



AEROSPACE INFORMATION REPORT

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AIRCRAFT NOISE RESEARCH NEEDS

1. INTRODUCTION

- 1.1 Wide-spread concern with ever-increasing noise exposure, as progress leads to ever-greater power sources and to greater speeds, has fostered increased research in the areas of noise generation, human and structural response to noise, and noise control. Particular attention has been focused in recent years on the noise environment of airports and the communities in the vicinity of airports. At the same time, interest has continued in improving the noise environment of crews, maintenance personnel, and passengers in and around commercial aircraft. Consequently, a great deal of research effort has been expended in the area of aircraft noise. Although substantial advances in the understanding of aircraft noise sources and in the ability to control and reduce aircraft noise have resulted, much additional research and development is needed.

SAE Committee A-21, "Aircraft Noise Measurement," because of its activities in the preparation and review of Information Reports, Recommended Practices, and Standards in the field of aircraft acoustics, is in a unique position to identify and evaluate requirements of additional noise research. This Information Report is the Committee's classification of current aircraft noise research needs, including work not within the province of the Committee's charter (e.g. paragraphs 2.6 and 4.2).

- 1.2 The areas in which research needs exist are characterized broadly as follows:

Acoustics areas which have general application to a wide variety of aircraft types and operations.

Specialized topics in acoustics which relate to certain aircraft or aircraft types.

Areas which are not related directly to acoustics but which may play a significant role in aircraft noise alleviation.

2. GENERAL ACOUSTICAL RESEARCH

The following research areas are identified as basic to aircraft noise control. Continued improvement in each of these areas is thus needed to establish a firm technical basis for the design and quiet operation of future commercial aircraft.

- 2.1 Noise from Components of Power Sources: Engine and auxiliary power unit (APU) noise is generated by rotating components such as fans, compressors, turbines, propellers, rotors, gears, etc.; by the airflow interactions with such internal components as struts, vanes, surfaces, burners, etc.; by accessories; and by the mixing of exhaust jets with the ambient air. Investigation is required to identify the mechanisms of noise generation in each case, relate the noise of the various sources parametrically to operational variables, establish reliable procedures for determining the relative strengths of the various sources, and develop effective and practical methods of noise reduction.
- 2.2 Duct Treatment Materials and Technology: This relates to the application of sound absorbing materials to the interior passages of the air flow ducts of all types of jet engines, for the purpose of reducing the noise propagating in the ducts and thus minimizing the noise radiated from the nacelles.

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Additional work is needed to optimize the acoustical, mechanical, and aerodynamic properties of the sound absorptive materials and the duct lining configurations. Of particular importance is the development of general methods for predicting the acoustical performance of duct treatment for specific applications.

- 2.3 Noise Propagation in the Atmosphere: In order to extrapolate measured static or flight airplane noise to reference conditions and to make meaningful predictions of community noise exposures associated with airplane operations, an understanding of the effects of the atmosphere on noise propagation is required. This involves the effects of such factors as temperature, humidity, wind, and turbulence and their gradients. In some cases there are the additional complications of ground plane effects and doppler frequency shifts.
- 2.4 Noise Propagation Along the Ground: To perform noise analysis and predictions for propagation from an airplane on or near the ground, a similar understanding must be developed for "excess ground attenuation." Study is required of the effects on over-the-ground propagation of terrain, ground condition and ground cover, wind direction and speed, and turbulence. The variation of ground attenuation with angle of elevation to an airplane above the ground but to the side of the receiver must also be investigated.
- 2.5 Subjective Noise Scales: Continued psychoacoustic study is needed to refine subjective noise scales (such as effective perceived noise level), to define their applicability to a wide variety of types of aircraft and aircraft operations, both subsonic and supersonic, and to develop supplementary or substitute procedures, or scales, as required.
- 2.6 Community Noise Criteria: In order to evaluate noise exposures in the community, to provide a firm basis for aircraft design and operation and guidance for effective land use planning, appropriate community noise criteria must be defined. The development of such criteria (e.g. based on the NEF contour concept) depends on continued integration of inputs from acoustician, psychologist, and social scientist.
- 2.7 Cabin Noise Specification: It has become customary to specify the airplane cabin noise environment in terms of overall sound pressure level (OASPL) and a speech interference level (SIL). The OASPL normally represents the low frequency end of the spectrum, and the SIL represents the medium to high frequency end. The use of OASPL and SIL has, in some cases, been shown to be an unsatisfactory means for indicating cabin acoustical acceptability. Investigation into more satisfactory forms of passenger cabin and crew compartment noise criteria is needed to provide a basis for guiding fuselage-wall and -interior acoustical design.
- 2.8 Noise Measurement and Analysis: Continuing review and improvement of noise measurement and analysis instrumentation and procedures is needed to keep pace with regulatory and monitoring requirements. Among items that should receive immediate attention are analyzer characteristics and procedures for defining tones in aircraft noise, integration times for analyses of flyby noise measurements, specification of test sites, and method of correction for ground plane effects.

3. NOISE RESEARCH RELATED TO SPECIFIC AIRCRAFT TYPES

In this section research items that are especially pertinent to particular types of aircraft are identified and roughly rank ordered. There is some repetition of general items from Section 2.

- 3.1 Subsonic Aircraft (including executive, as appropriate):
 - 3.1.1 Engine compressor and fan noise generation, prediction, and reduction.
 - 3.1.2 Engine duct treatment technology.
 - 3.1.3 Suppressor technology for medium velocity (1000 to 2000 ft/sec) jet-exhaust noise.
 - 3.1.4 APU noise prediction and control.
 - 3.1.5 Prediction of, and suppressor technology for, low velocity (below 1000 ft/sec) jet-exhaust noise.
 - 3.1.6 Aircraft interior noise criteria and evaluation.
 - 3.1.7 Subjective response to flyby, ramp, and interior noise.