

Area or Characteristic	Concern
Pipe Intermediate High Points	<p>Pipe pressure decreases with an increase in elevation; therefore, pipe high points are especially susceptible to vacuum formation. Areas where the pipe elevation exceeds the hydraulic grade line during the transient will experience vacuum pressures. Vaporization could cause a water column separation leading to a series of pressure surges as the cavity forms and collapses.</p> <p>Note that partial vacuums associated with the siphon effect can be beneficial. The siphon reduces the pumping power required during normal operating conditions and should not be broken.</p>
Flow Resistant Components	<p>Pipe flow friction causes a loss in pressure. Therefore, piping far from the pumps and areas immediately downstream of a large flow resistance, (such as a heat exchanger) are susceptible to vacuum formation because the steady state pressure is lower.</p>
Vertical Turbine Pumps	<p>Vertical turbine pumps will create vacuum pressures after shutdown. A vacuum forms as the water tries to drain out of the pump column.</p>
Pump Discharge to Buried Pipe	<p>Above ground pumps which discharge to buried piping may experience vacuum pressure near the pump discharge after shutdown. The above ground pipe will have a low static head due to its relatively high elevation and is, therefore, prone to vacuum formation.</p>
Valve Outlet	<p>Valves which close quickly (e.g., check valves) will create a low pressure (down-surge) zone at the valve outlet. Negative pressure pulses will add to the down surge and lower the pressure more.</p>
Level to Down Hill Pumping Layout	<p>If the normal operating static head (i.e., elevation difference between the source water level and discharge water level) is relatively level, transient pressure pulses can more easily drop pressures to the full vacuum level. The greater the down-slope the greater chance of vacuum will try to form after pump shutdown.</p>
Large Diameter Thin Wall Piping	<p>Piping is generally tolerant of positive internal pressures, but will easily collapse under a vacuum. If a vacuum cannot be eliminated, the pipe must be strengthened by reinforcing or the pipe wall thickness must be increased to prevent pipe buckling under transient conditions.</p>
Buried Piping	<p>Buried piping is under an external load which could cause the pipe to collapse if a vacuum occurs. An empty or partially filled pipe is more at risk.</p>
Pipe Draining	<p>Rapid or uncontrolled pipe draining may create a vacuum if the pipe is not properly vented. Arrangements which intermediate high spots can experience partial drain-out one or both sides after a pump trip. Vacuums can form in areas not adequately vented.</p>