Regulator Control Theory

1. All regulators should be installed and used in accordance with federal, state, and local codes and regulations.
2. Adequate overpressure protection should be installed to protect the regulator from overpressure. Adequate overpressure protection should also be installed to protect all downstream equipment in the event of regulator failure.
3. Downstream pressures significantly higher than the regulator's pressure setting may damage soft seats and other internal parts.
4. If two or more available springs have published pressure ranges that include the desired pressure setting, use the spring with the lower range for better accuracy.
5. The recommended selection for orifice diameters is the smallest orifice that will handle the flow.
6. Most regulators shown in this handbook are generally suitable for temperatures to 180°F (82°C). With high temperature fluoroelastomers (if available), the regulators can be used for temperatures to 300°F (149°C). Check the temperature capabilities to determine materials and temperature ranges available. Use stainless steel diaphragms and seats for higher temperatures, such as steam service.
7. The full advertised range of a spring can be utilized without sacrificing performance or spring life.
8. Regulator body size should not be larger than the pipe size. In many cases, the regulator body is one size smaller than the pipe size.
9. Do not oversize regulators. Pick the smallest orifice size or regulator that will work. Keep in mind when sizing a station that most restricted trims that do not reduce the main port size do not help with improved low flow control.
10. Speed of regulator response, in order:
    - Direct-operated
    - Two-path pilot-operated
    - Unloading pilot-operated
    - Control valve

    Note: Although direct-operated regulators give the fastest response, all types provide quick response.
11. When a regulator appears unable to pass the published flow rate, be sure to check the inlet pressure measured at the regulator body inlet connection. Piping up to and away from regulators can cause significant flowing pressure losses.
12. When adjusting setpoint, the regulator should be flowing at least 5% of the normal operating flow.
13. Direct-operated regulators generally have faster response to quick flow changes than pilot-operated regulators.
14. Droop is the reduction of outlet pressure experienced by pressure-reducing regulators as the flow rate increases. It is stated as a percent, in inches of water column (mbar) or in pounds per square inch (bar) and indicates the difference between the outlet pressure setting made at low flow rates and the actual outlet pressure at the published maximum flow rate. Droop is also called offset or proportional band.
15. Downstream pressure always changes to some extent when inlet pressure changes.
16. Most soft-seated regulators will maintain the pressure within reasonable limits down to zero flow. Therefore, a regulator sized for a high flow rate will usually have a turndown ratio sufficient to handle pilot-light loads during off cycles.
17. Do not undersize the monitor set. It is important to realize that the monitor regulator, even though it is wide-open, will require pressure drop for flow. Using two identical regulators in a monitor set will yield approximately 70 percent of the capacity of a single regulator.

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18. Diaphragms leak a small amount due to migration of gas through the diaphragm material. To allow escape of this gas, be sure casing vents (where provided) remain open.
19. Use control lines of equal or greater size than the control tap on the regulator. If a long control line is required, make it bigger. A rule of thumb is to use the next nominal pipe size for every 20 feet (6,1 meters) of control line. Small control lines cause a delayed response of the regulator, leading to increased chance of instability. 3/8-Inch OD tubing is the minimum recommended control line size.
20. For every 15 psid (1,0 bar, differential) pressure differential across the regulator, expect approximately a one degree drop in gas temperature due to the natural refrigeration effect. Freezing is often a problem when the ambient temperature is between 30° and 45°F (-1° and 7°C).
21. A disk with a cookie cut appearance probably means you had an overpressure situation. Thus, investigate further.
22. When using relief valves, be sure to remember that the reseat point is lower than the start-to-bubble point. To avoid seepage, keep the relief valve setpoint far enough above the regulator setpoint.
23. Vents should be pointed down to help avoid the accumulation of water condensation or other materials in the spring case.
24. Make control line connections in a straight run of pipe about 10 pipe diameters downstream of any area of turbulence, such as elbows, pipe swages, or block valves.
25. When installing a working monitor station, get as much volume between the two regulators as possible. This will give the upstream regulator more room to control intermediate pressure.
26. Cutting the supply pressure to a pilot-operated regulator reduces the regulator gain or sensitivity and, thus, may improve regulator stability. (This can only be used with two path control.)
27. Regulators with high flows and large pressure drops generate noise. Noise can wear parts which can cause failure and/or inaccurate control. Keep regulator noise below 110 dBA.
28. Do not place control lines immediately downstream of rotary or turbine meters.
29. Keep vents open. Do not use small diameter, long vent lines. Use the rule of thumb of the next nominal pipe size every 10 feet (6,1 meters) of vent line and 3 feet (0,91 meters) of vent line for every elbow in the line.
30. Fixed factor measurement (or PFM) requires the regulator to maintain outlet pressure within ±1% of absolute pressure. For example: Setpoint of 2 psig + 14.7 psia = 16.7 psia x 0.01 = ±0.167 psi. (Setpoint of 0,14 bar + 1,01 bar = 1,15 bar x 0,01 = ±0,0115 bar.)
31. Regulating C_g (coefficient of flow) can only be used for calculating flow capacities on pilot-operated regulators. Use capacity tables or flow charts for determining a direct-operated regulator's capacity.
32. Do not make the setpoints of the regulator/monitor too close together. The monitor can try to take over if the setpoints are too close, causing instability and reduction of capacity. Set them at least one proportional band apart.
33. Consider a butt-weld end regulator where available to lower costs and minimize flange leakages.
34. Do not use needle valves in control lines; use full-open valves. Needle valves can cause instability.
35. Burying regulators is not recommended. However, if you must, the vent should be protected from ground moisture and plugging.