Introduction to Overpressure Protection

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San Francisco, USA – 2026

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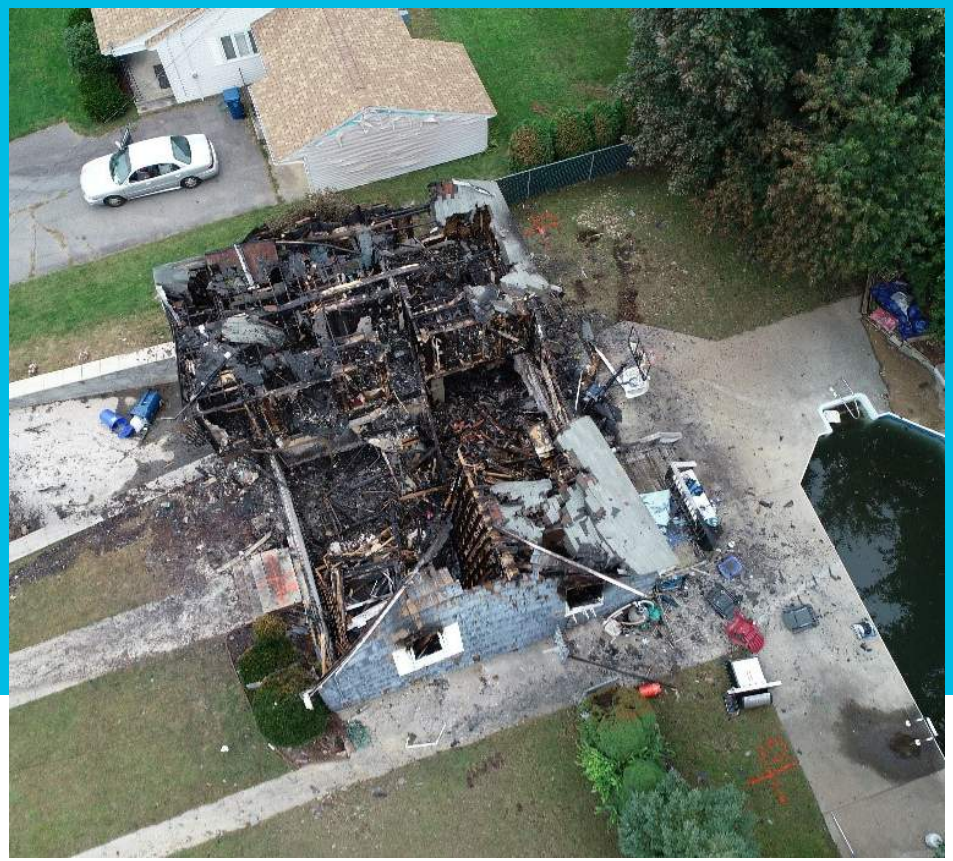
Course Overview

- Why we need Over-Pressure Protection (OPP)
- Industry Regulations
- Causes of Over-Pressure events
- OPP Design & Selection
- OPP Levels
- Maintenance
- Responding to an Over-Pressure event

Definitions

- **MAOP** – Maximum Allowable Operating Pressure
- **OPP** – Over-Pressure Protection
- **Over-Pressure** – The state at which the internal pressure in a pipeline exceeds the MAOP
- **Set Point** – The target downstream pressure a regulator works to maintain
- **Lock-Up** – The state in which a regulator has fully sealed and stopped flow



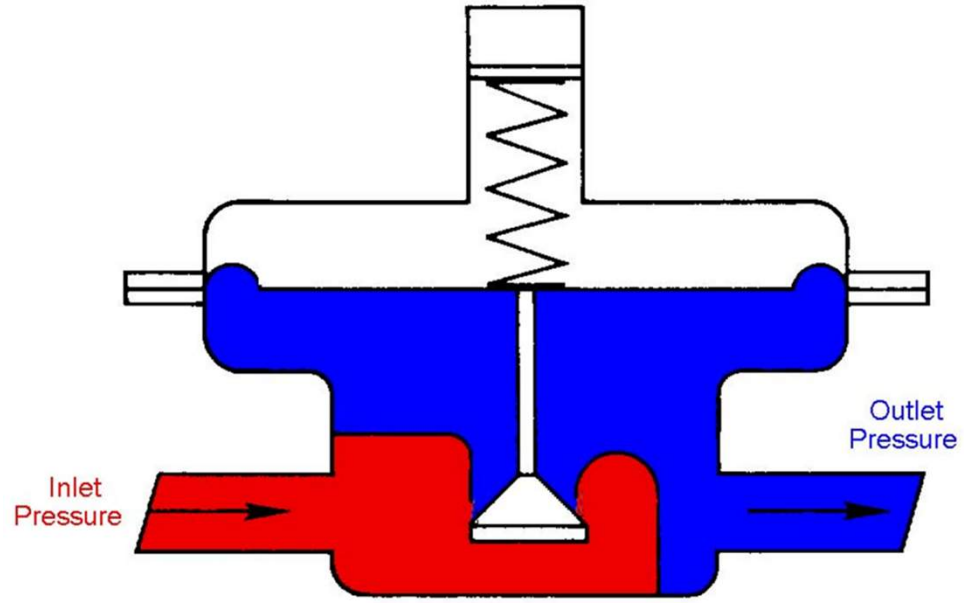
Over Pressure Protection is at the forefront of safety and the protection of life and property.

A critical safety element installed in natural gas distribution systems.

Why do we need OPP?

Because…
REGULATORS FAIL

Pressure Reducing Regulators



Simple Spring Regulator

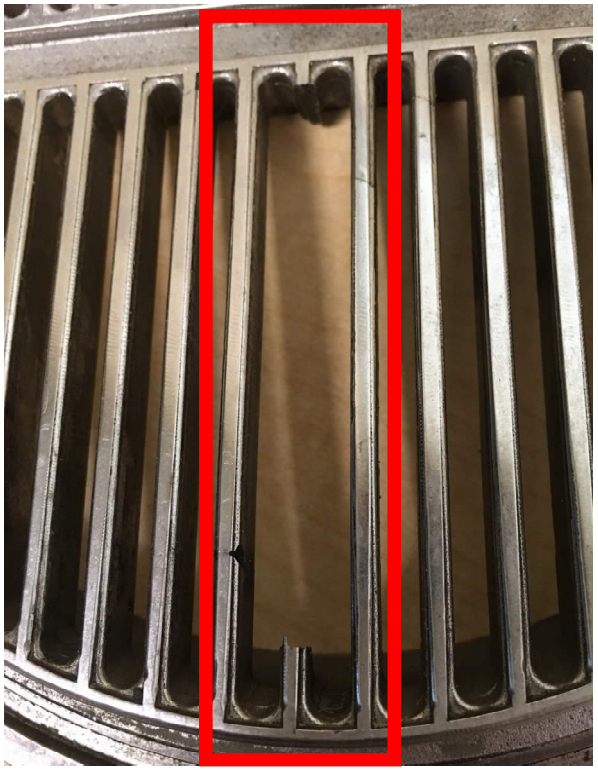
- All gas systems use regulators to reduce pressure from a higher pressure, to a lower pressure.
- These devices are 100% mechanical and are susceptible to failure.
- Operators maintain this equipment on a regular basis per code and best practice.

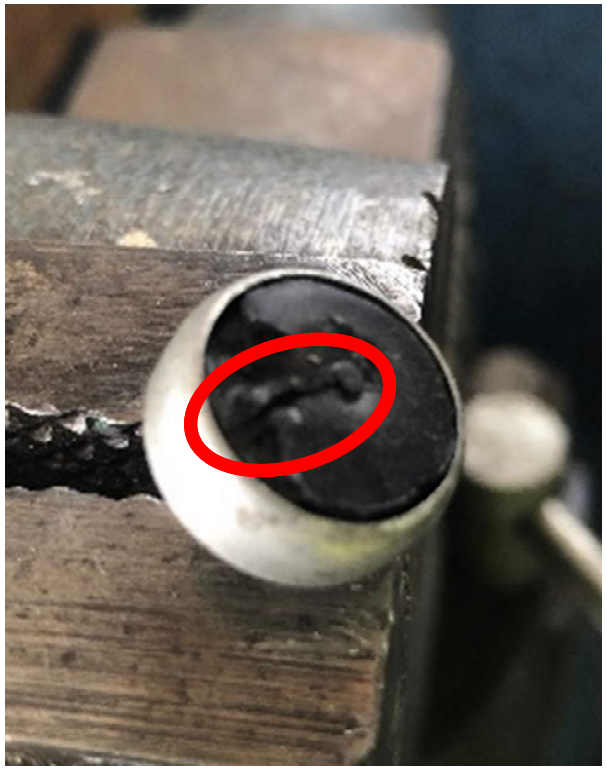
Types of Regulation Failure

- **Liquids and Debris**
  - Metal shavings, slag, scale, oil, grease, etc can block flexible element or orifice seals
  - Small parts and orifices in pilots are especially susceptible
  - This type of damage is reduced by use of filtering equipment

Types of Regulation Failure

- **Sealing Element / Surface Damage**
  - Many regulator problems occur at the sealing surface
  - Sealing elements can become damaged or prevented from creating a positive seal.
  - Orifice edges can be damaged or deformed by debris



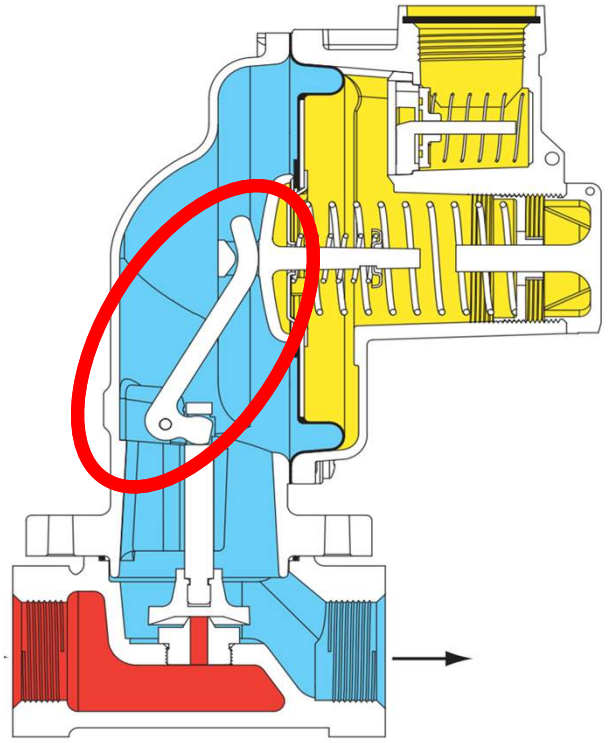


Types of Regulation Failure

- **Hydrates or Particulates**
  - Can disrupt sealing surfaces or clog small ports like debris
  - Difficult to filter out of gas stream
  - Sulfur compounds or hydrates are suspended in the gas stream
  - Fall out of suspension and solidify in certain flow conditions / temperatures

Types of Regulation Failure

- **Other Types of Equipment Failure**
  - **Lever disconnect**
    - Stem no longer connected to the diaphragm & spring.
  - Spring Damage
  - Diaphragm Damage
  - Vent Issues
    - Plugged
    - Water Intrusion
    - Debris

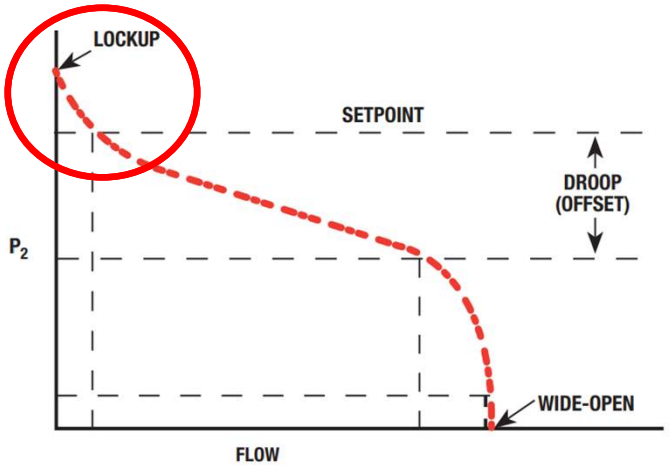


Another Cause of Over-Pressure

Regulator selection and configuration impacts performance.

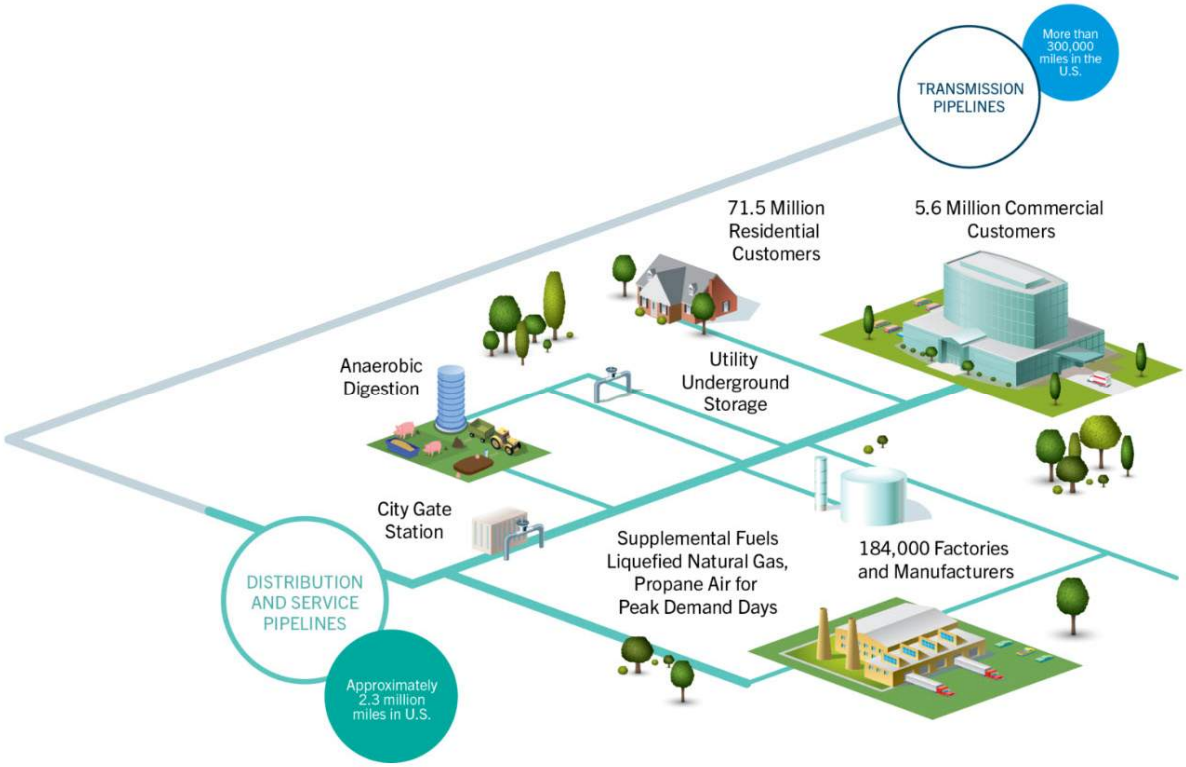
- Low Gain (aka Sensitivity or Response Time) + Erratic Flow Demand
  - The open & close movement of a regulator is not instantaneous.
  - Typically, pilot operated regulators either:
    - open fast, close slow
    - open slow, close fast

- Setpoint Causes High Lockup
  - A regulator setpoint is a function of pressure **and** flow.

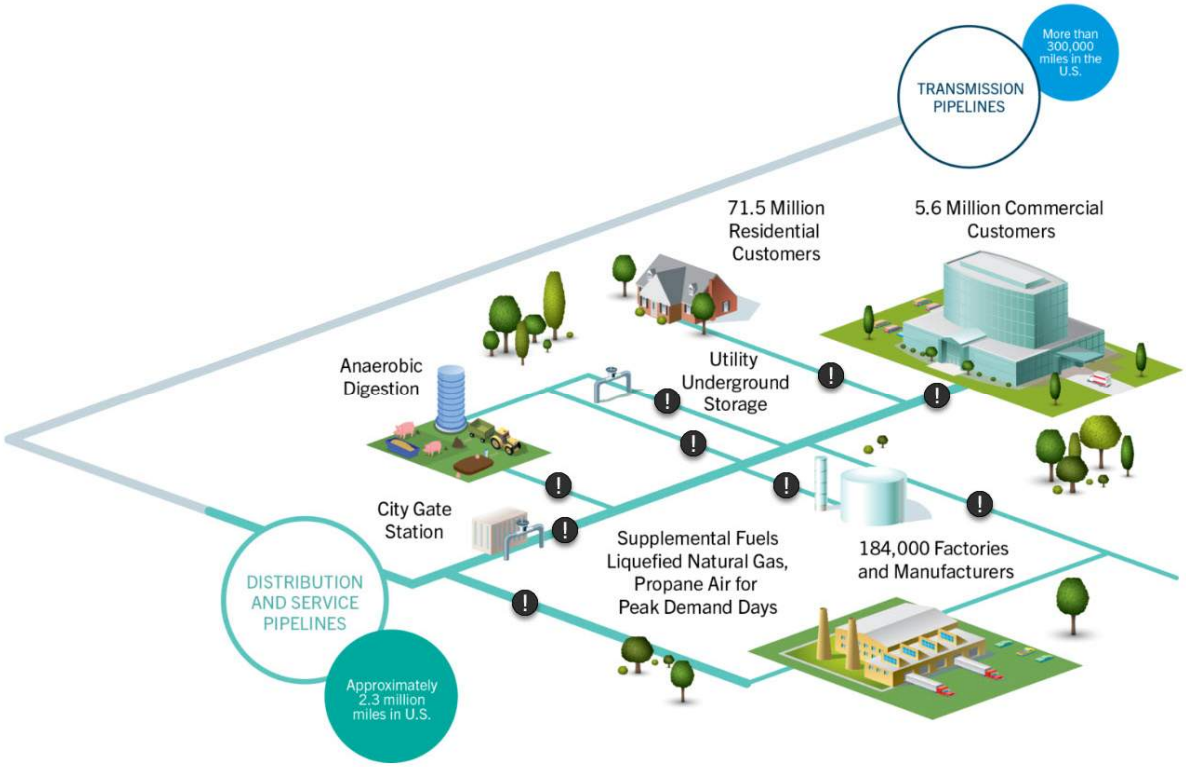


Source: Emerson Technical Reference - Principles of Direct-Operated Regulators

Why do we need OPP?



Why do we need OPP?



Code Requirements

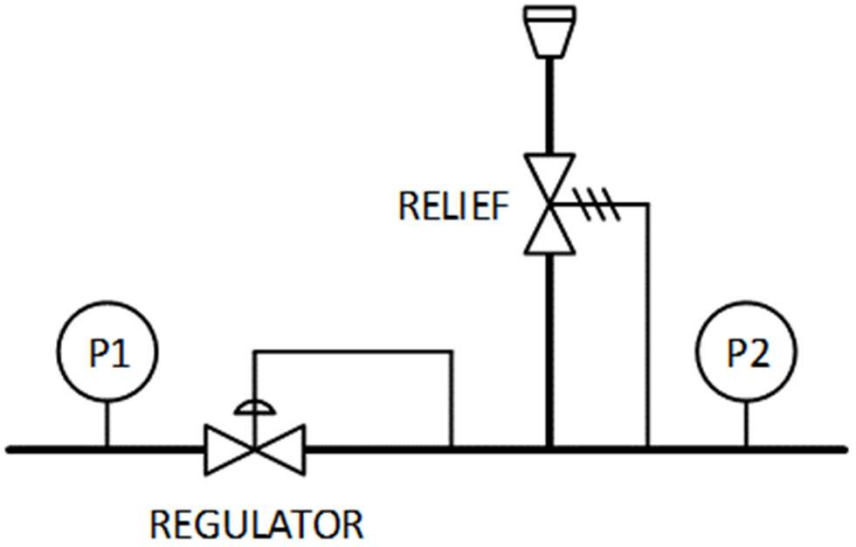
Minimum Code Requirements

Pipeline regulations under 49 CFR Part 192 (and the CSA Z662 counterparts) have established minimum requirements

- *§192.195 Protection against accidental over pressuring*
- *§192.197 Control of the pressure of gas delivered from high-pressure distribution systems*
- *§192.199 Requirements for design of pressure relief and limiting devices*
- *§192.201 Required capacity of pressure relieving and limiting stations*

Types of Over-Pressure Protection

Types of OPP – Relief Valves



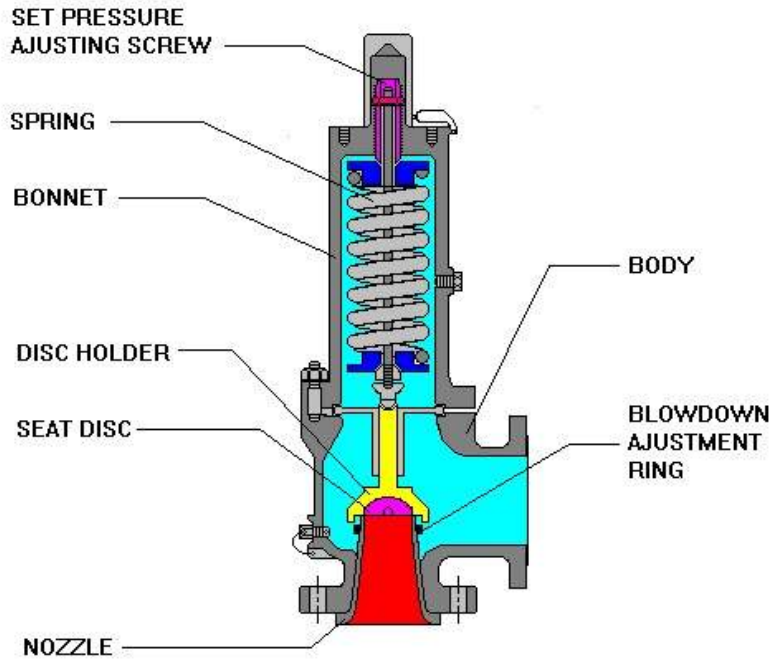
Relief Valves

- Senses and relieves excess pressure by venting gas
- Some regulators are designed to have an integral relief valve
- Relief valves can be installed separate of regulators.
- Prevents over-pressuring while maintaining downstream service

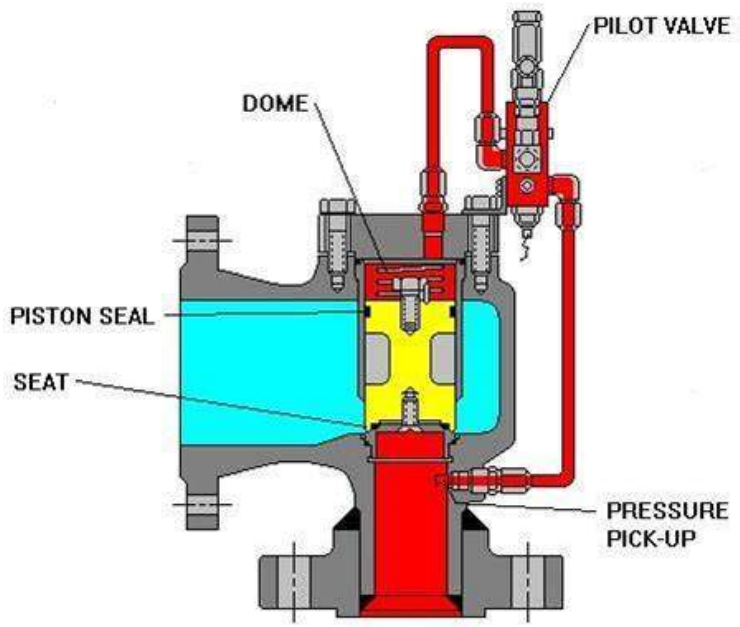
Types of OPP – Dedicated Relief Valve

Spring-Op Relief

- Spring-close regulator “sensing” upstream
- Does not reach full capacity immediately
- Set below MAOP (relief capacity modulates with increasing pressure)



Types of OPP – Dedicated Relief Valve



Pilot-Op Relief

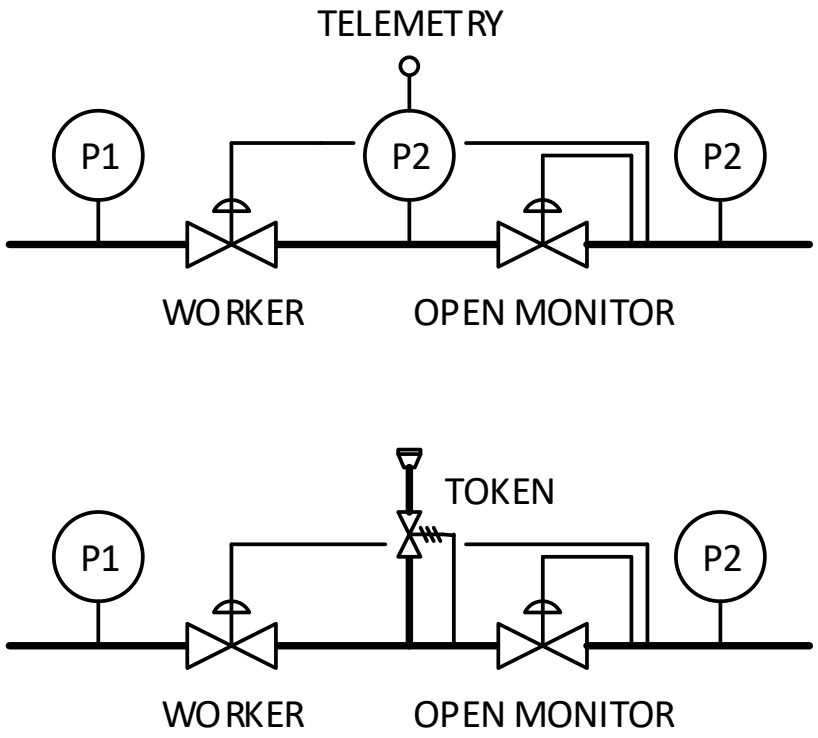
- Introduces idea of loading pressure
- Senses upstream, pilot opens valve
- Fully-opens at setpoint (no modulation like in spring-op)
- Allows setpoint at MAOP

Types of OPP – Relief Valve Sizing

Considerations for Sizing:

- Must relieve the excess gas volume through a failed regulator.
  - Regulator is assumed to fail fully open to size relief for worst case scenario
    - Note that in many cases the “fail open” flow capacity is higher than a regulator’s stated operational capacity.
  - Regulator manufacturers provide “wide open” sizing material for this purpose
- Reliefs are sized for full open failure of the **largest** upstream regulator at station.
- Assume during sizing of regulators that the inlet pressure is equal to upstream MAOP.
  - Note: higher pressure differential → higher regulator capacity → larger relief capacity required
- Regulator capacity plates can lower relief sizing requirements

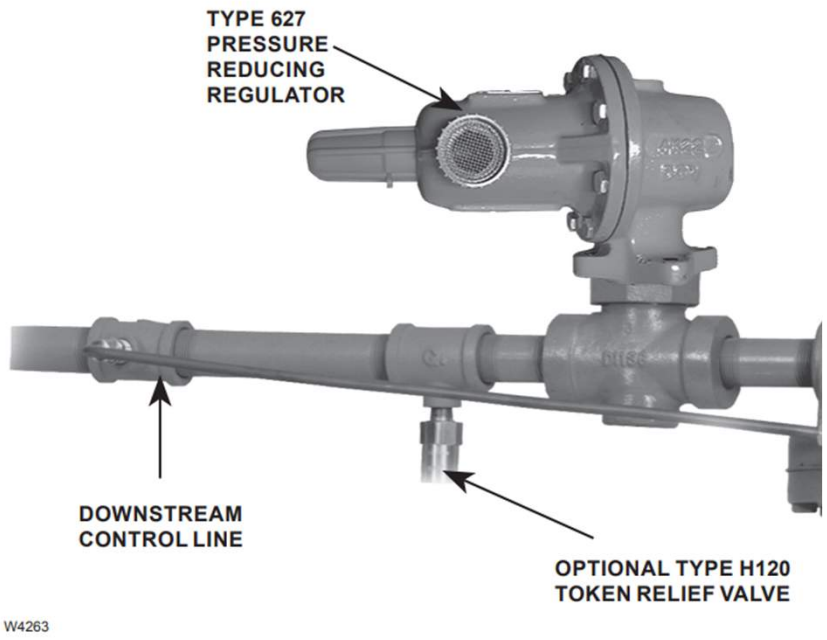
Types of OPP – Worker Monitor



Worker-Monitor Systems

- Redundant regulation in series
  - Regulators or control valves
- Useful for high-capacity stations in place of large reliefs
  - Prevents gas emissions from relief
- Prevents over-pressuring while maintaining downstream service
- Failure(s) monitored via telemetry system or **token relief**

Types of OPP – Worker Monitor



Token Relief Valve

- Small relief designed to vent gas for olfactory alert (if you smell it, pressure has exceeded setpoint!)
- Common between worker and monitor regulators
- Some regulators are designed with integral token reliefs
- **A token relief is does not provide over-pressure protection**

Types of OPP – Worker Monitor

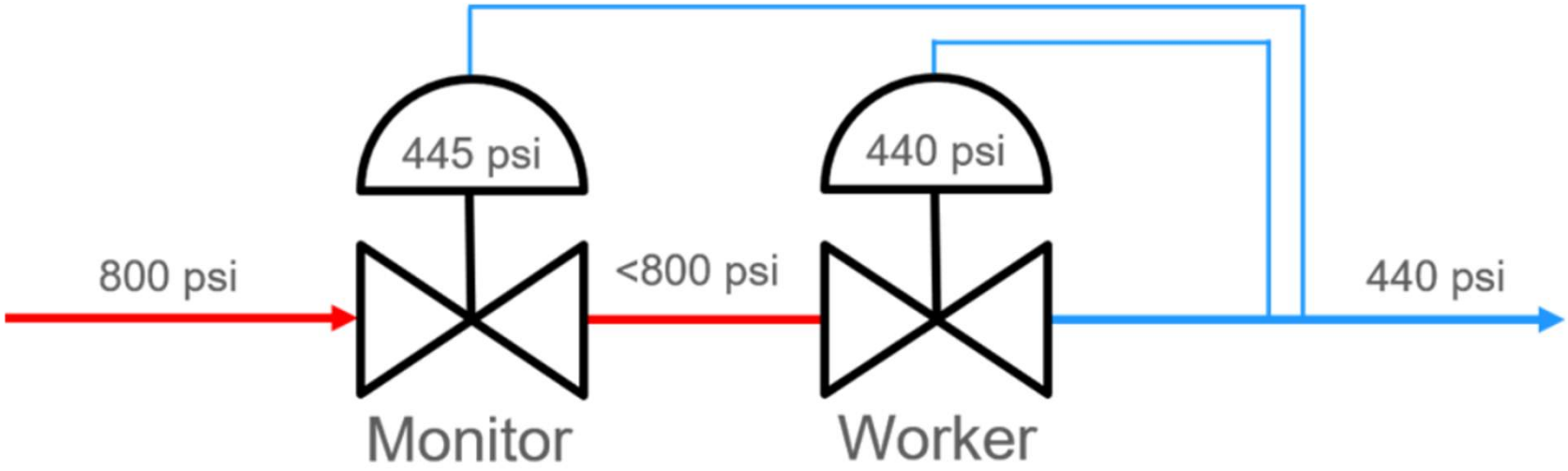
Control Logic

- Monitor set higher than worker
  - Wide-Open Configuration
  - “Working Monitor” Configuration
- Both regulators sense downstream pressure
- If worker valve fails and downstream pressure elevates, monitor closes at it’s setpoint.

Types of OPP – Worker Monitor

Wide Open Monitor

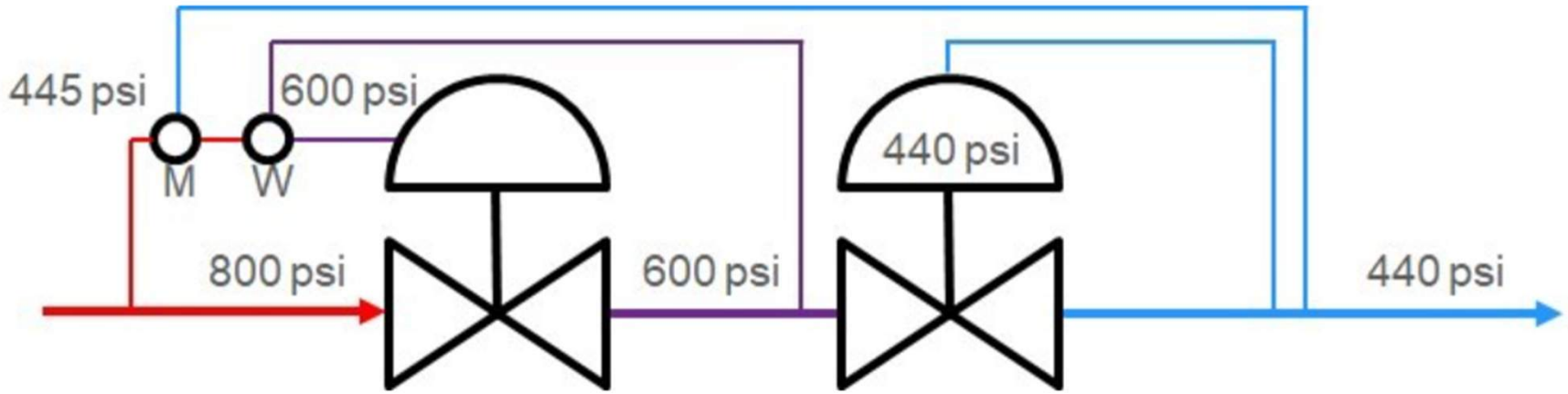
- Monitor valve remains fully open until a downstream pressure change is detected.
- Pros: Simple pilot configuration (one pilot per valve)
- Cons: Monitor valve is infrequently cycled, may lead to degradation of flexible elements



Types of OPP – Worker Monitor

Working Monitor

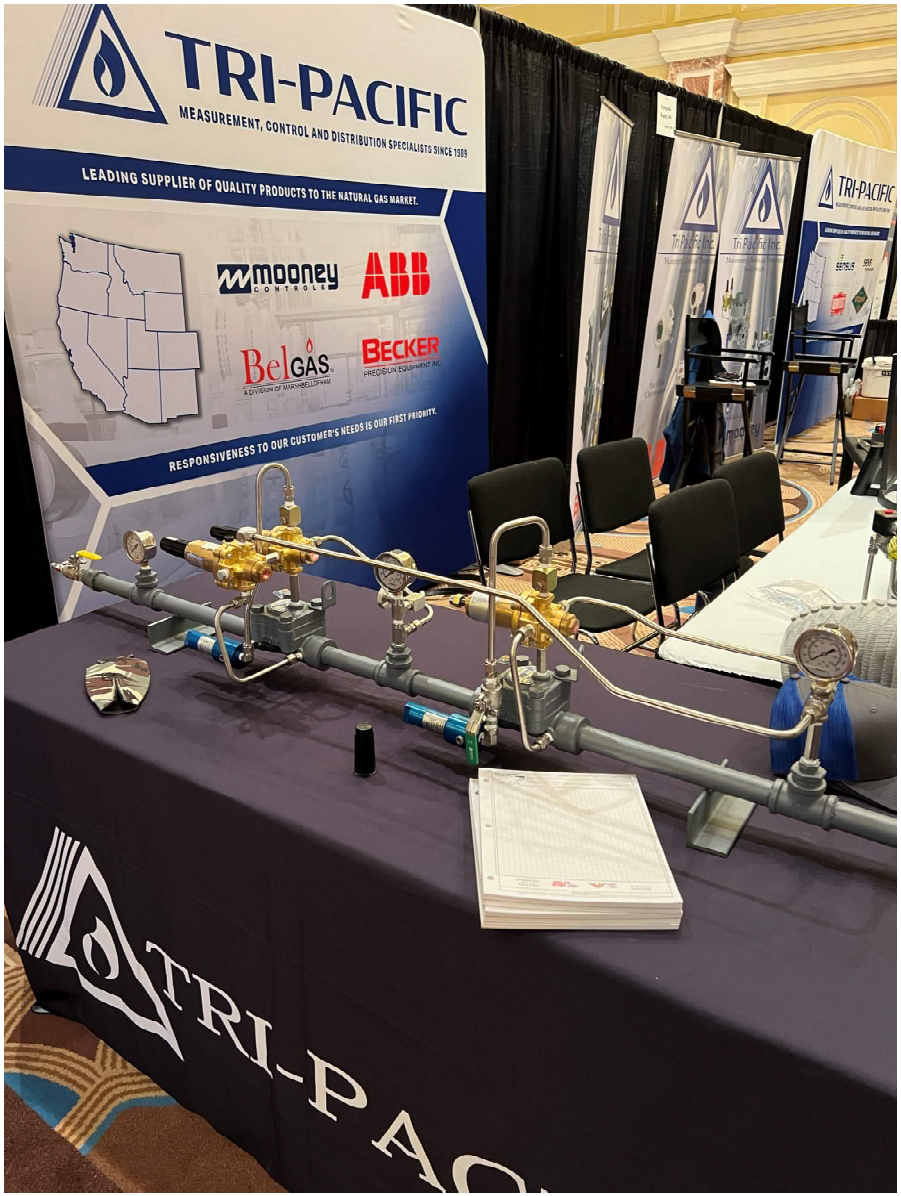
- Monitor valve regulates to a mid-pressure, while also sensing downstream pressure.
- Pros: Monitor valve is cycled just as frequently as the worker valve.
- Cons: Extra pilot and complexity in tubing for working monitor valve.



Types of OPP – Worker Monitor

Working Monitor –

Tri-Pacific Booth, WGMSC 2024



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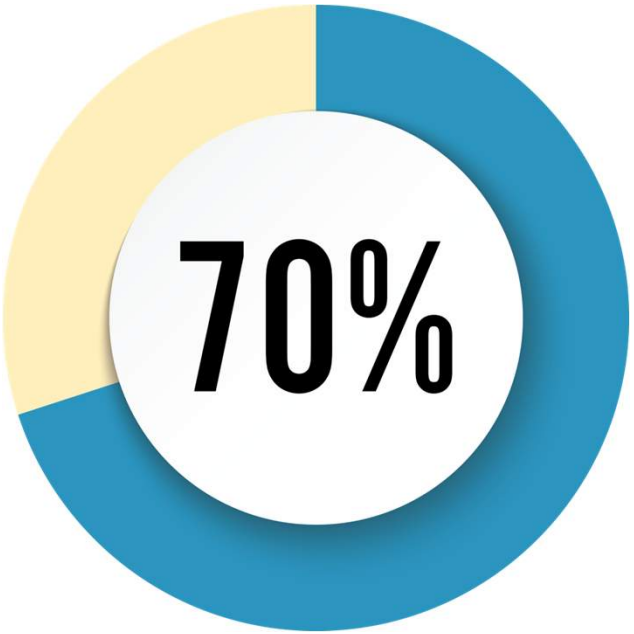
Types of OPP – Worker Monitor



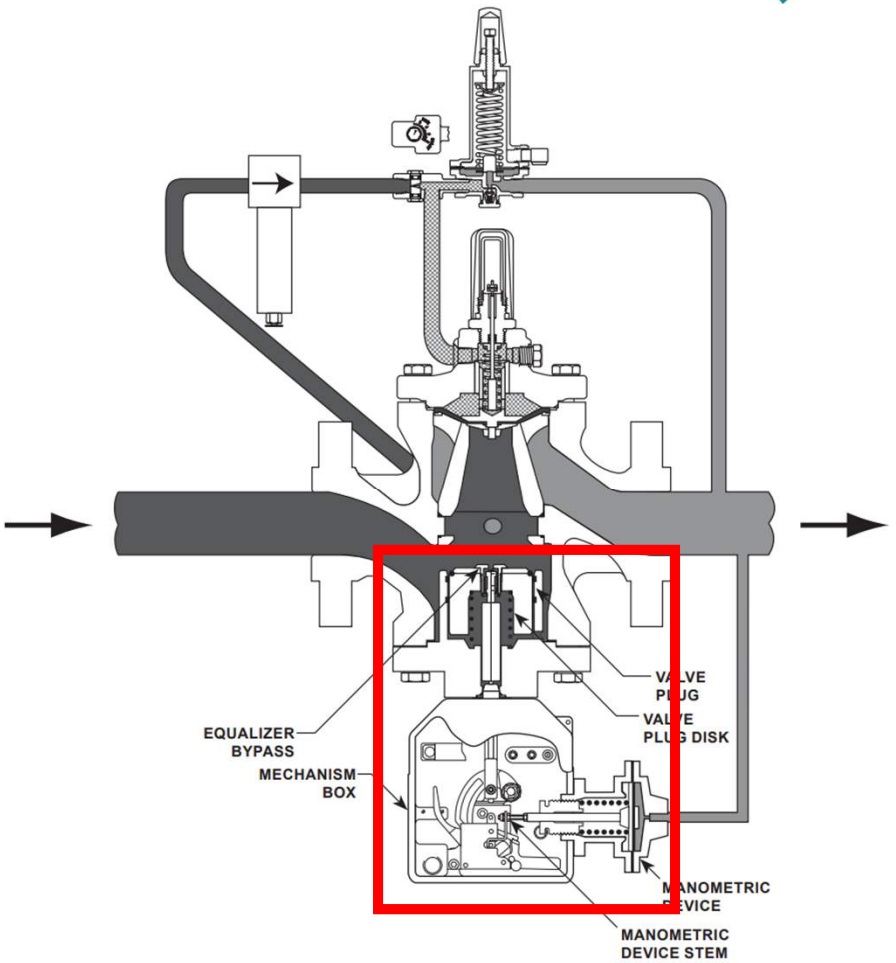
70% Capacity Rule-of-Thumb

- Monitor valve is in wide open position
  - Note: monitor valve causes extra pressure drop through the station
- Gas travels through two orifices
- For sizing a worker monitor regulator site, a rule of thumb is to take 70% of the normal full regulating capacity of the smaller valve (typically the worker).

Types of OPP – Slam Shuts

Slam Shut Valve or "Shut-Off Valve"

- Senses downstream pressure for increase above setpoint
  - Snap action close
- Must be field reset
  - Completely shuts in flow with a separate sealing edge and element
- Standalone or integral construction



OPP Selection

→ Venting Vs. Containment
→ Levels of OPP

OPP Selection

Gas Venting Devices – **Relief Valves**

Pros:

- Maintains gas service in the event of regulation failure
- Simple relative to other options
- Methane smell provides natural “alarm”
- Does **not require** station telemetry for monitoring

Cons:

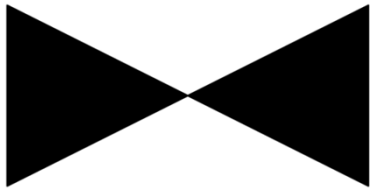
- Increased Odor Calls
- Noise Exposure near vent location
- Emits methane to atmosphere – may be restricted per local regulations
- Visibility
  - Appearance of a “Smoke Stack” etc.

OPP Selection

Gas Containment Devices – **Monitors & Slam Shuts**

Pros:

- No emissions – may be required by local regulations
- Often installed with redundancies, results in more resilient and adaptable station designs
  - Dual Run stations
  - Station Telemetry



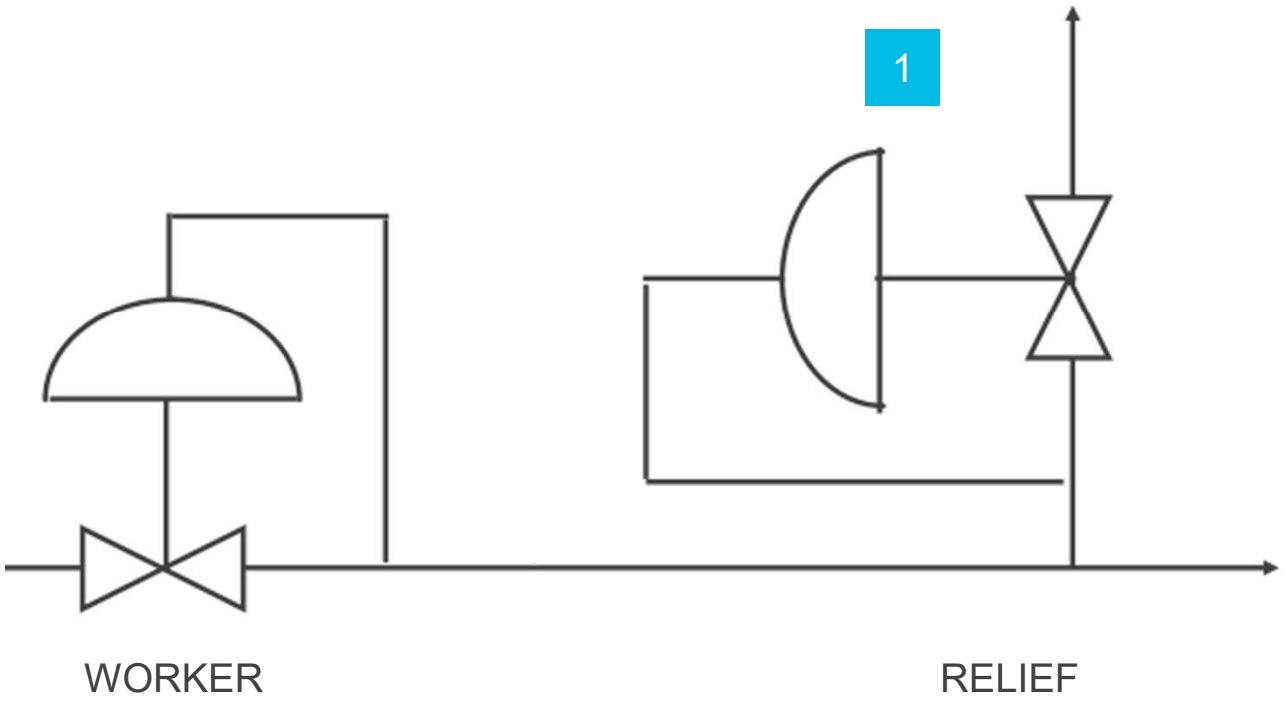
Cons:

- Increased complexity and project scope
- **Requires** station telemetry for monitoring
  - Token relief can also be used for monitoring, if emissions are allowed
  - Back-fed systems
- More assets to maintain

OPP Levels

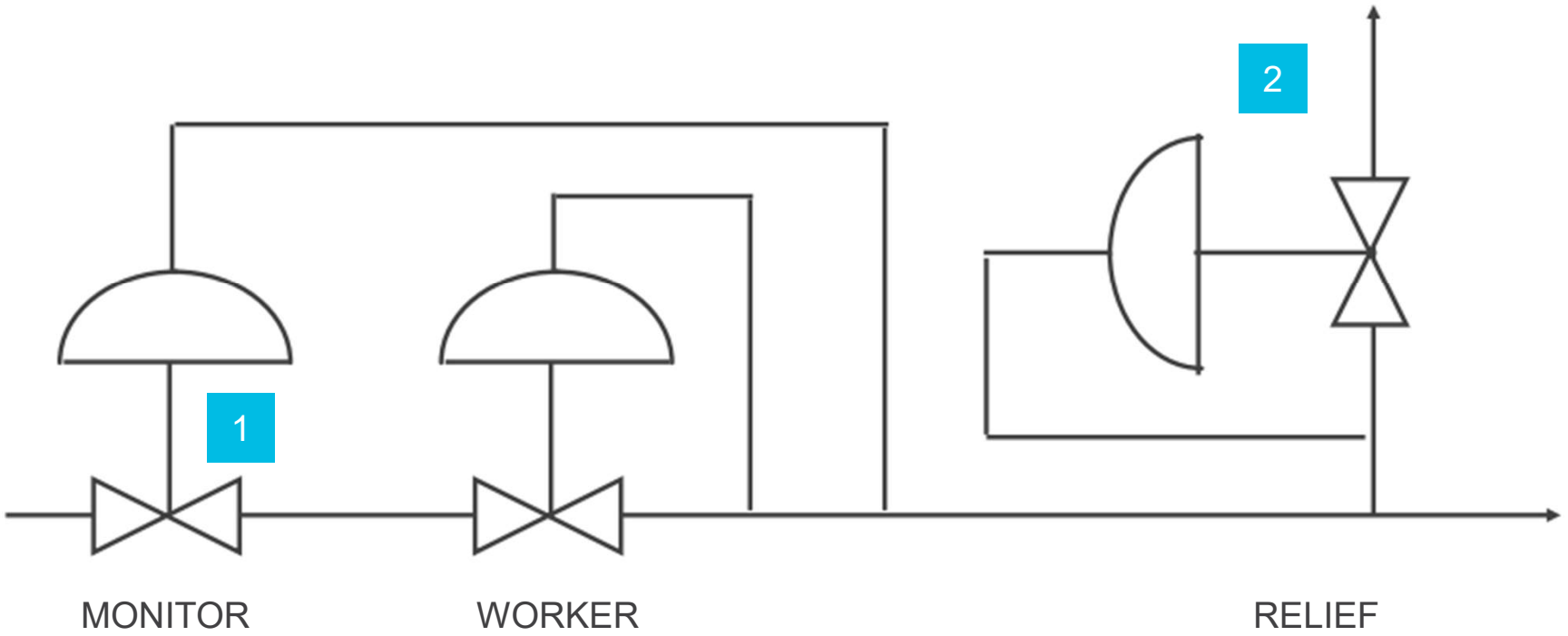
One Level OPP – Example

Single Relief



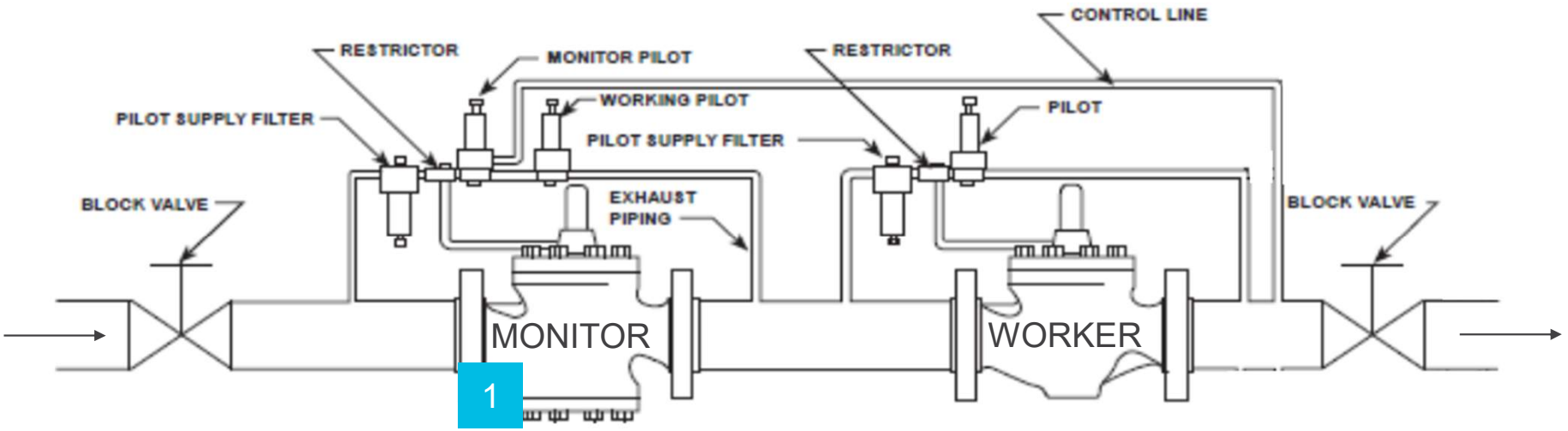
Two Level OPP – Example

Single Relief + Monitor



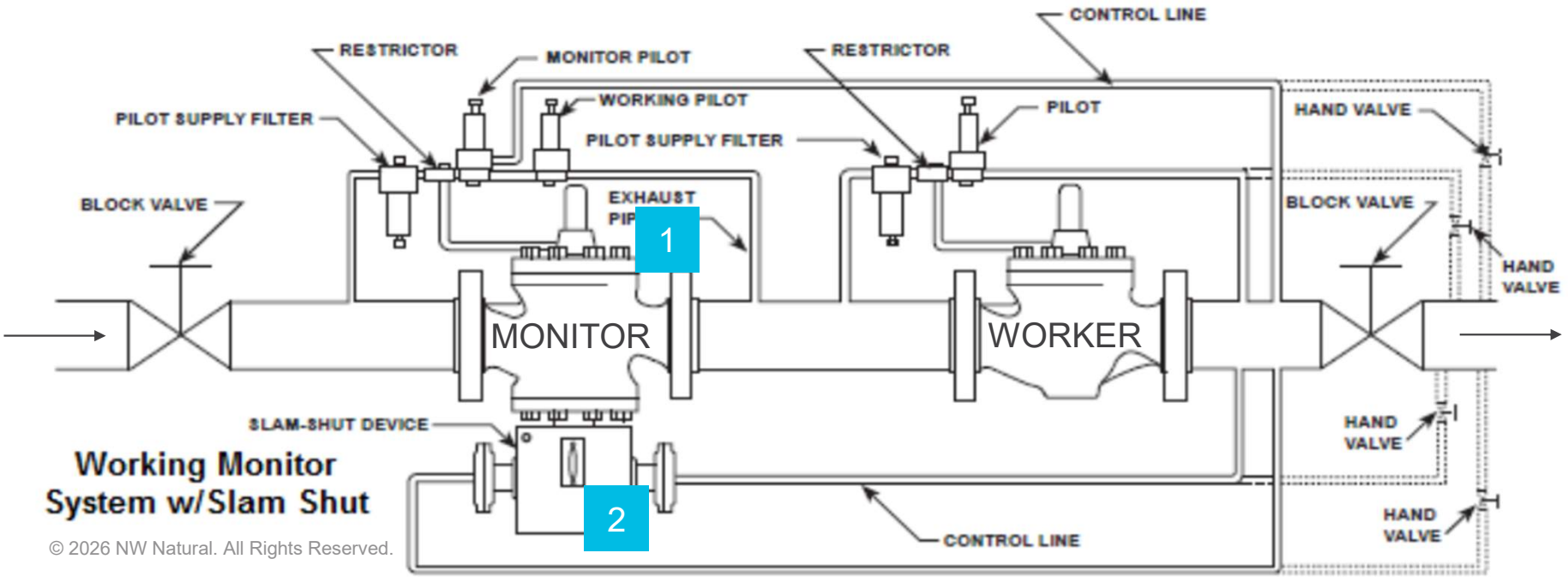
One Level OPP – Example

Single Working Monitor



Two Level OPP – Example

→ Single Working Monitor + Slam Shut

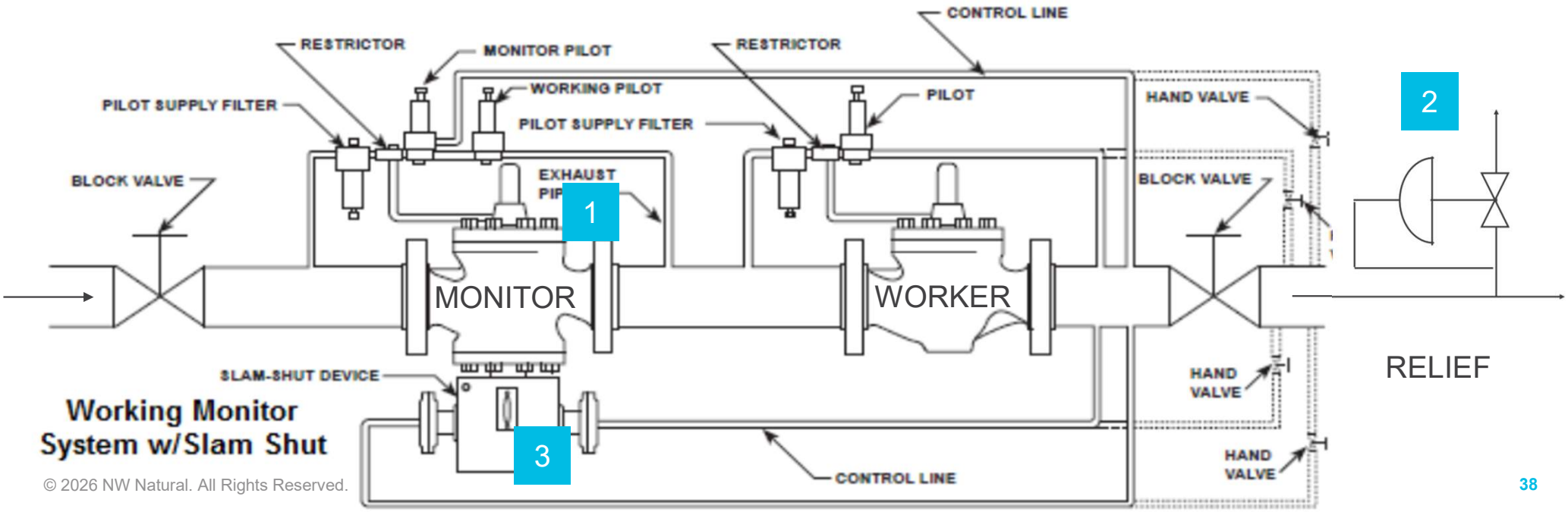


Working Monitor System w/Slam Shut

Three Level OPP – Example

→ Single Working Monitor + Relief + Slam Shut

NOTE: Change in order of layers!

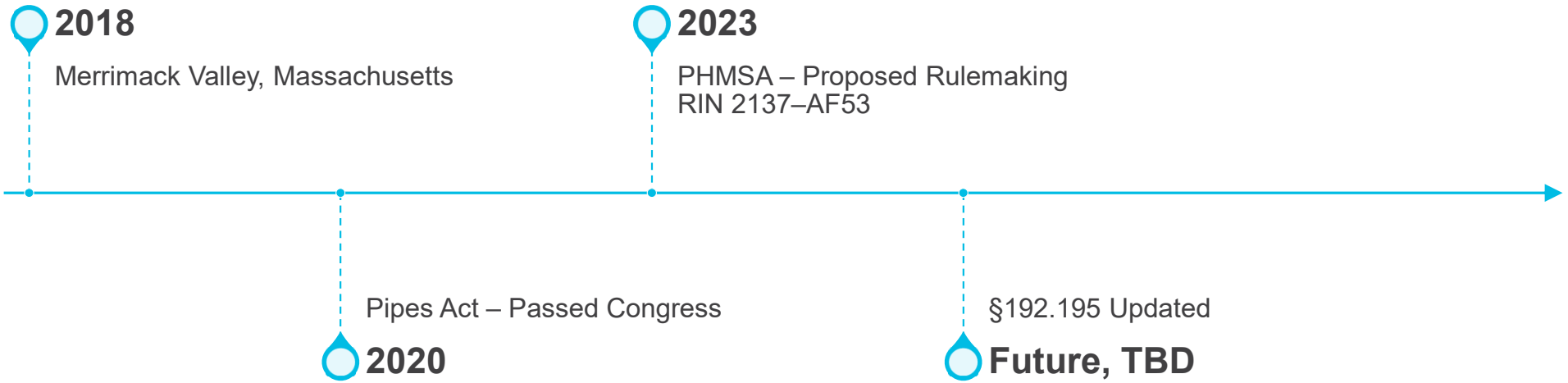


Future (USA) Regulations

Low Pressure System OPP Requirements

- Pipeline regulations currently require 1 level of OPP.
- For operators of low pressure distribution systems, that **may** change
  - Low Pressure Distribution Systems – distribute gas at pressures "substantially the same as the pressure provided to the customer"

Low Pressure System OPP Requirements



2018 Merrimack Valley, Massachusetts

- Incorrectly installed regulator sense lines caused failure in both worker and monitor pressure regulation.
- Over-pressurized the low-pressure distribution downstream.
- 40+ damaged homes, 25+ injuries, 1 death.

2020 Pipes Act – Passed Congress

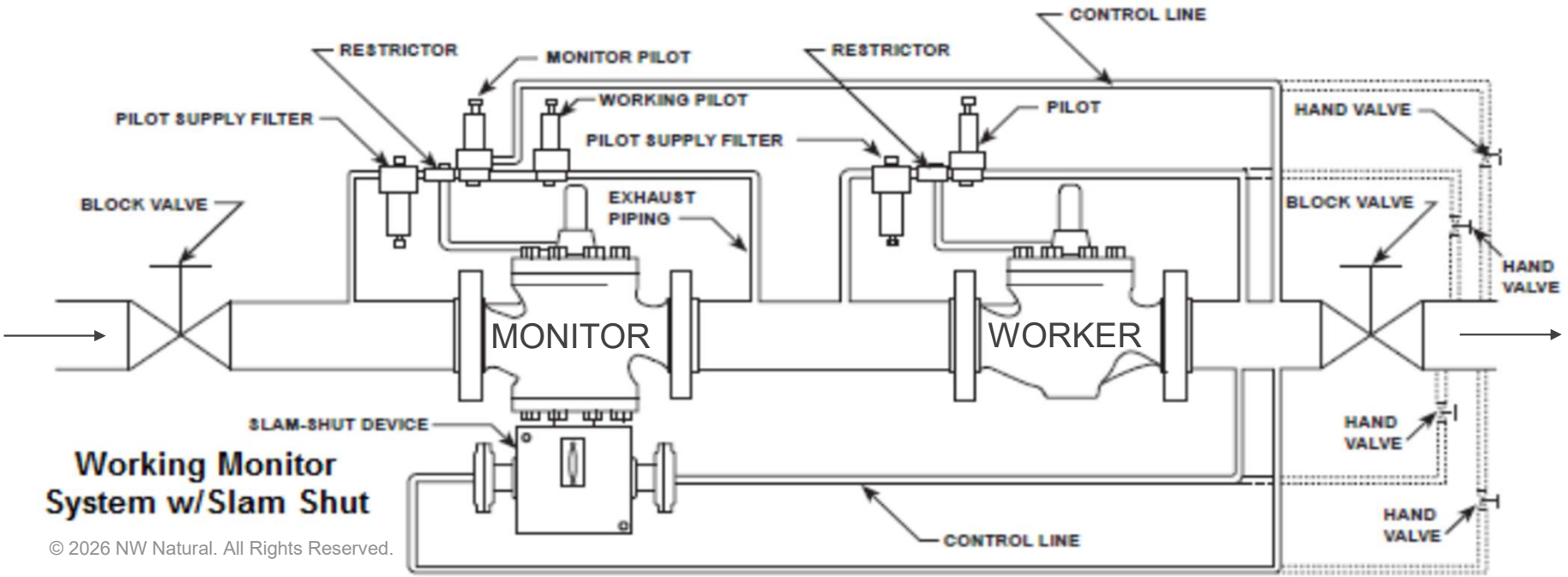
- Tasked PHMSA with developing safety directives for pipeline infrastructure (partially in result of the Merrimack Valley Incident).
  - DIVISION R -- **P**ROTECTING OUR **I**NFRASTRUCTURE OF **P**IPELINES AND **E**NHANCING **S**AFETY ACT OF 2020

2023 PHMSA – Proposed Rulemaking RIN 2137–AF53

- Proposed rulemaking would:
  - modify §192.195 and require that operators serving low-pressure distribution systems install “at least two methods of overpressure protection” (two levels of OPP).
- Currently on hold as of 11/6/23 pending Gas Pipeline Advisory Committee Meeting

Retrofit Opportunities

Add slamshut



Working Monitor System w/Slam Shut

OPP Maintenance

Maintenance Considerations

Maintenance plans are generally developed in house (by Operators)

USA Regulation – Pressure Limiting Stations:

- Per CFR 192.739 –
  - inspections at intervals **not exceeding 15 months**, at least every calendar year

Maintenance Approaches:

- Run to Failure
- Preventative Maintenance

Maintenance Criteria:

- Manufacturer Recommendations
- Industry Best Practices

Maintenance Approaches, Some Extremes

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Preventative Maintenance

- Conservative Approach
- Higher Cost
  - Replacing rubber elements (o-rings, diaphragms, orifice seats etc.) more frequently, even when operating normally.
  - Operators may decide to “rebuild” regulator components every time they come to do an inspection.

Run to Failure “Corrective Maintenance”

- Budget Conscious
- Lower O&M Costs
  - Element replacements may be delayed, or criteria less stringent. Operators must diligently monitor system performance.
- Increased risk of regulation failure and OPP methods activating.
- For back-fed or parallel redundant systems, risks of single regulator failure could be lower

Maintenance Approaches

Most operators adopt a maintenance approach that **incorporates aspects of both extremes**.

- Inspect assets per mandated timelines
- Assess valve elements for wear, debris, damage, or failure to lock-up
- Replace component(s) that are damaged per established criteria
- Inspect OPP devices at the same time as other station assets, such are regulators, control valves, etc.

What to Do in an Over-Pressure Event

Operations, Compliance, Reporting

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party
1. **Make Safe**	Gas Operations Personnel

- Isolate the source of unregulated gas pressure
- Identify OPP devices and monitor changing system pressures while OPP is activated
  - Any excess gas pressure above MAOP shall be removed
  - Return any over-pressured pipeline sections to a safe operating pressure
    - Shut-in completely, if required

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party
1. **Make Safe**	Gas Operations Personnel

2. **Get the Facts**
• Key Data Points
  • Peak Pressure Reached
  • Duration of Over-pressure
  • Extent of over-pressure
  • Time of notification
  • Time of mobilization
  • Time to isolation
	Person in Charge, Incident Command

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party
1. **Make Safe**	Gas Operations Personnel
2. **Get the Facts**	Person in Charge, Incident Command
3. **Investigate and Remediate**	Engineers, Gas Operators, Gas Controllers

- Did OPP work to protect the pipeline?
- Failure Cause?
- Remediation Steps? Re-Pressure Test (step 6)?
- Repeatable Failure Mode?

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party
1. **Make Safe**	Gas Operations Personnel
2. **Get the Facts**	Person in Charge, Incident Command
3. **Investigate and Remediate**	Engineers, Gas Operators, Gas Controllers
4. **Reporting**	Operations Supervisors, Directors, Managers

- At a minimum, be prepared to report:

Peak Pressure	Length / Extent of affected line
Percent Over MAOP	Associated damages
Duration of Over-Pressure	Recovery / Re-Certification plan

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party
1. **Make Safe**	Gas Operations Personnel
2. **Get the Facts**	Person in Charge, Incident Command
3. **Investigate and Remediate**	Engineers, Gas Operators, Gas Controllers
4. **Reporting**	Operations Supervisors, Directors, Managers
5. **Leak Survey**	Gas Operations Personnel, Leakage Survey Crews

Document:

- Survey date/time,
- Pressures in pipe during survey
- Survey Area
- Unusual or notable findings

If (when) Over-Pressure Occurs

High Level Steps	Responsible Party
1. **Make Safe**	Gas Operations Personnel
2. **Get the Facts**	Person in Charge, Incident Command
3. **Investigate and Remediate**	Engineers, Gas Operators, Gas Controllers
4. **Reporting**	Operations Supervisors, Directors, Managers
5. **Leak Survey**	Gas Operations Personnel, Leakage Survey Crews
6. **Pressure Test**	Construction, Installation, Specialists

- A pressure test may be required based on repairs completed to re-certify pipeline.

Introduction to Overpressure Protection

Thank you!

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