Swagelok®

Improve safety and performance of Gas Distribution Applications

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February 13, 2025

Introduction Swagelok

Aidan Lourier
Technical Support

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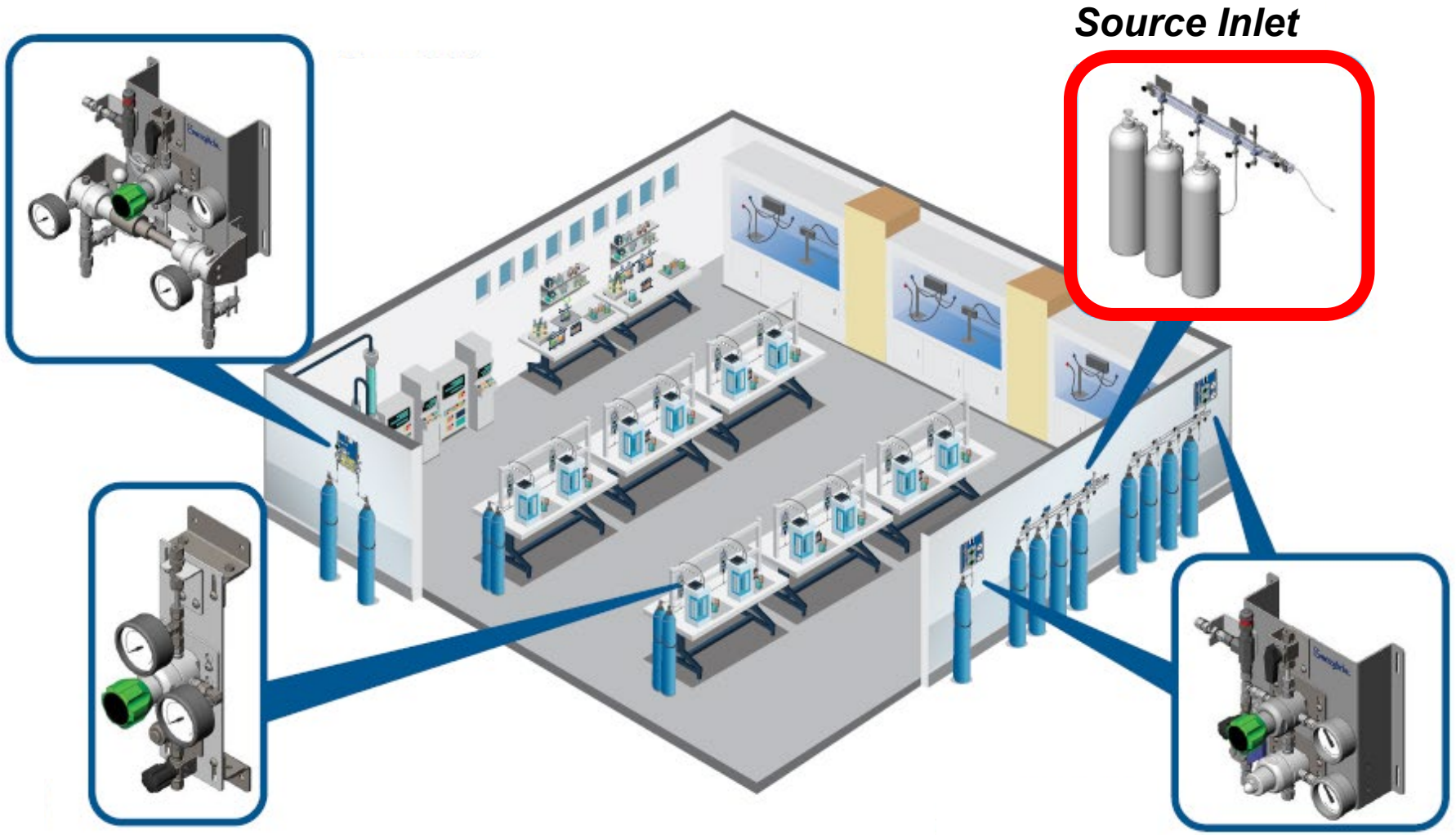
Field Engineer

Agenda

What is a Gas Distribution Application?

- Regulator flow curves
  - Droop
  - Lockup
- Supply Pressure Effect
  - Single vs multiple regulator stages
- Changeover panels
  - Operation
  - Selecting changeover pressure
- Selecting line regulation
- Questions

What is a Gas Distribution Application?



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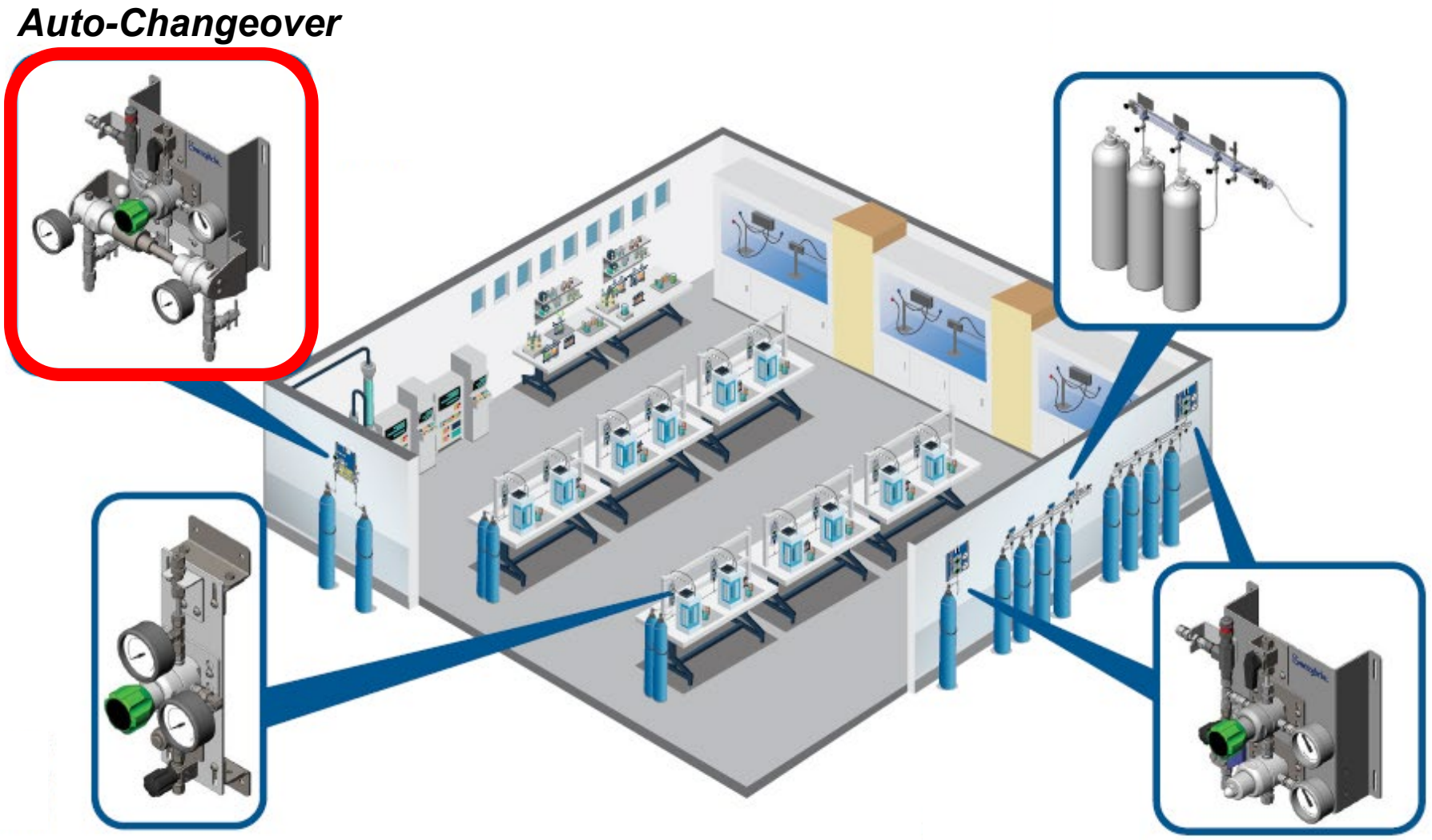

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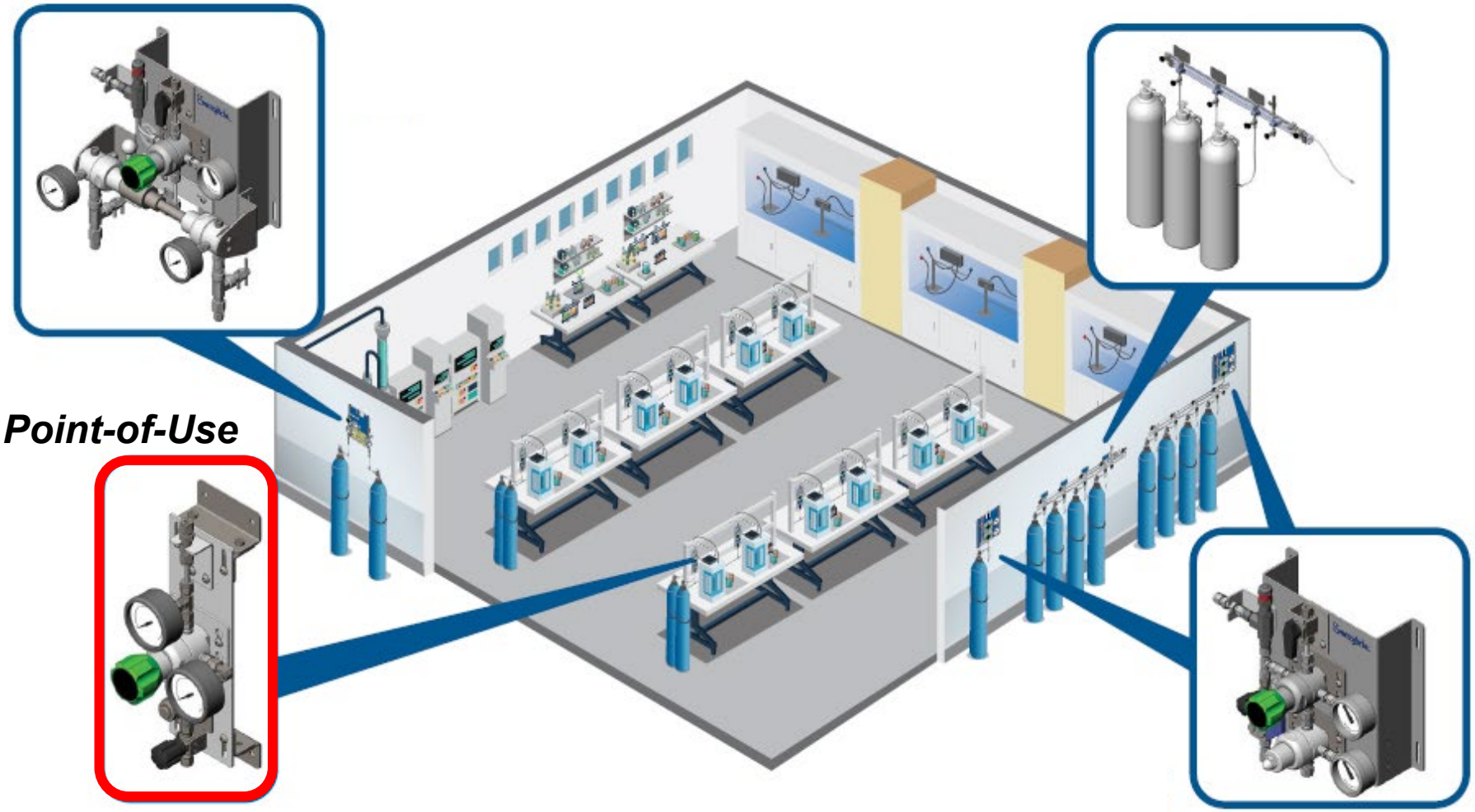
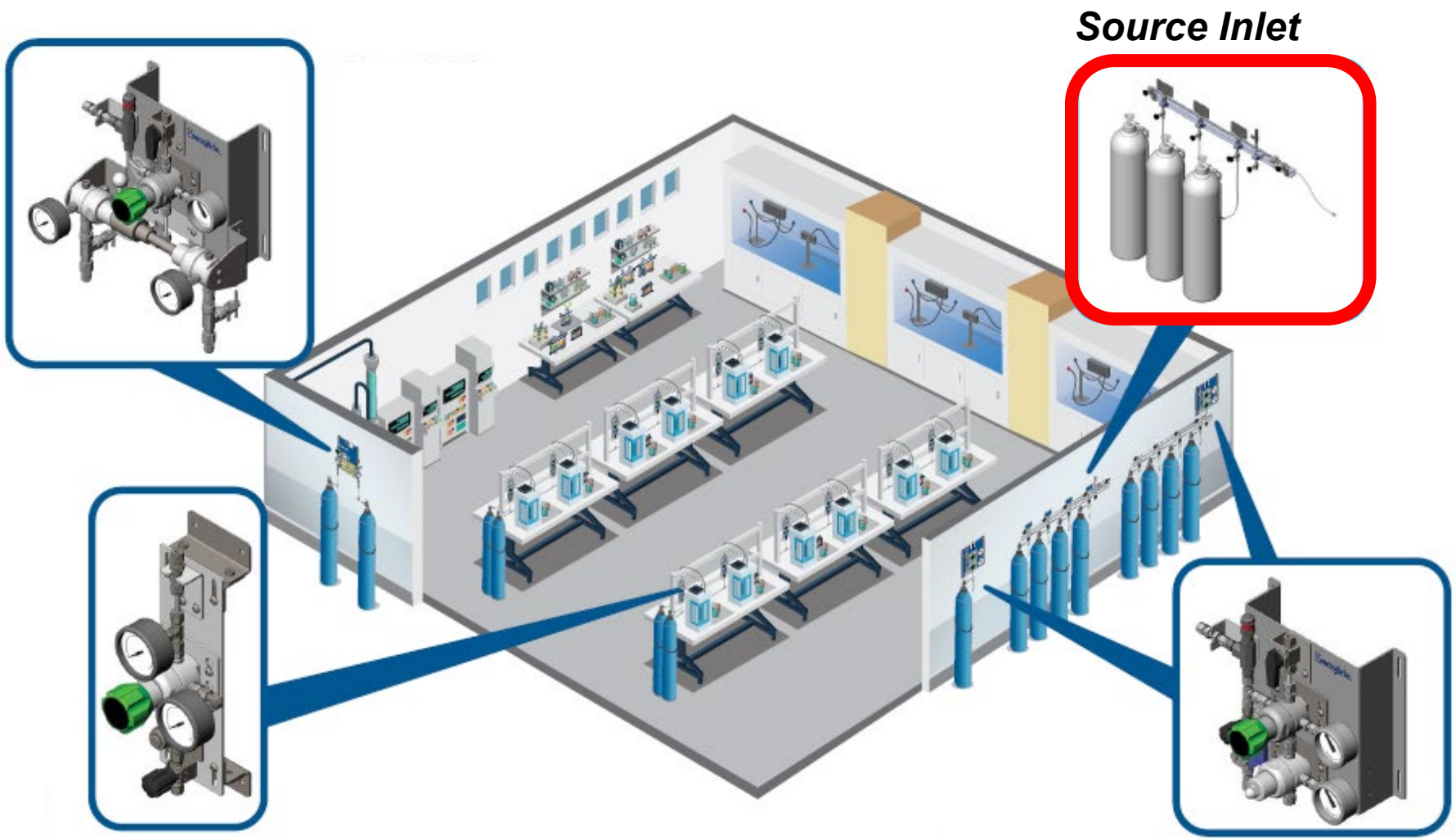


Source Inlet



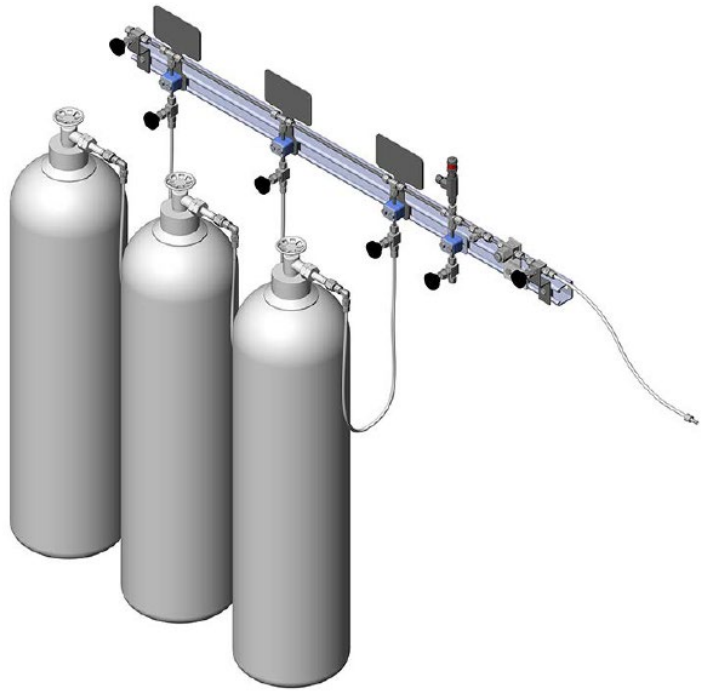
Ability to connect multiple cylinders with efficient space management

Swagelok Source Inlet (SSI)

Operation:

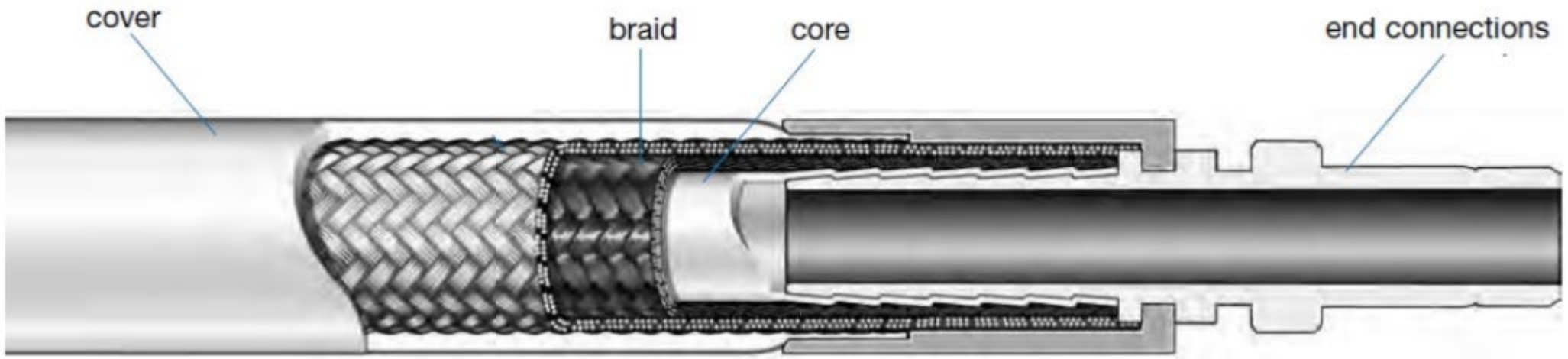
- Establishes a connection between the high-pressure gas source and the distribution system
- Can be one bottle or multiple bottles

- Highly configurable options ensures operator safety
- Option to vent individual lines to maximize uptime



Source Inlet (SSI) Hoses (Construction)

1. Core tube
2. Reinforcement (braid)
3. Cover
4. End connections



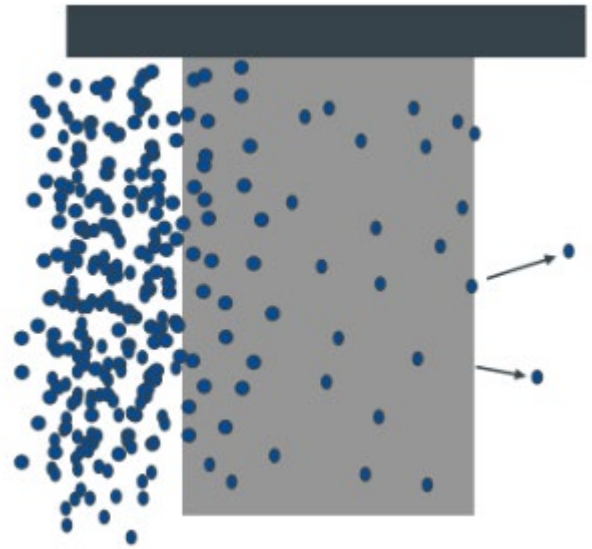
Hoses (Type of Hoses)

- Difficult part to select
- Metal vs PTFE vs Thermoplastic vs Rubber
- Pressure, Temperature & Medium

	Metal Core	PTFE	Thermoplastic	Rubber
Temperature	🟢	🟡	🔴	🔴
Pressure	🟢	🟢	🟡	🔴
Impulse	🔴	🟡	🟢	🟢
Dynamic Bend	🔴	🟢	🟢	🟡
Permeation	🟢	🟡	🔴	🔴
Cleanliness	🔴	🟢	🟡	🟡
Compatibility	🟡	🟢	🔴	🔴

Hoses (Permeability)

- Permeation should be considered for applications with small molecules such as:
  - Helium
  - Hydrogen
- Leakage from inside the hose to the outside of the hose, or form outside the hose to inside the hose

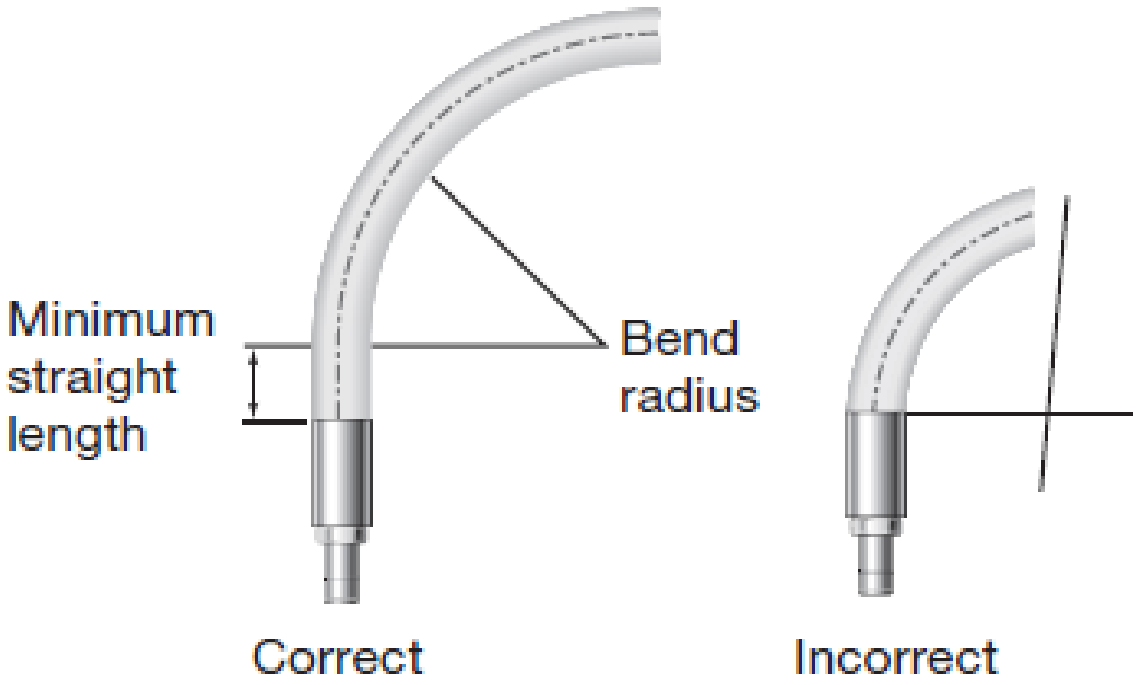


Factor	Description	Affect
Surface area	Hose length and hose diameter have a linear affect on total permeation	↑ Linear
Pressure	Pressure increases linearly with molecular count (2x Pressure means 2X gas molecules). Permeation rate is also linear with gas molecule count	↑ Linear
Temperature	Higher temperature molecules are moving faster, therefore permeate faster.	↑ Linear (absolute T)
Wall thickness	The core tube wall thickness (0.025” thru 0.050”) will determine how easily gas molecules can find a path to permeate	↓ Sq. Root

Hoses (Quick Connects)

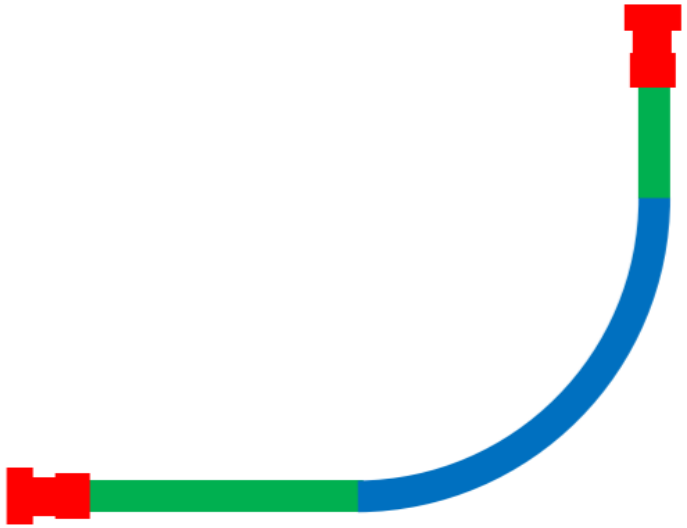
- Easy to couple and uncouple hoses
- No use of tools for coupling
- Keyed options possible

Hoses (Routing and Length)



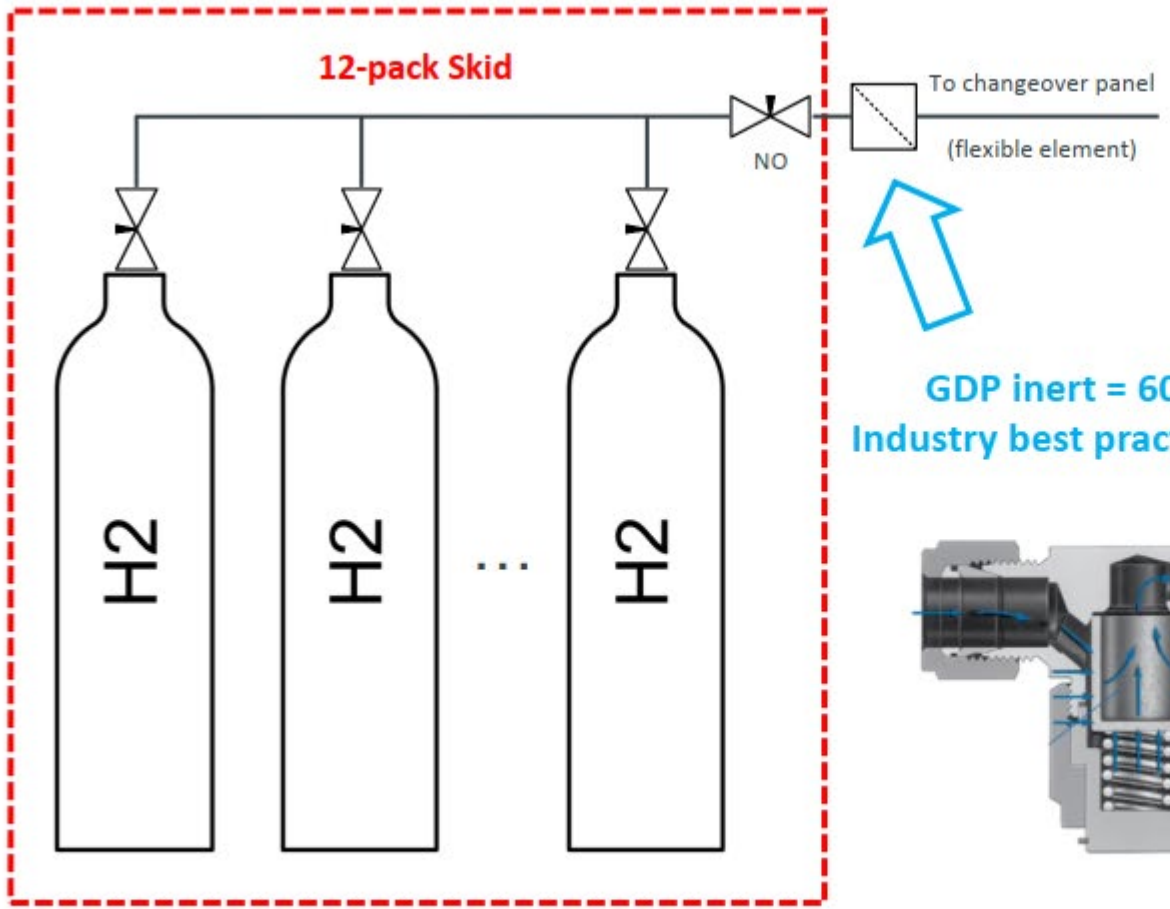
Elbows and adapters can be used to relieve hose strain.

Hoses (Routing and Length)



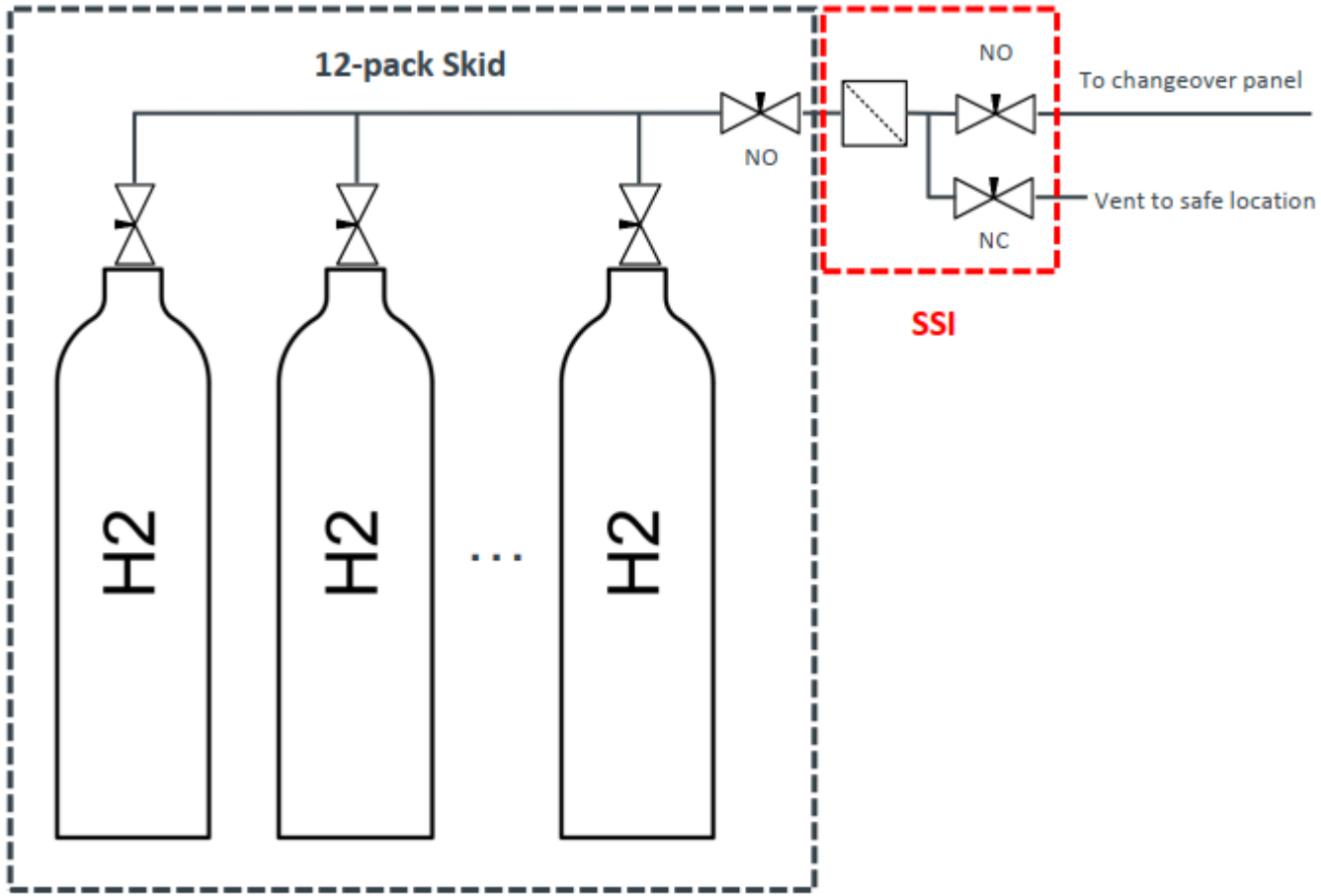
$$OAL = (End\ Connections) + (Straight\ Sections) + (Bent\ Sections)$$

Source Inlet (SSI) Filtering



GDP inert = 60um (STD)
Industry best practices: 5~10um

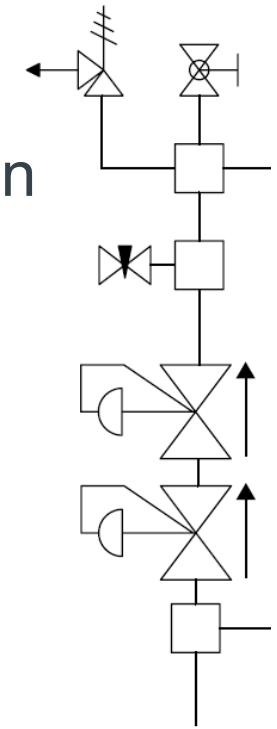
Source Inlet (SSI)

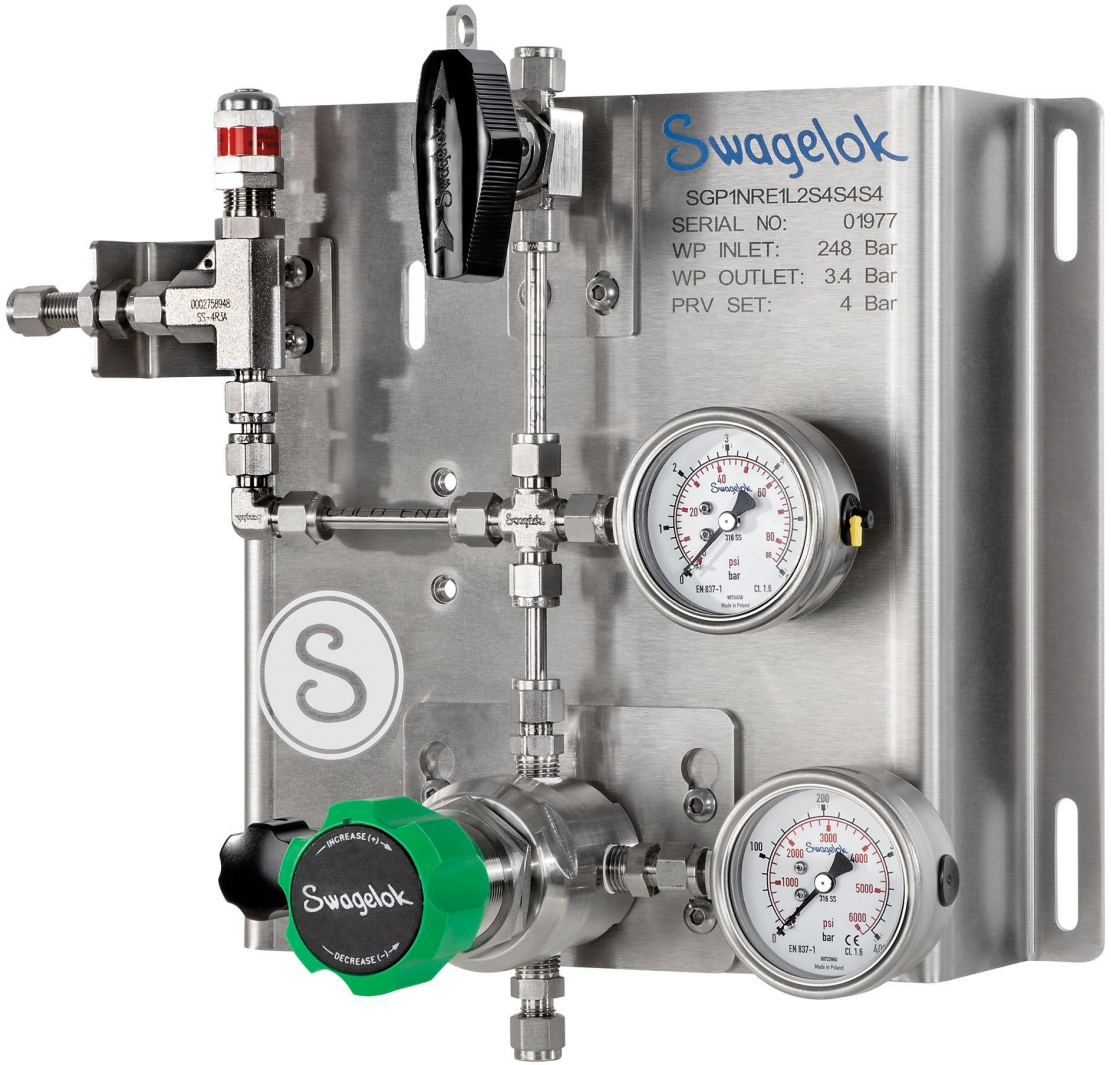


Gas Panel

Gas Panel

- First point of gas control
- Single- or Dual stage
- Dual stage configuration to minimize DROOP / SPE / Joule Thomson effect
- Vent and Relief options to enhance safety

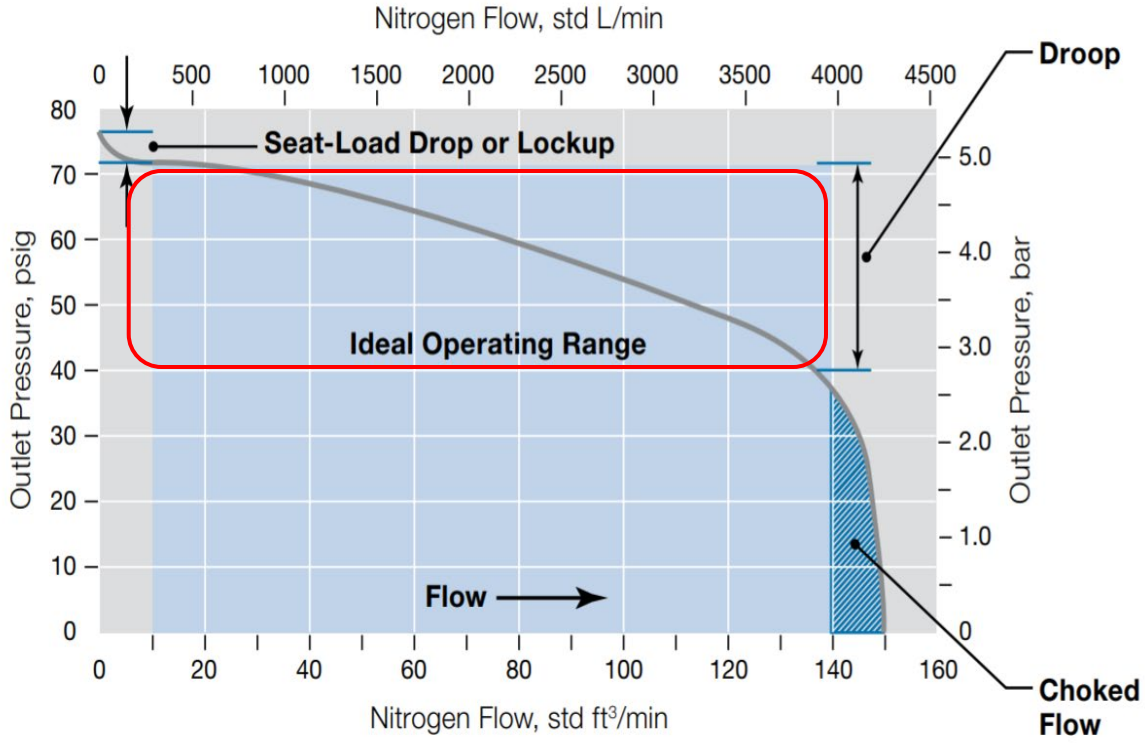




How Pressure Regulator Selection Affects Gas Distribution Performance?

Flow curve consists of three parts:

- A steep drop on the far left, which shows seat-load drop or lockup
- The ideal operating range, a relatively flat part in the middle
- A steep drop on the far right, which shows the choked-flow area



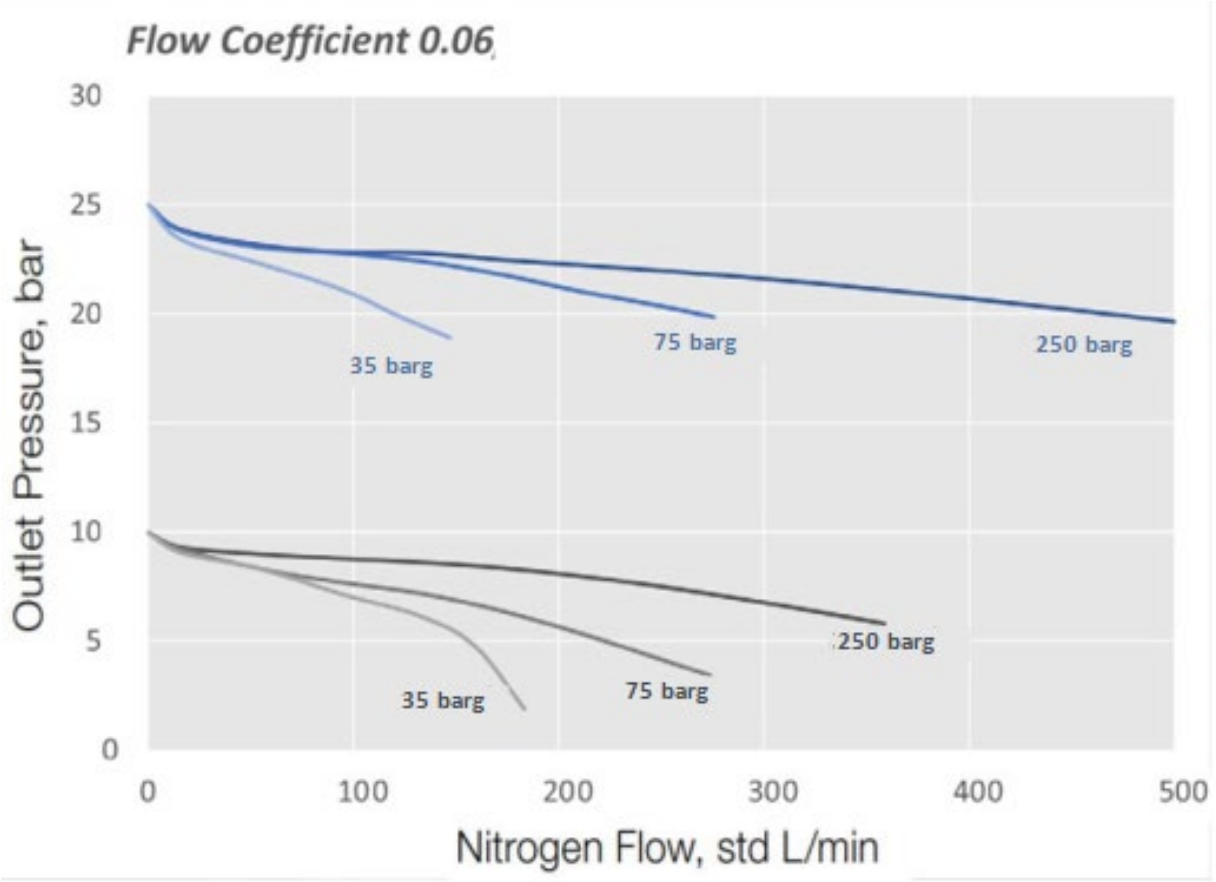
Families of Curves

Characteristics:

- Flow performance is less sensitive to outlet pressure
- Much more sensitive to inlet pressure
- ↓ Inlet pressure = ↓ Flow capacity

Why is it important:

- As your cylinder drains, flow capacity is reduced
- With multiple regulation stages, downstream regulator is limited by upstream setting



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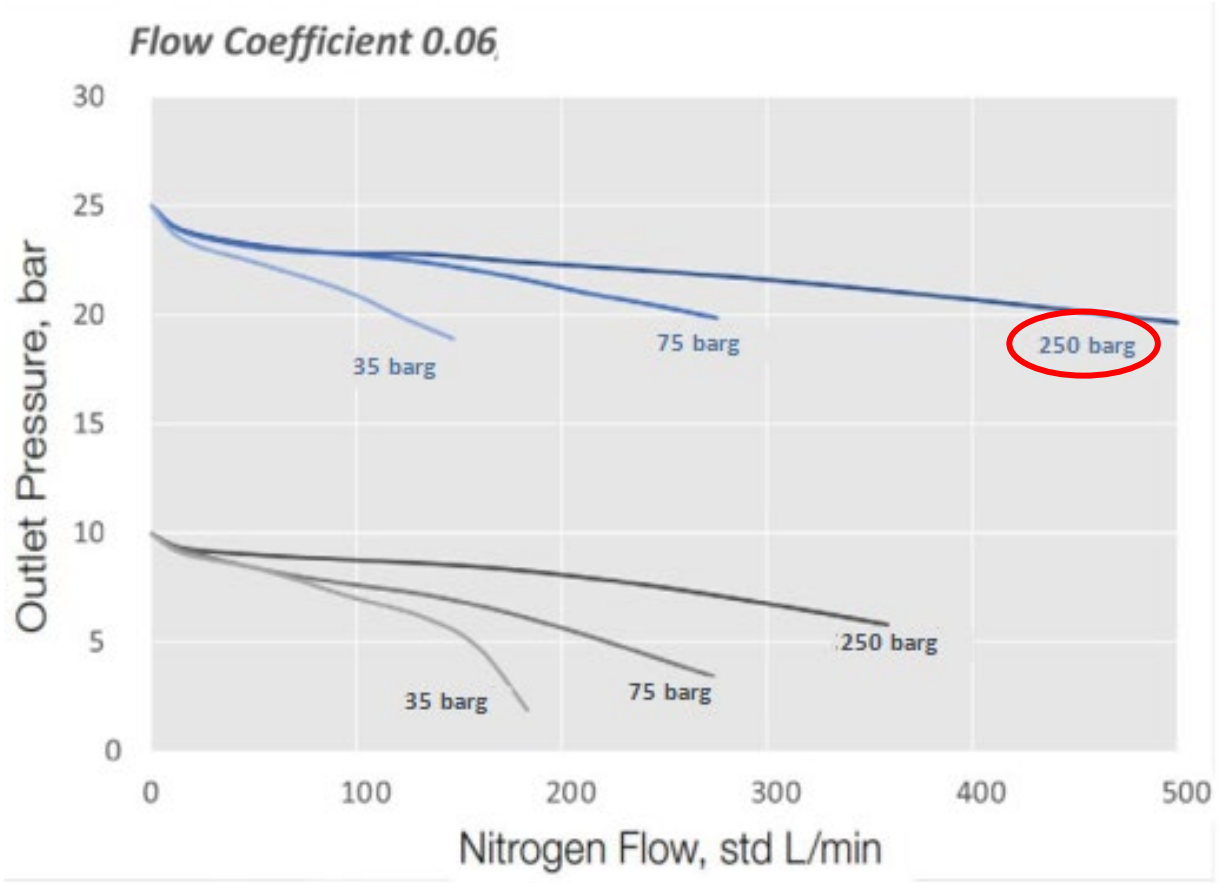

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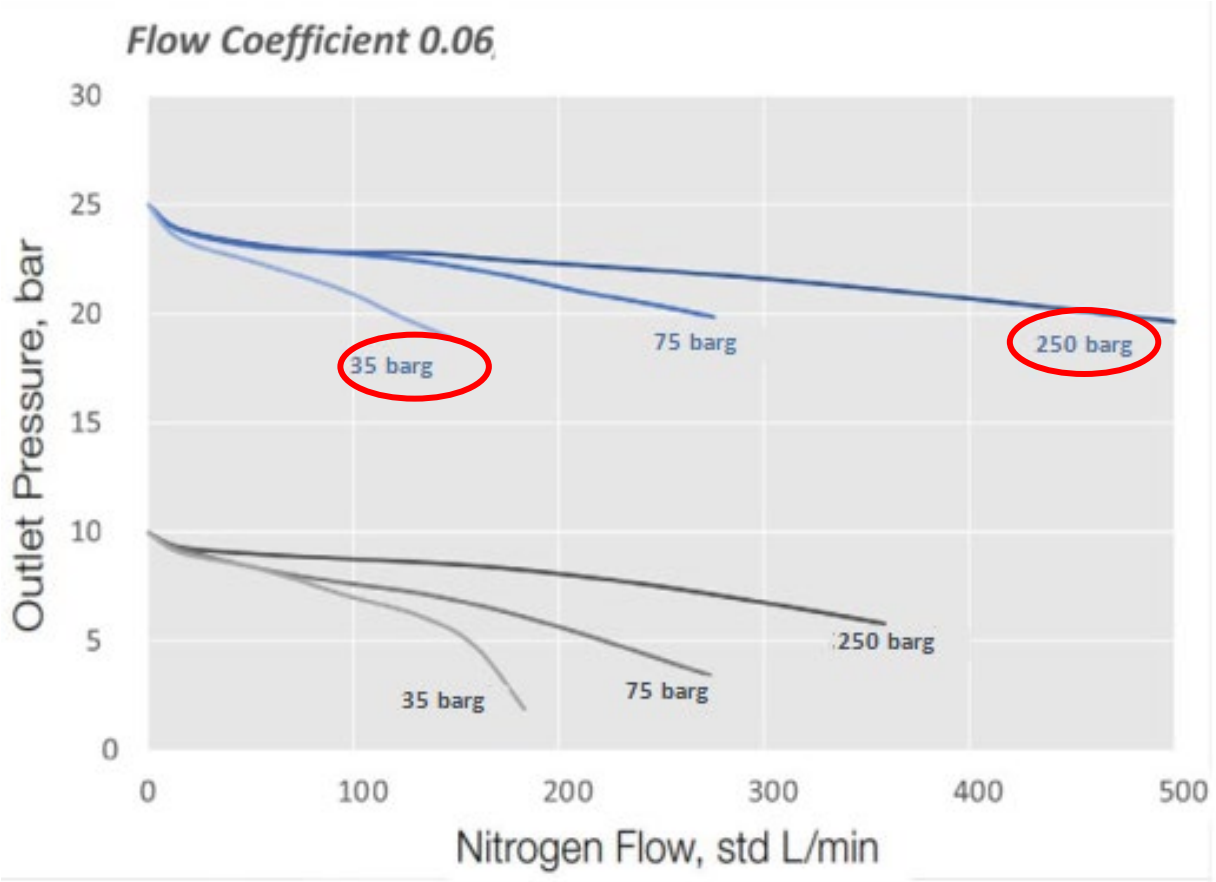


SPE- Supply Pressure Effect

General-Purpose Diaphragm-Sensing, Pressure-Reducing Regulators (KPR Series)

The KPR series is a compact regulator with excellent accuracy, sensitivity, and set-point pressure stability.

Features

- Convoluted, nonperforated diaphragm
- Metal-to-metal diaphragm seal
- Low internal volume
- Two-piece cap design provides linear load on the diaphragm seal
- High-flow, dual-gauze type filter in inlet ports

Technical Data

Maximum Inlet Pressure

- 3600 psig (248 bar)
- 6000 psig (413 bar) with PEEK seat

Pressure Control Ranges

- 0 to 10 psig (0.68 bar) through 0 to 500 psig (34.4 bar)

Flow Coefficient (C_v)

- 0.06 and 0.20

See page 41 for flow graphs.

- 0.02 and 0.50 also available

Supply-Pressure Effect

Flow Coefficient (C_v)	Pressure Control Range	
	Up to 100 psig (6.8 bar)	250 psig (17.2 bar) and Higher
	Supply Pressure Effect, %	
0.02	0.3	0.5
0.06	1.0	1.5
0.20	1.7	2.5
0.50	2.3	3.3

Maximum Operating Temperature

- 176°F (80°C) with PCTFE seat
- 392°F (200°C) with PEEK seat
- 212°F (100°C) with PEEK seat and maximum inlet pressure greater than 3600 psig (248 bar)

Weight

- 2.4 lb (1.1 kg)

Ports

- 1/4 in. female NPT inlet, outlet, and gauge ports (all body materials)
- 1/4 in. tube butt weld inlet, outlet, and gauge ports (316 SS body material only)
- 1/4 in. VCR® inlet, outlet, and gauge ports (316 SS body material only)

SPE- Supply Pressure Effect (Inlet Dependency)

If inlet pressure **drops** ⬇, the outlet pressure goes **up** ⬆

OR

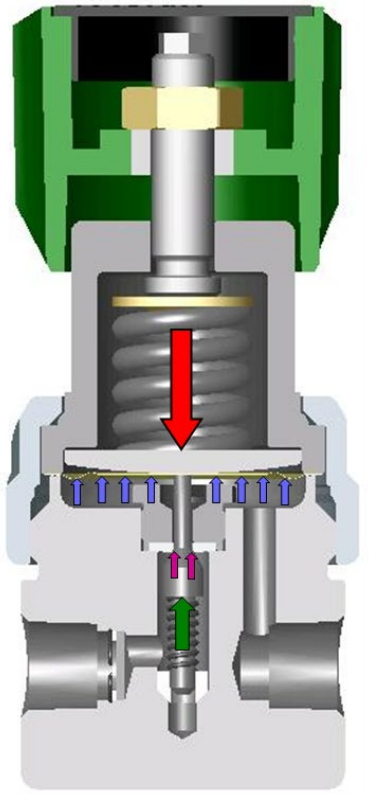
If inlet pressure goes **up** ⬆, the outlet pressure **drops** ⬇

Theory

The inlet pressure creates a force (**F4**) on the poppet valve. The higher the inlet pressure, the higher the force

This will affect the balance equation:

F1 = F2 + F3 + F4



F1 = Spring Force

F2 = Poppet Spring Force

F3 = Outlet Pressure Force

F4 = Inlet Pressure Force

SPE- Supply Pressure Effect Single-Stage

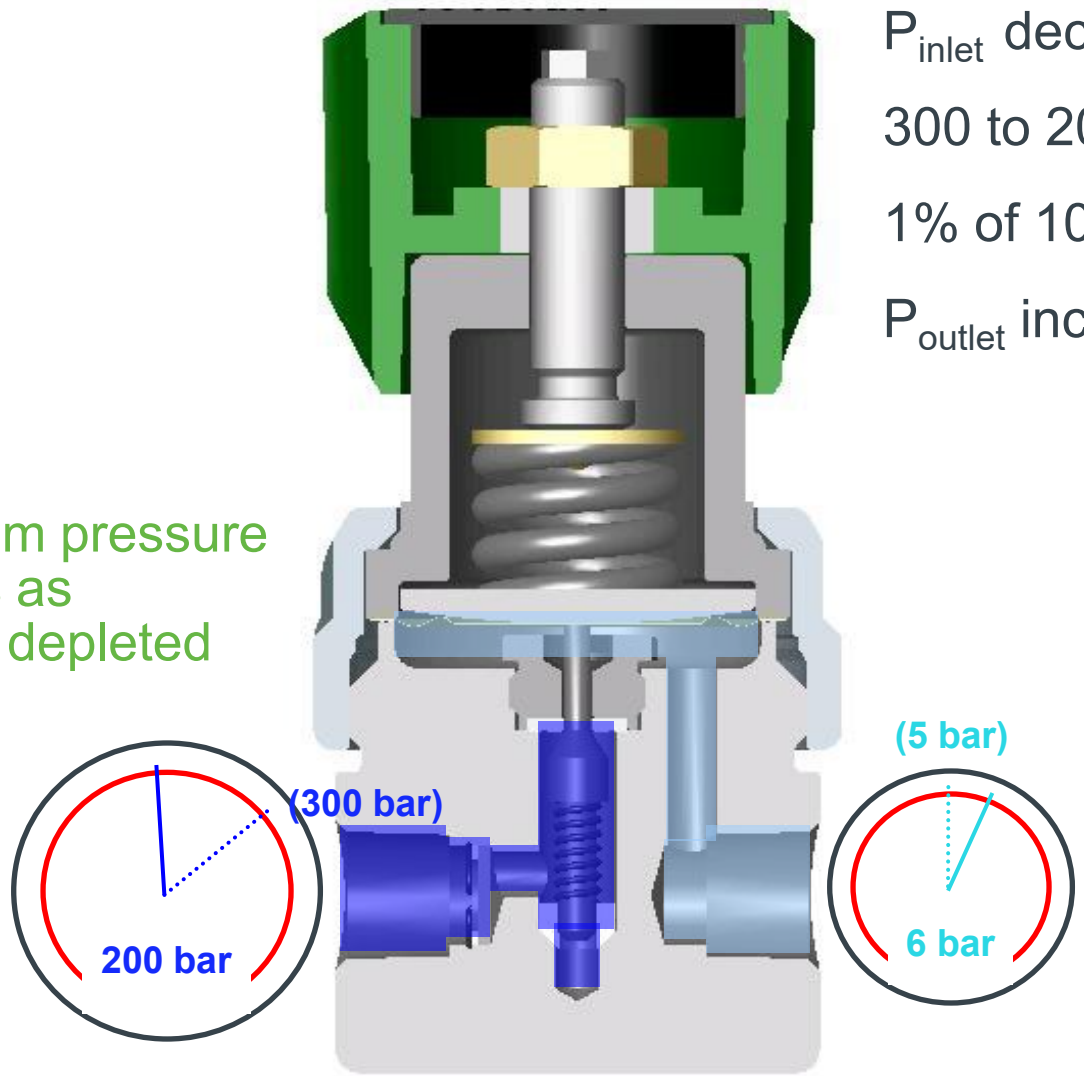
P_{inlet} decreases from

300 to 200 = 100 bar

1% of 100 bar = 1 bar

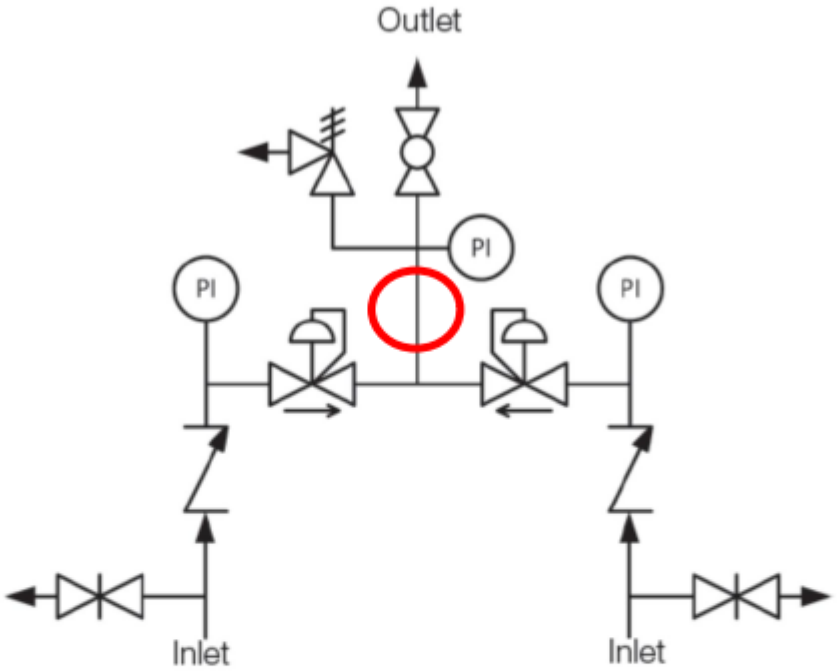
P_{outlet} increases 1 bar

1. Upstream pressure decreases as cylinder is depleted



2. Downstream pressure increases 1% of the inlet decrease

SPE- Supply Pressure Effect Changeover



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0.50	2.3	3.3

MS-06-114

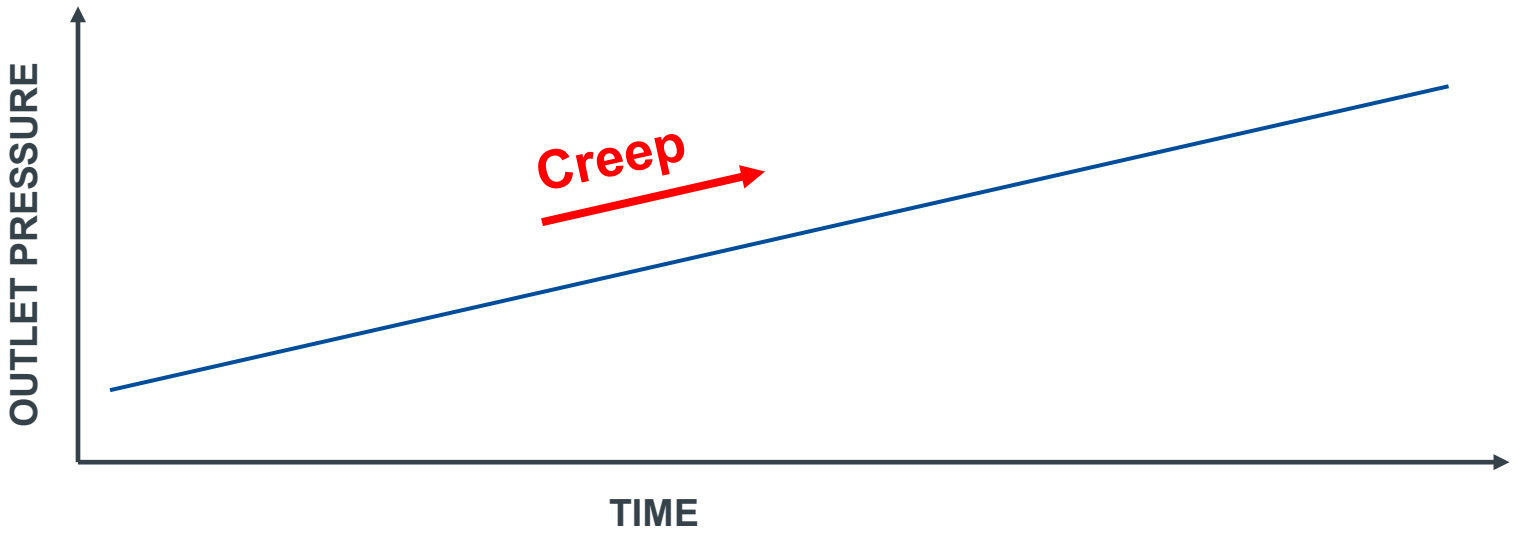
$$\Delta P_{SPE} = SPE\ \% * \Delta P_{Bottle}$$

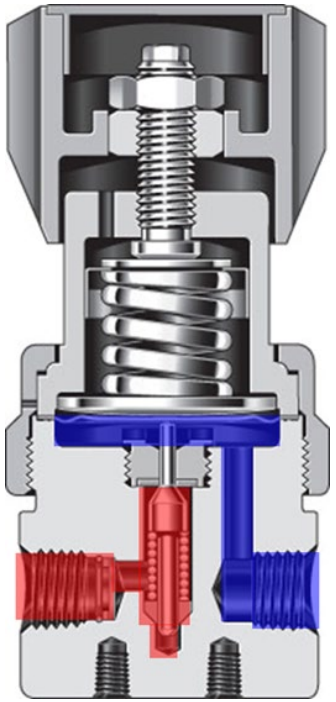
$$\Delta P_{SPE} = 0.5\% * (300\ bar - 10\ bar) = 1.45\ bar$$

Rise in outlet pressure with drop in inlet pressure

Creep

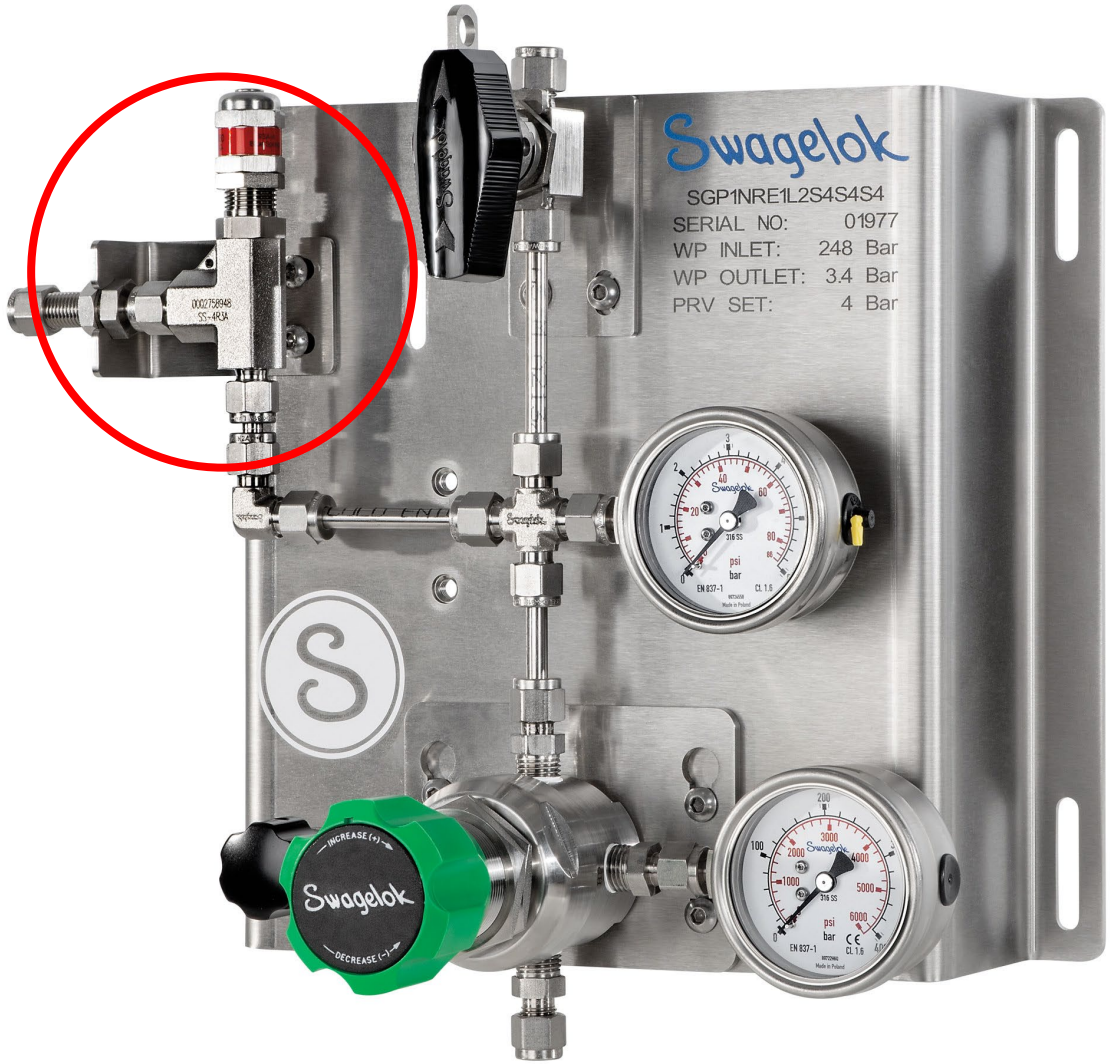
- Outlet pressure increases over time
- If the poppet does not fully seat in the orifice, inlet pressure may continue to bleed through the orifice.
  - Over time, this leakage can increase to the point where the outlet pressure equals the inlet pressure



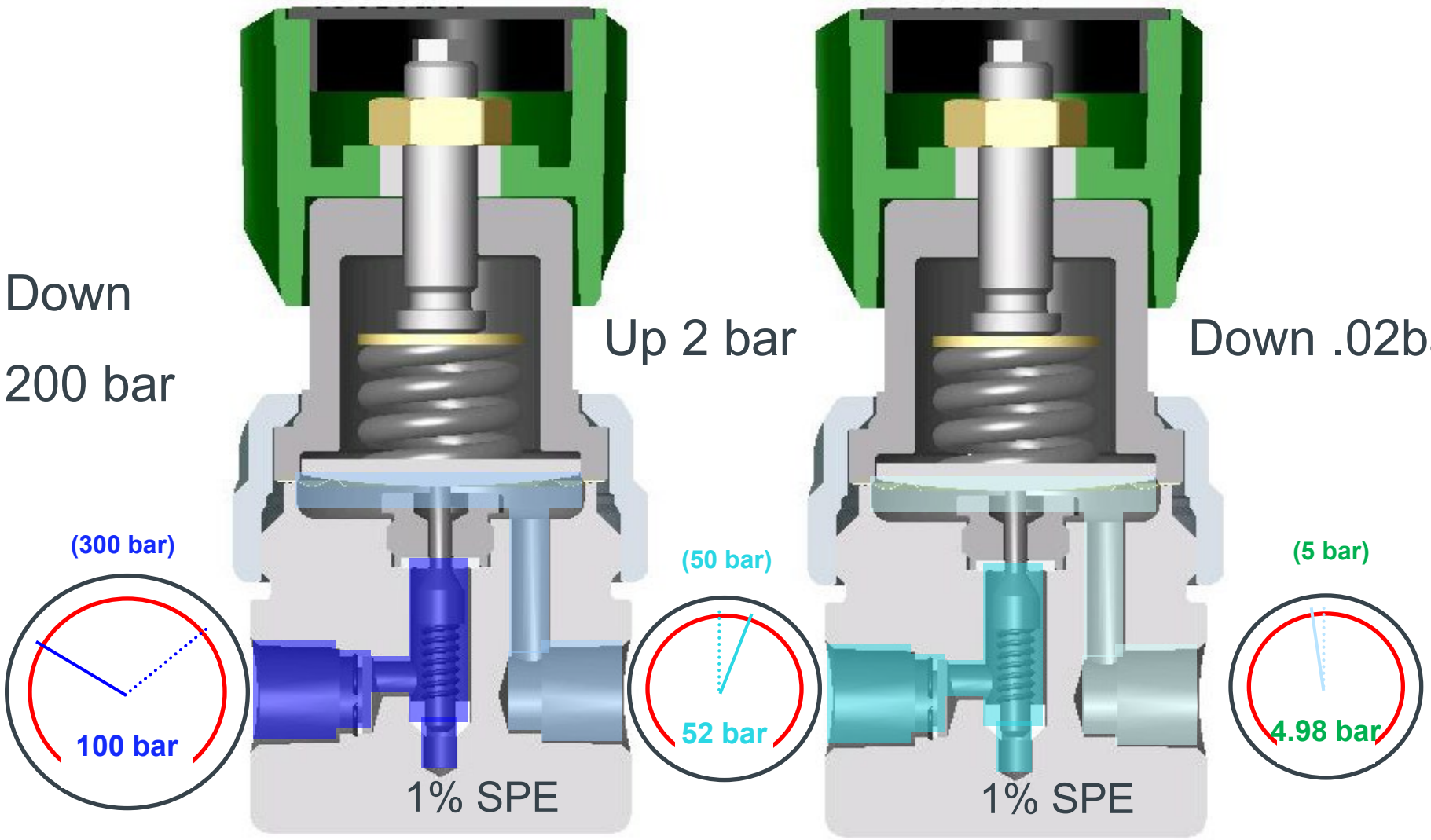


Relief Valve Setting

- If relief valve is located downstream, consider SPE
- Typical set pressure: 110% working pressure (10% over)
- If regulator is set at 100% working pressure, SPE may cause the relief valve to open
- Mitigate SPE or relief valve setting may need to increase to accommodate



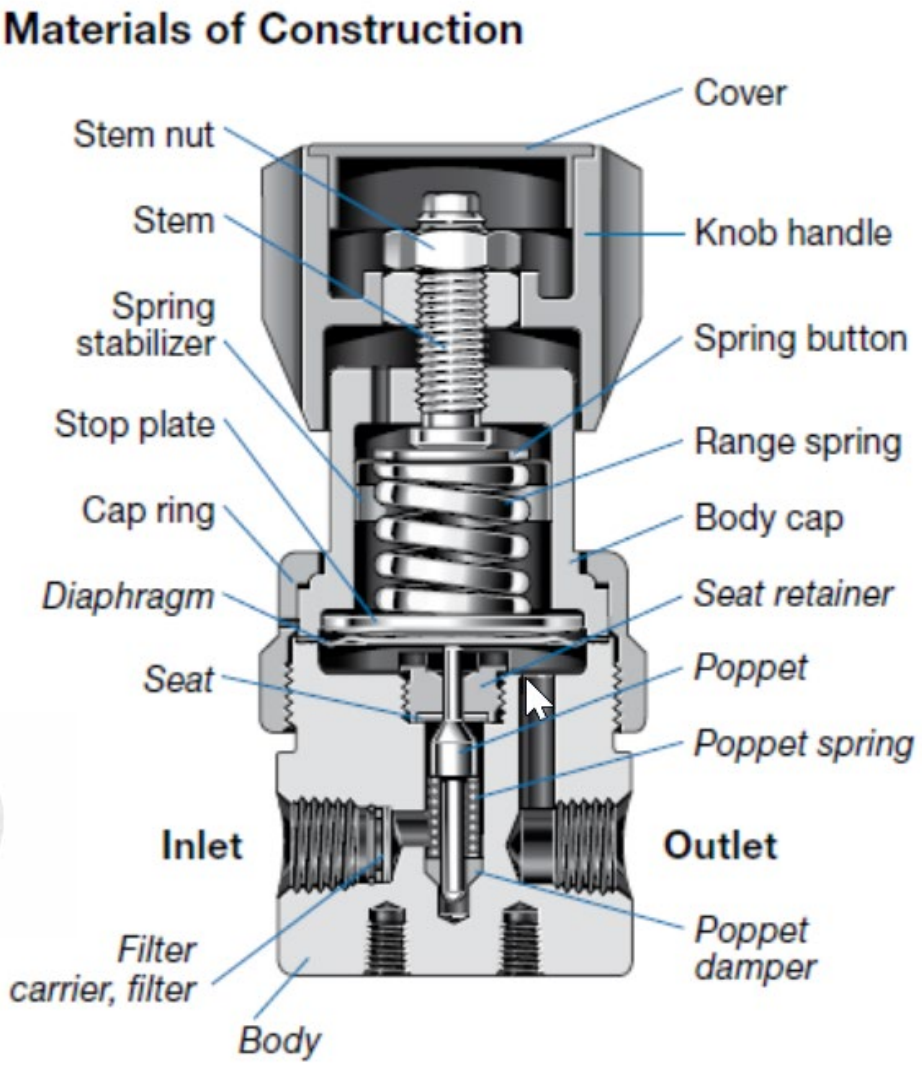
SPE- Supply Pressure Effect Dual-Stage



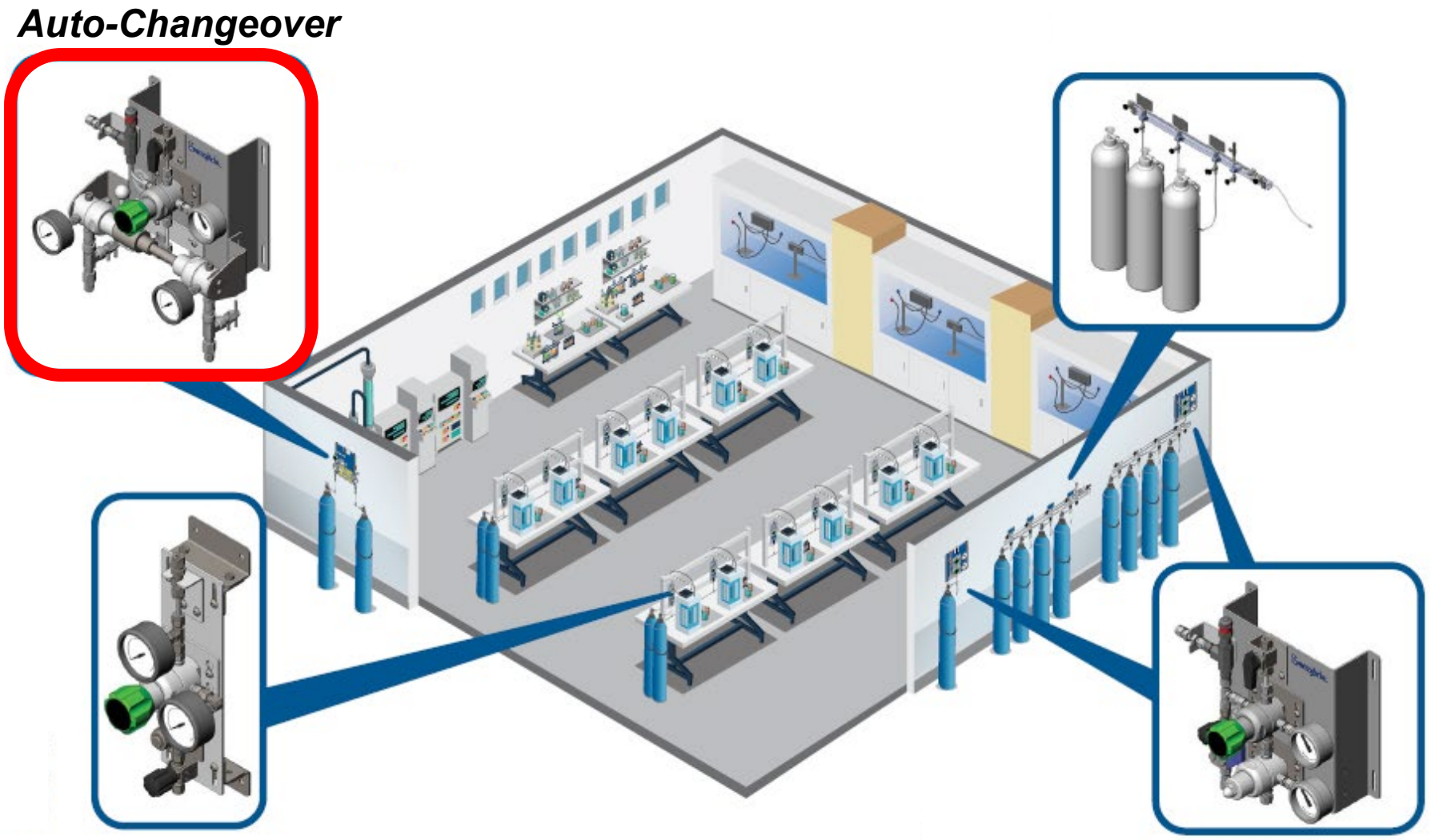
Filtration – Increase Uptime and Improve Safety

Filters are used to remove particulate matter from the gas stream in which they are deployed.

Match the filter to the task

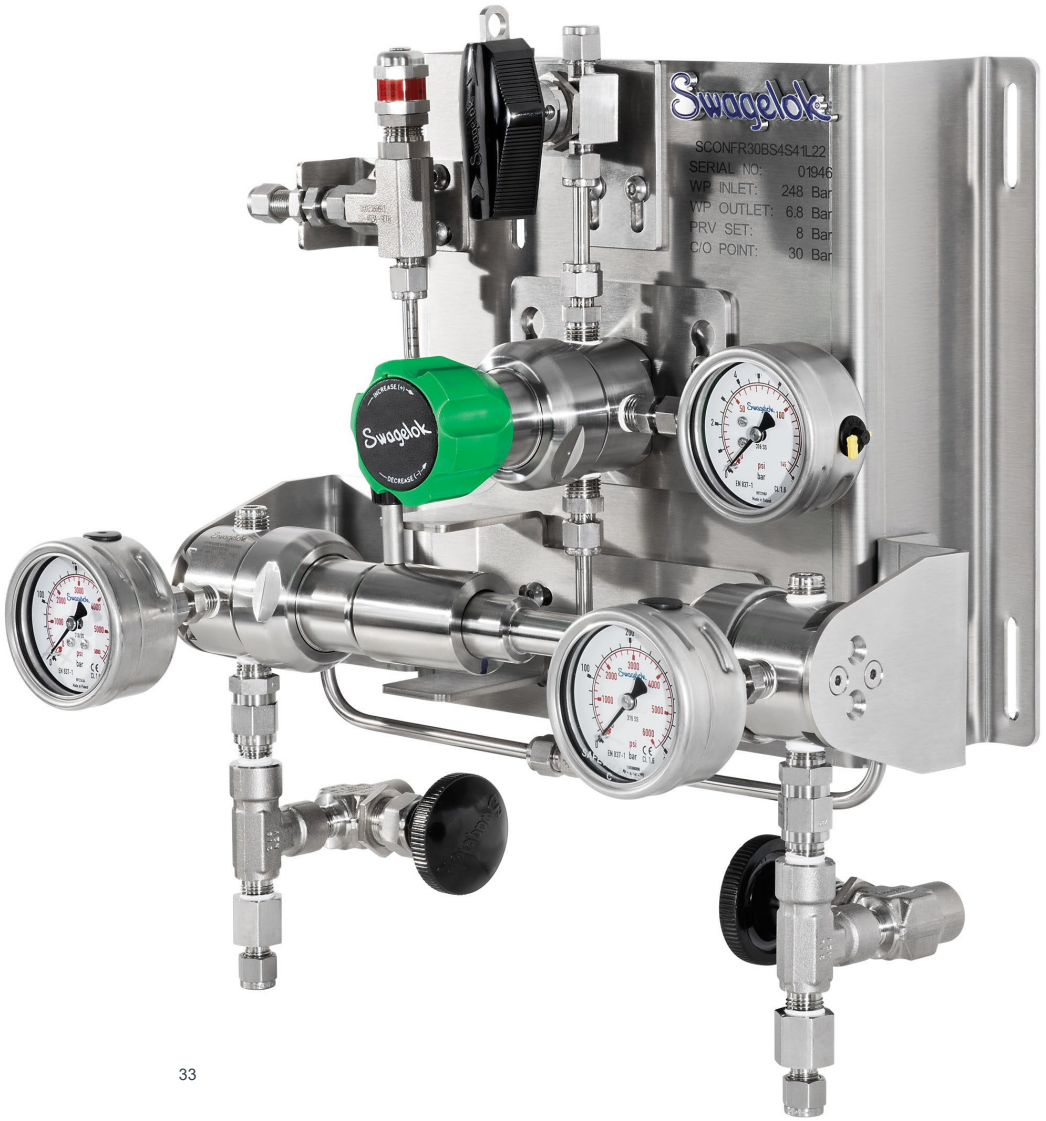


Auto Changeover

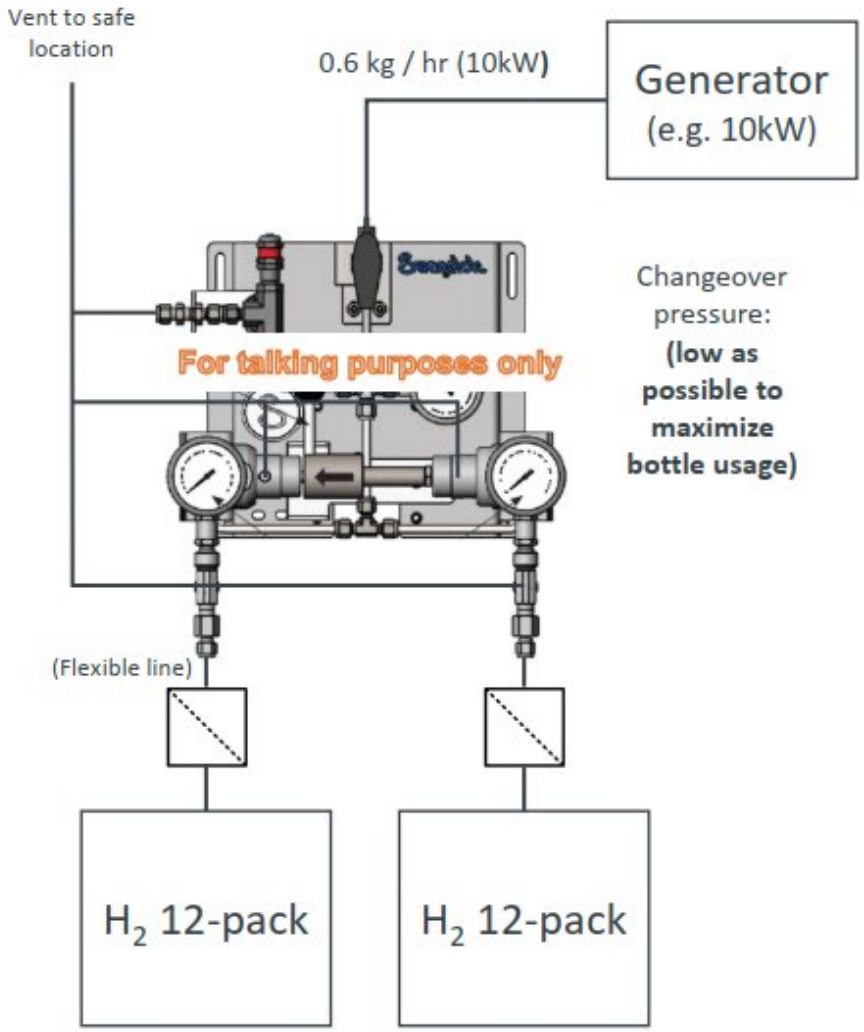


AutoChangeover

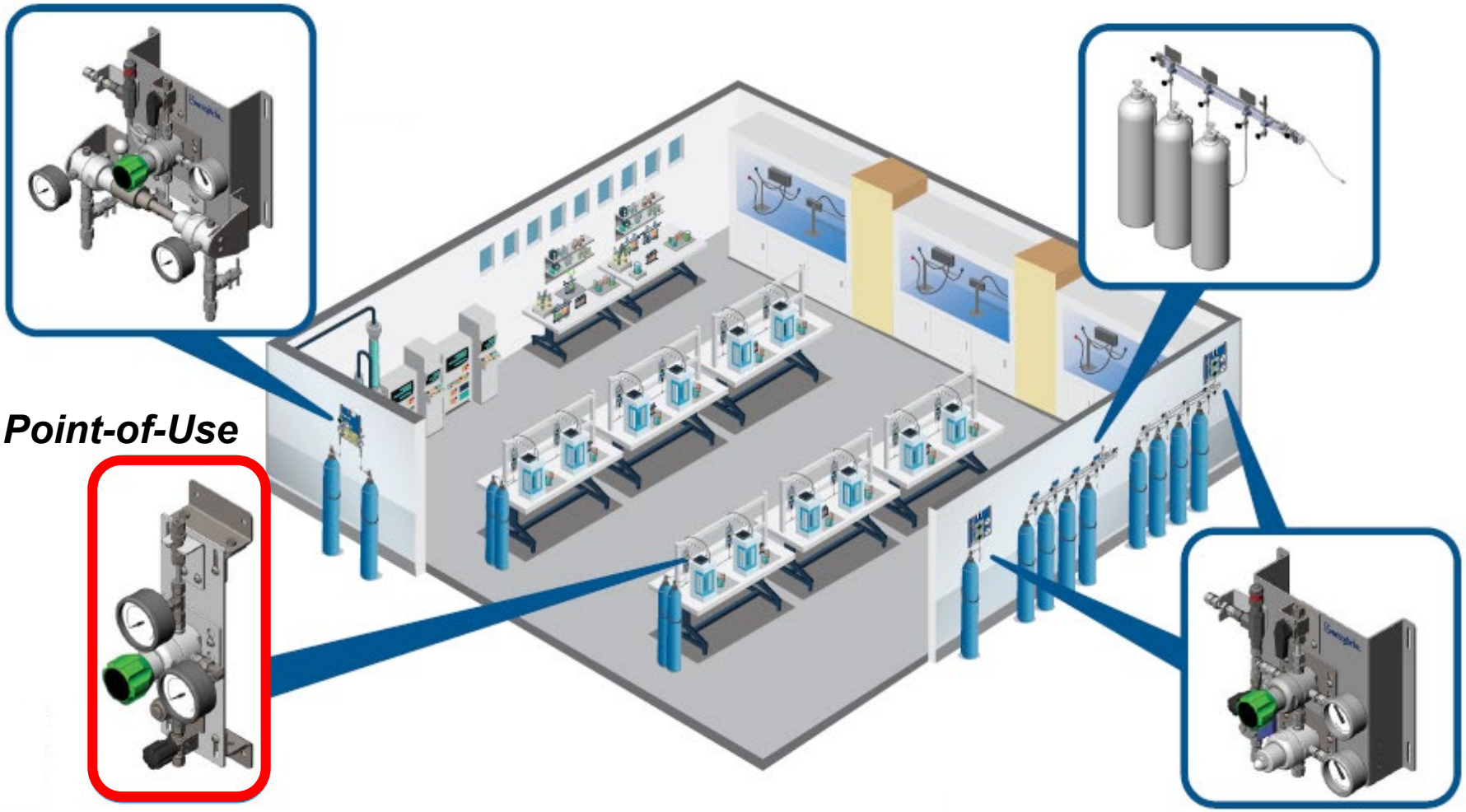
- One- or two-stage regulator panel
- What does it do?
  - Two inlet sources
  - Use one source at a time
  - Automatically changes from one to the other – no operator intervention required
- User selectable “primary” source



H2 Micro-grid



Point of Use

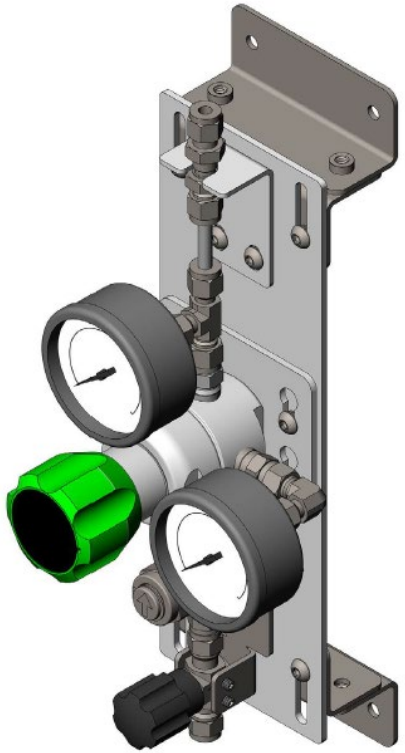


Compact system and accurate pressure control

Swagelok Point of Use (SPU)

Operation:

- Critical last stage pressure control
- Provides standardization and consistent operation
- Can be set up for either top-down or down-top flow
- Compact design saves space
- Multiple mounting options



Regulator maintenance to avoid downtime

- Regulators need maintenance, intervals vary according to application, system media and usage
- Keep maintenance kit om stock at start up and decide on maintenance periods
- Train al end users in the correct usage of a SPU or change over application to avoid damaging the regulators in your system

Maintenance Kits

KPR, KCP, AND KBP Series Maintenance Kits

Maintenance kits include:

- all wetted components, except for the regulator body and piston, if applicable
- wetted lubricant with MSDS
- instructions.

Maintenance Kits for Other Regulator Series

Maintenance kits for KLF, KHF, KPP, KPF, KHP, KHR, KFB, KCB, KCY, KPB, KHB, KSV, and KEV series regulators are available.

To order, contact your authorized Swagelok representative; to ensure correct kit contents, please provide the original regulator ordering number.

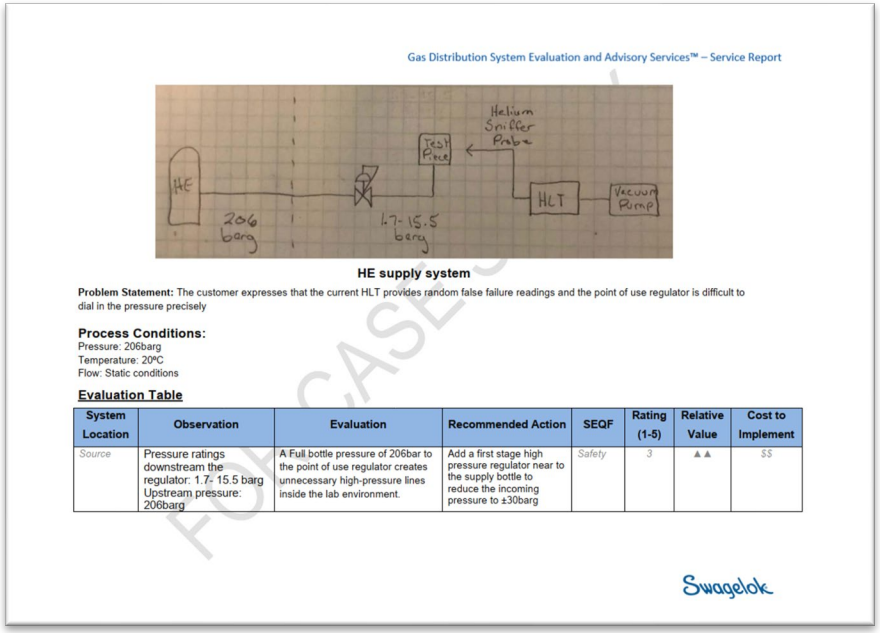
Maintenance Instructions

Maintenance instructions for all Swagelok regulators are available from your Swagelok website.

Maintenance Tools

Specially designed tools and tool kits are available to assist in the service and repair of Swagelok regulators. Contact your authorized Swagelok representative for more information.

Gas Distribution System Evaluation and Advisory

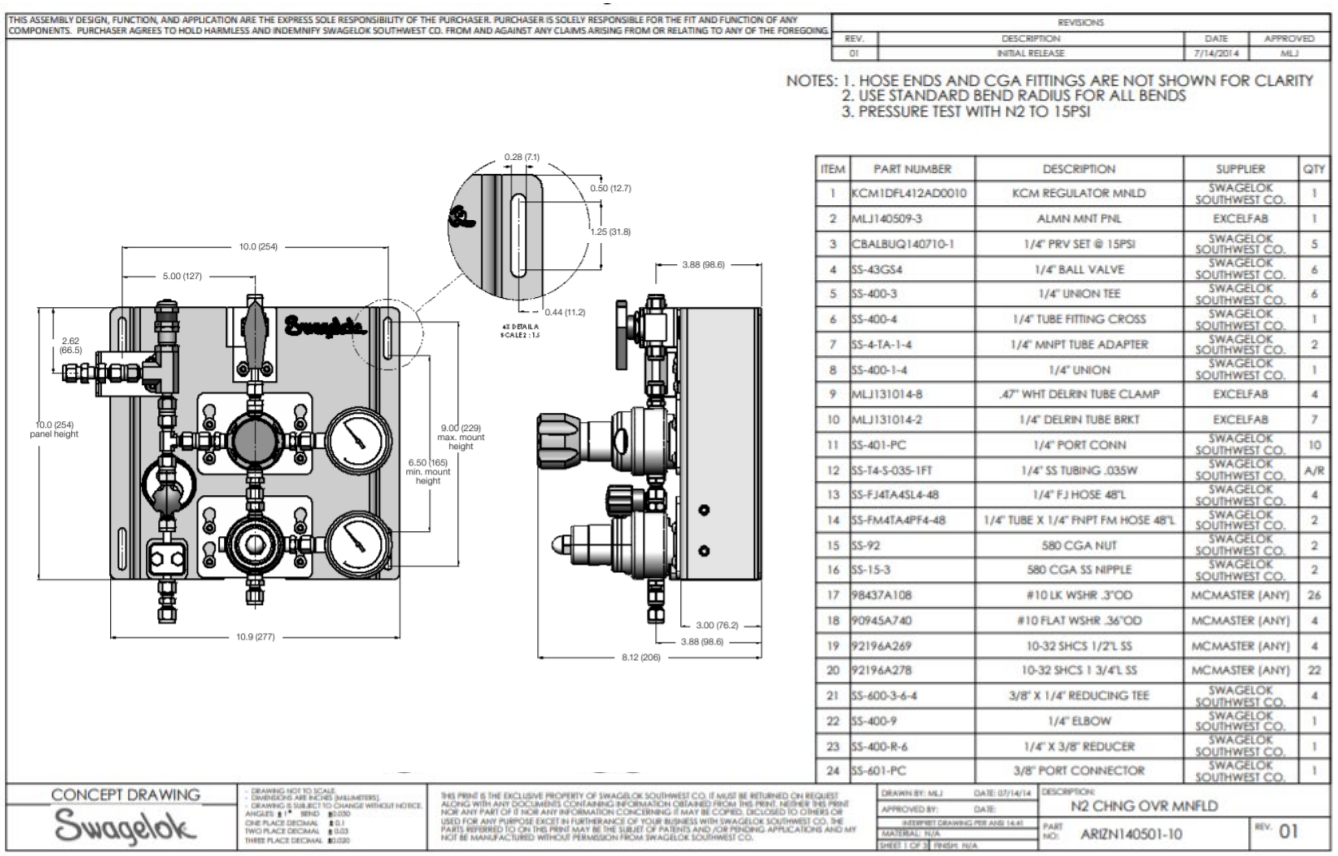


Review

- Hose and Filter selection are essential for a safe and cost-efficient gas distribution
- Gas distribution applications require consideration of regulator performance
  - Supply Pressure Effect (SPE)
  - Lockup
  - Droop
- Regulator characteristics affect other choices in the application
  - Number of regulators
  - Flow performance
  - Relief valve setting
  - Changeover specification

How can Swagelok support your Gas Distribution Application

- Customizable user's manual
- Drawings
- Complete bill of materials
  - Spare parts list if needed



Questions?

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