Flame extinction continues to hinder the performance of combustion technologies used in propulsion systems and power generating turbomachinery. Within these technologies, there is a crucial need to improve energy output while minimizing harmful emissions. Lean combustion helps attain these goals by minimizing fuel costs and reducing NOx emissions. However, lean combustion increases the likelihood of flame extinction; the flame becomes more susceptible to hydrodynamic instabilities which can induce global blow-out. The work in this thesis is focused on identifying the mechanisms of flame extinction and controlling these mechanisms via pressure gradient tailoring. This is accomplished with a premixed blow-down combustion facility utilizing a bluff body flame stabilizer. Flame extinction is induced by removing the flow of fuel into the reactant mixture. CH* chemiluminescence imaging and high-speed particle imaging velocimetry (PIV) are used to determine the flame boundary and resolve the reacting flow field, respectively. Additionally, C2*CH* concentration measurements are made to determine local equivalence ratios within the reacting domain. The mechanisms of flame extinction are attributed to the changing vorticity dynamics within the flow field as the equivalence ratio is reduced; it is the interaction between the flame boundary and the local vorticity that drives blow-out. Additionally, the various pressure gradients alter the mechanisms of flame generated vorticity, thereby allowing for the attenuation and amplification of flame blow-out.