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Flow Instability and Flow Control Scaling Laws DANIEL VAN NESS, THOMAS CORKE, SCOTT MORRIS, University of Notre Dame — A flow instability that is receptive to perturbations is present in the tip clearance leakage flow over the tip of a turbine blade. This instability was investigated through the introduction of active flow control in the viscous flow field. Control was implemented in the form of a dielectric barrier discharge created by a weakly-ionized plasma actuation arrangement. The experimental setup consisted of a low-speed linear turbine cascade made up of an array of nine Pratt & Whitney "PakB" turbine blades. This idealized cascade configuration was used to examine the tip clearance leakage flow that exists within the low pressure turbine stage of a gas-turbine engine. The center blade of the cascade array had a variable tip clearance up to five percent chord. Reynolds numbers based on axial blade chord varied from 10^4 to 10^5. Multi-port pressure probe measurements, as well as Stereo Particle Image Velocimetry were used to document the dependence of the instability on the frequency and amplitude of flow control perturbations. Scaling laws based on the variation of blade tip clearance height and inflow conditions were investigated. These results permitted an improved understanding of the mechanism of flow instability.

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