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# NASA TECH BRIEF
*Lewis Research Center*

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## Sound Separation Probe

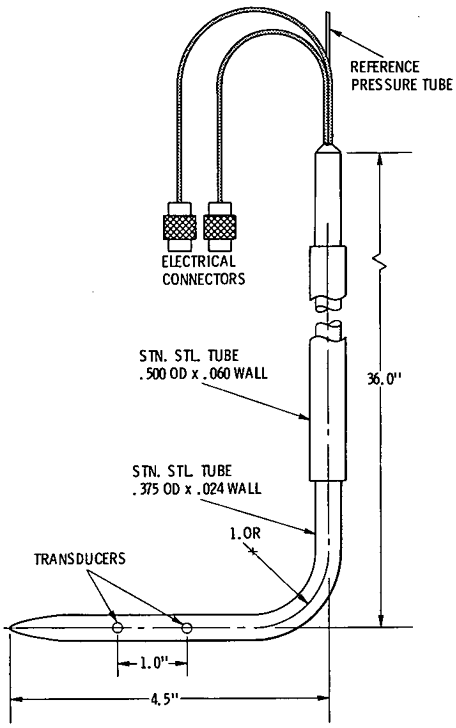

Figure 1

A probe has been developed that is able to separate sound waves from turbulent flow pressure fluctuations in ducted airstreams by using the principle that sound waves and turbulent flow pressure perturbations travel at different velocities.

In order to understand the propagation of sound waves from a device such as a jet engine, it is necessary to make pressure measurements in the ducted airstream. These measurements are made with probes in the ducts to determine what type of sound deadening devices can be applied to the duct walls to absorb the sound energy.

The problem with making probe measurements is that the fluctuating pressures sensed by the probe are not exclusively associated with sound. Turbulence due to the flow of air causes pressure perturbations which frequently mask the existing noise levels over much of the low frequency portion of the sound spectrum. Therefore, probe pressure measurements can be misleading as to the amount of acoustic energy that is actually propagating along the duct and radiating to the surrounding atmosphere.

The sound separation probe shown in Figure 1 senses the pressure fluctuations simultaneously at two closely spaced points with flush-mounted pressure transducers. The time-averaged signals at the two measurement points on the probe will be similar and each represents the usual probe measurements. However, the instantaneous signals will not be alike due to the different propagation times of sound waves and turbulent flow noise between the two measurement points. By using standard cross-correlation analysis, the signal from the aft transducer on the probe is compared to the time-delayed signal from the forward transducer to determine the amount of similarity between the two signals. This analysis results in a graph of the similarity between the two signals as a function of time delay between them. A typical cross-correlogram for sound mixed with turbulence in a flowing duct is shown in Figure 2. The cross-correlation function displays two peaks. The first peak is the portion of the signal

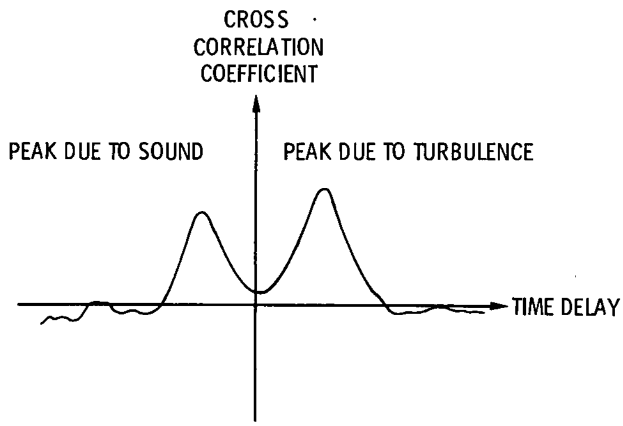

Figure 2

(continued overleaf)

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propagating at the speed of sound relative to the flow. The second peak is the portion of the signal corresponding to the flow turbulence. The ratio of the two peaks together with the overall level of the signal is then used to determine the level of the sound separated from the turbulence. The results of separating various levels of sound of a typical spectrum is shown in Figure 3.

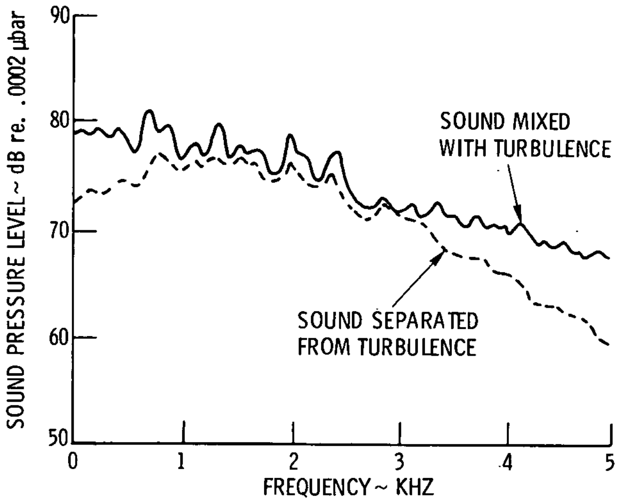


Figure 3

## Note:

No additional documentation is available. Specific technical questions, however, may be directed to:

Technology Utilization Officer
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Reference: B75-10286

## Patent Status:

NASA has decided not to apply for a patent.

Source: M.T. Moore and E.B. Smith
General Electric Co.
under contract to
Lewis Research Center
(LEW-12507)