Assessment of noise exposure in commercial aircraft cockpits (interim report, December 1998).

Investigators

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Objectives of the study

The objective of the study is to optimize auditory display design technology by characterizing the commercial aircraft acoustic environment and the hearing capacity of pilots through quantifiable measurements. This involves data collection of acoustic spectral data from commercial aircraft flight decks and audiogram data from pilots, and data analysis for a possible correlation between hearing loss and noise exposure.

Progress and results

Questionnaire data from 64 pilots were analyzed (see Begault, et al. 1998). Within specific age groups, the proportions responding positively for hearing loss and tinnitus exceed the corresponding proportions in the general population reported by the National Center for Health Statistics (NCHS): see Figure 1.

Audiogram data was analyzed from 26 pilots for high frequency loss, and the data were adjusted for presbycusis (loss of hearing ability due to aging) per California Occupational Safety and Health Administration (CAL-OSHA) guidelines. Data indicates around 12 dB loss in excess of presbycusis at 4-8 kHz, with high inter-subject variability- see Figure 2.

Acoustic measurements to date have been performed from the flight deck jumpseat position on aircraft operated by a major U.S. cargo carrier. Acoustic levels (one-third octave band spectral data) were measured for two different flight decks (Airbus 310 and the relatively older Boeing 727). Preliminary results indicate an overall level difference of 9 decibels (A-weighted L_{eq}), the 727 being the loudest at around 84 dB during cruise phase of flight. Additional data collection (spectral data and noise dose data) is planned during FY99, along with additional audiogram data.

Significance of the results

The results contribute substantially to forming engineering guidelines for adapting advanced acoustic avionics displays using 3-D sound technology to personalized hearing sensitivity curves. The data also supports accurate acoustic simulations in flight simulator experiments. Finally, the levels measured in the Boeing 727 were high enough to suggest implementation of measures to improve intra-cockpit communications and mitigate auditory fatigue.

Publications

Begault, D. R., Wenzel, E. M., Tran, L. L., & Anderson, M. R. (1998). Survey of Commercial Airline Pilot's Hearing Loss. *Perceptual and Motor Skills*, 86, 258.

Begault, D. R. (1998). Virtual acoustics, aeronautics and communications. *Journal of the Audio Engineering Society*, 46(6), 520-530.

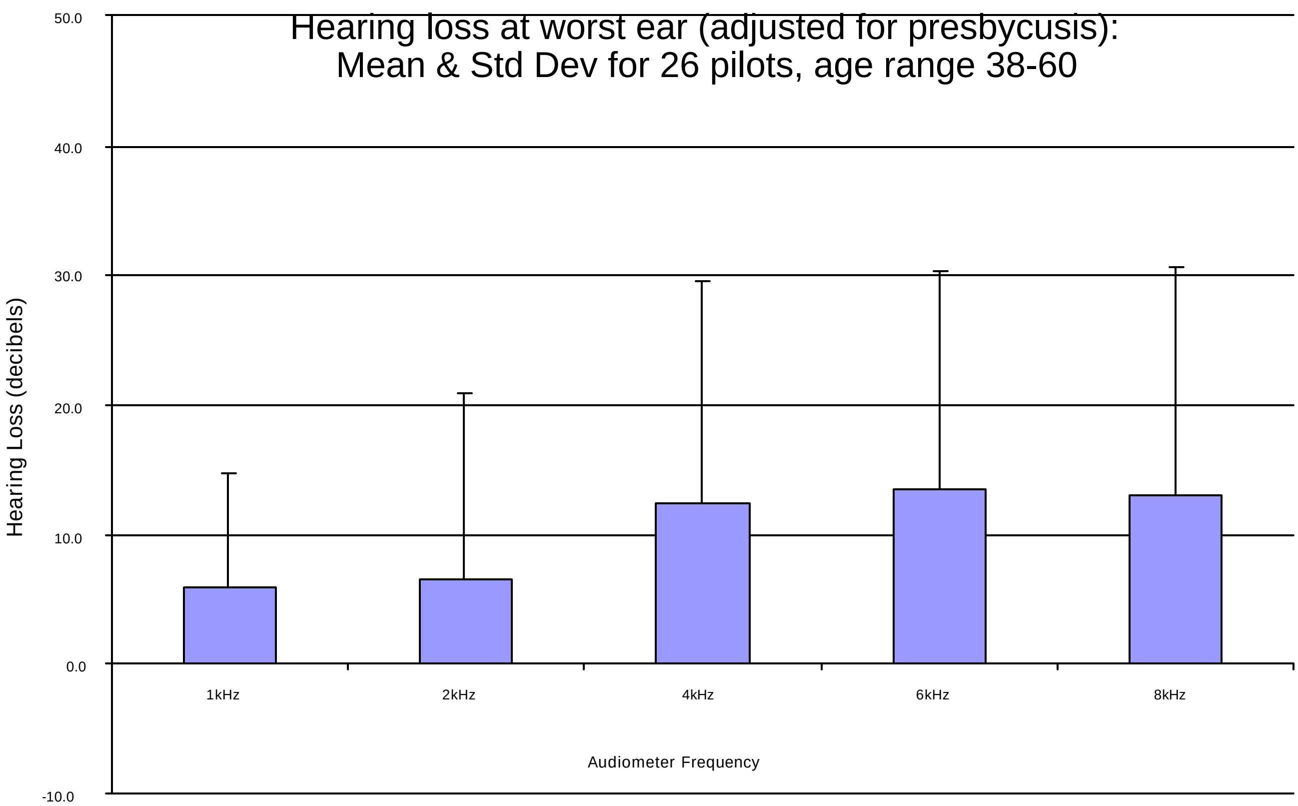
FIGURE 1. Questionnaire data results

Age group, number of respondents	Hearing loss identified by a doctor:	Personally suspect they have an occupationally-related hearing loss	General population data (NCHS)
35-44 (n = 11)	**27%**	**36%**	**6%**
45-54 (n = 23)	**48%**	**60%**	**10%**
55-64 (n = 30)	**53%**	**56%**	**15%**

"Do you have a buzzing, ringing, or whistling or both ears (tinnitus)?"

occasionally or frequently	**29.5%**
rarely or never	**70.5%**

FIGURE 2



Hearing loss at worst ear (adjusted for presbycusis):
Mean & Std Dev for 26 pilots, age range 38-60
Hearing Loss (decibels)
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
1kHz
2kHz
4kHz
6kHz
8kHz
Audiometer Frequency