The effect of two passive boundary layer flow control techniques, Large-Eddy Break-Up (LEBU) devices and wall heating/cooling, on turbulent boundary layer induced aero-optical aberrations is experimentally investigated. A series of experiments is performed investigating the effect of LEBUs on levels of optical aberrations in the turbulent boundary layer. The results of these experiments are analyzed to determine the physical mechanisms responsible for the experimentally observed changes, and to characterize the sensitivity of optical distortions to different LEBU device configurations. The effect of moderate levels of boundary layer wall cooling, both for full and partial wall cooling, on aero-optic aberrations is also experimentally investigated, and the results are compared to a statistical model derived using the temperature-velocity relation from the Extended Strong Reynolds Analogy and a simple model for the development of thermal sub-layers in partially cooled boundary layers. A method is proposed to use wall heating to passively amplify aero-optic aberrations to measure wavefront distortions in boundary layers with normally weak aero-optical effects. The method is used to study turbulent boundary layers with low Reynolds numbers. This work concludes with a brief summary of important findings, and a discussion of the implementation of these flow control techniques for real laser transmitting systems.