Capacity Control

The pressure and flow conditions for which the compressor is designed and/or operated can vary across a wide range. The three primary reasons for changing the capacity of a compressor are process flow requirements, suction or discharge pressure management, or load management due to changing pressure conditions and driver power limitations. Several methods can be used to reduce the effective capacity of a compressor. The “best practice” order of the unloading method is included in the table below.

Preferred Order of Unloading Method	
Required Action	**Method Of Unloading**
Reduce Flow	1 Reduce Speed 2 Add Clearance 3 Single Acting Cylinders 4 Bypass to Suction 5 Throttle Suction Pressure
Reduce Torque	1 Add Clearance 2 Single Acting Cylinders (speed dependent) 3 Throttle Suction Pressure
Maintain Suction or Discharge Pressure	1 Reduce Speed 2 Add Clearance 3 Bypass to Suction 4 Single Acting Cylinders 5 Throttle Suction Pressure

1. The use of driver speed for control can be one of the most effective methods for capacity reduction and suction and/or discharge pressure management. The available power of the driver will decrease as the speed is decreased. The compressor power efficiency increases as the speed decreases due to lower gas velocities creating lower valve and cylinder losses.
2. The addition of clearance will reduce capacity and required power through a decrease in the volumetric efficiency of the cylinder. Methods of adding clearance are the following:
   - High Clearance Valve Assembly
   - Variable Volume Clearance Pockets
   - Pneumatic Fixed Volume Clearance Pockets
   - Double Deck Valve Volume Pockets
3. Single acting cylinder operation will reduce capacity through cylinder end deactivation. Cylinder head end deactivation can be accomplished by removing the head end suction valves, installing head end Suction Valve Unloaders, or installing a head end bypass unloader. Refer to Single Acting Cylinder configuration for further information.
4. Bypass to suction is the recycling (bypassing) of gas from the discharge back to suction. This reduces the downstream capacity. Bypassing gas from discharge back to suction does not reduce the power consumption (unless fully bypasses for zero flow downstream).

5. Suction throttling (artificially lowering the suction pressure) reduces the capacity by lowering the actual flow into the first stage cylinder. Suction throttling can reduce power consumption, but may have an impact on the discharge temperatures and rod loads generated by the higher compression ratio.

Capacity control methods can have an impact on various performance characteristics besides flow and power. Partial load conditions should be reviewed for acceptable performance including valve lift selection and dynamics, volumetric efficiency, discharge temperatures, rod reversal, gas rod loads, torsional and acoustical response.

Automated capacity control sequences must be communicated so that the same set of loading steps is considered in the acoustical analysis, torsional analysis and control panel logic.

Compressor valves are selected to have optimum dynamic motion at one operating condition, and have some flexibility for off conditions. A general rule of thumb for speed impacts on valve dynamics is that a single valve selection can be operated with a 2:1 maximum speed range. This may be limited with a minimum speed. Operation below half frame rated speed may see reduced valve life. Varying suction pressures, discharge pressures and gas analyses can further limit this speed range. Low lift valves may be necessary for speed ranges outside a 25% variation. When applying variations in speed and single acting cylinder configurations the torsional and acoustical response analysis will be much simplified by applying single acting configuration only at one given speed.