Effect of Local Impedance Variation and Non-Linearity on Multiple Tone Attenuation

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Abstract  An iterative model based on an FEM propagation code is introduced for prediction of acoustic attenuation in a duct in the presence of a two degree of freedom acoustic lining for which impedance depends on local grazing flow speed and overall local sound pressure level. A general approach is described with emphasis on the case of a source spectrum dominated by several tones characteristic of multiple pure tones. Each tone is specified by its frequency, circumferential mode, and a statistically represented radial mode amplitude distribution. The result is a method for prediction of the suppression of a multiple tone spectrum including the effect of lining non-linearity related to local sound pressure level. The iterative model is implemented in the context of the assessment of performance of a two degree of freedom acoustic lining for a typical turbo-fan engine.

Walter Eversman is Curators’ Professor of Mechanical and Aerospace Engineering at Missouri University of Science and Technology. He received the PhD in Aeronautics and Astronautics from Stanford University in 1964. His industrial experience includes orbital and flight mechanics with Lockheed Missiles and Space Company and aircraft noise and structural dynamics and flutter with Boeing-Wichita and Boeing-Seattle.

Dr. Eversman has achieved international recognition for theoretical and numerical contributions in aeroacoustics. This has included pioneering work in the application of finite element methods in acoustics, principally for propagation and radiation in high speed ducted inlet and exhaust flows. Specific contributions included the introduction of wave envelope and mapped infinite wave envelop elements for the radiation boundary condition, a variational formulation for the shear layer in exhaust flows, and a consistent FEM formulation of the Myers boundary condition. Resulting codes have been widely used in government and industry, including a NASA/Pratt and Whitney source modeling code. Published results and the continuously evolving “Eversman Code” are now considered standards against which other work is benchmarked.

Dr. Eversman’s often cited theoretical contributions have included development of an asymptotic approximation for thin boundary layers for modeling acoustic propagation in ducts that became a significant component of NASA acoustic lining design methodology and fundamental studies of acoustic power and acoustic reciprocity in ducts.

Dr. Eversman has recently adapted his computational codes to reveal that realized acoustic attenuation in ducts for a given acoustic lining is dependent on the source model. This has resulted in the development of a statistical approach to the design of acoustic linings and assessment of lining performance.

Dr. Eversman was the recipient of the 2008 AIAA Aeroacoustics Award.

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(Refreshments Served at 3:15 p.m.)