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Vortex Ring State and Asymmetric Thrust Oscillations¹ GREGORY MCCAULEY, OMER SAVAS, University of California Berkeley, FRANCIS CARADONNA, NASA Ames Research Center — When the helical vortices of a rotor are not convected away, the vortices may form a ring-like structure about the rotor disk. This vortex ring state (VRS) is most common during rapid descent and leads to thrust oscillations coupled to the formation and subsequent breakdown of the ring. Experimental observations at and near VRS were made using strobed particle image velocimetry on a three-blade rotor in a towing tank. Simultaneous strain gage readings allowed direct measurement of the rotor's thrust history in this state. Operating conditions near the cusp of VRS were investigated to offer insight into the initial evolution of this undesirable state. In addition, asymmetries in the periodic thrust histories during non-axial descent are analyzed in conjunction with corresponding vorticity evolutions. Salient features of the vortex wake structure during highly asymmetric thrust oscillations are discussed in contrast to VRS cases with nearly symmetric thrust oscillations.

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