Welcome to the Regulator Selection and Sizing Webinar

Presented by: Brian Misutka, Swagelok Field Engineer

- Please put your phone or computer on ***mute*** to prevent background noises

- If you have questions throughout the webinar, please utilize the ***chat function*** in the upper right hand corner to submit them

Swagelok®

Swagelok North Carolina | East Tennessee

Regulator Foundations

Theory and Operation

2/17/2021

Agenda

- Regulator Theory & Operation
  - Regulator Basics & Types
  - Regulator Selection
    - Flow Curves
  - Performance Criteria
    - Seat-Load Drop or Lockup
    - Droop
    - Choked Flow

Pressure Regulator Product Offering

Analytical and Instrumentation

Process

Regulator Basics

- What is a Regulator?

  A pressure regulator is a control valve that reduces the input pressure of a fluid to a desired value at its output.

- What is it's function?

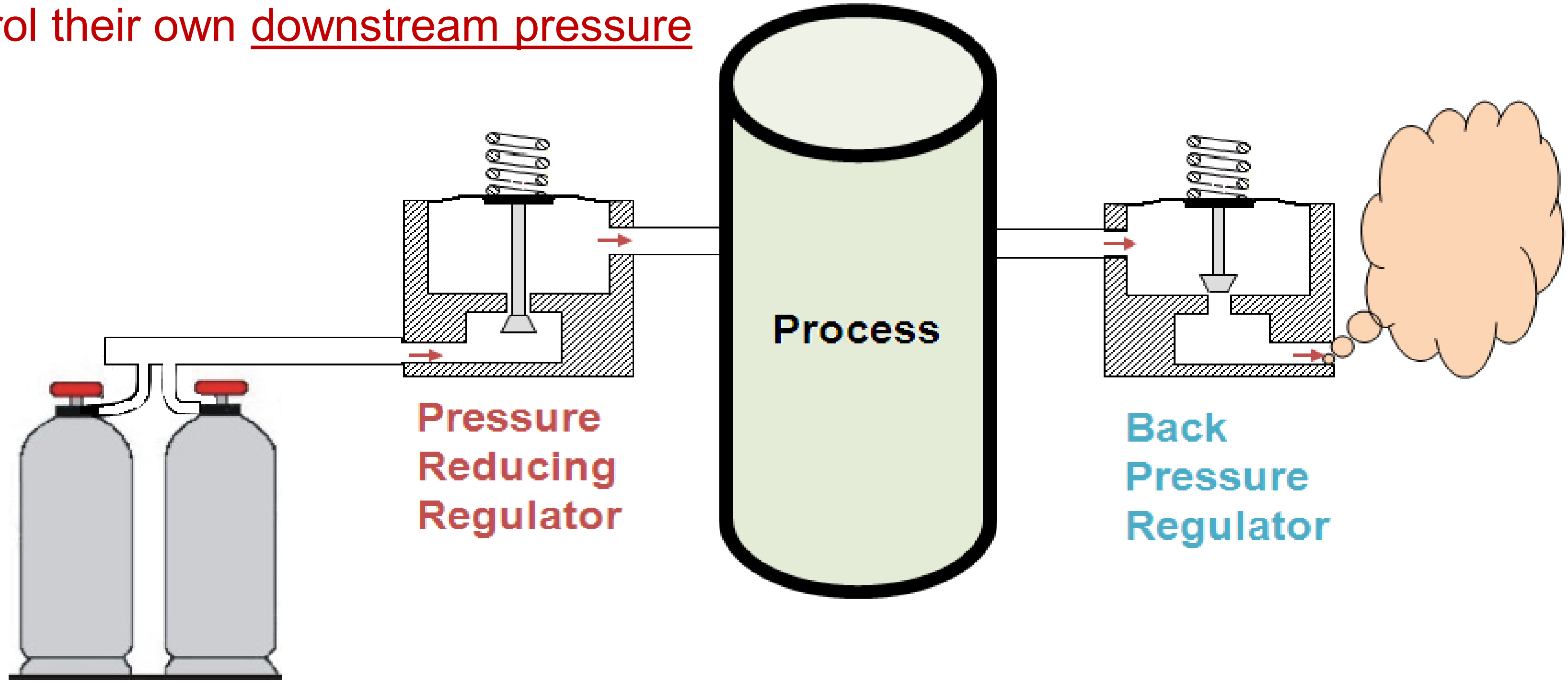
  To maintain a constant pressure on one side of the regulator even though there is a different pressure or fluctuating pressure on the other side.

- *Does not control flow! It responds as flow in the system changes.*

Types of Regulators

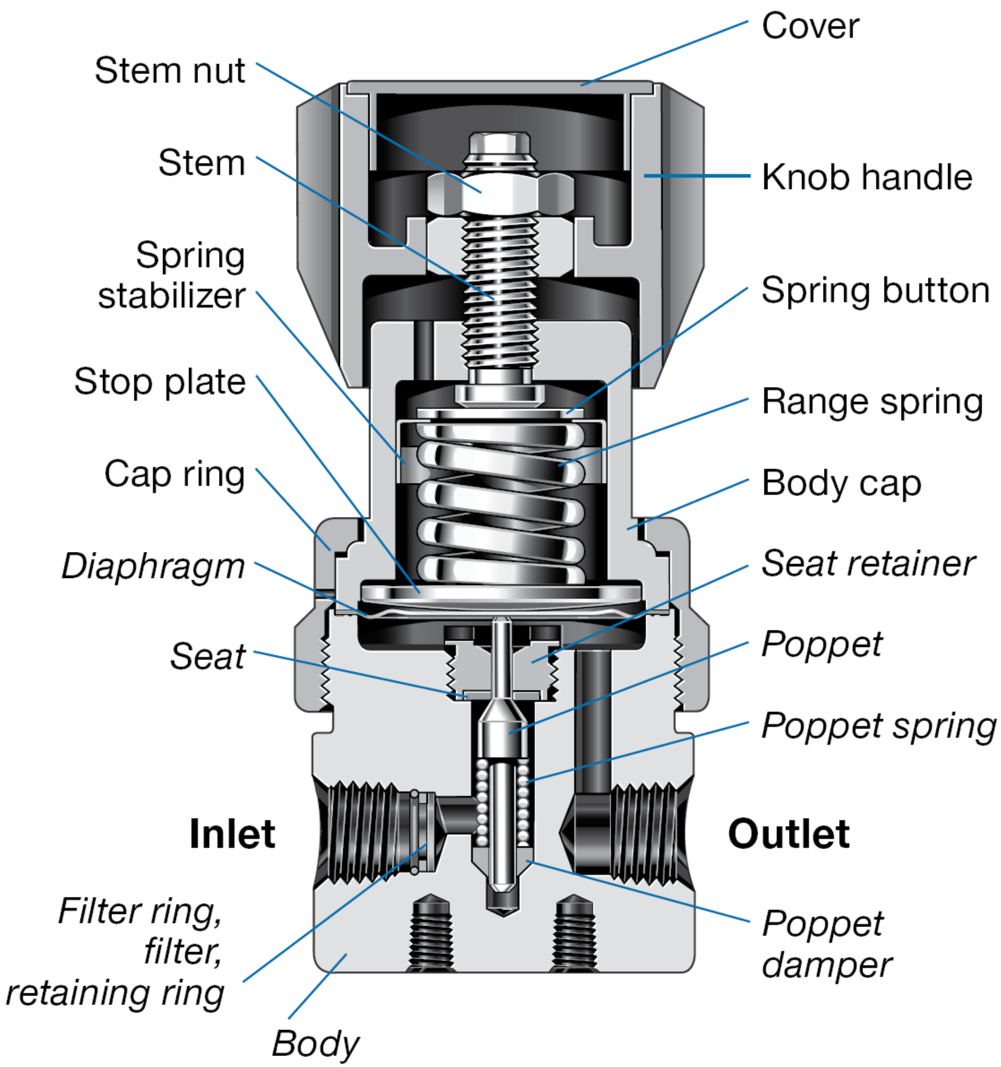
BACK-PRESSURE Regulators control pressure from the process by sensing the inlet pressure – they control their own upstream pressure

PRESSURE REDUCING Regulators control pressure to the process by sensing the outlet pressure – they control their own downstream pressure

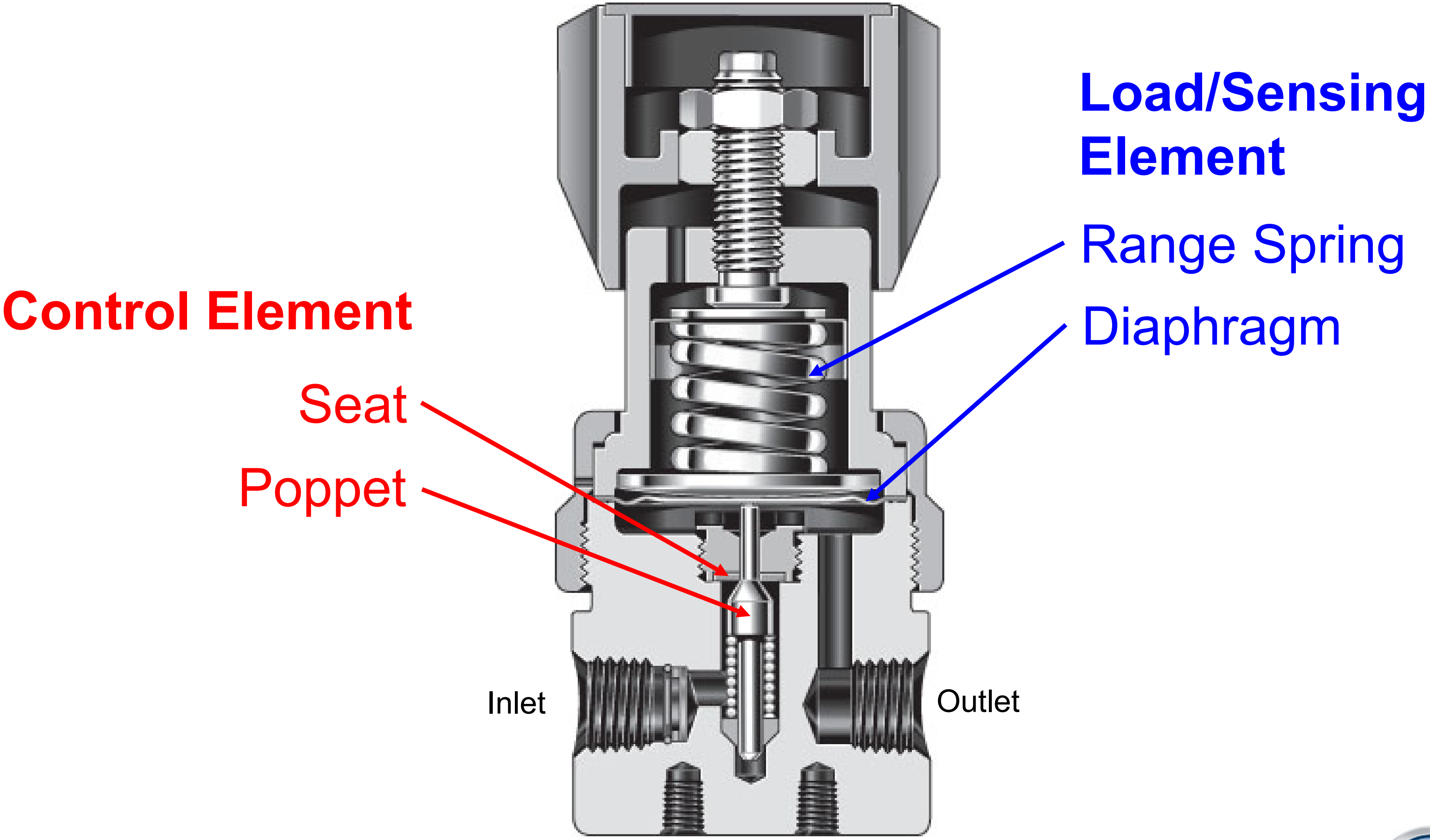


Pressure Reducing Regulators

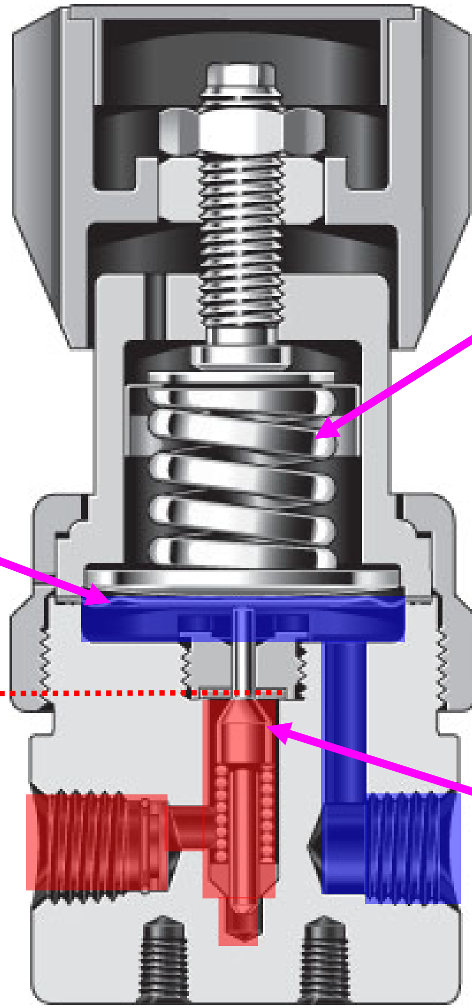
Regulator Basics – Pressure Reducing Regulator



Basic Theory – Pressure Reducing Regulators

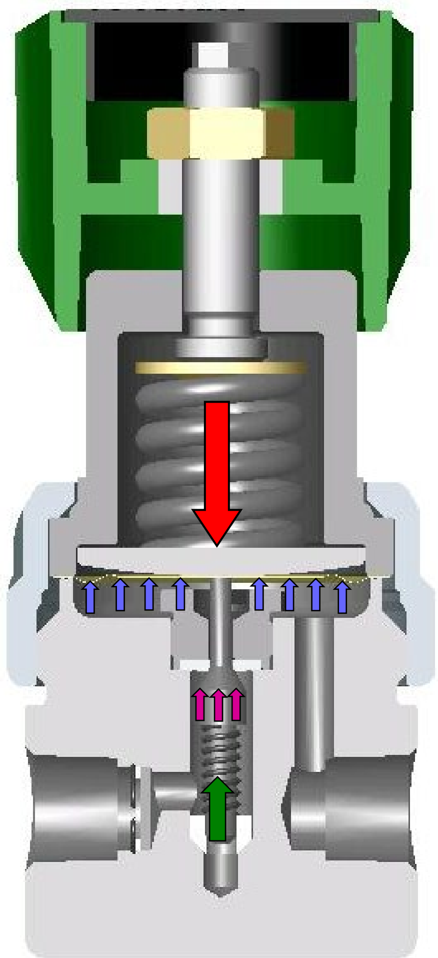


Basic Theory – Pressure Reducing Regulators



Basic Theory – Pressure Reducing Regulators

Operating Principle - Balance of Forces



F1 = Range Spring Force

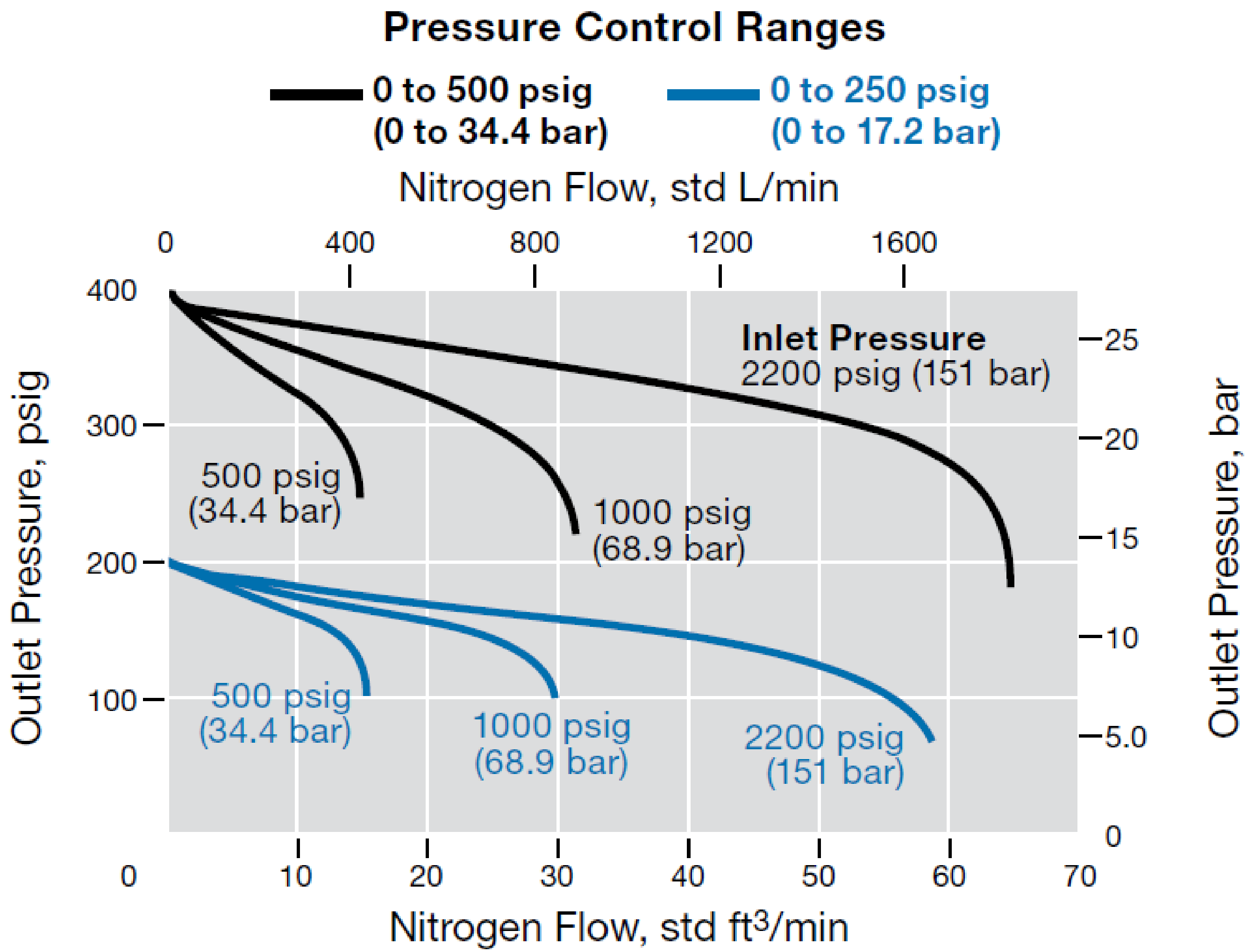
F2 = Poppet Spring Force

F3 = Outlet Pressure Force

F4 = Inlet Pressure Force

$$F1 = F2 + F3 + F4$$

Flow Curve Introduction

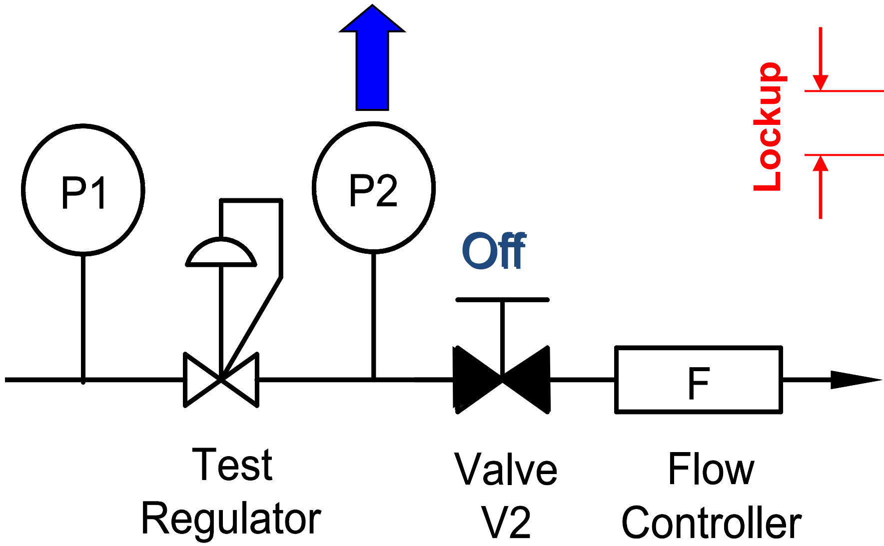


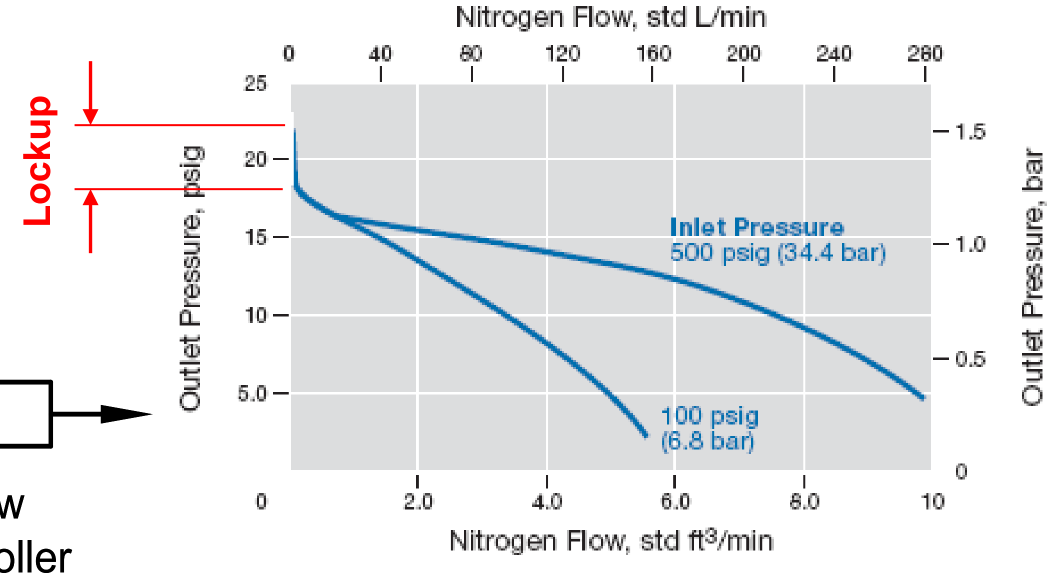
Performance Criteria

- Seat-Load Drop or Lockup
- Droop
- Choked Flow
- Optimal Flow

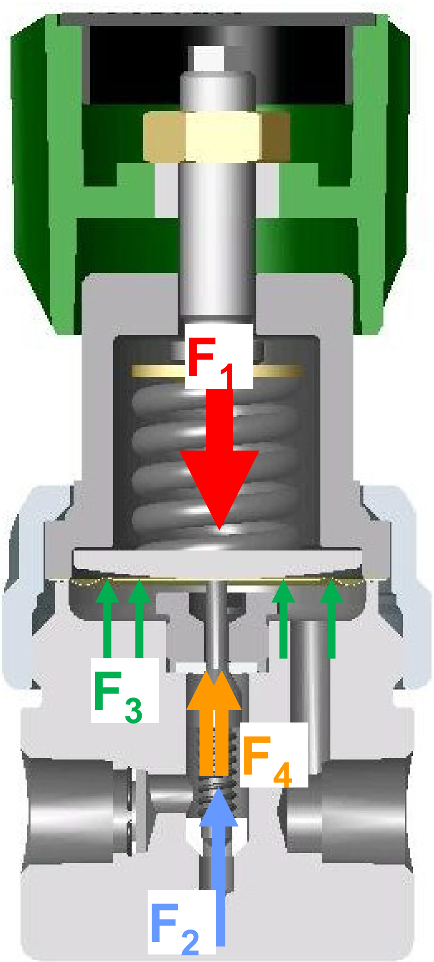
Seat-Load Drop or Lockup

- The difference in pressure between a flowing and non-flowing condition
- When flow is stopped, as outlet pressure builds, the balance of forces favor the control element which allows the poppet to seat itself and close off inlet pressure
- Therefore, P2 increases when V2 is shut off





Operating Principle
Force of Lockup



Lockup is dependent upon:

F_2 = Poppet Spring Force

and

F_4 = Inlet Pressure Force

The higher the inlet pressure, the more lockup!!!

Lockup

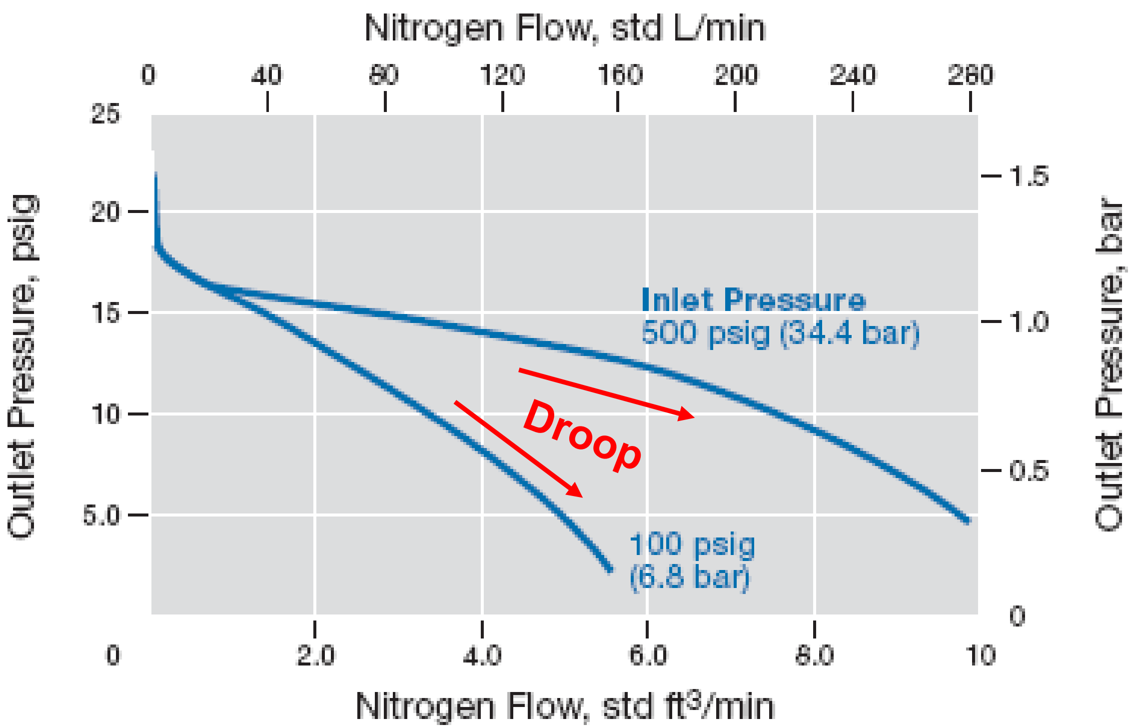
- How to reduce lockup
  - Use soft sealing material
  - Use a soft poppet spring
  - Use the smallest Cv possible for the application
  - Prevent high inlet pressures

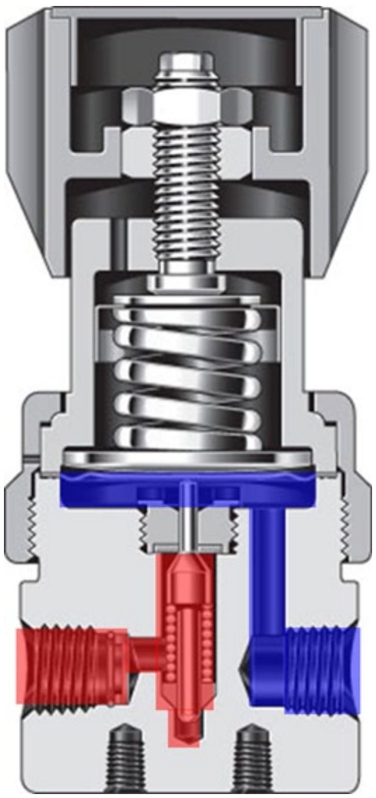
The use of the smallest Cv gives the lowest lockup.

Smaller Cv, smaller seat, smaller inlet pressure force.

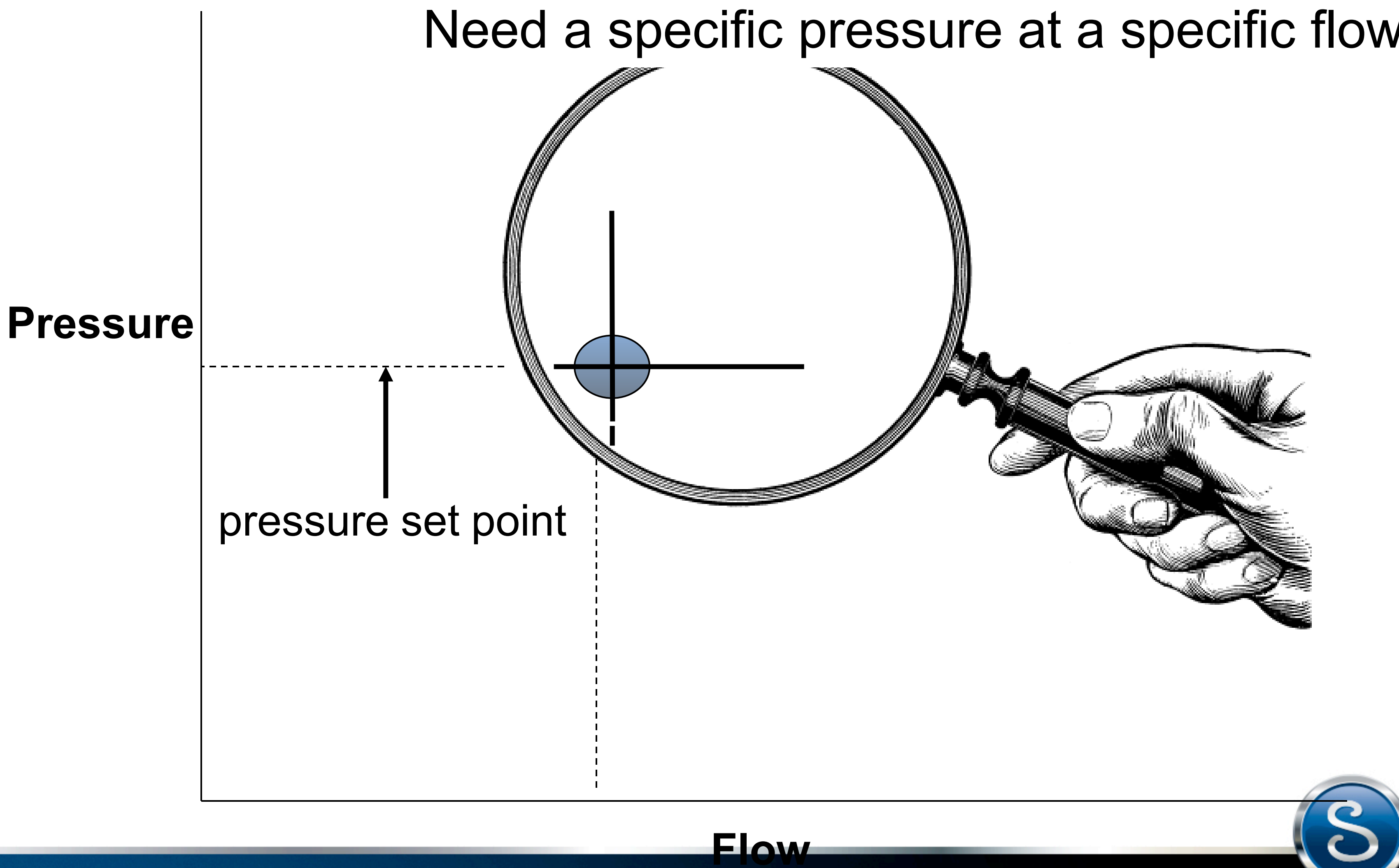
Droop (or Flow Effect)

- Droop is the reduction of outlet pressure as the flow rate increases.

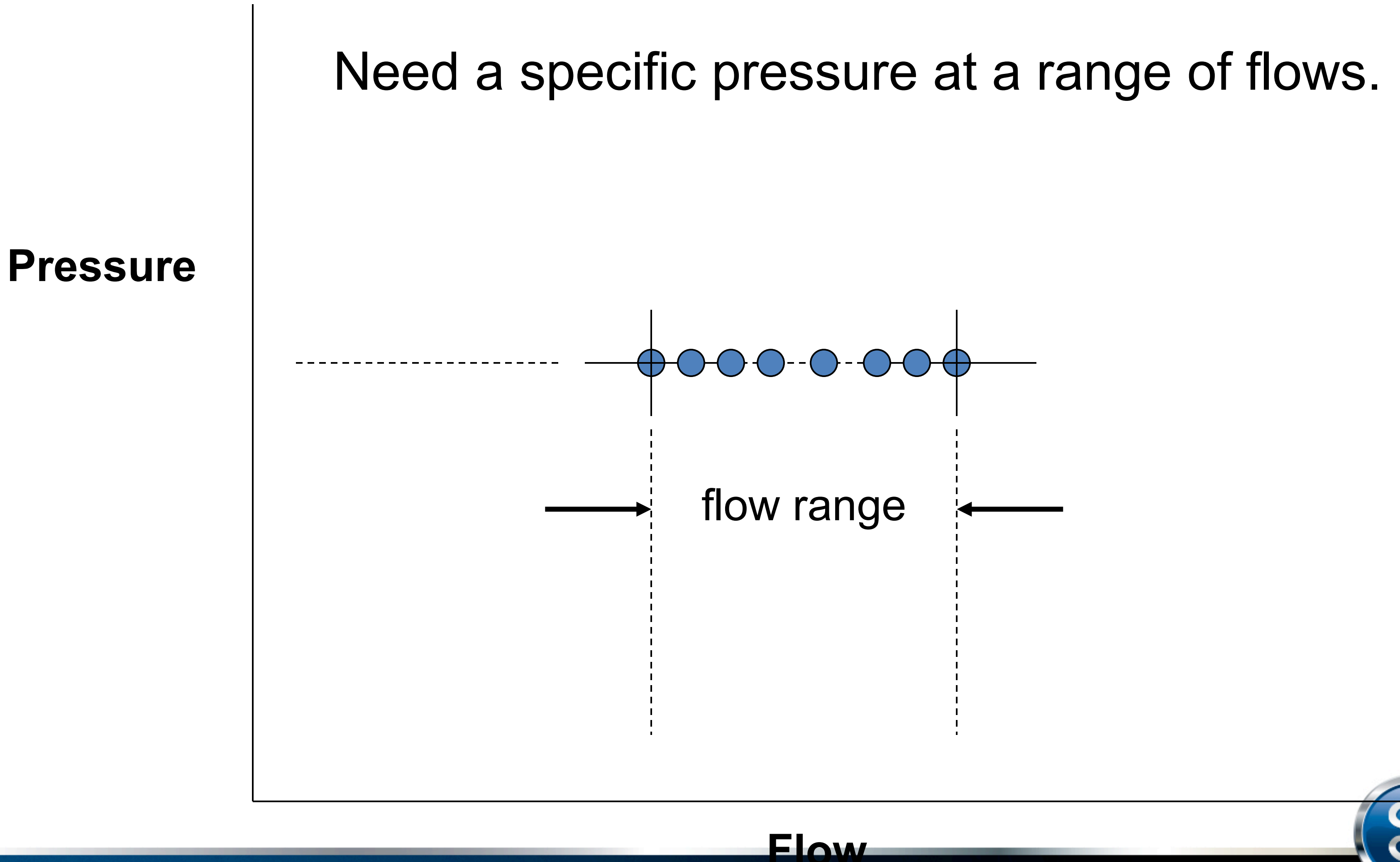




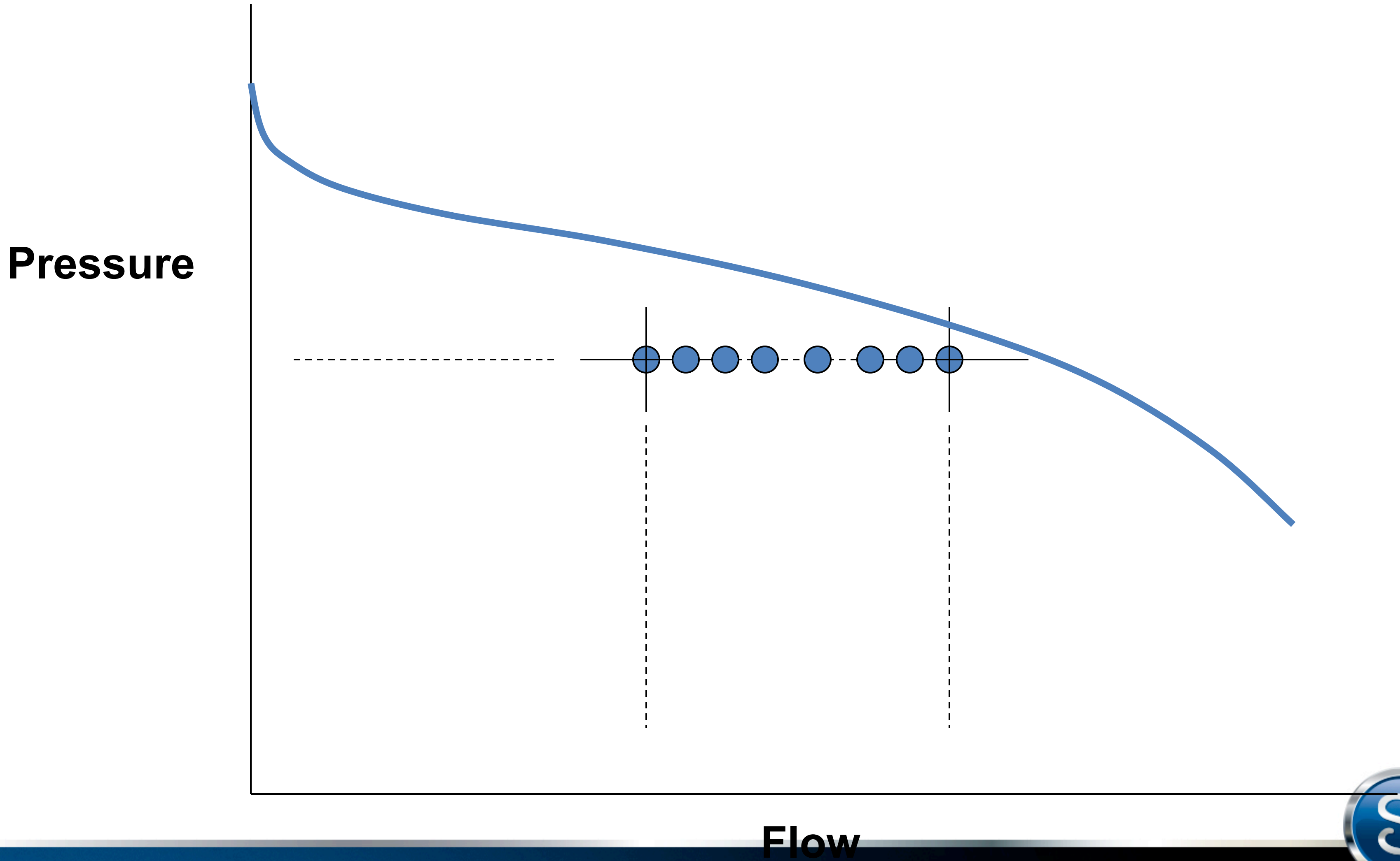
Why is droop important?:
Perceived Problem



Why is droop important?:
Actual Problem

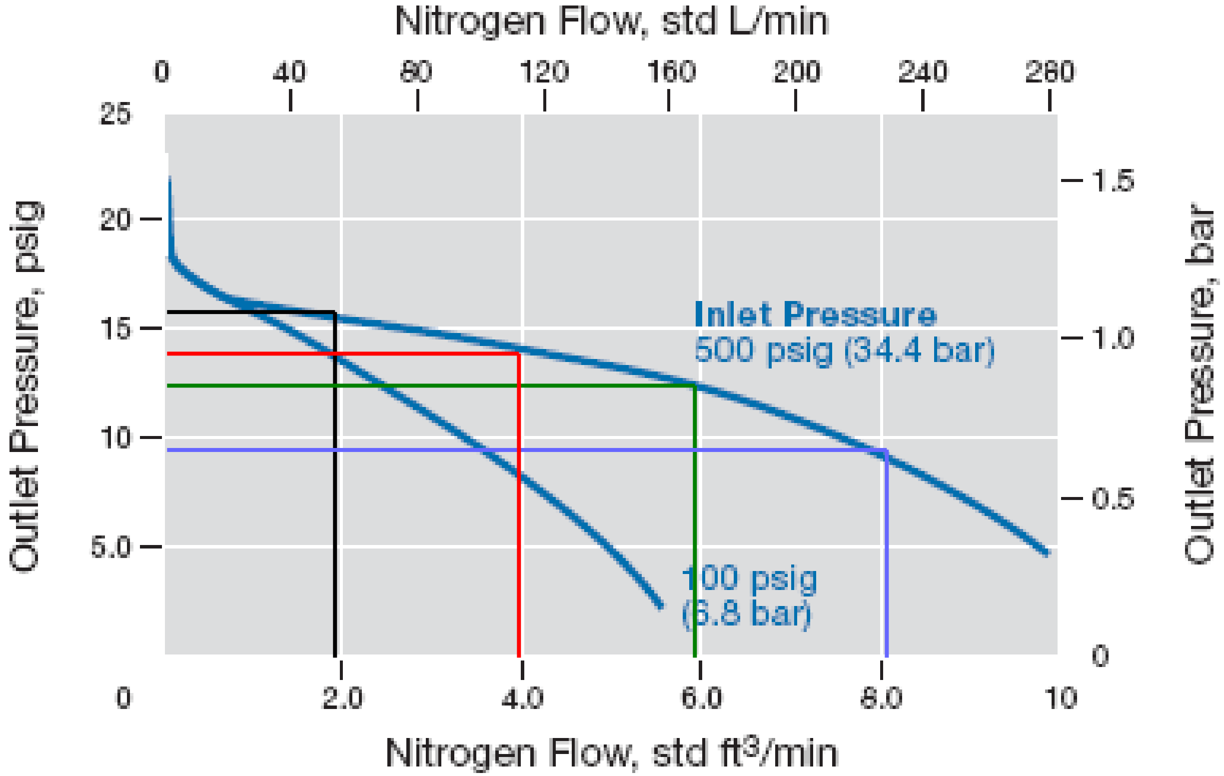


Why is droop important?:
Flow Curve vs. Need

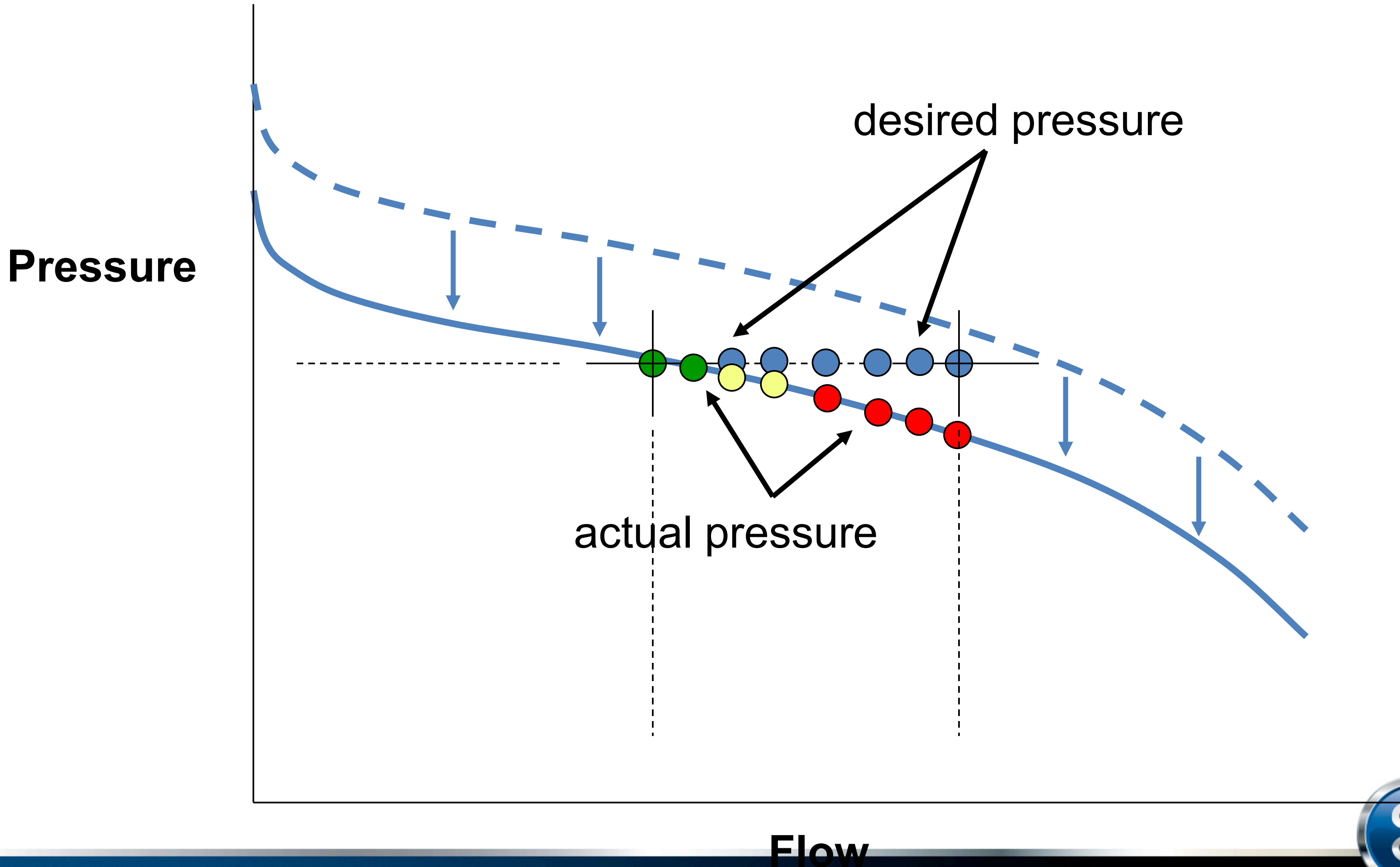


Droop

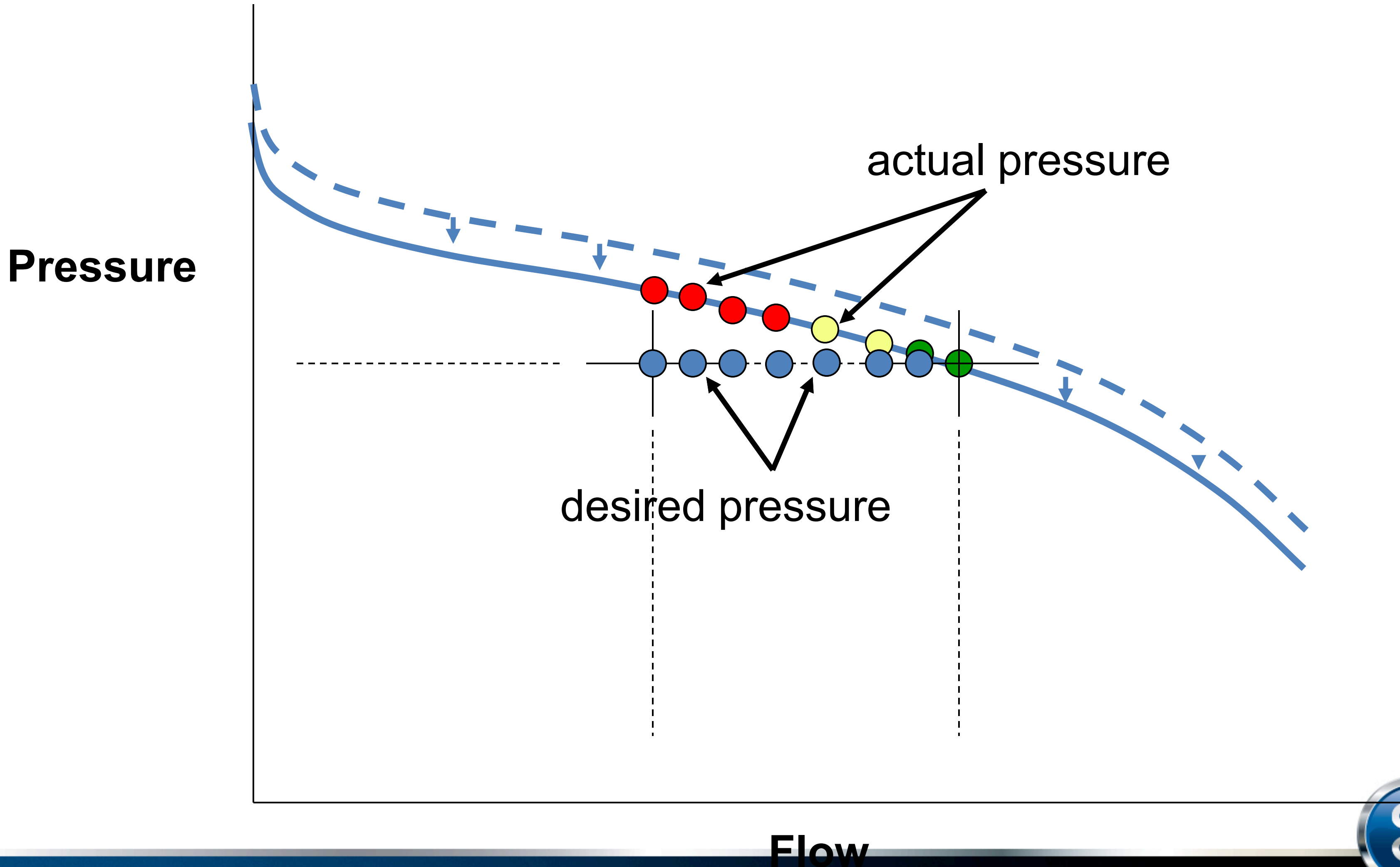
- Inlet pressure 500 psig/ Set Static Outlet Pressure at 22 psig
- Flow increases to 2 std. ft³/min; outlet drops to 16 psig.
- What happens to outlet pressure if downstream demand increases to 4 std. ft³/min? 6 std. ft³/min? 8 std. ft³/min?



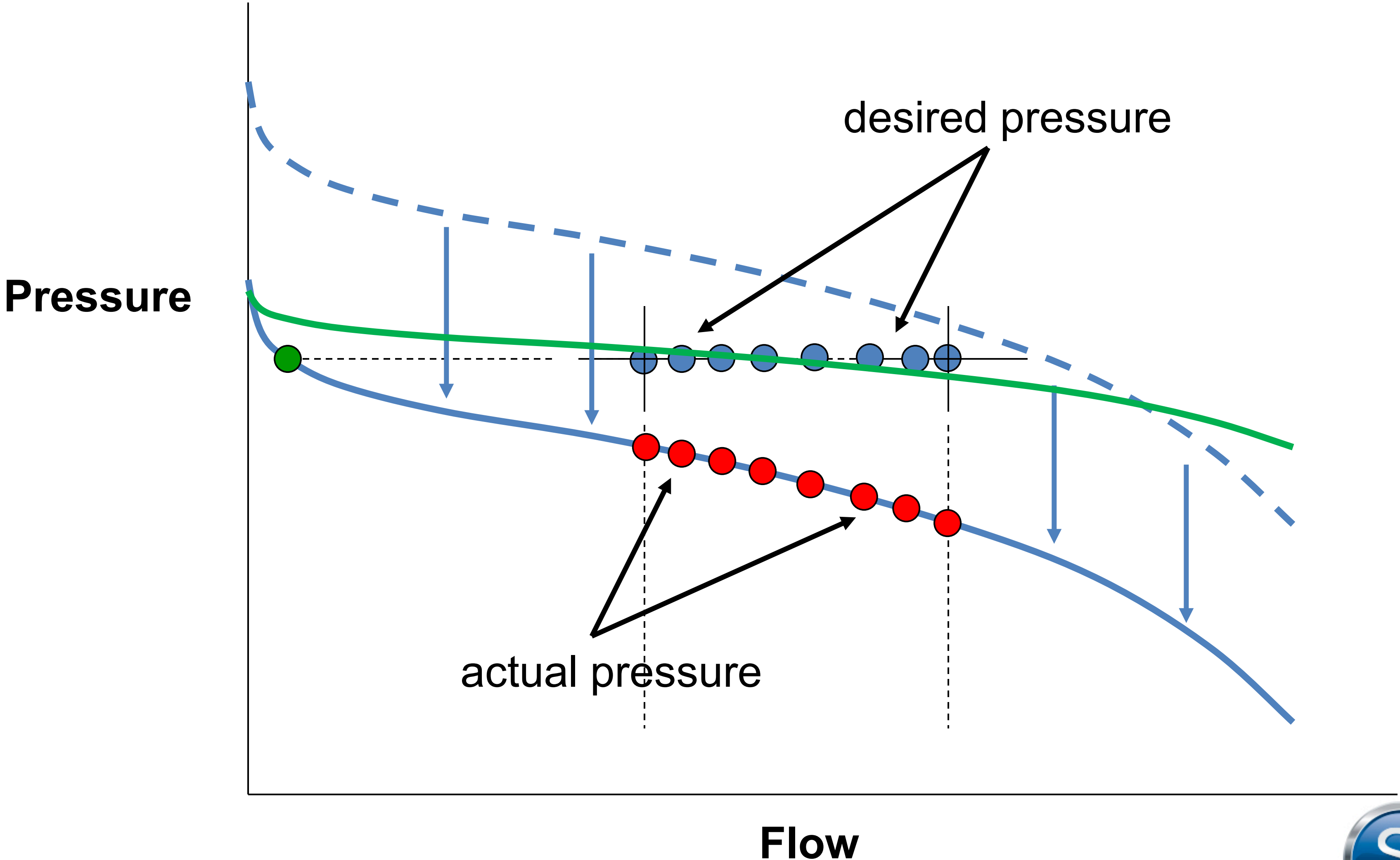
Why is droop important?:
Flow Curve with Outlet Pressure set at Lowest Flow



Why is droop important?:
Flow Curve with Outlet Pressure set at Highest Flow



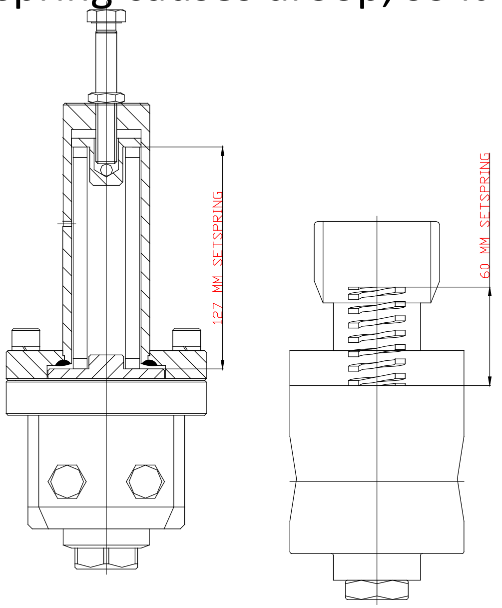
Why is droop important?:
Flow Curve with Outlet Pressure set at Nominal Flow

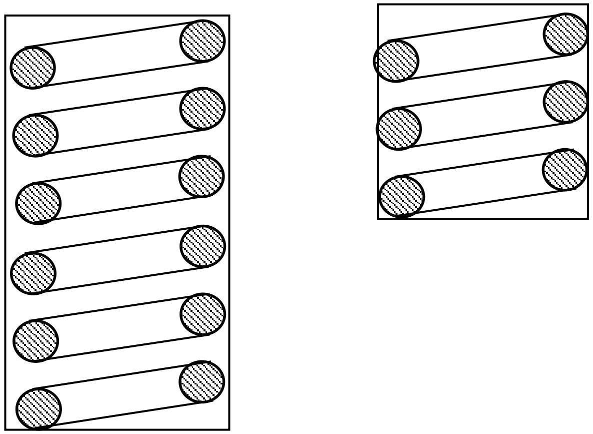


How to Read a Flow Curve: Droop

What causes droop?
Simply put droop is primarily caused by the set spring.
As more flow is required, the set spring extends and looses load force. The result is a dropping outlet pressure.(droop).

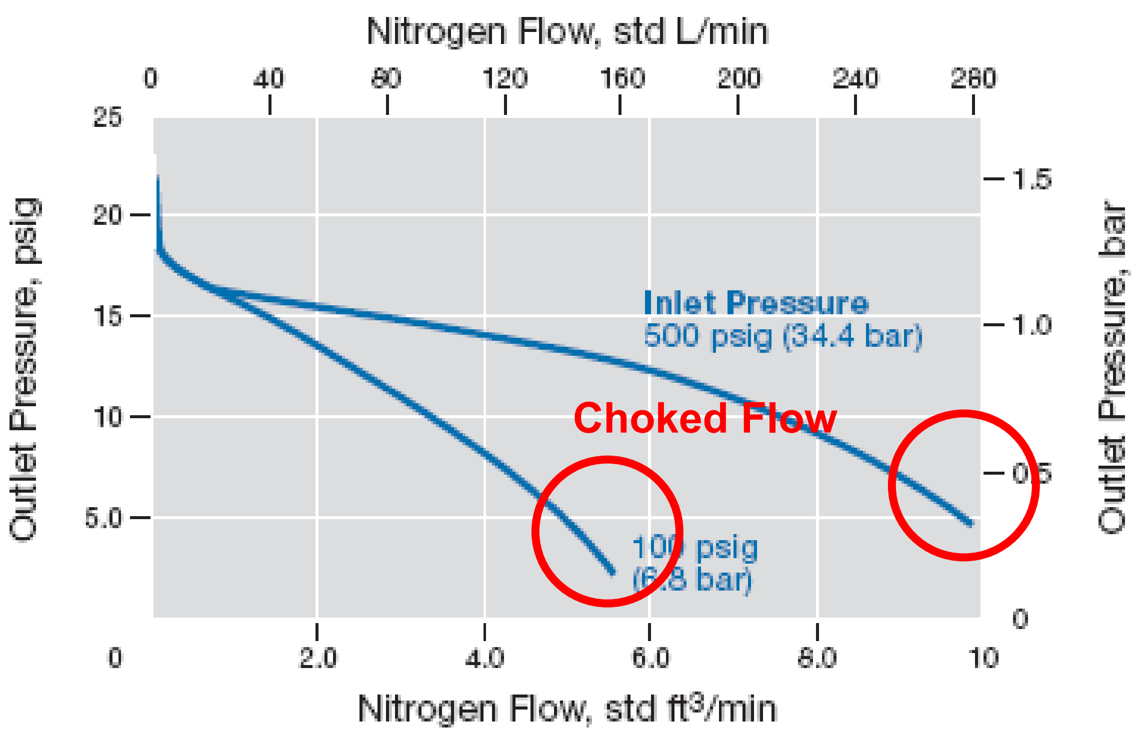
What to do about droop?
The set spring causes droop, so it would make sense to look at the set spring first.

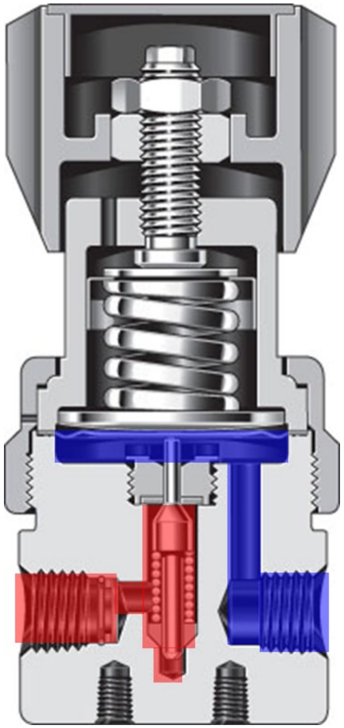




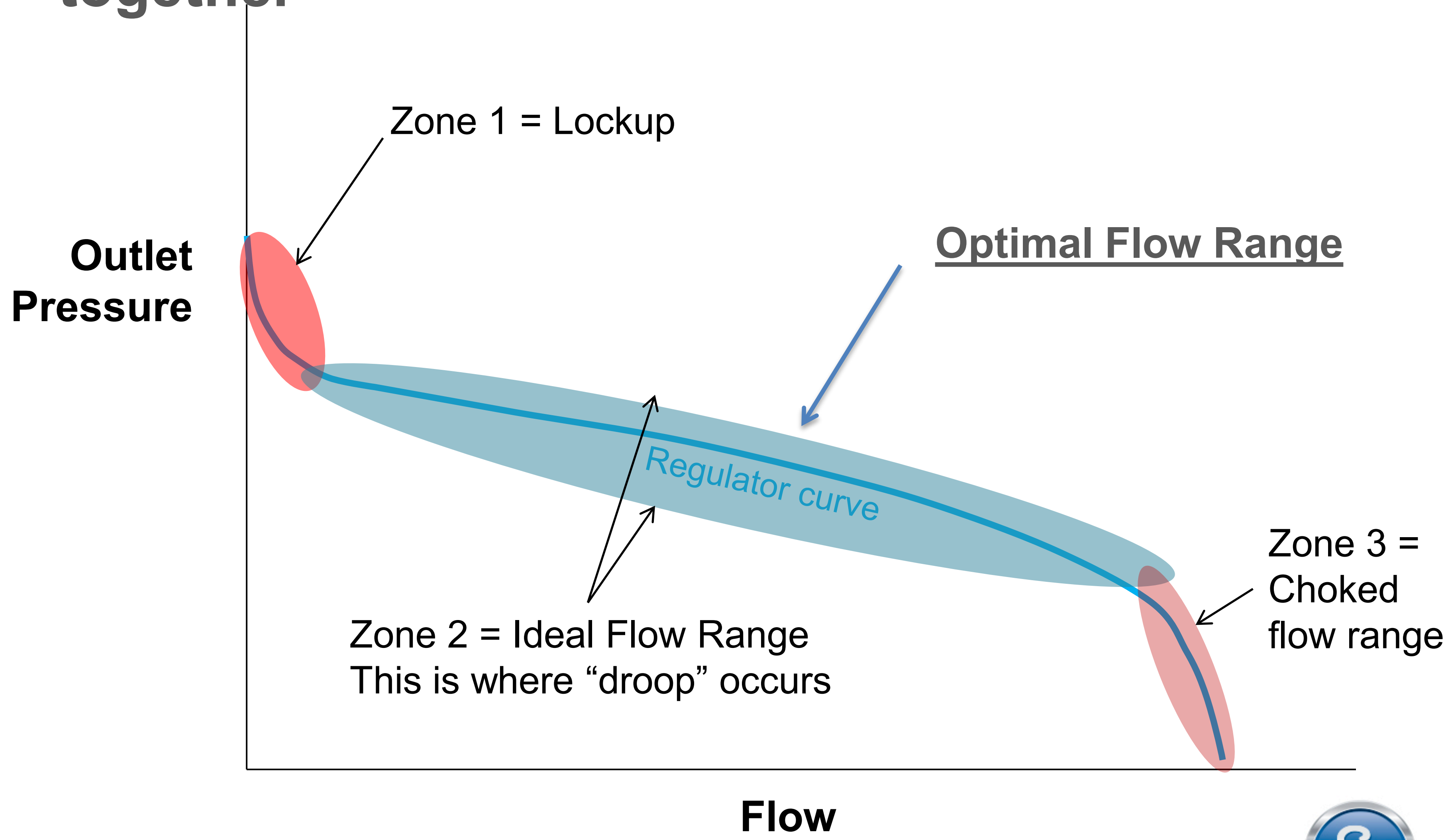
Choked Flow

- When a regulator is in the full open position it is no longer regulating pressure
  - It acts as a restricting orifice
  - Increasing the actuating spring load will not increase pressure or flow

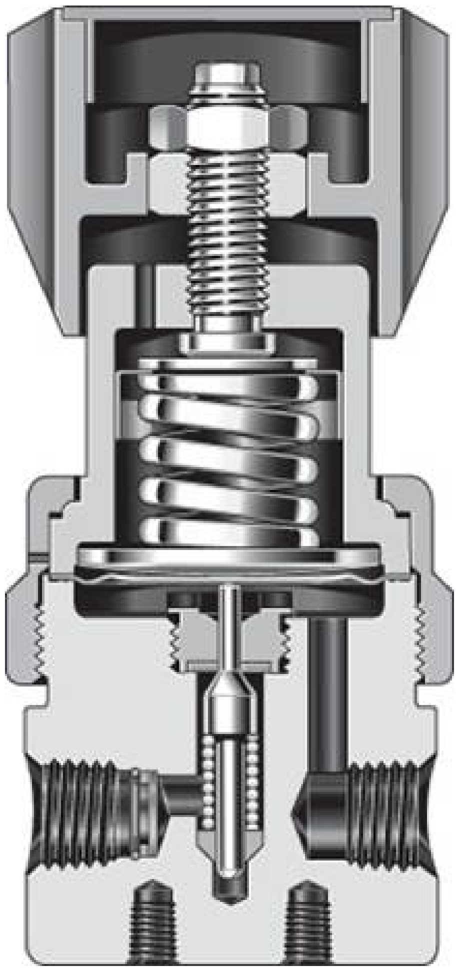




Understanding Flow Curves – bring it all together



C_v of a Regulator (Flow Coefficient)



- The C_v of a regulator is measured when regulator is fully open
- In practice the C_v of a regulator is variable as it throttles the seat
- The flow curves in the catalog provide the **best** means of determining C_v as these are based on actual flow data
- The associated system pipe work may be the restricting feature.
- Cv is important to understand the maximum flow in the case of a failure.
  - Can be used to size the system relief valve.

Summary

- Force equation

  F1 = F2 + F3 + F4

- Select using the flow curve
- Performance criteria

  Seat-Load Drop or Lockup, Droop, Choked Flow, Optimal Flow

- Droop is the reduction of outlet pressure as flow increases

Upcoming Tech Talks

March Tech Talk: Tube Fitting Essentials

Wednesday, March 24th 11:30 am to 12:00 pm

Tube Fittings are a critical component in ensuring the safety of your fluid system. Learn why when selecting a tube fitting it's important to consider the design of the product, how it will perform, and the importance of having a proper installation procedure.

April Tech Talk: Tube vs. Pipe

Wednesday, April 21st 11:30 am to 12:00 pm

Many facilities depend on fluid delivery sent through piping systems; however, stainless steel tubing, instead of hard pipe, can greatly simplify installation and plant maintenance. We will discuss specific advantages of tube over pipe including size and pressure ratings, end connections, and other considerations.