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End-effects-regime in full scale and lab scale rocket nozzles RAYMUNDO ROJO, CHARLES TINNEY, University of Texas at Austin, Aerospace Engineering & Engineering Mechanics, WOUTIJN BAARS, University of Melbourne, JOSEPH RUF, NASA Marshall Space Flight Center — Modern rockets utilize a thrust-optimized parabolic-contour design for their nozzles for its high performance and reliability. However, the evolving internal flow structures within these high area ratio rocket nozzles during start up generate a powerful amount of vibro-acoustic loads that act on the launch vehicle. Modern rockets must be designed to accommodate for these heavy loads or else risk a catastrophic failure. This study quantifies a particular moment referred to as the "end-effects regime," or the largest source of vibro-acoustic loading during start-up [Nave & Coffey, AIAA Paper 1973-1284]. Measurements from full scale ignitions are compared with aerodynamically scaled representations in a fully anechoic chamber. Laboratory scale data is then matched with both static and dynamic wall pressure measurements to capture the associating shock structures within the nozzle. The event generated during the "end-effects regime" was successfully reproduced in the both the lab-scale models, and was characterized in terms of its mean, variance and skewness, as well as the spectral properties of the signal obtained by way of time-frequency analyses.

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