PHMSA & UTC
Training & Qualification
Gas Regulations and Code Compliance Seminar

**REGULATORS 101 AGENDA**

- Spring Operated Regs: principles of operation
- Pilot Op Regs: principle of operation
- System pressure trouble: causes & solutions
- Safety & Overpressure Protection
  - Monitors
  - Slam shuts
  - Relief valves: sizing
- Over pressure protection
Gas Systems
Operators & Direct Sales companies
Spring operated regs: Principles of Operation - Force Balance

- Purpose of a reg: to satisfy downstream flow demand
- Energy disturber: as load turns on regs disturb the potential energy that had been resting upstream during no demand & changes it to kinetic energy (velocity/flow) to satisfy downstream load demand
- DP: the greater the differential pressure across the reg the greater the flow
- The industry asks these devices to act as: regulator, relief valve and as a block valve
**Piloted op regs:** Principles of Operation

-Pilot (amplifier): controls the main valve
-Pilots attain their power from upstream pressure. The pilots amplified pressure is used to move the main valve. The gain (sensitivity) of the pilot makes the movement of the main valve more accurate.

**Pressure loading Reg:** On increasing demand loading pressure is added to main diaphragm by the pilot. Appx 3psid is req’d to open.

**Pressure Unloading Reg:** On increasing Demand loading pressure is added to Main diaphragm by the pilot.

~3psid is req’d to open

~15psid is req’d to open
Operator Stations
Annual UTC stroke & lock up tests

Gate stations: ~700 to 250#
District stations: ~250-55#
Direct Sales: NFPA codes and DOT regulations

- NFPA guidance
NFPA 86

Requirements address the safe design; installation; operation; and inspection, testing, and maintenance of Class A, B, C, and D ovens, dryers, and furnaces, thermal oxidizers, and any other heated enclosure used for processing of materials and related equipment.
System Pressure Trouble: delivery pressure-high-low-unstable
Could lead to code or tariff issue

- **Instability**: tariff compliance, asset issues
  - Cause: oversized regs, load smaller than planned, quick acting load, inadequate downstream piping volume
  - Solution: check total connected load & resize reg, add pipe volume, change equipment operation procedures

- **Low pressure**: tariff compliance, asset issues
  - Cause: under sized reg, load larger than planned
  - Solution: check total connected load & resize reg, check upstream pressure

- **High pressure**: UTC safety compliance issue, asset issues
  - Cause: reg can’t lock up due to pipe debris, Sulphur, quick closing load, inadequate piping volume, JT freezing
  - Solution: clean/rebuild reg, add strainer, add pipe volume, change equipment procedure, add heat
Overpressure protection

Holding pressure to a maximum safe value
Protecting to one failure

• Relief valves: holding pressure to max safe value through venting

• Monitors: holding pressure to max safe value through containment

• Slam shuts: holding pressure to max safe value by shutting off gas flow
Overpressure protection: Relief valve sizing

![Diagram of overpressure protection system](image1)

![Image of overpressure protection system](image2)
§192.743   Pressure limiting and regulating stations: Capacity of relief devices.
(a) Pressure relief devices at pressure limiting stations and pressure regulating stations
must have sufficient capacity to protect the facilities to which they are connected. Except
as provided in §192.739(b), the capacity must be consistent with the pressure limits of
§192.201
(a). This capacity must be determined at intervals not exceeding 15 months, but at least
once each calendar year, by testing the devices in place or by review and calculations.
(b) If review and calculations are used to determine if a device has sufficient capacity, the
calculated capacity must be compared with the rated or experimentally determined
relieving capacity of the device for the conditions under which it operates. After the
initial calculations, subsequent calculations need not be made if the annual review
documents that parameters have not changed to cause the rated or experimentally
determined relieving capacity to be insufficient.
(c) If a relief device is of insufficient capacity, a new or additional device must be
installed to provide the capacity required by paragraph (a) of this section.
[Amdt. 192-93, 68 FR 53901, Sept. 15, 2003, as amended by Amdt. 192-96, 69 FR 27863,
May 17, 2004]
Overpressure protection: monitors

Wide Open Monitor

Worker Monitor

Wide Open Monitor & Relief
Monitor lock up test procedure

- **Shutdown**: Close inlet and outlet isolation valves, install christmas tree in pipe tap between reg and downstream block valve, open and close needle valve on tree and record pressure in which reg locks up at, if value is too high take apart the reg and clean or replace components
- **Start up**: Open outlet valve first (so only have 45lbs pressures) and check or leaks
  - Open sense line valves
  - Back out pilots so not feeding
  - Open inlet valve
- **Calibration**: set monitor at 55lb
  - Set worker at 45lb
Overpressure protection: slam shuts
Shutting off the flow of gas
Overpressure protection: slam shuts
Industrial meter sets and user fuel trains
# Types of Over-Pressure Protection

<table>
<thead>
<tr>
<th>Keeps Customer “On Line”</th>
<th>Relief</th>
<th>Worker Monitor</th>
<th>Wide Monitor</th>
<th>Series Regulation</th>
<th>Shut Off</th>
<th>Relief Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<table>
<thead>
<tr>
<th>Public Relations Problems Caused by Venting?</th>
<th>Relief</th>
<th>Worker Monitor</th>
<th>Wide Monitor</th>
<th>Series Regulation</th>
<th>Shut Off</th>
<th>Relief Monitor</th>
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<tbody>
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<th>Required After Operation</th>
<th>Relief</th>
<th>Worker Monitor</th>
<th>Wide Monitor</th>
<th>Series Regulation</th>
<th>Shut Off</th>
<th>Relief Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>No</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduces Capacity of Regulator?</th>
<th>Relief</th>
<th>Worker Monitor</th>
<th>Wide Monitor</th>
<th>Series Regulation</th>
<th>Shut Off</th>
<th>Relief Monitor</th>
</tr>
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<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<table>
<thead>
<tr>
<th>Constantly Working During Normal Operation?</th>
<th>Relief</th>
<th>Worker Monitor</th>
<th>Wide Monitor</th>
<th>Series Regulation</th>
<th>Shut Off</th>
<th>Relief Monitor</th>
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<tbody>
<tr>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Maybe</td>
</tr>
</tbody>
</table>

Ken Goodwin
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When adjusting a reg set pt what should flow rate be?
Droop: what delivery pressure must drop to during increasing demand
Best practices: sense line location

- After every 20’ of sense line length go one size larger
- 6-10 pipe diameters downstream of the reg

Regulator Supplying to Large Header

Correct: Connection is 6 to 10 pipe diameters downstream of the regulator. (A)
Wrong: Too much turbulence at an elbow. (B)
Correct: Connection is 6 to 10 pipe diameters downstream of the second elbow. With the connection at this point, the regulator will compensate for pressure loss through the two elbows. (C)

Wrong: Pressure may be lower in the connecting piping due to higher velocity. (D)

Wrong: Pressure may be lower in the smaller piping due to higher velocity. (E)

Regulator in Swages

Correct: Connection is 6 to 10 pipe diameters downstream of the regulator. (A)
Wrong: Too close to regulator outlet. (B)
Wrong: Pressure may be lower in the connecting piping due to higher velocity. (C)

Controls pressure up to valve 1. (A)
Controls pressure between valve 1 and 2. (B)
Controls pressure going to the process. (C)

Manual valve
Check valve
Best Practice Freezing trouble: Joules' Thompson gas effect

Temperature change of a gas or liquid across a restriction.
-for every 15dp temp drops 1F

Best practices

• Heat the gas main
• Heat the pilot supply

• Remove moisture from the gas stream
• Inject antifreeze in pilot supply
• Hydrates can freeze above 32F

~Common gas quality market spec = 7lbs water per million cubic feet gas~
### REGULATOR TROUBLESHOOTING

**System Components:** piping (small volume, restricted, turbulent) & load (fast changing, low flows)

**Regulator Components:** valve & actuator size

#### p2 OVER PRESSURE
- Bleed restriction clogged: clean
- Pilot leaking: check disc & plug-replace
- Main valve leaking: ck disc & plug-replace
- Quick closing load

#### p2 UNDER PRESSURE
- Valve undersized: check load requirements-valve capacity, inc. orifice size, inc. p1 (move reg closer to pres source)
- Check upstream pressure: Pilot filter or line strainer clogged-blow down, leaking trap or safety valve-rebuild
- Incorrect spring setting: vary setting and recalibrate
- Quick opening loads
- Diaphragm rupture

#### p2 UNSTABLE
- Valve oversized: check req’d capacity, check valve capacity, consider putting self op in sense line set at 30# above set point
- Be sure sense line valves are full port: reduced port valves intro speed & cycling into the system
- High pressure drops: too large dp can cause excessive forces in valve which cannot be overpowered by the actuator. Consider two cut.
- Small volume piping: any flow into or out of this volume will shock system pressure & reg can’t respond quick enough, inc pipe size, inc pilot supply/valve won’t have to open so much
- Restricted piping: too many headers, valves, meter run downstream that create small volume situation in large systems
- Turbulent piping: piping components (contractions or expansions) create erratic pressure profiles
- Sense line tap in turbulent area: check tap location
## Final control element selection: control valve vs regulator

<table>
<thead>
<tr>
<th></th>
<th>Accuracy</th>
<th>Set point change</th>
<th>Position feedback</th>
<th>Clean medium</th>
<th>Air supply</th>
<th>Speed of response</th>
<th>budget</th>
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</thead>
<tbody>
<tr>
<td>Regulator</td>
<td>1%</td>
<td>Field</td>
<td>No</td>
<td>Must be clean</td>
<td>Air not needed</td>
<td>Fastest</td>
<td>½ price of control valve</td>
</tr>
<tr>
<td>Control valve</td>
<td>.25%</td>
<td>Work Station</td>
<td>Yes</td>
<td>Any medium</td>
<td>Air Required</td>
<td>Fast</td>
<td>Expensive</td>
</tr>
</tbody>
</table>

### Regulator

![Regulator](image1.png)

### Control Valve

![Control Valve](image2.png)
Questions?

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