Sources and characteristics of interior noise in general aviation aircraft

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quite another thing to embody that knowledge in effective regulation. This paper reviews the experience of a number of European countries and certain North American cities, with the aim of assessing the results achieved by their various approaches to the tasks of formulating and enforcing noise control laws.

10:00

DD3. **Criteria for building-equipment noise control.** W. J. Cavanaugh (Cavanaugh Tocci Associates, Natick, MA 01760)

The cost and complexity of building equipment has progressively increased as more sophisticated techniques for controlling the thermal and general architectural environment evolve. An unavoidable byproduct of most systems for moving and conditioning air, or for moving people (elevators) etc., is noise. While initially building occupants accepted sometimes uncomfortably high noise levels as a necessary evil that went with a new convenience, an almost universal attitude toward quiet operation of building equipment has arrived. Decisions on how much quieting, and by whom, ultimately involve the goals or criteria for acceptable noise levels. Acceptable limits vary with the activities in the usually diverse spaces involved. This paper reviews experience with the selection and application of criteria for building equipment noise. The NC (and more recently PNC) noise criteria curves introduced by Beranek in 1957 are widely used for acoustical performance specifications, particularly for generally steady noises. While "quiet" operation is always the objective, "silent" operation of some building equipment systems may result in a condition as objectionable as excessively high noise levels. Some case histories of building equipment noise are reviewed to illustrate how criteria have been applied and assessed toward satisfying typical building occupants.

Contributed Papers

10:30

DD4. **Prediction of aircraft interior noise.** James T. Howlett and David A. Morales (NASA Langley Research Center, Hampton, VA 23665)

At the present time, predictions of aircraft interior noise depend heavily on empirical correction factors derived from previous flight measurements. However, to design for acceptable interior noise levels and to optimize acoustic treatments, analytical techniques which do not depend on empirical data are needed. This paper describes a research program which involves evaluating current interior-noise prediction methods, conducting basic research on noise transmission through aircraft structure and structural panels, and incorporating the latest improvements in noise prediction techniques into a computerized prediction method. An existing analytical program (developed by Cockburn and Jolly in 1968) forms the basis of some modal analysis work which will be described. The accuracy of this modal analysis technique for predicting low-frequency, coupled acoustic-structural natural frequencies will be presented along with trends indicating the effects of varying parameters such as fuselage length and diameter. The paper will include the latest results of this work and will discuss the relationship between these results and the ultimate objective: an accurate analytical technique for predicting aircraft interior noise.

10:45

DD5. **Sources and characteristics of interior noise in general aviation aircraft.** S. K. Jha (Visiting Professor, Cranfield Institute of Technology, NASA Langley Research Center) and J. J. Catherines (NASA Langley Research Center, Hampton, VA 23665)

A field study has been conducted to examine the interior noise characteristics of a general aviation aircraft. The noise environment that is encountered in flight as well as the variation of noise with speed and altitude of the flight is described. It is shown that the noise consists of very high level, low frequency components, and its intensity is determined primarily by the components in the frequency range below 2000 Hz. Noise analyses to identify the sources of noise suggest that among the many conceivable sources, the engine and the propeller are the two dominant sources. The relative importance of these two sources is described. In addition to the flight measurements, interior noise measurements have been made on aircraft operating under stationary condition on the ground. A comparison of the noise data in flight with those on the ground indicates that there are some differences in the spectral characteristics for these two conditions. Another part of this study involved measuring the acoustic field around the aircraft both in near-field and far-field conditions. Data will be presented to describe the variation of sound pressure levels around the aircraft in 10-ft increments up to 50 ft during constant-rpm operation. During this ground study, accelerometers were mounted on various aircraft components such as engine, engine frame, interior floor, etc. and the resultant vibration characteristics will be compared with the interior noise spectral characteristics.

11:00

DD6. **Ventilation-louver sound transmission-loss test results.** Allan M. Teplitzky (Office of Environmental Affairs) and John P. Carlson (Emissions Control Engineering Section, Consolidated Edison Company of New York, Inc., New York, NY 10003)

Indoor machinery installations, air conditioning equipment, and transformer vaults may need louvers to permit required air flows. These louvers may be significant paths for sound that is radiated into the surrounding community. Previous investigators reported field measurements on metal louvers. In this study, a series of laboratory sound transmission-loss tests (ASTM E90-70) were performed on various types of metal and masonry louver systems. Masonry louvers included experimental configurations of resonant cavity blocks and concrete grill screens. Metal louvers tested included "V"-shaped and 45° blades. Louvers were tested to quantitatively determine the effects of blinding the "line-of-sight," forming a labyrinth, or double set of louvers separated by an air space between. Test results are discussed. As expected, mostly all of the louvers tested provided relatively little attenuation at low frequencies. Attenuation generally improved by disruption of the line-of-sight through the louvers.

11:15

DD7. **Contemporary noise control programs in Australia, Brasil, and Japan—An assessment.** Arun G. Jhaveri (Acoustical Consultant and Director of Research and Production Development, ACOUSTECH Division of Agrimedics, Inc., Bellevue, WA 98004)

Since the beginning of this decade, a large number of developing as well as industrialized countries of the world have committed a small fraction of their national resources to combat the detrimental impacts of environmental pollution. The control and abatement of environmental and occupational noise levels in many urban communities has been a difficult and sometimes frustrating exercise as it