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The bifurcation and stability of vortex flow states at near-crtical swirl ratios LEI XU, ZVI RUSAK, RPI, SHIXIAO WANG, Auckland University — A theoretical and computational study of the bifurcation and stability of vortex flow states at near-critical swirl levels is presented. The theoretical analysis is based on a nonlinear model problem of the dynamics of small perturbations on a columnar flow. The model is first used to study the bifurcation of additional branches of equilibrium states and the stability of these states. The response of the columnar flow to various initial conditions is also studied. A frequency response analysis to inlet perturbations at various amplitudes and initial conditions is conducted and demonstrates the ability to control the growth of the perturbations when certain oscillations are imposed. However, this approach is limited to relatively small-amplitude initial perturbations. A bang-bang control approach where swirl is changed as a function of outlet centerline axial speed shows the ability to induce limit-cycle oscillations on the flow and control the growth of perturbations at a wider range of swirl levels and initial conditions.

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