REGULATOR & RELIEF VALVE - FIELD CHALLENGES

WRITING & IMPLEMENTING FIELD PROCEDURES
FOR TESTING REGULATOR LOCK UP AND RELIEF SET POINTS

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Paper written in collaboration with:

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FOR TESTING REGULATOR LOCK UP AND RELIEF SET POINTS

Agenda:

- Procedures: Common means of enhancing the reliability and safety of pilot operated regs/reliefs and satisfying the requirements PHMSA 49CFR192-199 and -739
- Principles of operation: Pilot operated regulators/relief dynamics
- Methods: Testing practices included in procedure writing and implemented in the field
- Verification: Techniques applied to verify the test was successful
- Challenges: Common field difficulties in completing a test at reg stations and larger meter sets
- Adjustments: Reg/relief set point and lock up practices
- Risk reduction: ID potential risks of elements included or not included in field procedures and in station design.

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United States Department of Transportation

PHMSA Pipeline and Hazardous Materials Safety Administration

49 CFR 192

Subpart A - General (192.1 - 192.16)
Subpart B - Materials (92.51 - 192.67)
Subpart C - Pipe Design (192.101 - 192.125)
Subpart D - Design of Pipeline Components (192.141 - 192.204). **-199 Requirement for design of pressure relief & limiting devices**
Subpart E - Welding of Steel in Pipelines (192.221 - 192.245)
Subpart F - Joining of Materials Other Than by Welding (192.271 - 192.287)
Subpart G - General Construction Requirements for Transmission Lines and Mains (192.301 - 192.329)
Subpart H - Customer Meters, Service Regulators, and Service Lines (192.351 - 192.385)
Subpart I - Requirements for Corrosion Control (192.451 - 192.491)
Subpart J - Test Requirements (192.501 - 192.517)
Subpart K - Uprating (192.551 - 192.557)
Subpart L - Operations (192.601 - 192.631)
Subpart M - Maintenance (192.701 - 192.756). **-739 Pressure limiting and regulating stations-Inspection and testing**
Subpart N - Qualification of Pipeline Personnel (192.801 - 192.809)
Subpart O - Gas Transmission Pipeline Integrity Management (192.901 - 192.951)
Subpart P - Gas Distribution Pipeline Integrity Management (192.1001 - 192.1015)
Appendix A to Part 192 [Reserved]
Appendix B to Part 192 - Qualification of Pipe
Appendix C to Part 192 - Qualification of Welders for Low Stress Level Pipe
Appendix D to Part 192 - Criteria for Cathodic Protection and Determination of Measurements
Appendix E to Part 192 - Guide on Determining High Consequence Areas & on Carrying out Requirements in Integrity Mgmt Rule

§192.739 Pressure limiting and regulating stations: Inspection and testing.

(a) Each pressure limiting station, relief device (except rupture discs), and pressure regulating station and its equipment must be subjected at intervals not exceeding 15 months, but at least once each calendar year, to inspections and tests to determine that it is—

(1) In good mechanical condition;

(2) Adequate from the standpoint of capacity and reliability of operation for the service in which it is employed;

(3) Except as provided in paragraph (b) of this section, set to control or relieve at the correct pressure consistent with the pressure limits of §192.201(a); and

(4) Properly installed and protected from dirt, liquids, or other conditions that might prevent proper operation.

(b) For steel pipelines whose MAOP is determined under §192.619(c), if the MAOP is 60 psi (414 kPa) gage or more, the control or relief pressure limit is as follows:

If the MAOP produces a hoop stress that is:	Then the pressure limit is:
Greater than 72 percent of SMYS	MAOP plus 4 percent.
Unknown as a percentage of SMYS	A pressure that will prevent unsafe operation of the pipeline considering its operating and maintenance history and MAOP.

[35 FR 13257, Aug. 19, 1970, as amended by Amdt. 192-43, 47 FR 46851, Oct. 21, 1982; Amdt. 192-93, 68 FR 53901, Sept. 15, 2003; Amdt. 192-96, 69 FR 27863, May 17, 2004]

§192.199 Requirements for design of pressure relief and limiting devices.

Except for rupture discs, each pressure relief or pressure limiting device must:

(a) Be constructed of materials such that the operation of the device will not be impaired by corrosion;

(b) Have valves and valve seats that are designed not to stick in a position that will make the device inoperative;

(c) Be designed and installed so that it can be readily operated to determine if the valve is free, can be tested to determine the pressure at which it will operate, and can be tested for leakage when in the closed position;

(d) Have support made of noncombustible material;

(e) Have discharge stacks, vents, or outlet ports designed to prevent accumulation of water, ice, or snow, located where gas can be discharged into the atmosphere without undue hazard;

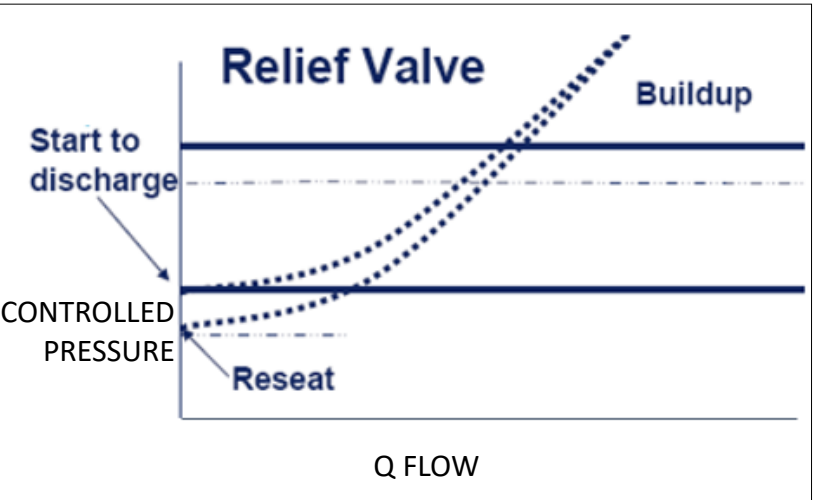
(f) Be designed and installed so that the size of the openings, pipe, and fittings located between the system to be protected and the pressure relieving device, and the size of the vent line, are adequate to prevent hammering of the valve and to prevent impairment of relief capacity;

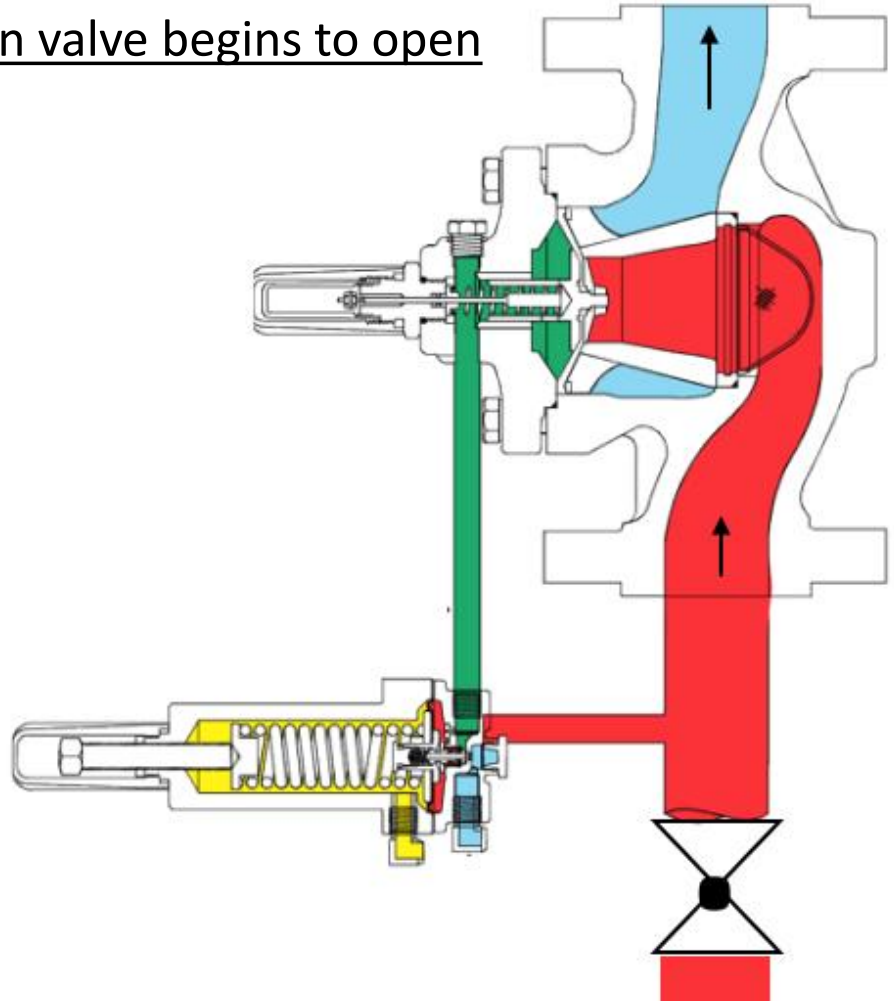
(g) Where installed at a district regulator station to protect a pipeline system from overpressuring, be designed and installed to prevent any single incident such as an explosion in a vault or damage by a vehicle from affecting the operation of both the overpressure protective device and the district regulator; and

(h) Except for a valve that will isolate the system under protection from its source of pressure, be designed to prevent unauthorized operation of any stop valve that will make the pressure relief valve or pressure limiting device inoperative.

Pilot Op Relief-Principles of Operations:

- During normal conditions the pilot and main valve is held closed by a spring. Many device designs also use loading pressure to hold the main valve closed.
- If pressure coming into relief valve exceeds the pilot spring force the pilot opens and dumps the main valve's loading pressure to atmosphere.
- This allows the main valve to open and for gas to enter the vent stack, exhaust to atmosphere & hold inlet gas to a maximum safe value.
- <u>The pilot must open before the main valve begins to open</u>

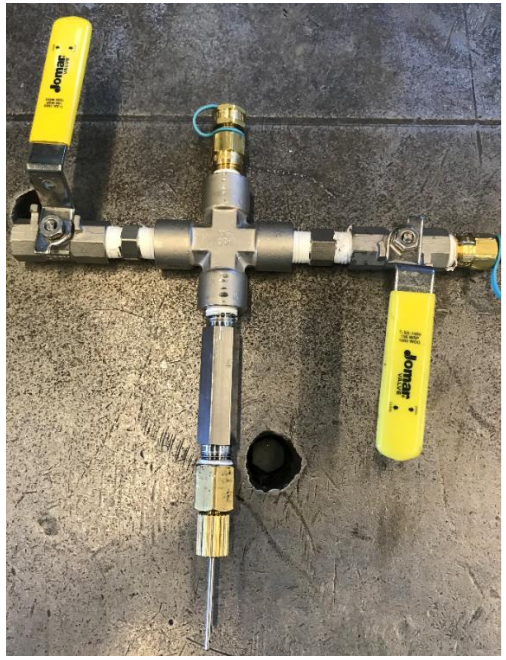


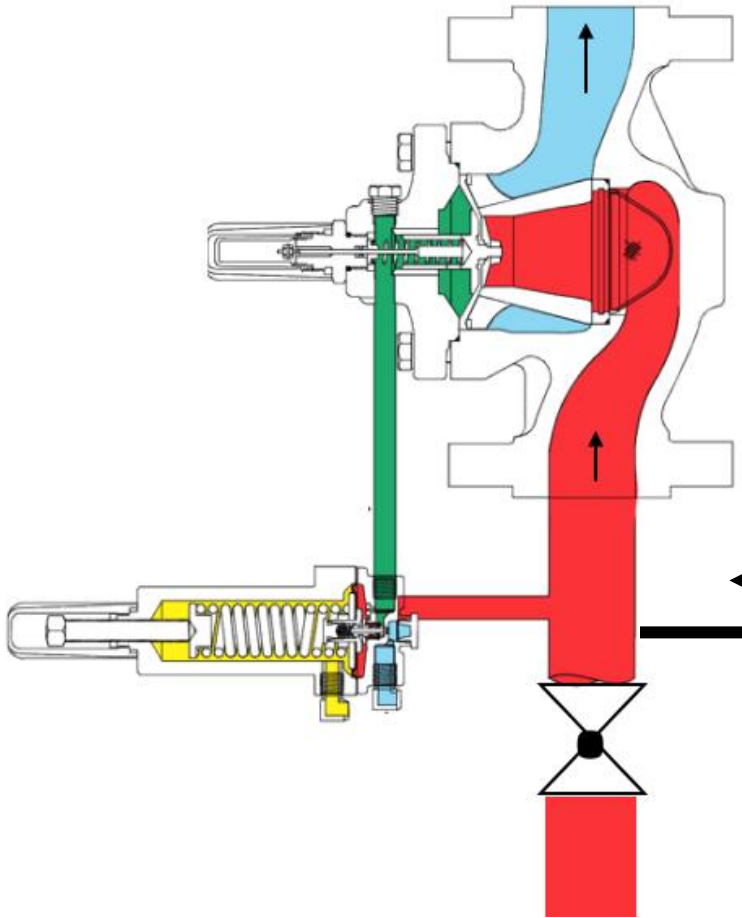


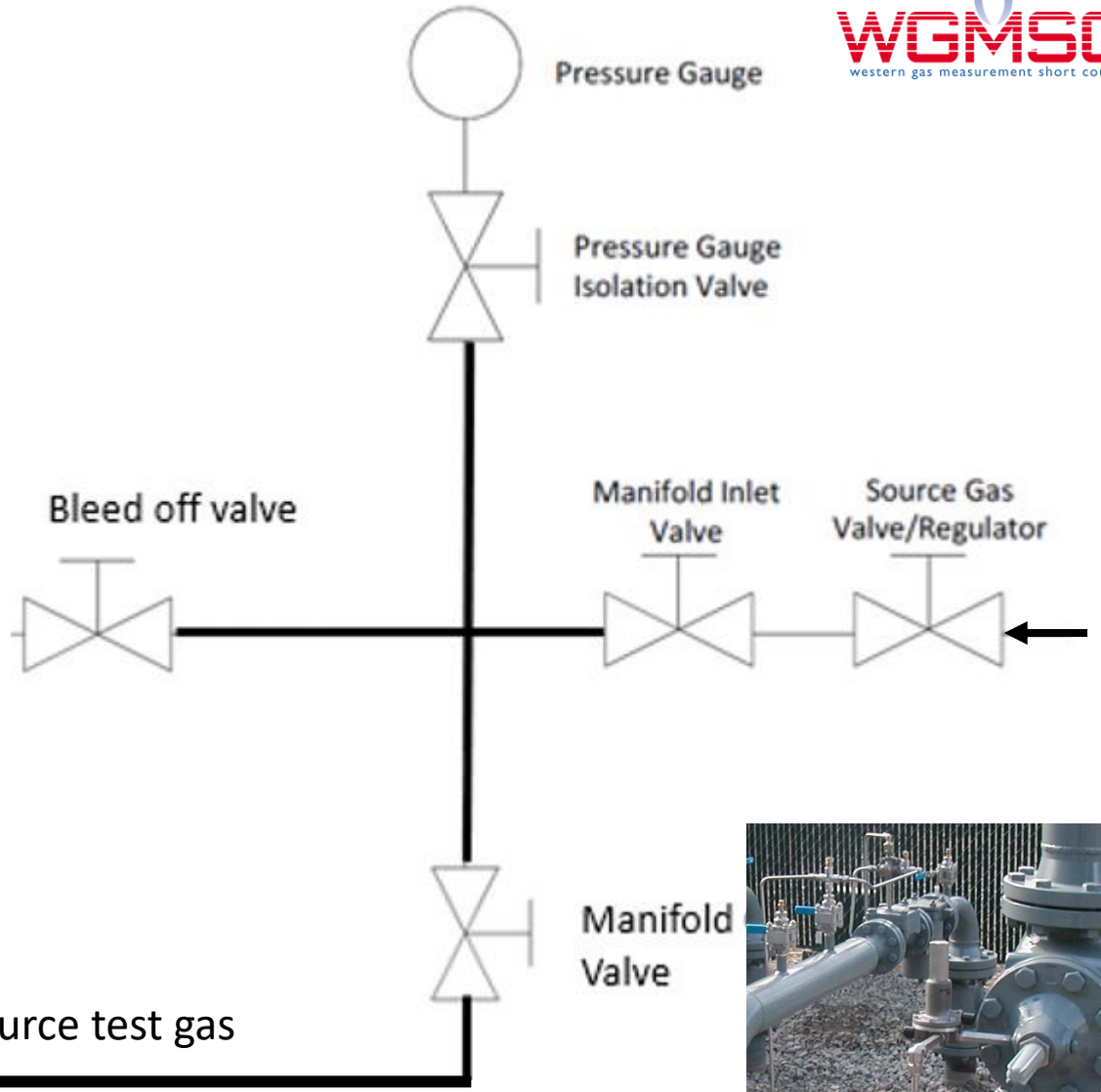
192.739 Inspection & Testing requires
-Set to relieve at correct pressure
-Relieve at correct pressure limits

192.199 Design of relief and limiting devices requires
-Test to determine the pressure at which it will operate
-Test for leakage when closed

Test Method
-Inject test gas
-Monitor pressure
-Bleed test gas



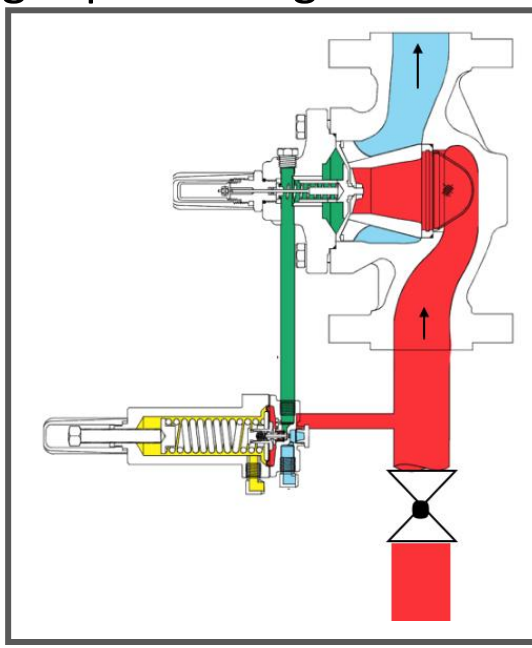




Field Challenge-Test Gas Volume: a pilot's capacity may have the ability to bleed off the test gas preventing required pressure build up to open the main valve

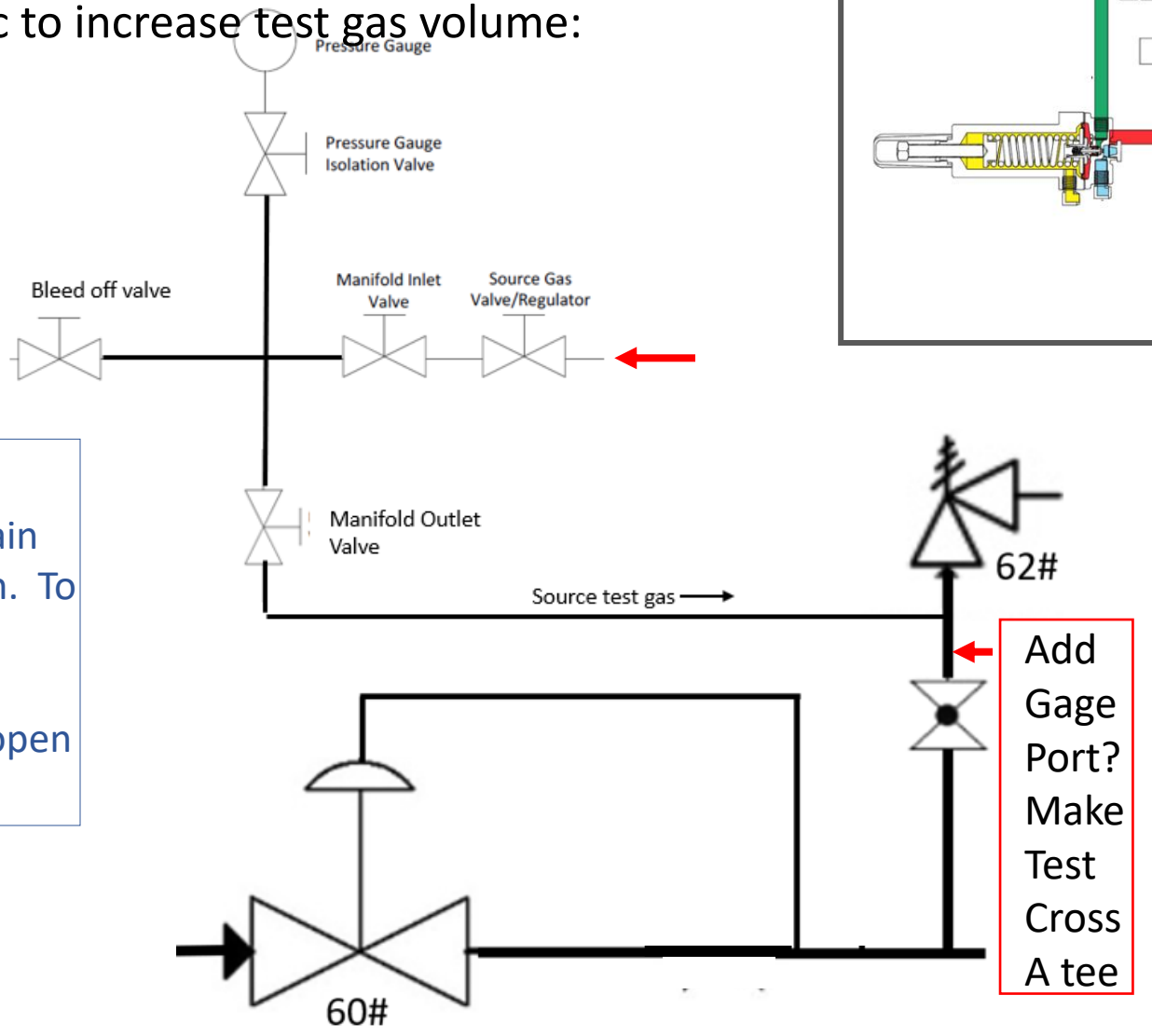
-Root cause: Restrictions in test equipment reducing the test gas pressure and volume.

Christmas tree test manifold and hose restrictions



Should field procedure include test equipment spec to increase test gas volume:

- No pete's plugs?
- Full port ball/needle valves (Swagelok #SS-6NBF40)
- Test hose diameter
- Test hose length
- Include separate test ports for test gas injection and for the gage.



Examples of required relief build up:

1) Say a pilot starts to open at its set point of 58lbs, the main valve may require pressure to build to 59.4 to start to open. To get the main valve to fully open may require 60.5

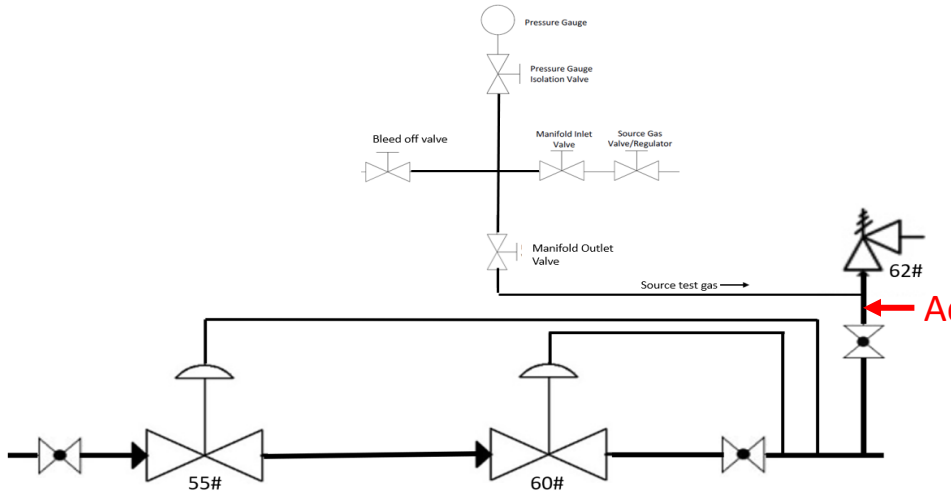
2) Say a pilot starts to open at 293lbs, the main valve may require pressure to continue to build to 299lbs to start to open

-A word on reseat: a pilot set at 293 may reseat at 291

Procedure language: Verifying the Relief Valve operates

Should the procedure writer include specific practices to verify the relief operates, if so how:

- Listen: for flow
- Feel: exhaust gas
- Observe:
  - 1. Vent stack cap
  - 2.Plastic bag on vent stack
  - 3. Travel indicator on the main valve
  - 4. Gauge located in the pipe pup between the relief valve and it's upstream isolation valve?
    - What should the gauge read during the test:
      - 1st stabilized pressure: When the observed pressure on the gauge stops climbing when injecting test gas. This pressure value is likely the start to open pressure, the set point of assembly. An indication the pilot has begun to open.
      - 2nd stabilized pressure: Once the pilot opens the tech must <u>continue to inject the test gas</u>, the pressure observed on the gauge should drop significantly, then stabilize-an indicator the main is opening



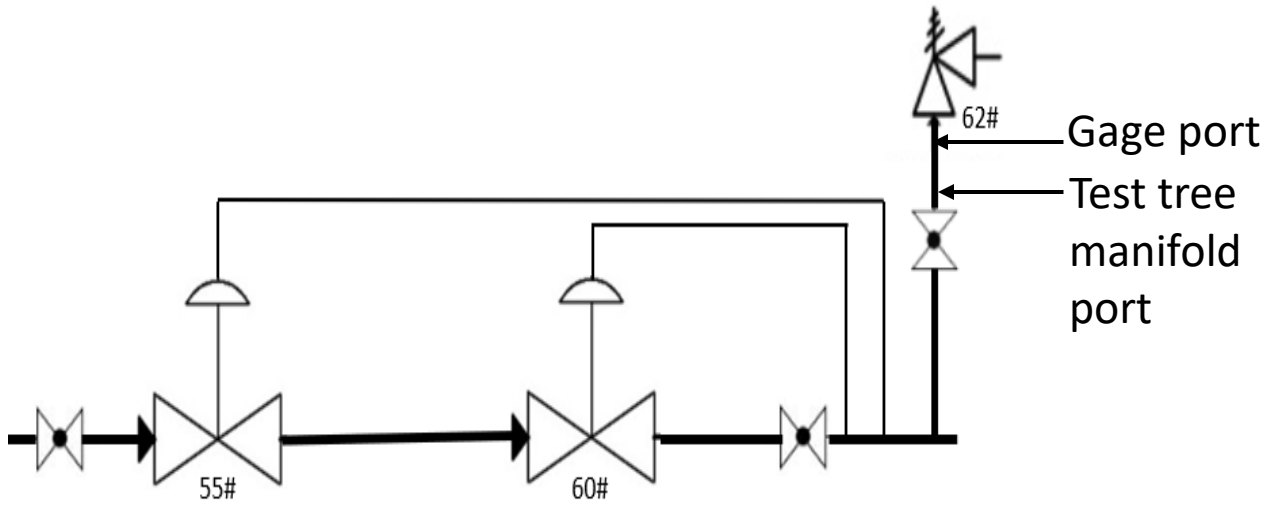
Add Gage Port?

Should the test procedure specifically state that both the pilot and main valve shall be Operated during the annual inspection

Writing relief valve procedures

Additional concepts procedure writers may want to evaluate:

- Should the set point of the relief be defined in the procedure? If so, will it be:
  - Below the MAOP pressure limit
  - At the MAOP pressure limit
  - Above the MAOP in the appropriate allowance area
- How many relief opening tests should be required? One or two or three, calc an average?
- Should procedure include using 2 taps during test. One for injection and one for monitoring and bleeding?
- Should decreasing the relief set point during the test be allowed in the procedure to get more main valve dp
- Should manipulating the station reg to deliver higher pressure to the relief be allowed in the procedure to get more main valve dp, if so how?
  - Disconnect sense line
  - Adjust set point to higher value than the relief setting



PILOT OPERATED REGS

192.739 Inspection & Testing requires

-Set to control at correct pressure

-Control at correct pressure limits

192.199 Design of relief and limiting devices requires

-Test to determine the pressure at which it will operate

-Test for leakage when closed

Reg test methods: flow and lock up tests

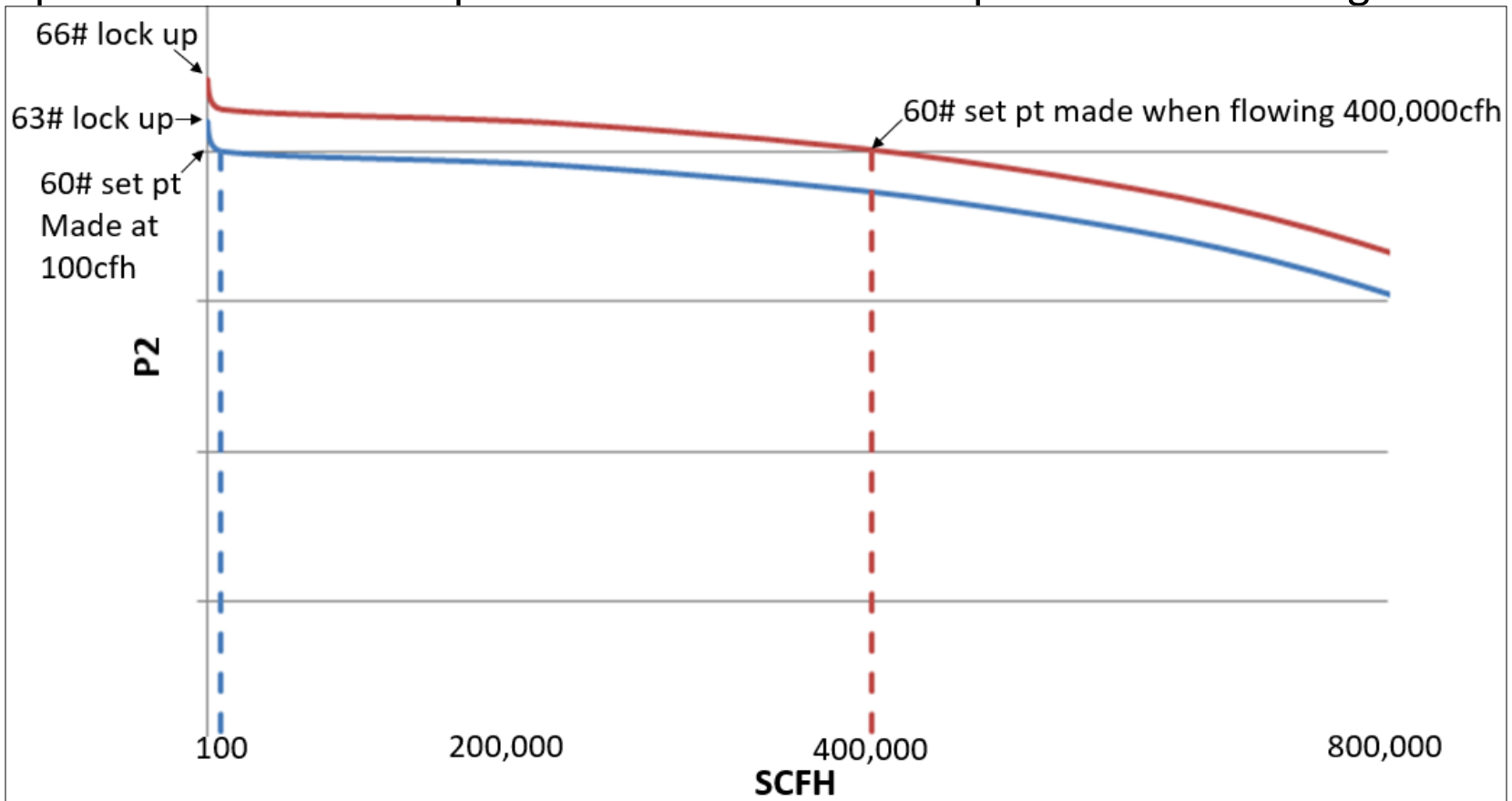
- Test to determine if reg is set to control at the correct pressure:
  - Flow test: while running (or venting through bleed valve) observe pressure value on the gauge.
- Test to determine if reg will control at MAOP pressure limit:
  - Lock up test: using higher pressure source gas close downstream block valve and observe the pressure value the gauge stops climbing.
- Test for leakage when reg assembly is closed
  - Lock up test: using higher pressure source gas close downstream block valve and observe gauge for any creep

192.739 control at correct pressure

Flow test and reg adjustments: while flowing set point is adjusted and observed, then documented in the inspection report. **Should procedure include required test flow?**

- Adjustments made at lower flow: Reduces the pressure value the reg locks up at. Any time downstream flow demand is higher than what was flowing when set point was made, downstream pressure must decrease (droop, proportional band, offset, error)
- Adjustments made at higher flow: Reduces droop at higher flows. Increases the value the reg locks up at.
- Adjustments made during 'normal' flow: there will be no outlet pressure offset when flow is 'normal'.
- Once running set point is made it's important to then do lock up test to assure reg locks up below MAOP & relief reseat

Lock up: pressure build up above set point when flow is zero



Offset/droop proportional band/error: what p2 must fall to, below set point, whenever demand is higher than what was flowing when set point was adjusted

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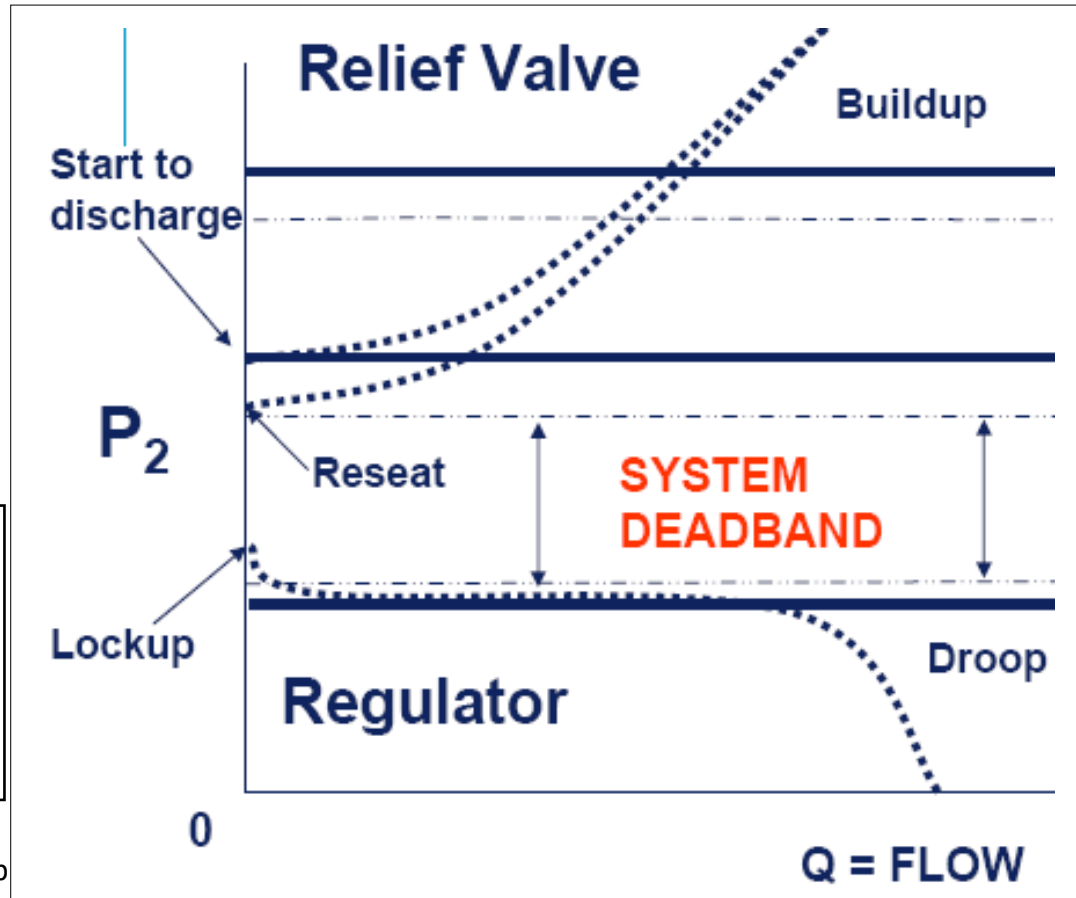
192.739 control at correct pressure limits

Lock up test and reg adjustments based on lockup value:

- This method involves locking up the reg & then adjusting it until the lock up value is at the pressure limit (MAOP).
- For some operators this is the only reg adjustment and test they perform. After the adjustment & when iso valves are opened the flowing pressure will be somewhere below the documented lock up pressure.
- At single cut stations this technique is considered to maximize station send out and delivery pressure as it eliminates the required deadband between the reg lock up pressure & the relief's start to open
- Procedure writers must evaluate where the lock value shall be:
  - Below the MAOP
  - At the MAOP
  - Above the MAOP (in appropriate allowance area)

Not adjusting set point when flowing can only be considered at reg stations. Larger meter stations require reg adjustment to be make while flowing for delivery pressure accuracy and contract reasons

MAOP: 10% allowance, 6psig, or 50% depending on the maop



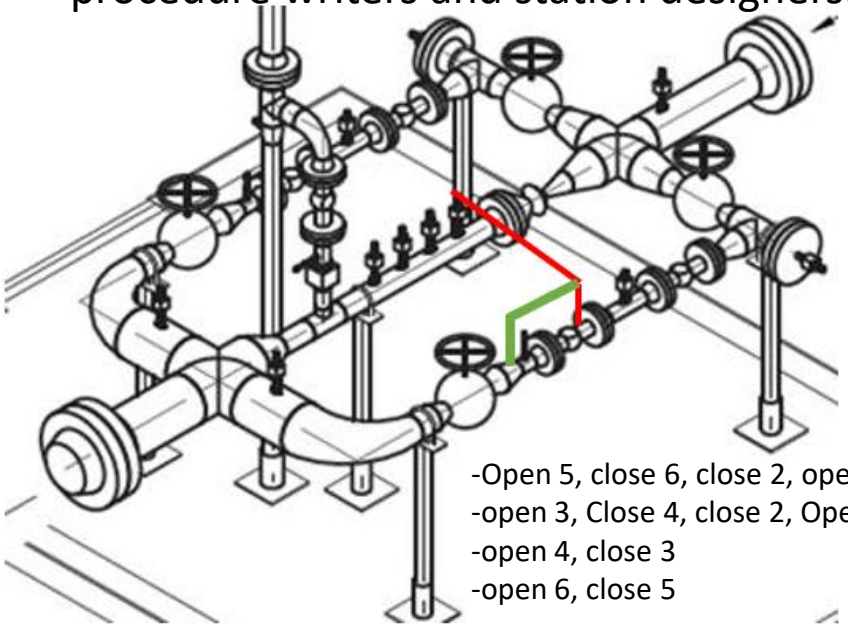
Regulator lock up procedures and sense line locations: station design (192.199)
Control at correct pressure and pressure limit (192.739)

To lock up a reg the sense line tap must be located between the regulator and a downstream iso valve.

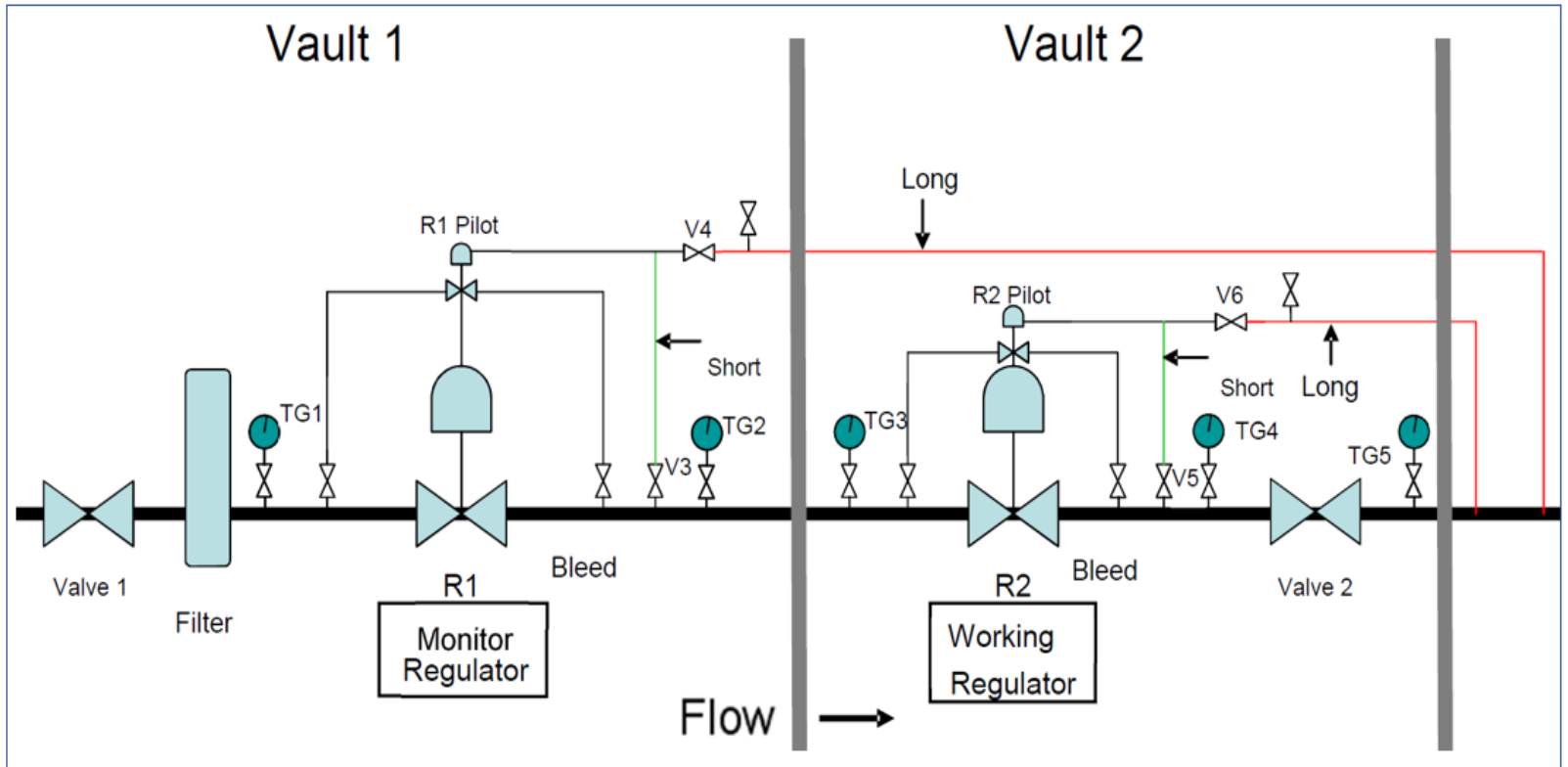
- A lock up test cannot be performed if the sense line tap is located downstream of the Operator's last station iso valve (ie. Unmaintainables)
- This can be problematic as the design considers the required straight run of pipe for the sense line tap location in their station design.

To overcome this issue more Operators are designing stations with two sense lines per regulator.

- Short sense line: Between the reg and the closest downstream iso valve, is only used during annual lock up tests
- Second long sense line: Often located in the bypass is only used during normal operation.
- Reduces station piping length
- Its important collaboration occurs between procedure writers and station designers.



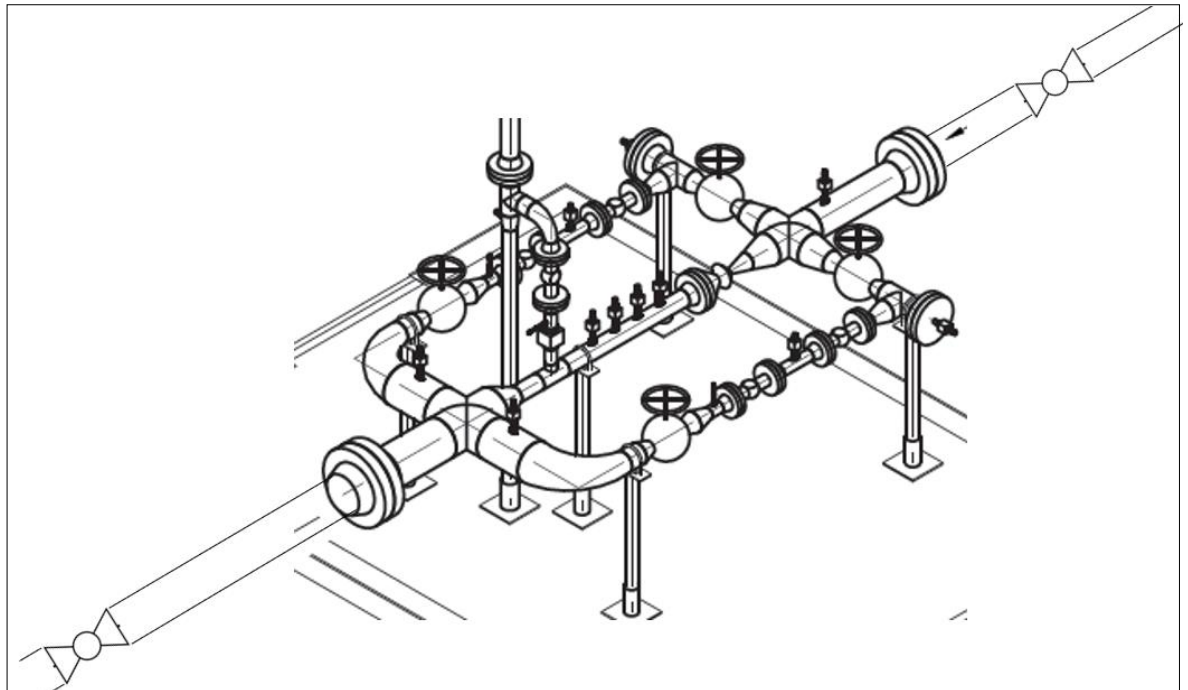
-Open 5, close 6, close 2, open 2
-open 3, Close 4, close 2, Open 2
-open 4, close 3
-open 6, close 5



Regulator lock up procedures and sense line locations: final thoughts

Additional considerations for procedure writers:

- Observing p2 during the inspection procedure: continuously monitoring p2 during any activity that could potentially cause over-pressurization.
  - Out of sight monitoring points: If the tech cannot see the p2 gauge when working on the reg run should this test become a 2 person type job
- Evaluate how many times the technician should lock up the regulator
  - Many Operator procedures include 1 lock up test.
    - If the test is successful the test is complete and results are documented. Some manufactures state replace parts are necessary, as rebuilding a reg may not be done properly
    - If the test fails procedure includes rebuilding the reg and retesting
- Communication: Between writer & field workers increases probability for the tech to properly perform annual testing.



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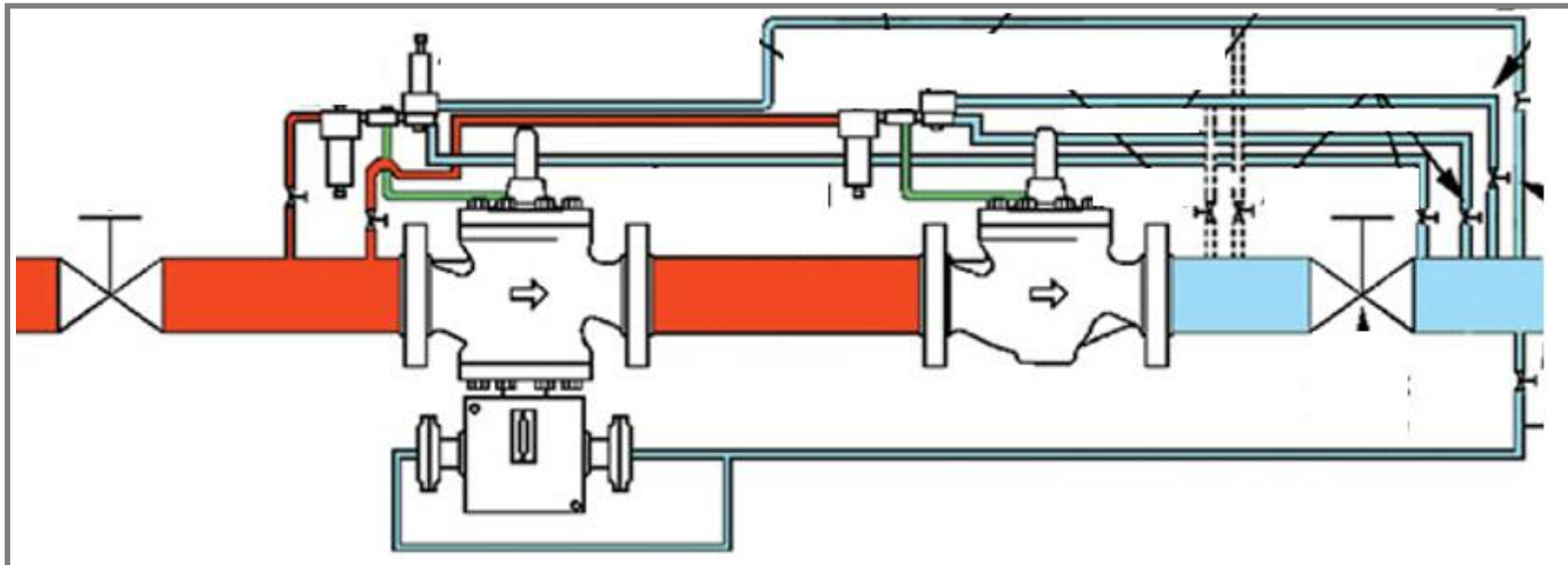
Standardized common procedures: same method all the time -- by everyone

- Common procedure template: reduce risk, increase repeatability & consistency
  - Some Operators are considering creating a procedure template
    - Any deviation from the standard will require management of change process review that has been approved by a professional who has attained a certain level of proficiency.
  - Reduce risk: Clear knowing how procedures are being implemented
  - Repeatability: Including required flow, when setting to flow, in the adjustment procedure
  - Consistency: Same methods being applied by everyone. Internal and audit document uniformity.

Procedures to Consider to Reduce the Possibility of a Natural Gas Over-Pressurization Event

- Update test procedures at all retrofitted stations where new design may now include an additional layer of overpressure protection that protects to two failures.
- Should large industrial meter sets be put on inspection/test schedule
- Should a certain professional competency level of personnel stamping Operator procedures be required?
- Increased inspection frequency: Use a tighter interval than 15 months in 49CFR192.739. With this consideration Operators may evaluate:
  -recent construction/pigging activity in the vicinity of the station-complexity of station configuration-below
  -station maximum differential pressure and maximum shutoff pressure.
  -station history, design, reg type
  -above grade site
  -dithiazine history
- Should procedures include a replacement parts schedule based on a calendar
- Should engineering, operations and gas control all review proceduress on certain field work



One event taking about both reg and OPP: 192.199.G states reg stations be designed and installed to prevent any single incident affecting the operation of both the reg and OPP

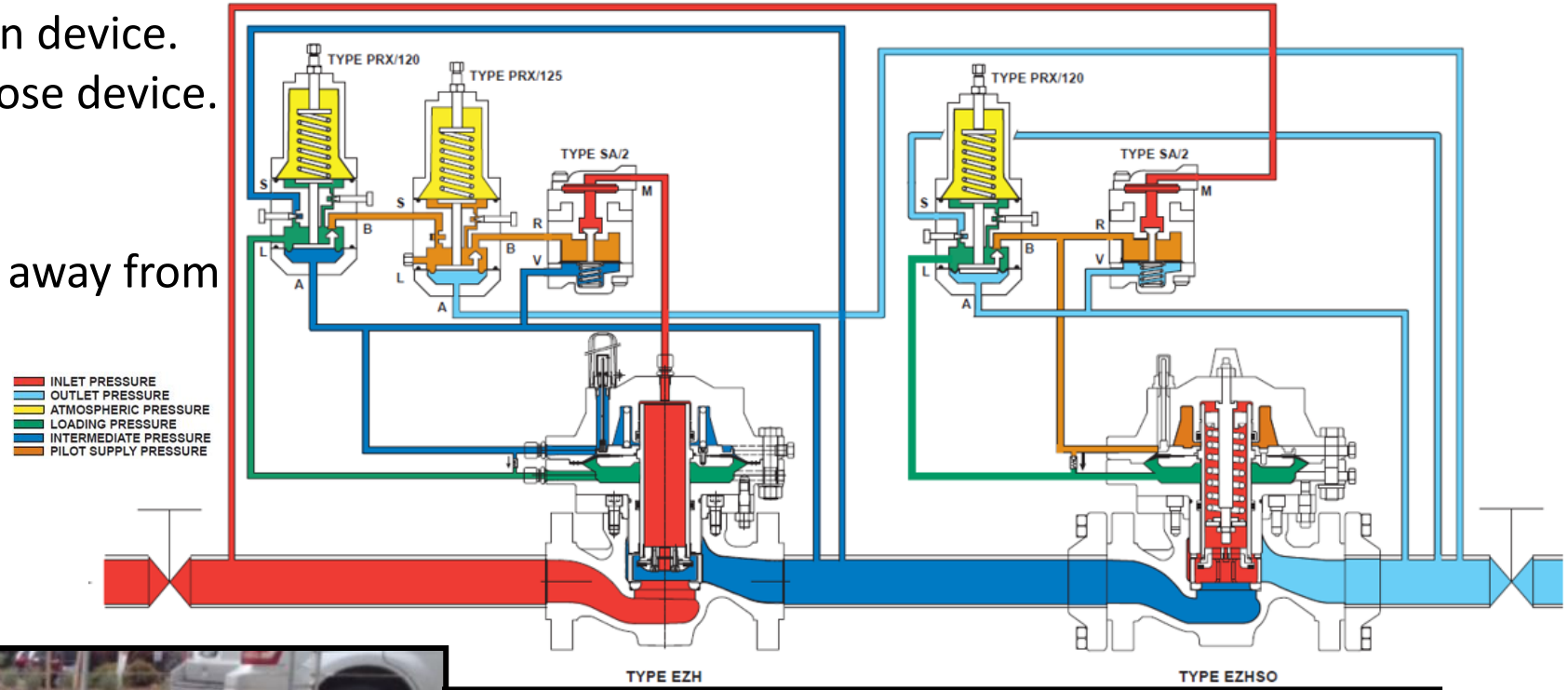
For compliance and risk reduction at DR's some Operators are considering:

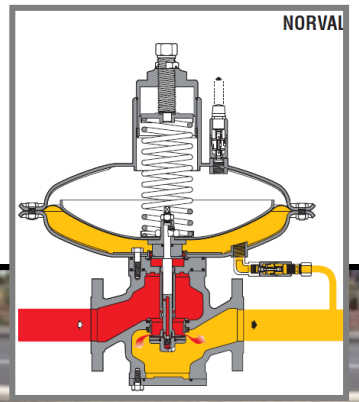
-Appling a external & internal registration device.

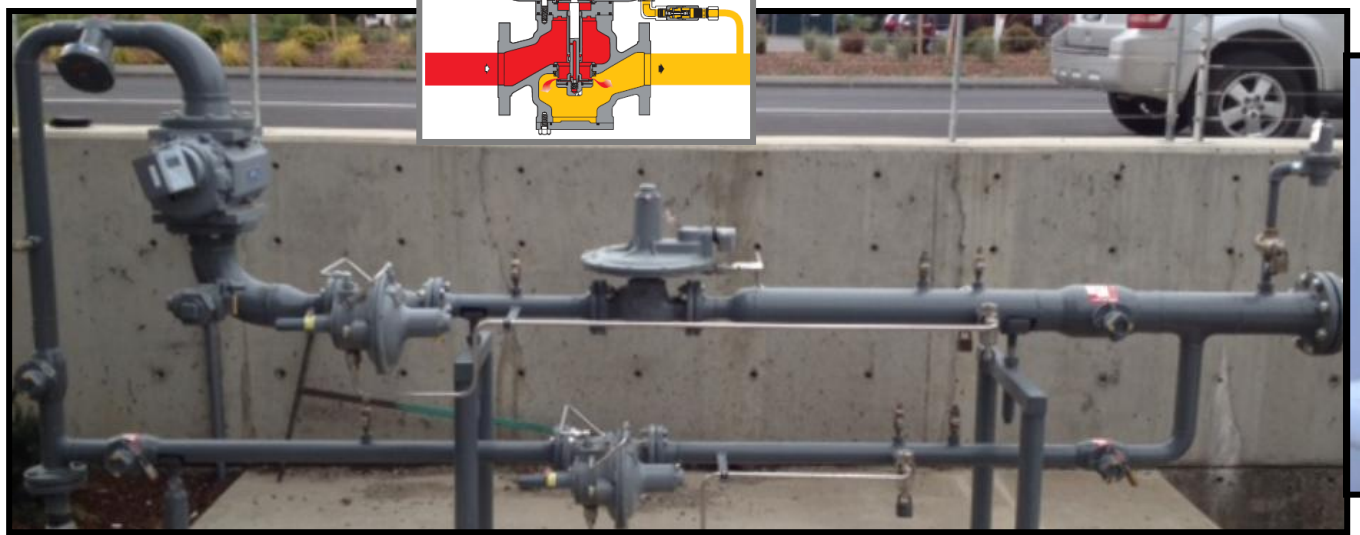
-Applying a spring to open & spring to close device.

-Applying a pressure loading & pressure unloading device

-locate sense lines on side of pipe facing away from traffic







QUESTIONS?

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Paper written in collaboration with:

- Dan MacDonald, Dominion Energy
- Matt Davidson, Pacific Gas and Electric

Reference schematics:

- Emerson, D350927X012 2015
- GEA 19187, Mooney Flowgrid Regulator Rev 08.2012
- Pietro Fiorentini, Norval and Reflux

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