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ON ACTIVE NOISE REDUCTION IN AN AIRCRAFT CABINS AND ENGINE NOZZLES

Luís Manuel Braga da Costa Campos[1], F.J.P. Lau[2], J. Oliveira[3]
Secção de Mecânica Aeroespacial, IRR, Instituto Superior Técnico, 1096 Lisboa Codex, Portugal
E-mail: [1]luis.campos@ist.utl.pt

Abstract. An analytical approach to active noise reduction is presented in the case of a line-source in a cylindrical enclosure, minimizing the noise in a sector, corresponding to the 'passenger head area' of an aircraft cabin. The noise is assumed to consist of any superposition of modes and the anti-noise sources is used to cancel the fundamental. The total acoustic energy, in the region of interest, is calculated for the residual and original sound field, and their ratio specifies the noise reduction function. The latter is minimized by adjusting the source position, and the noise reduction achieved is plotted versus frequency, ω made dimensionless $\Omega \equiv \omega R/C$, using the cylinder radius R and sound speed c. The case of original noise field consisting of the fundamental and anti-noise source set to cancel this demonstrating a noise reduction of -9.1 dB. Cases with several anti-noise line-sources set to cancel various combinations of fundamental and harmonics, are illustrated in presentation. If N anti-noise sources are used to cancel the fundamental and first N-1 harmonics, the noise reduction achieved at low frequencies for cylindrical and planar enclosures. At high-frequencies, the addition of anti-noise sources causes an increase in noise, which may be countered by passive means. All results obtained follow from the calculation of the noise reduction function in terms of Bessel functions, which can be evaluated, together with their zeros, using asymptotic methods, which are shown to be reasonably accurate. The analytical results in the present paper are broadly consistent with numerical simulations and experimental measurements of active noise control.

Keywords: aircraft cabin, analytical approach, active noise reduction.