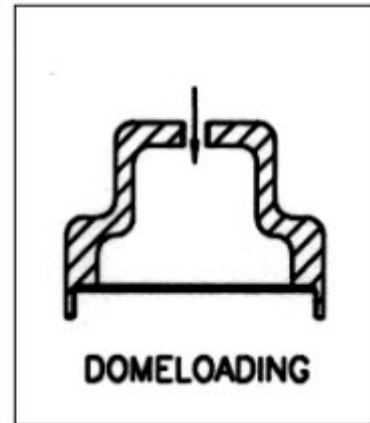
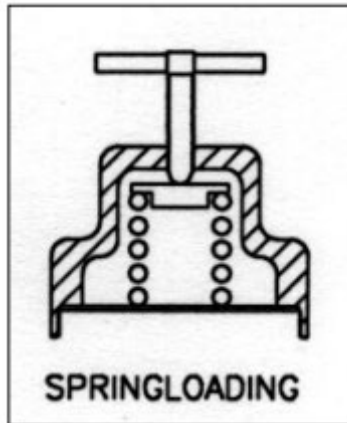
Regulator Series – Process Series

Loading Mechanism: 4 types



Regulator Series – Process Series

Loading Mechanism: 4 types



Regulator Series – Process Series, Spring Loaded



Connection size: 1/4 to 2 in.

Regulator Series – Process Series, Spring Loaded



Connection size: 1/4 to 2 in.

Applications

- Gas Filling Stations
- Process Supply
- Main Gas supply
- Gas Distribution



Regulator Series – Process Series, Spring Loaded



Applications

- Gas Filling Stations
- Process Supply
- Main Gas supply
- Gas Distribution

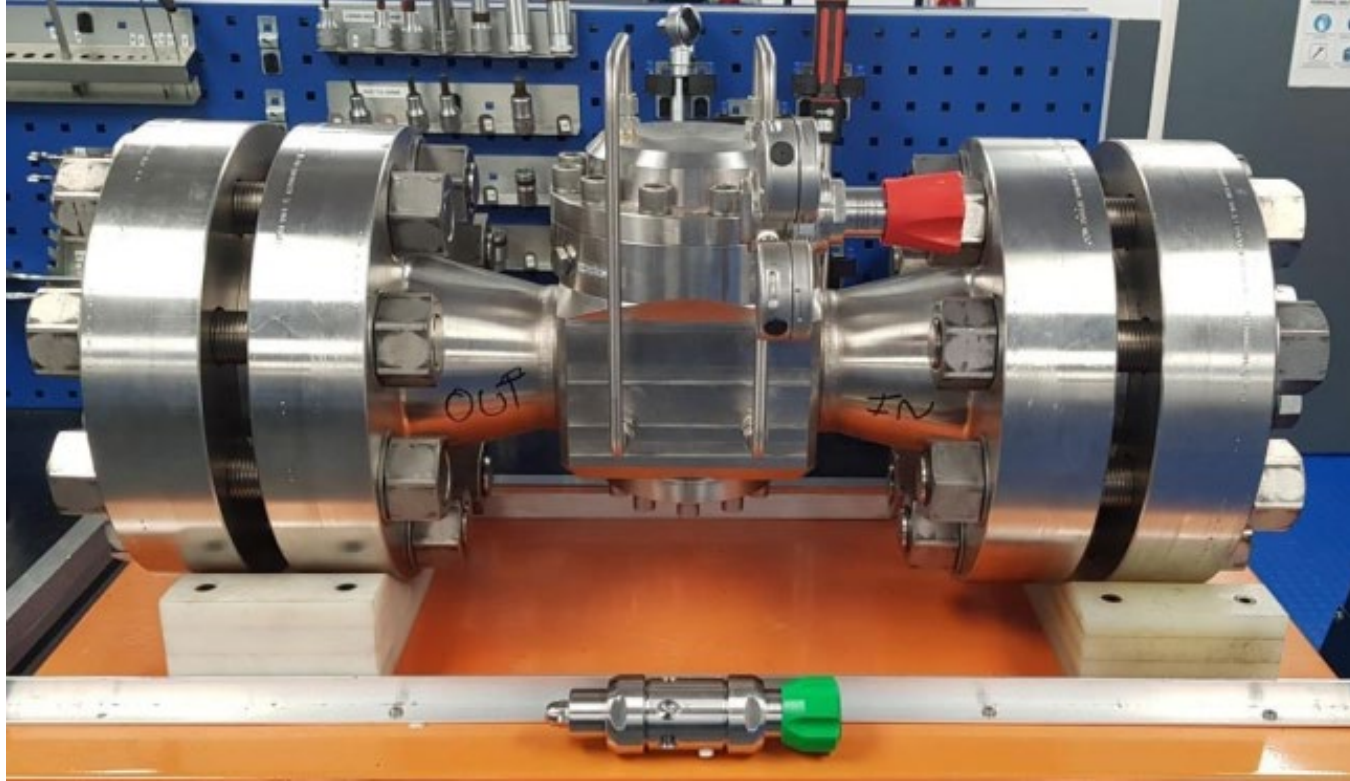


Regulator Series – Process Series, Dome Loaded

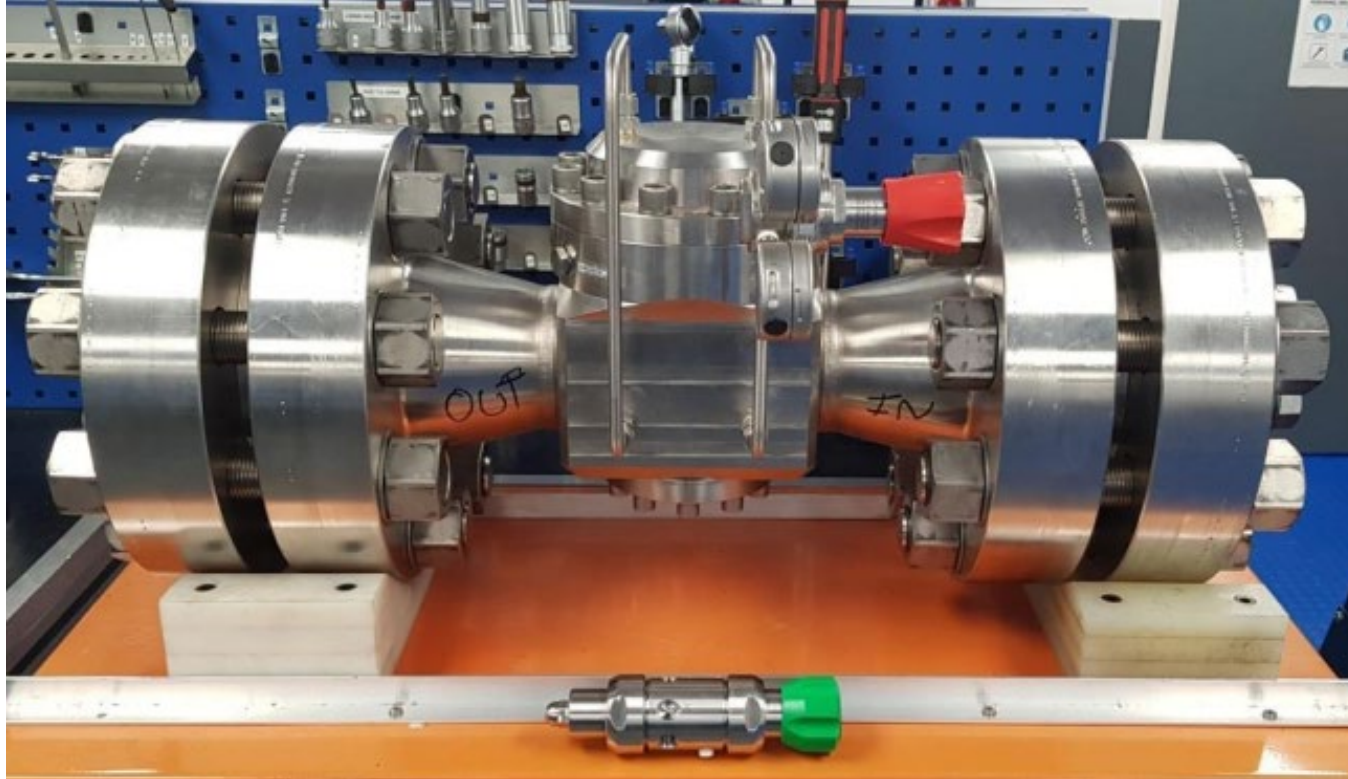


Connection size: 3/4 to 4 in.

Regulator Series – Process Series, Dome Loaded



Regulator Series – Process Series, Dome Loaded

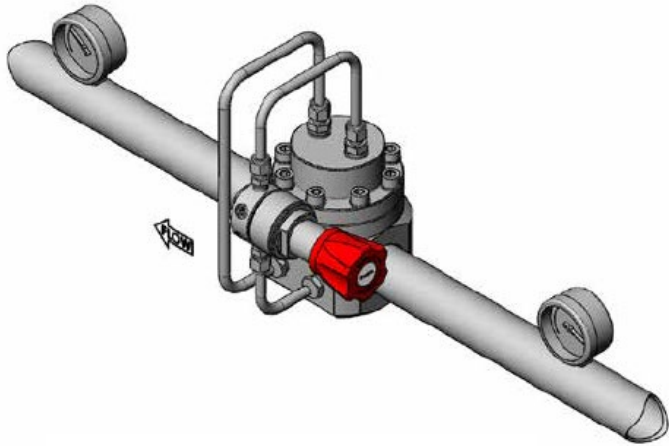
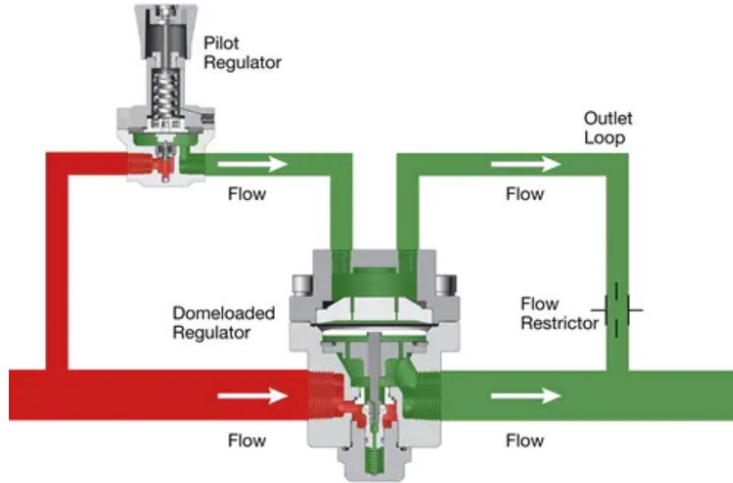


Applications

- Process Supply
- Main Gas supply
- Where a stable Outlet Pressure is required

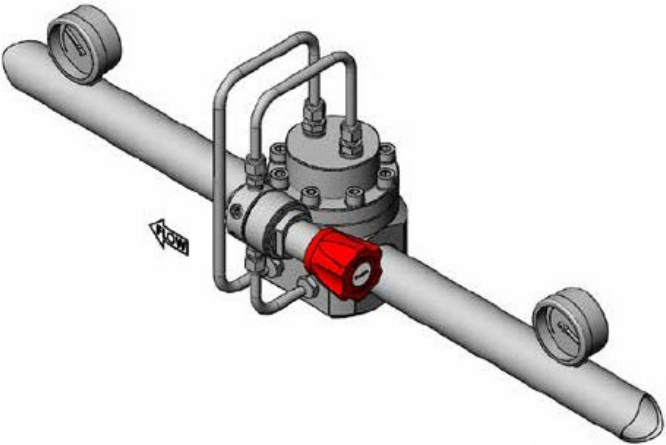
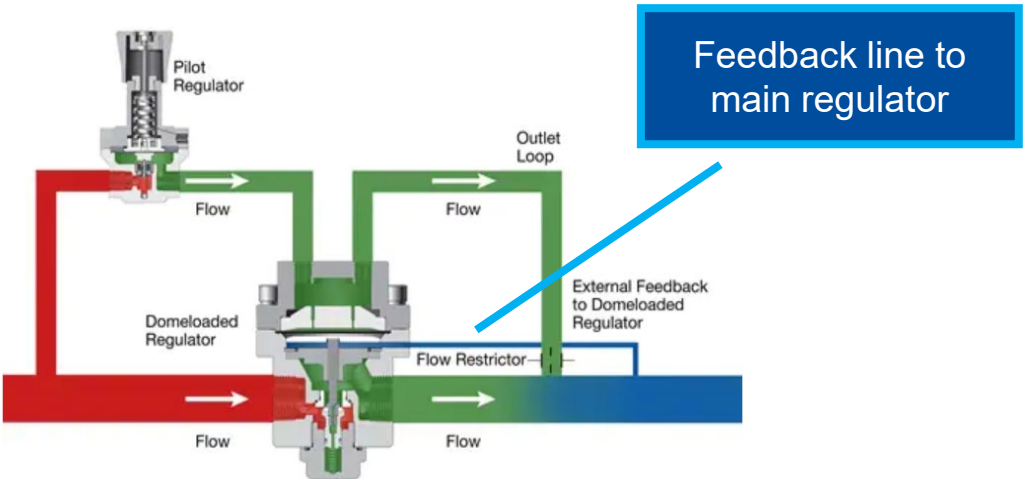
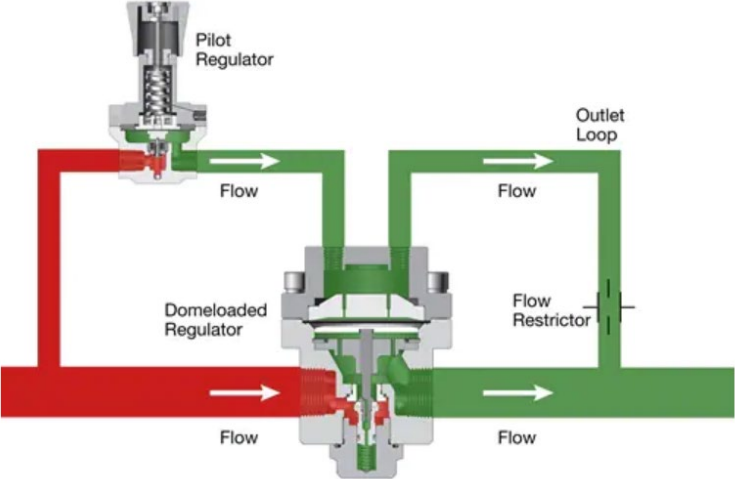


Regulator Series – Process Series, Dome Loaded

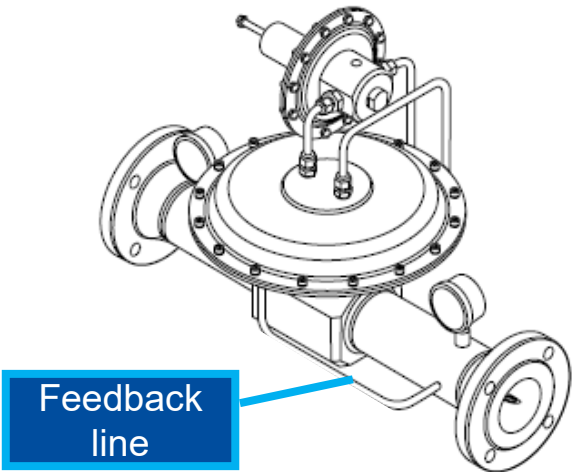


Dome Loaded Regulator

Regulator Series – Process Series, Dome Loaded EF



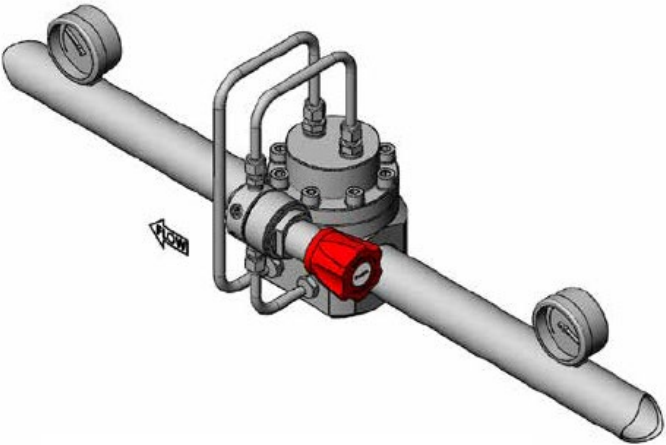
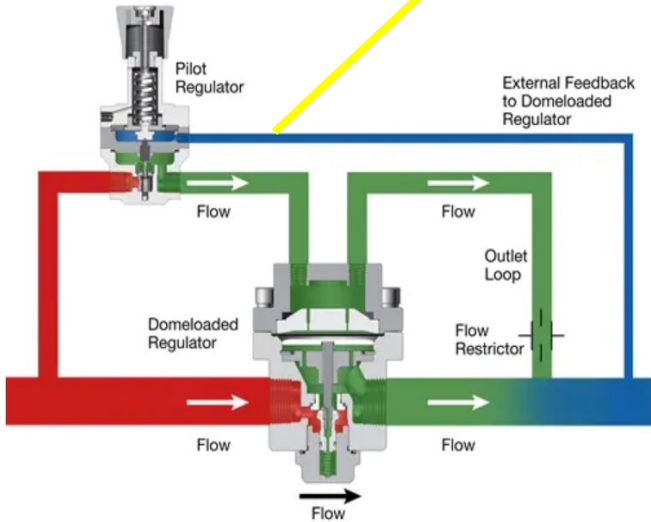
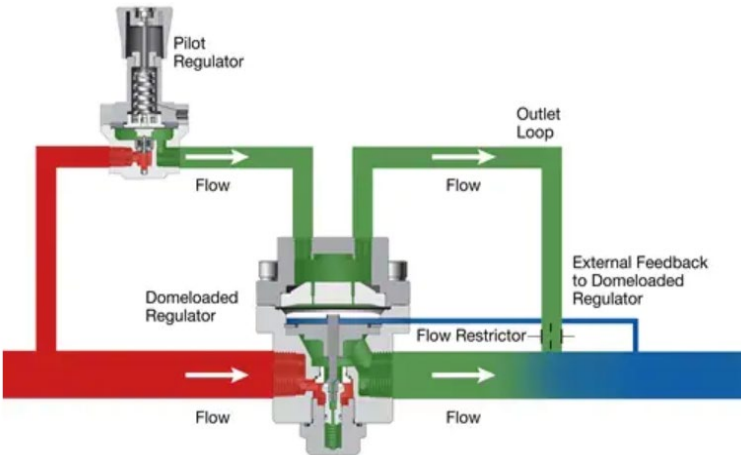
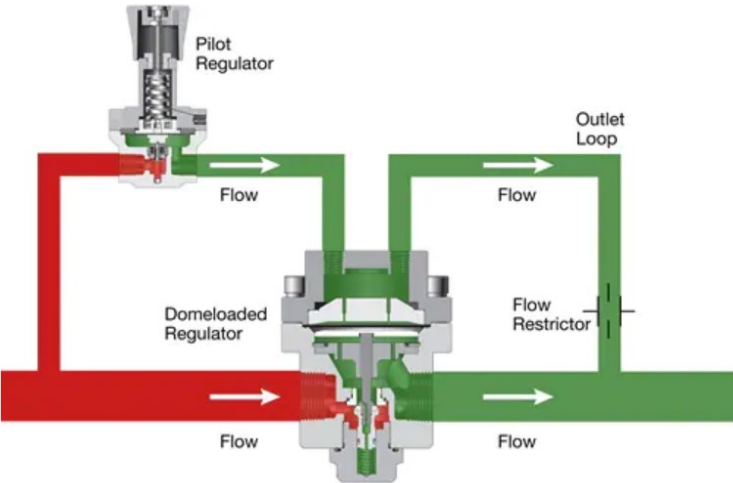
Dome Loaded Regulator



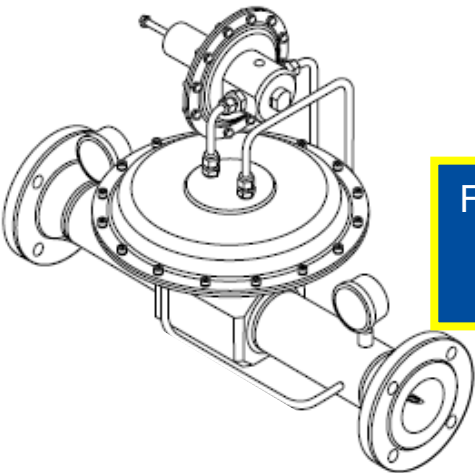
Dome Loaded Regulator with External
Feed back to main Regulator

Regulator Series – Process Series, Dome Loaded EFP

Feedback line to pilot regulator

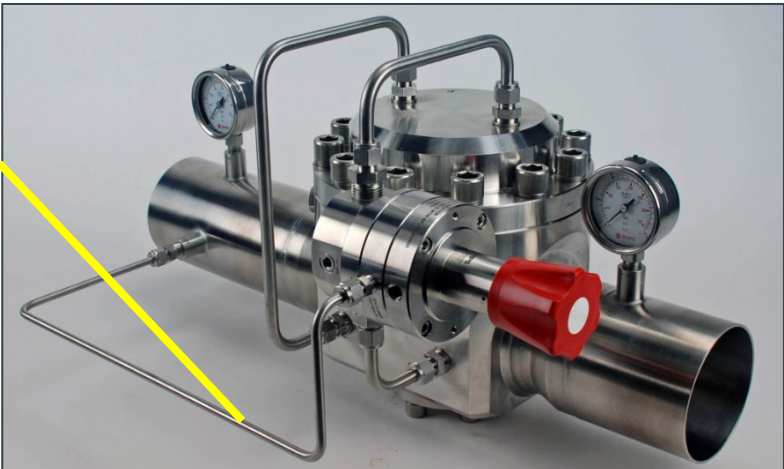


Dome Loaded Regulator



Dome Loaded Regulator with External Feed back to Dome Regulator

Feedback line to pilot regulator



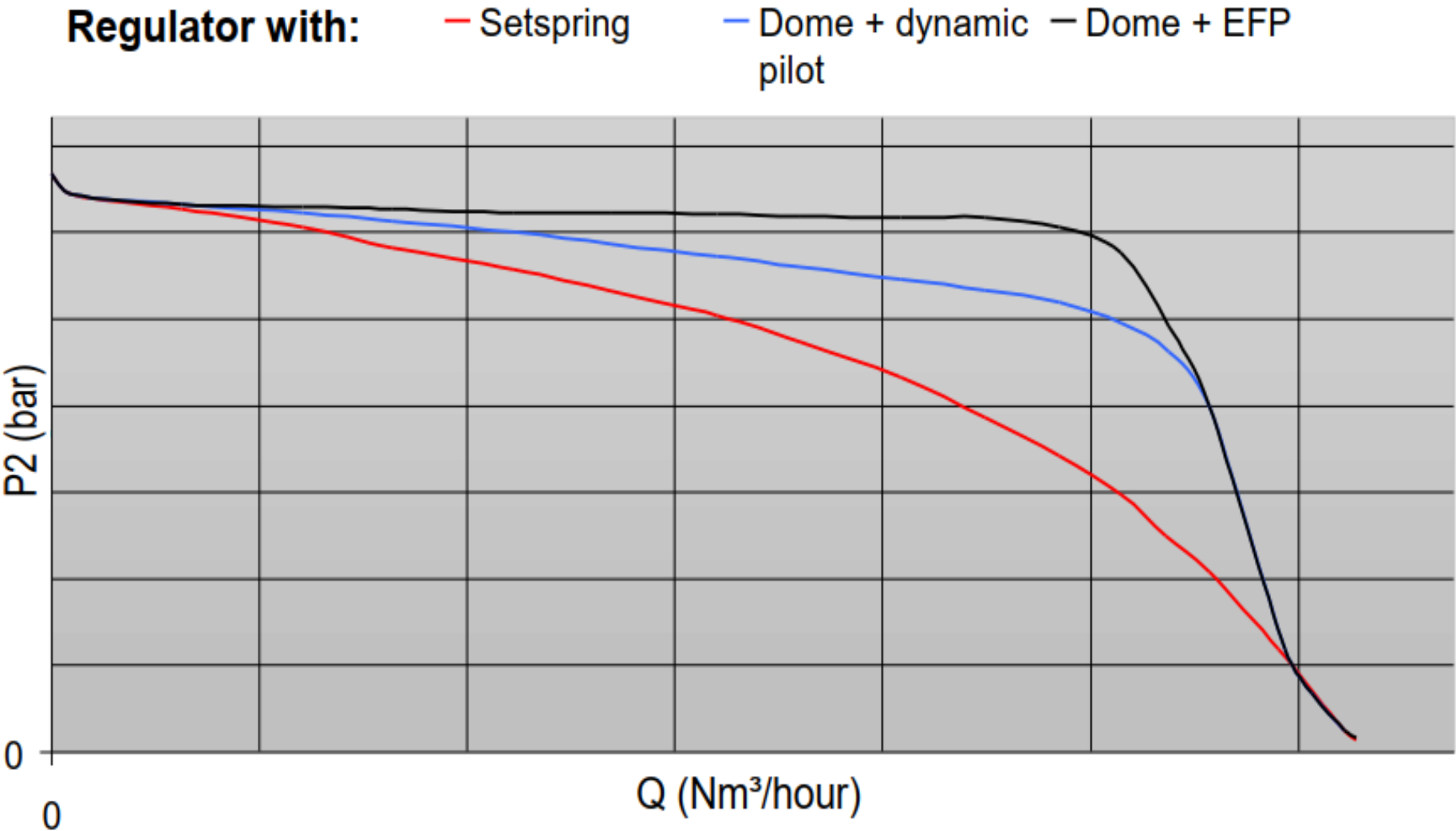
Dome Loaded Regulator with External Feed back to Pilot Regulator

Regulator Series – Process Series, Dome Loaded EFP

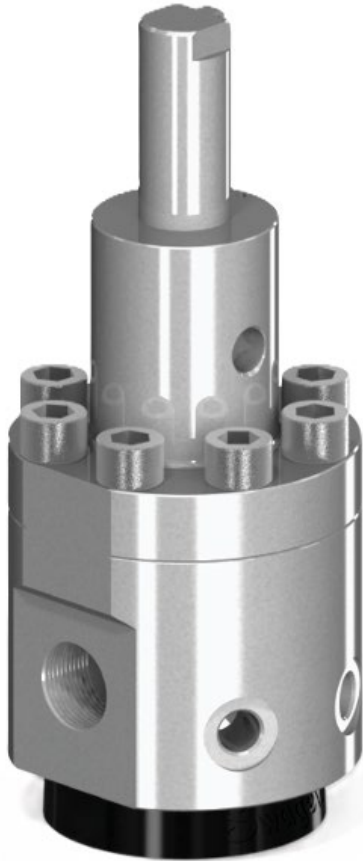
Swagelok



Regulator Series – Process Series, Dome Loaded

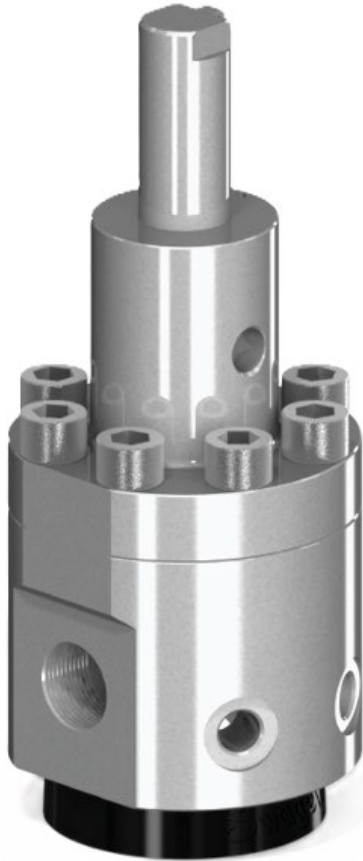


Regulator Series – Process Series, Dome and Spring



Connection size: 3/4 to 1 1/2 in.

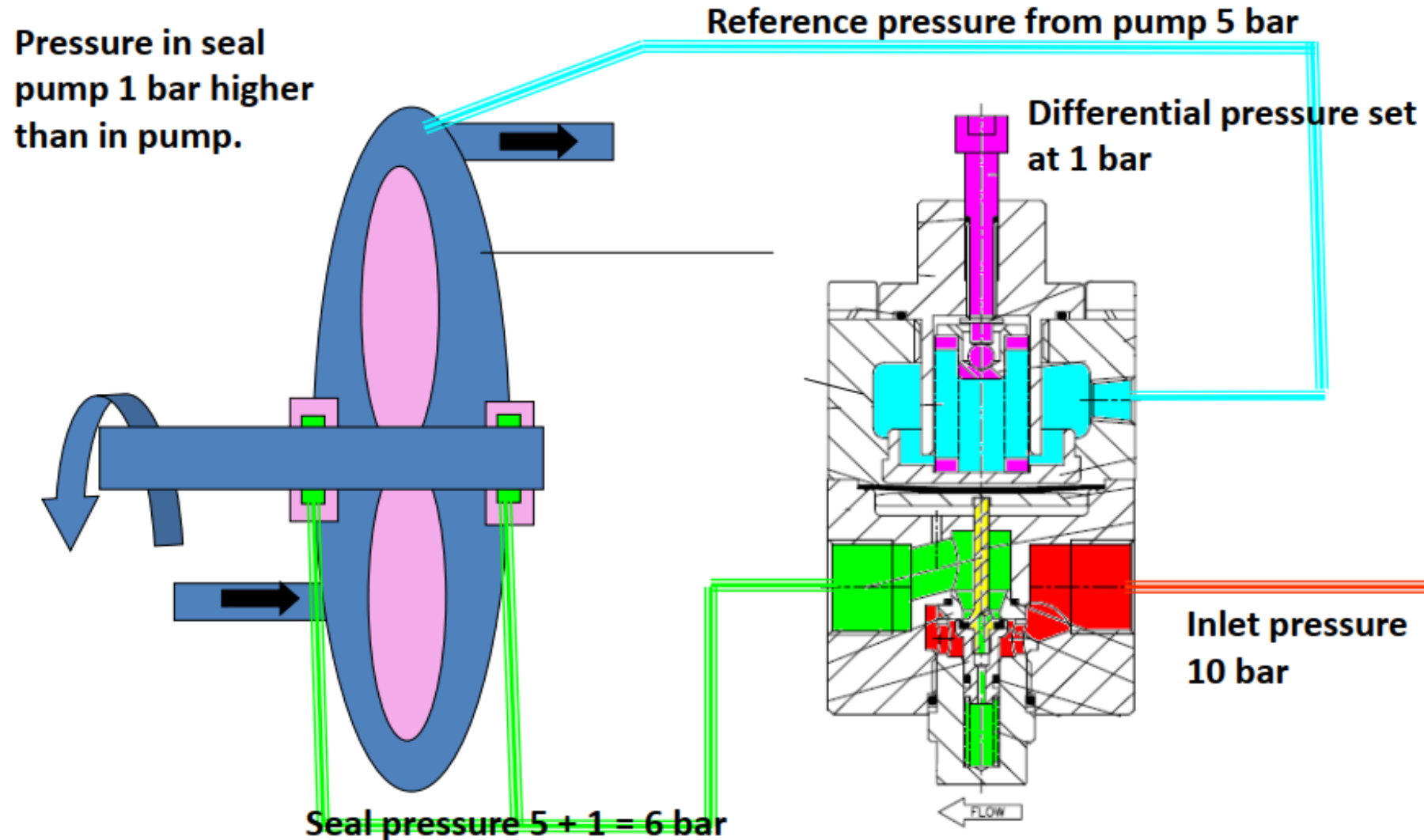
Regulator Series – Process Series, Dome and Spring



Connection size: 3/4 to 1 1/2 in.



Regulator Series – Process Series, Dome and Spring



Regulator Series – Process Series, Ratio

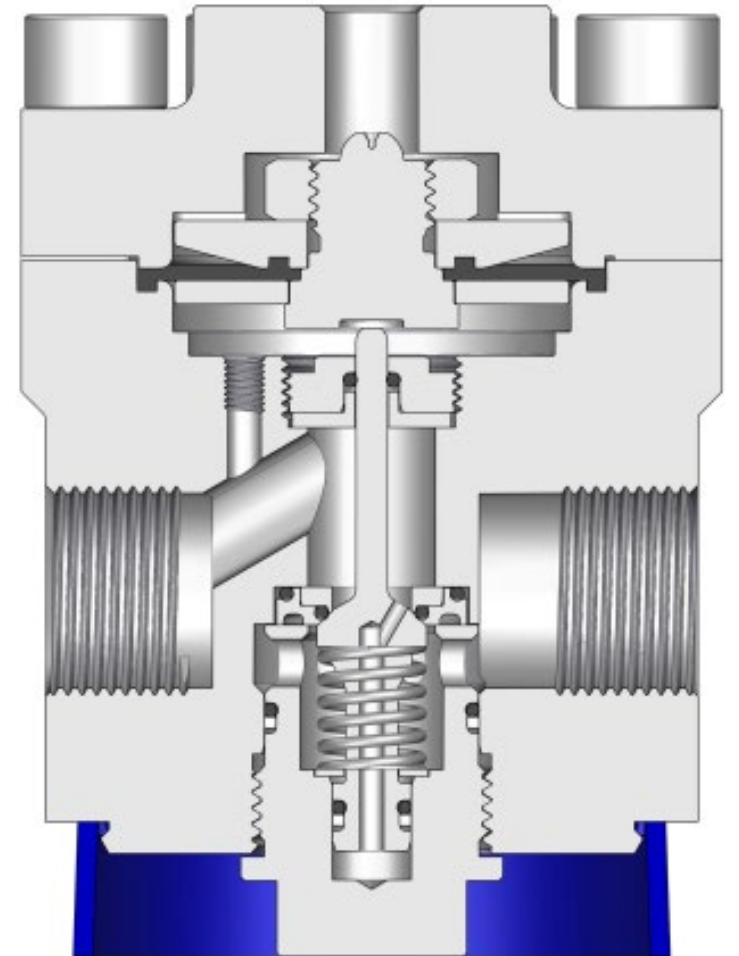
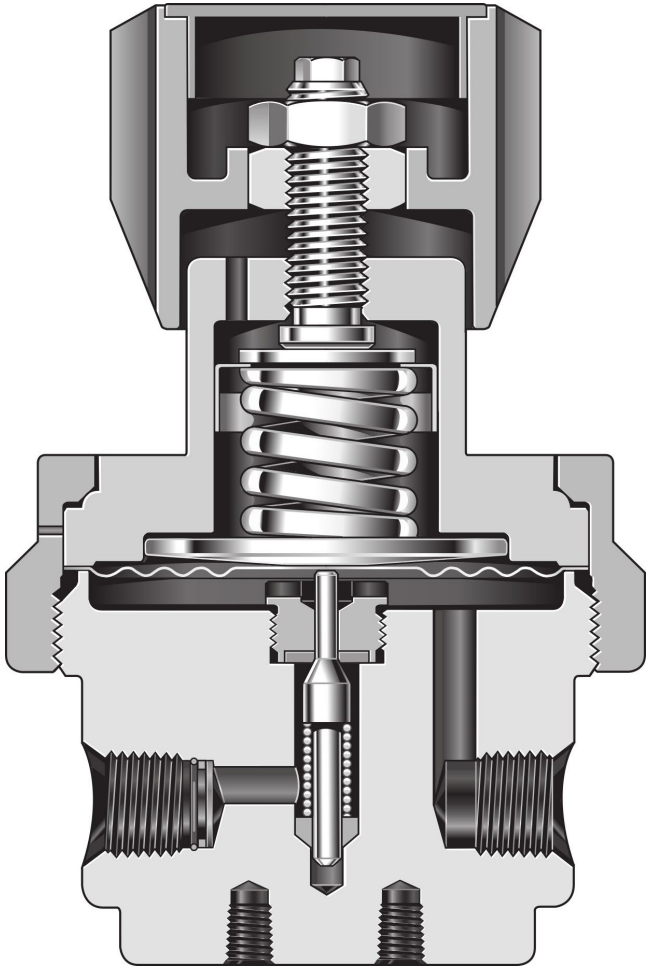


Connection size: 1/2 to 3/4 in.

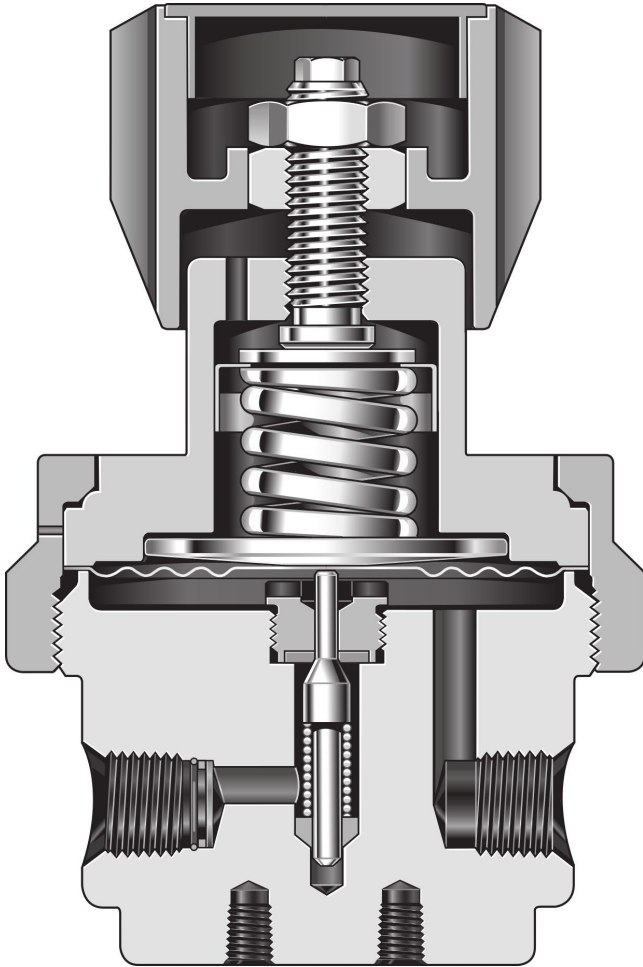


Ramp Regulator

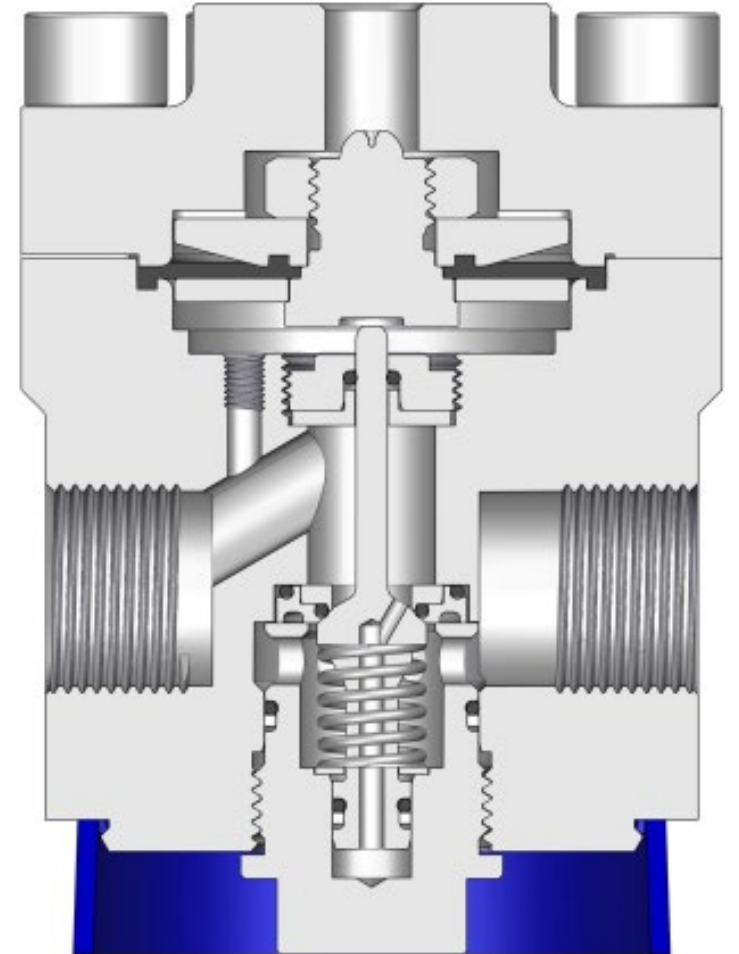
Maintenance and failure



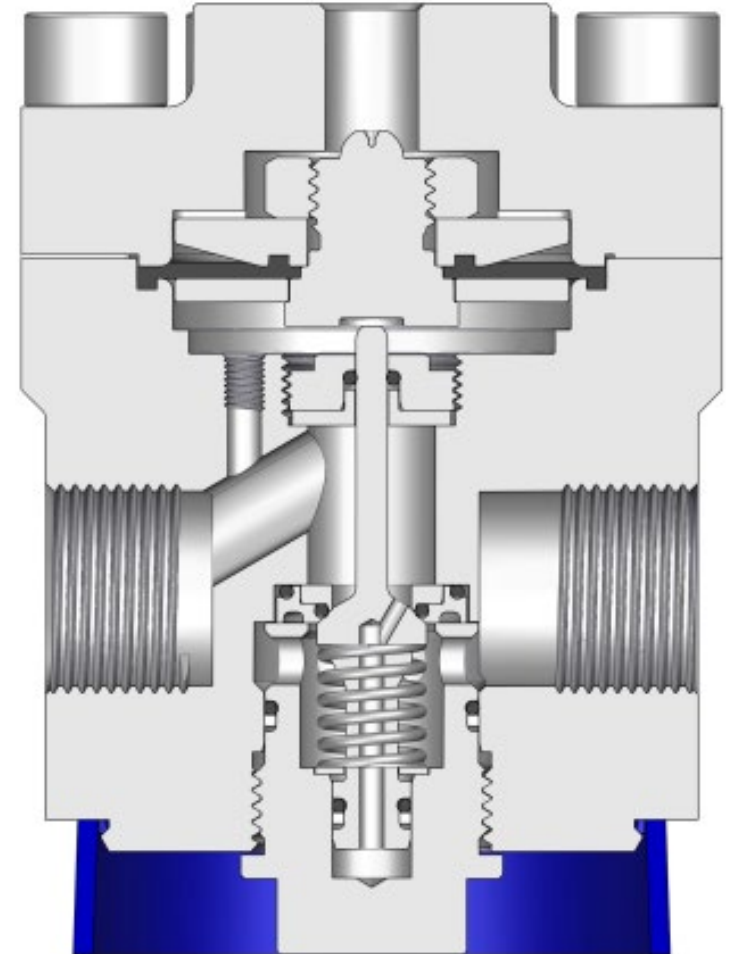
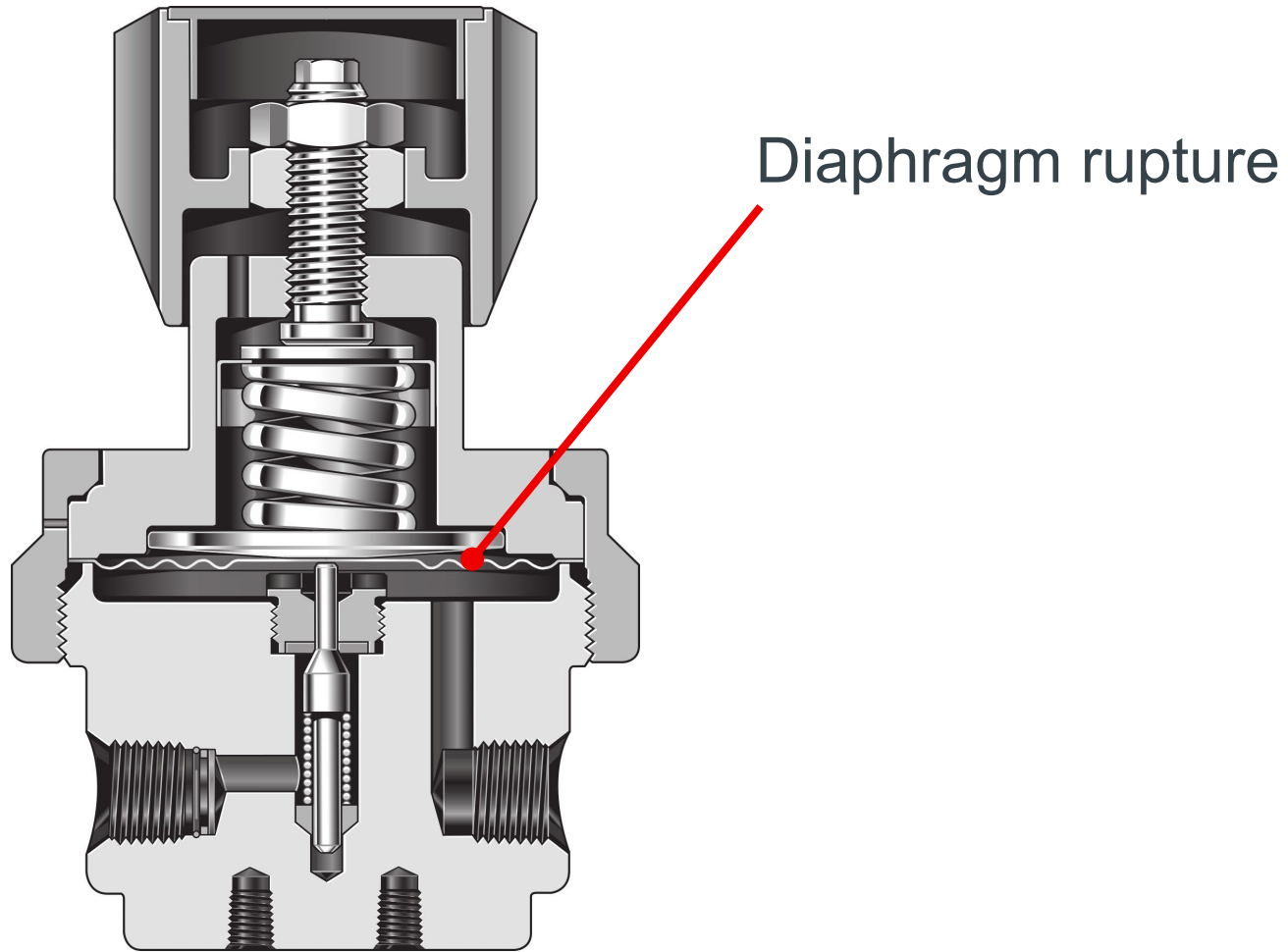
Maintenance and failure



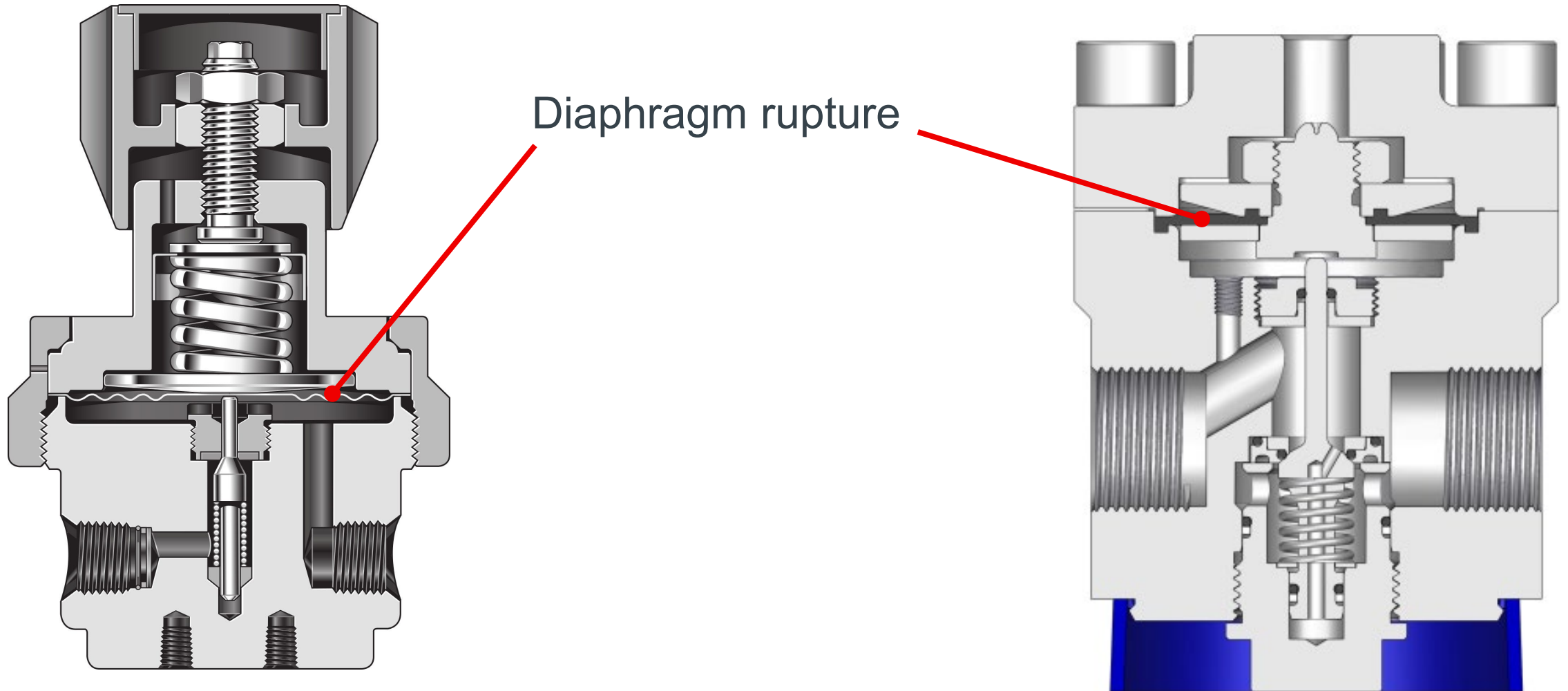
Diaphragm rupture



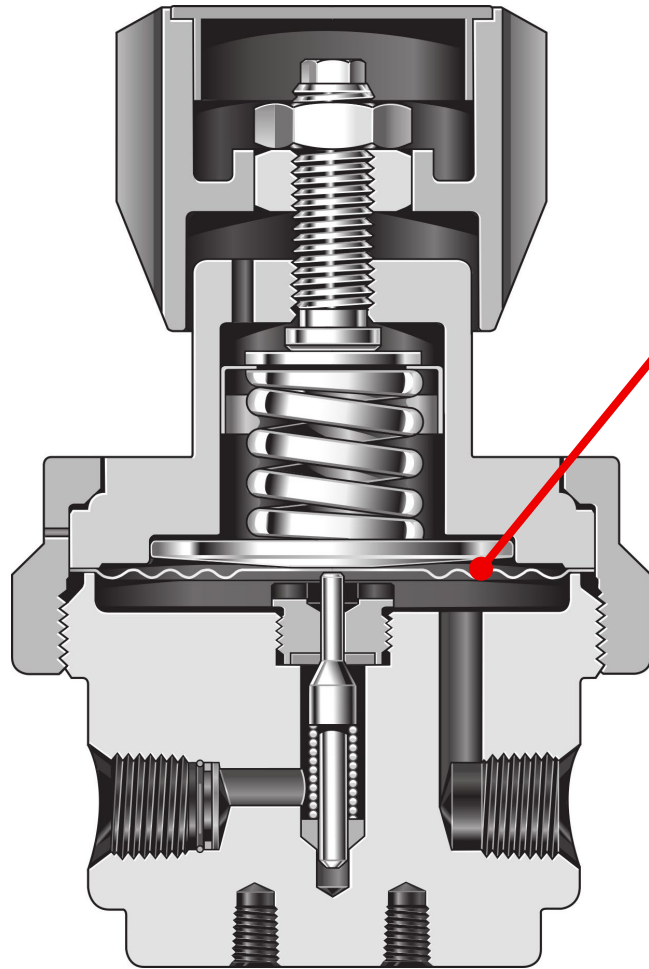
Maintenance and failure



Maintenance and failure

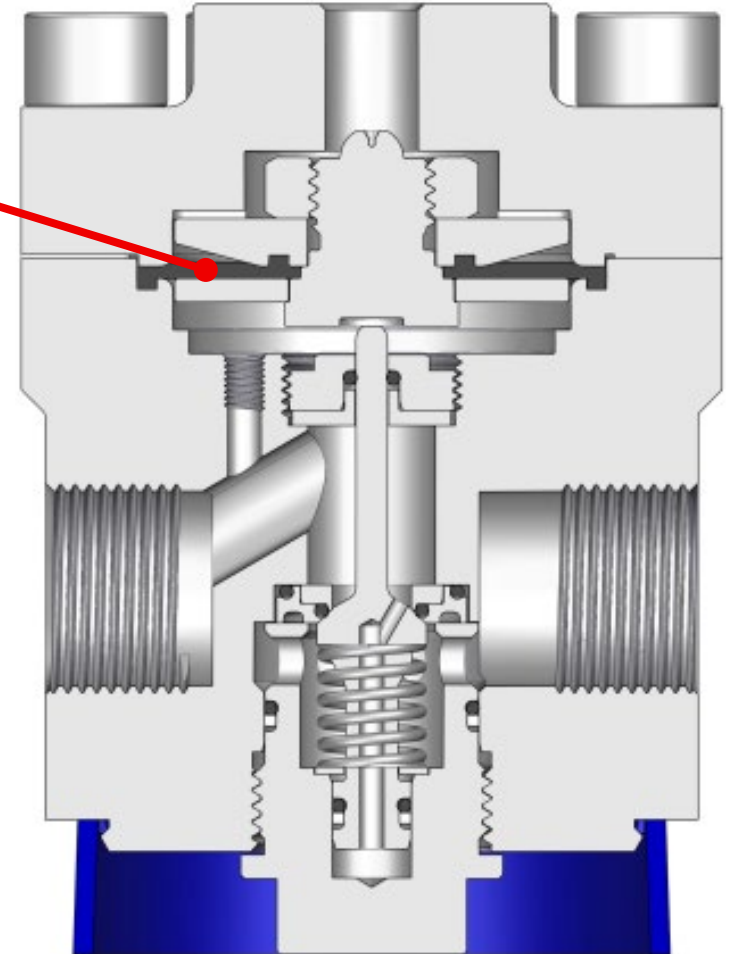


Maintenance and failure

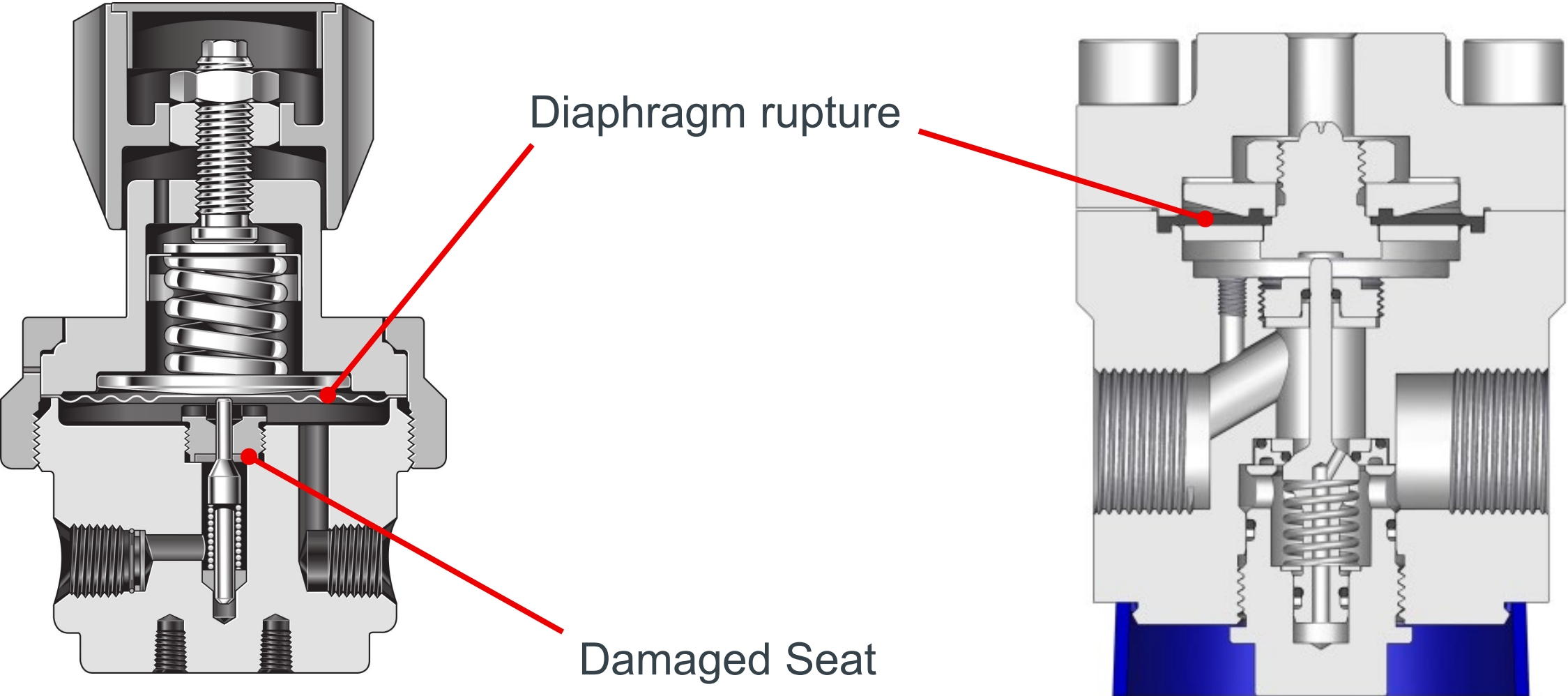


Diaphragm rupture

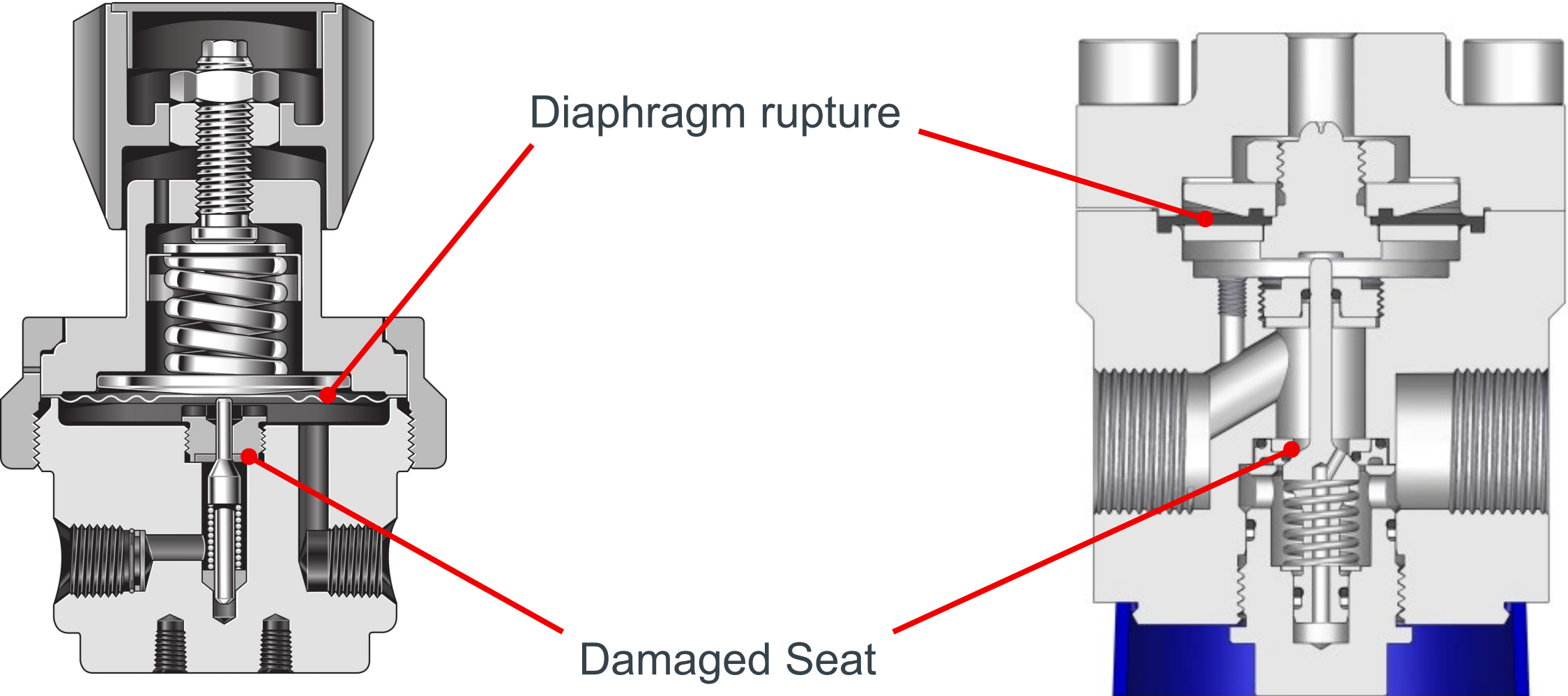
Damaged Seat



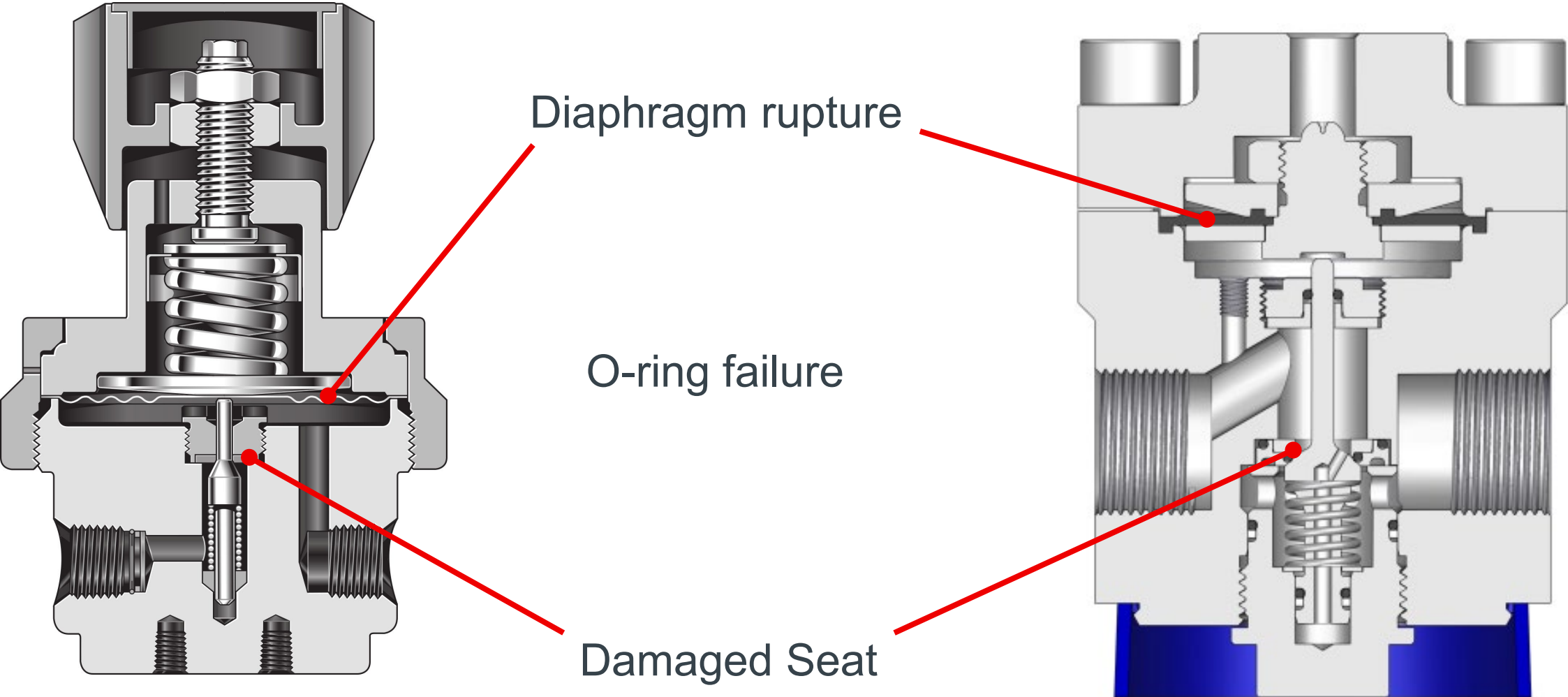
Maintenance and failure



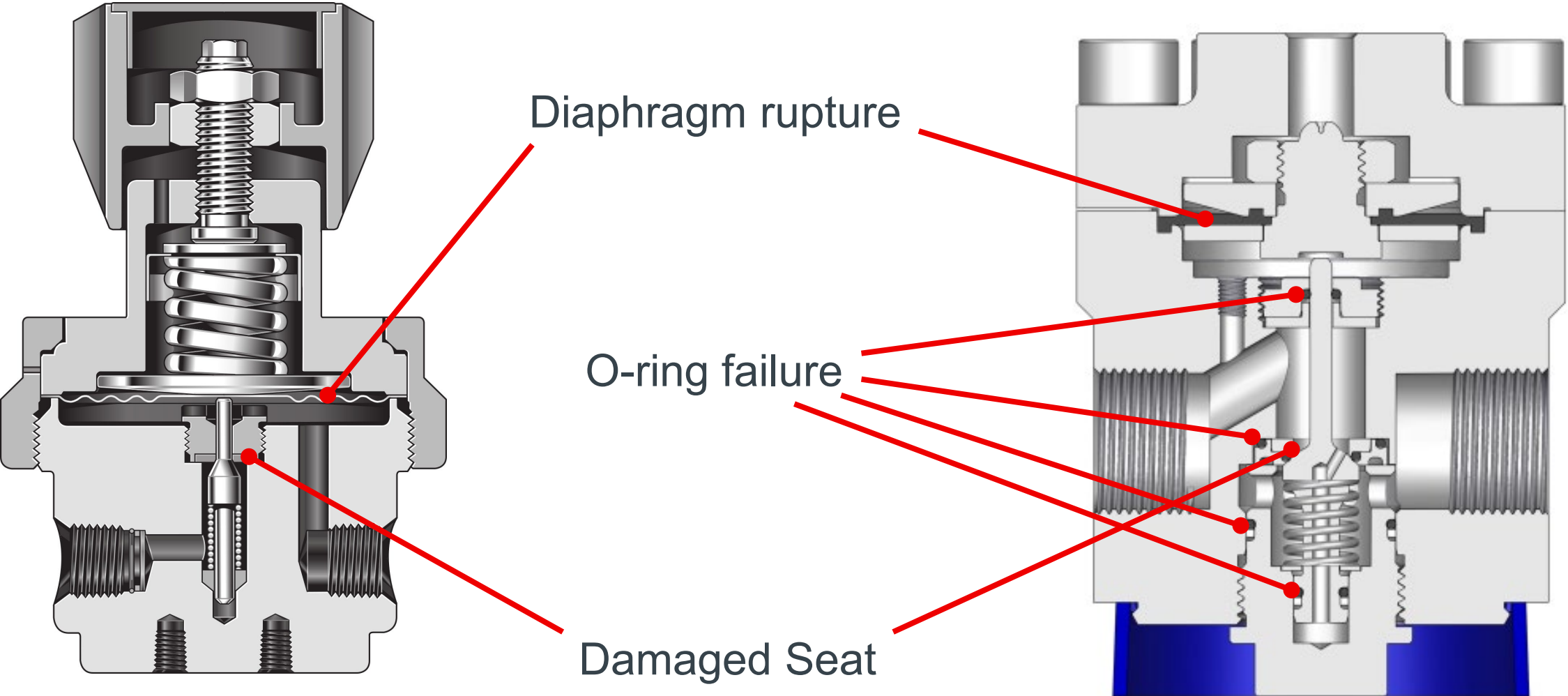
Maintenance and failure



Maintenance and failure



Maintenance and failure



Maintenance and failure - Creep

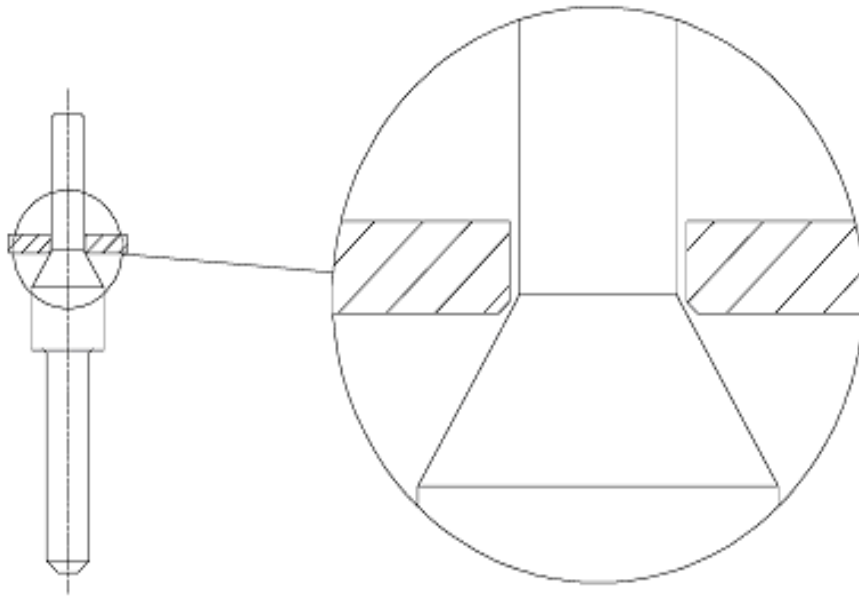
Most common cause:

- Contamination of the seat
- Damage to the poppet or seat

Maintenance and failure - Creep

Most common cause:

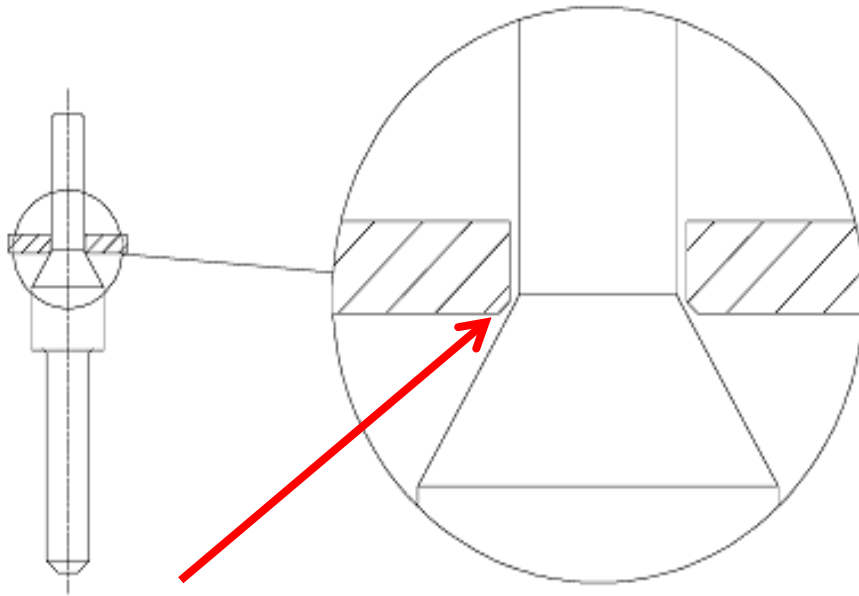
- Contamination of the seat
- Damage to the poppet or seat



Maintenance and failure - Creep

Most common cause:

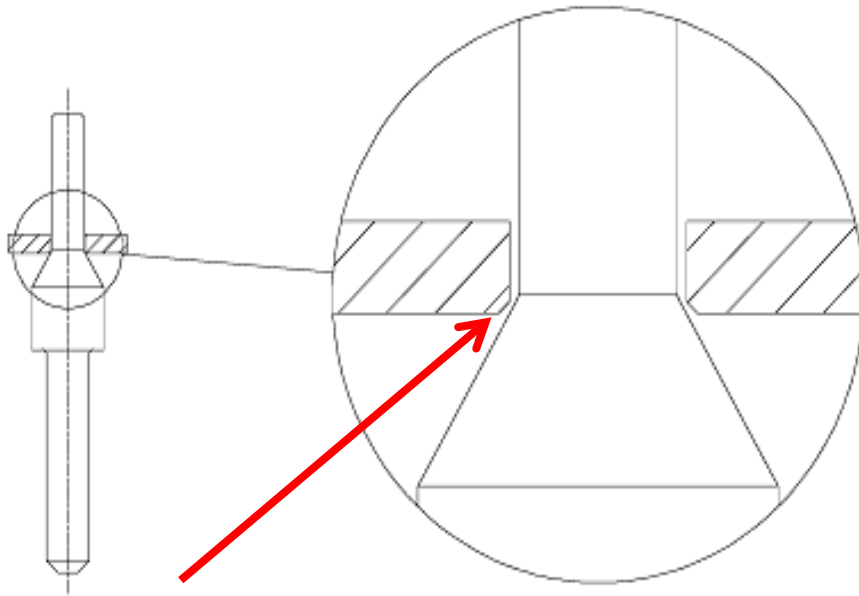
- Contamination of the seat
- Damage to the poppet or seat



Maintenance and failure - Creep

Most common cause:

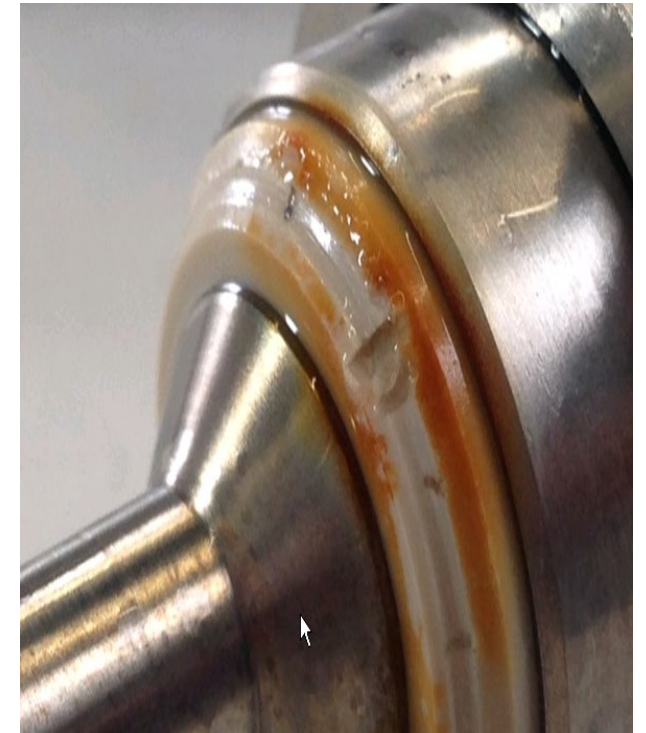
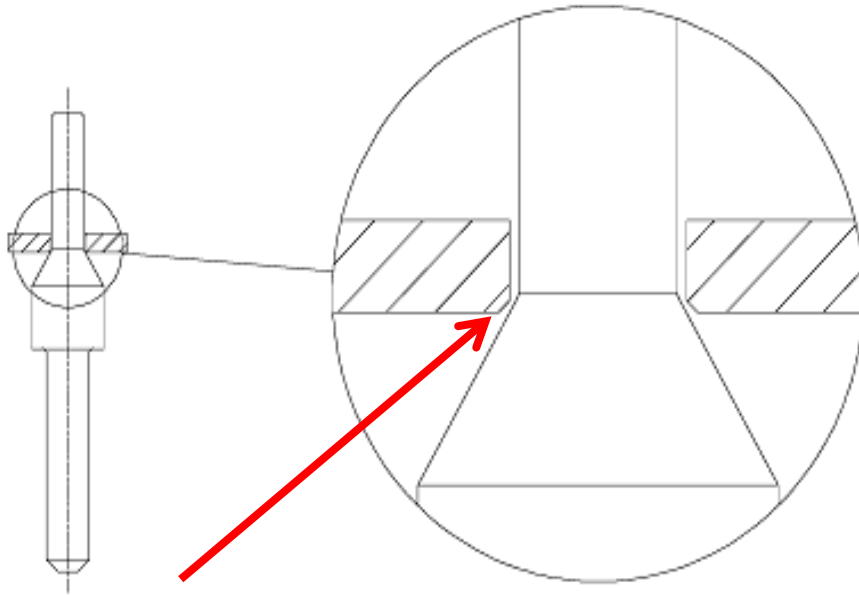
- Contamination of the seat
- Damage to the poppet or seat



Maintenance and failure - Creep

Most common cause:

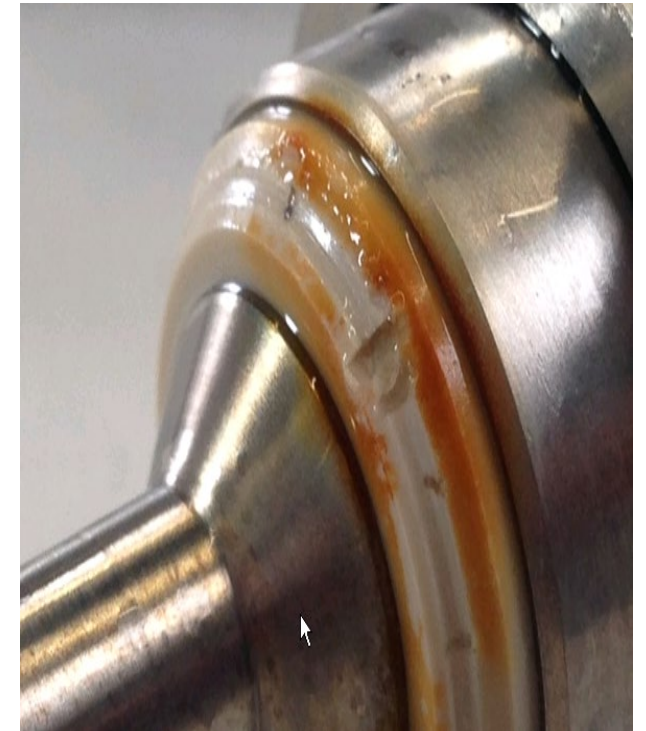
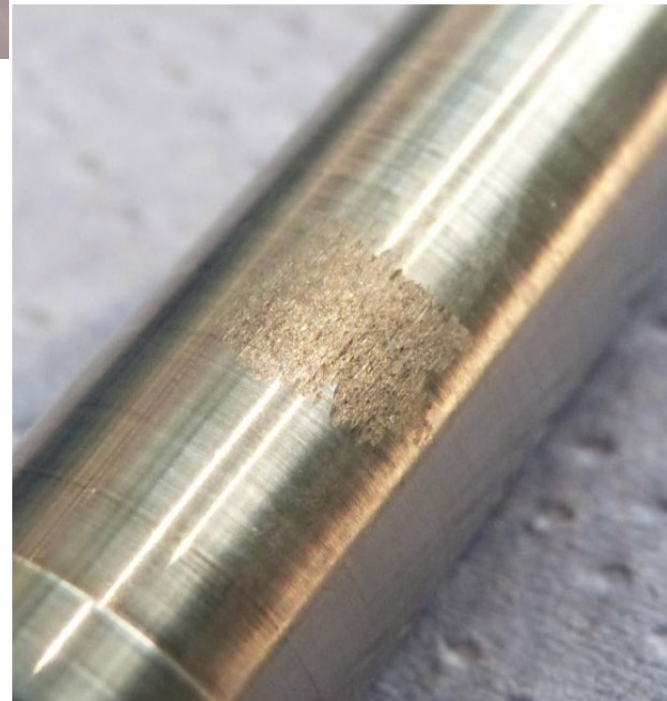
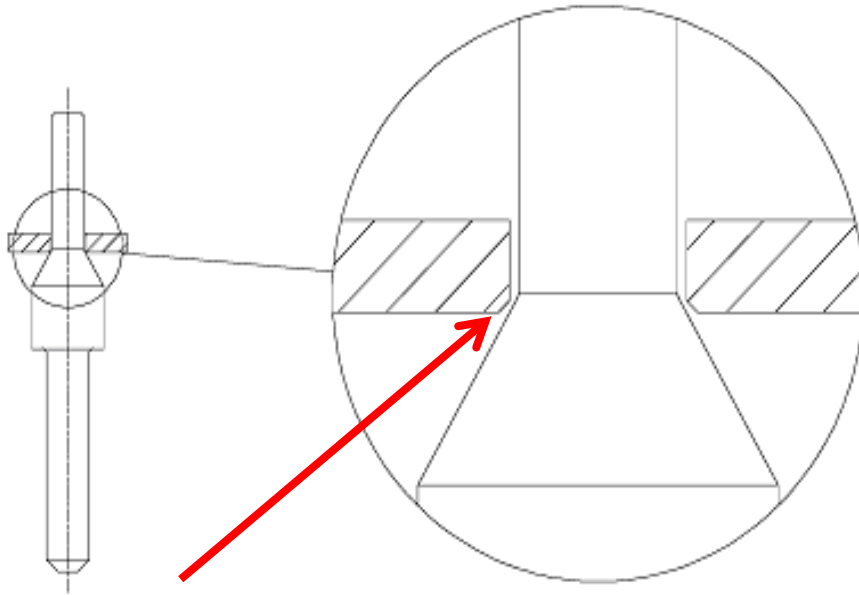
- Contamination of the seat
- Damage to the poppet or seat



Maintenance and failure - Creep

Most common cause:

- Contamination of the seat
- Damage to the poppet or seat



Maintenance and failure - Filter

Prevent contamination:

- Filter in inlet of Regulator
- Separate Filter

Maintenance and failure - Filter

Prevent contamination:

- Filter in inlet of Regulator
- Separate Filter



Maintenance and failure - Filter

Prevent contamination:

- Filter in inlet of Regulator
- Separate Filter



Maintenance and failure - Filter

Prevent contamination:

- Filter in inlet of Regulator
- Separate Filter



Maintenance and failure – Kits K-Series

Preventive or corrective:

- Maintenance Kit
- Spare parts

Ordering Information

Build a maintenance kit ordering number by combining the designators in the sequence shown below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
K	P	R	1	D	0	0	4	1	2	A	0	-	K	I	T

1 2 3 Regulator Series

KPR = KPR

KCP = KCP

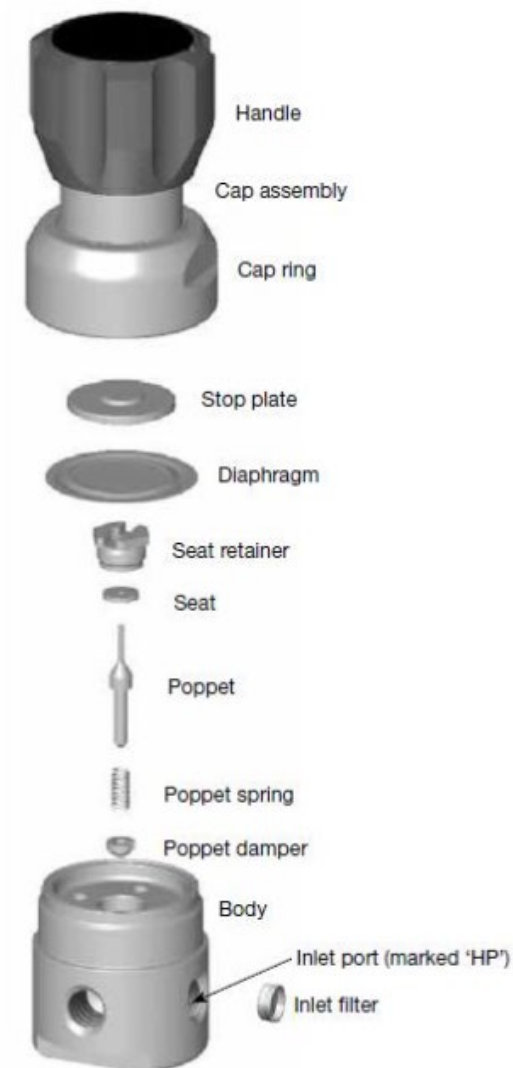
6 Maximum Inlet Pressure

0 = Not applicable

10 Flow Coefficient (C_v)

1 = 0.02

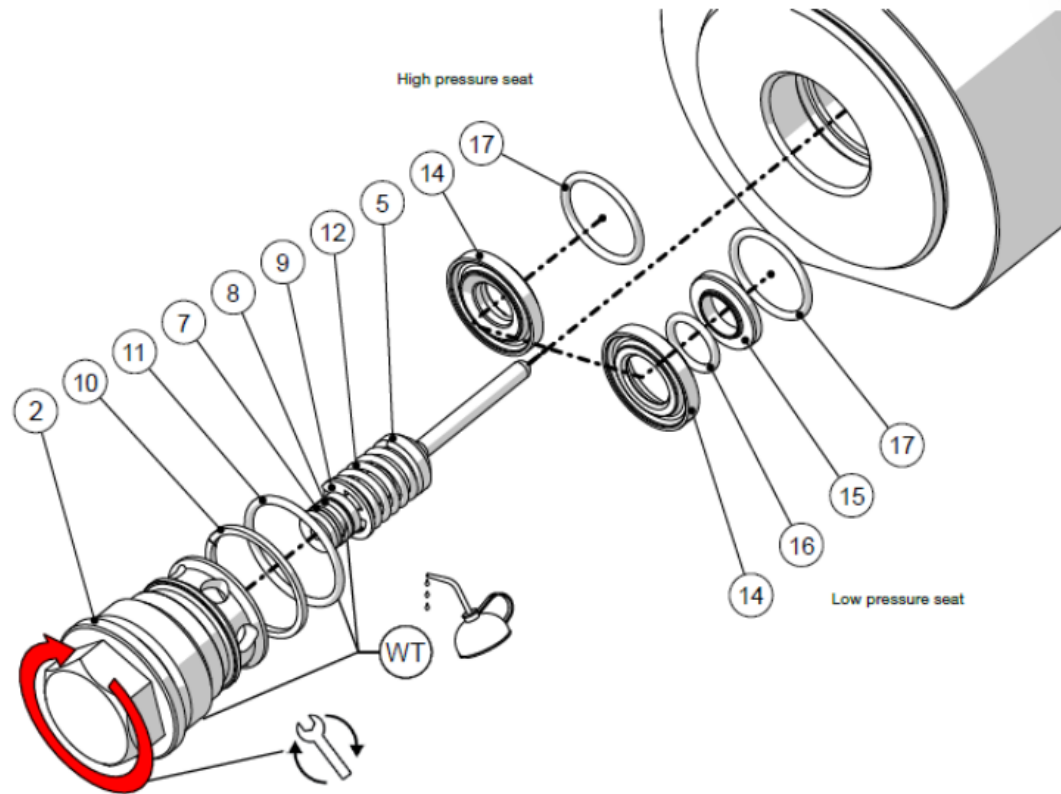
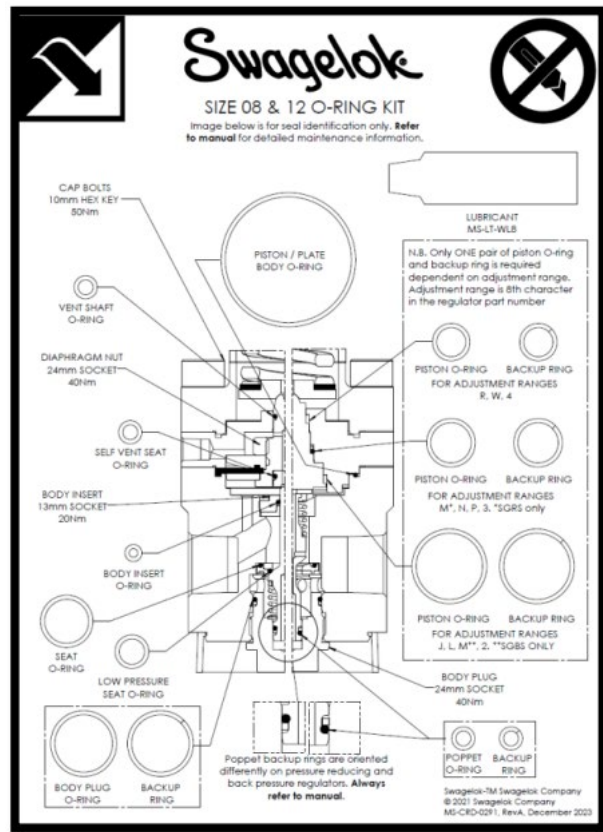
2 = 0.06



Maintenance and failure – Kits Process Serie

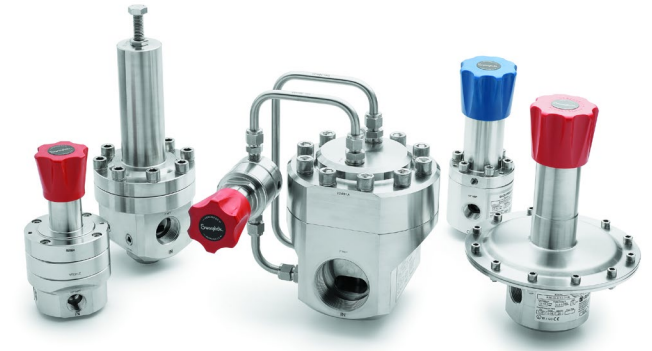
Preventive or corrective:

- Maintenance Kit
- Spare parts



Summary

- Regulators Basics (reducing & back pressure)
- Main regulator components (loading, sensing and control element)
- How to read a Flow curve
- Different Series, various applications
- What causes malfunction
- Filtration
- Maintenance and repair kits



Questions?



Paul Krouwels

paul.krouwels@swagelok.nl



Dick van Camp

dick.van.camp@swagelok.nl

