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NASA TECH BRIEF

Lewis Research Center

Computer Program for the Attenuation of High Bypass Turbofan Engine Noise

Two computer programs (EPNL and PHI) have been developed to determine the effect of boundary layer on the attenuation of sound in a circular duct lined with a material typical of the type used in noise suppression in the fan inlet and exhaust ducts of turbofan engines.

The EPNL program (Effective Perceived Noise Level) was developed to accept individual noise component spectra with each spectra defining the 1/3 octave SPL (sound pressure level) variation with frequency and position. The acoustic characteristic of a turbofan engine was defined by four noise components: (1) noise due to the low pressure compressor rotation, usually referred to as "Fan Noise" or simply "Fan;" (2) primary exhaust jet noise; (3) secondary exhaust jet noise; and (4) turbomachinery noise. The array defining the turbomachinery noise includes all other internally generated noise.

The object of this computer program is to use aircraft sound data to estimate the time pattern at other hypothetical observer locations and convert the projected sound into subjective units. The time history of an aircraft flyby is simulated using either stationary ground runup data, flyover data measured at other than requested conditions, or predicted data. Acceptable input consists of one-third octave band sound pressure levels (SPL) as a function of: (1) directivity angle at a constant polar radius, or (2) directivity angle at a constant sideline distance. Since these input spectra may be derived by other prediction methods, or may be actual test measurements, this computer program will be useful in all phases of aircraft development from preliminary design to final test. Output consists of SPL spectra for both the input and projected conditions with the results presented in terms of perceived noise level (PNL), tone corrected PNL (TCPNL), peak TCPNL, effective perceived noise level (EPNL, as defined by the FAA), and overall sound pressure level (OASPL).

The simulation technique consists of applying various corrections to the input SPL spectra to obtain the projected SPL spectra. Corrections due to the following effects are determined by this program: (1) spherical divergence, (2) atmospheric absorption, (3) extra ground attenuation, and (4) number of engines. Also, the program has the options to determine: (1) doppler shift effects, and (2) tone corrected PNL and effective perceived noise level.

State-of-the-art techniques of sound calculation are incorporated in such a way that if the calculation procedures change and become standardized, this program can be easily modified. The basic idea is to control the correction effects by selection of the calculation techniques used. A program user controls the selection of computation by means of an input control card which selects the sequence of calculation subroutines. The subroutines are in a general form such that the conditions supplied by input determine the value of the corrections to be applied. Variations in noise characteristics might be achieved for example by considering doppler shift effects and extra ground attenuation for one simulation and neglecting these effects for another simulation.

The input data can consist of three basic types of noise spectra: (1) SPL measurements on a polar arc around a stationary engine, (2) SPL measurements on a sideline parallel to the stationary engine, and (3) SPL measurements at a given location during an aircraft flyby. All data inputing is handled by the main program.

The output from this program consists of printed, plotted, and/or punched parameters. All printing, plotting and punching of the output data are controlled by the program user by control card indicators.

The PHI program (Program to Evaluate the Relative Effectiveness of Inlet and Fan Duct Lining Materials) evaluates the relative effectiveness of the inlet and fan duct lining and the fundamental and harmonic attenuation. The main program of the PHI accepts the punched output from the EPNL program.

Notes:

1. The EPNL computer program provides an option for allowing either fan or combined fan and secondary jet noise as basic component input.
2. This program is written in FORTRAN IV for use on an IBM 7094 or 360 computer system.

(continued overleaf)

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