ACRP Problem Statement 17-02-07

Active Noise Reduction of Aircraft Takeoff and Maintenance Run-up Operations

ACRP Staff Comments

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TRB Aviation Committee Comments

ENVIRONMENTAL IMPACTS OF AVIATION: Supported. Overall contribution of noise from takeoff and maintenance mostly remains within an airport boundary and needs to be researched. Low frequency remains a problem around airports. Currently there is very limited research addressing this topic. Would be a good feasibility study.

Review Panel Recommendation and Comments

Not recommended. Noise from airport operations continues to be an important issue, yet several concerns were raised about the proposed research. First, there was concern about undertaking the research before first validating its initial premise, namely, determining the pervasiveness of the problem. Second, there was a sense that the proposed approach was "fantastic" and like "science fiction." There was also concern about implementing the technology in an airport setting, as installing loudspeakers at GREs and runway ends is fraught with safety concerns—it would also be expensive. The proposed technology might be more implementable at homes (the receiver side of the noise issue)—but it still would be big technical problem.

AOC Disposition

This project was brought up for discussion from the Not Recommended list of problem statements. While the idea was deemed interesting, it was noted that the proposed research might be more appropriate for FAA. Other noise-related topics have a higher priority. No funds were allocated.
ACRP Problem Statement

I. PROBLEM STATEMENT TITLE

Active Noise Reduction of Aircraft Takeoff and Maintenance Run-up Operations

II. BACKGROUND

Low-frequency (LF) sound, such as that generated by aircraft maintenance testing in the form of high-power run-ups and by aircraft behind their start of takeoff roll, are often a source of annoyance and complaints by people near airports. Aircraft depart any time of day or night and maintenance activity often occurs during the nighttime hours. Operators do not have the freedom to conduct engine maintenance operations near their hangers anytime of day without affecting the local community. Traditional passive noise control techniques, such as barriers (Eisses 2015), Ground Run-up Enclosures (GREs) and sound insulation, are relatively ineffective against LF noise. These passive techniques can also be relatively difficult and costly to implement. Another mitigation technique is to relocate run-up operations far from residential areas but this is not typically practical or possible. Complaints from residents near airports can result in restrictions as to the timing and type of run-up operations allowed in addition to flight hour limitations. Operational restrictions, whether mandatory or voluntary, cost the airlines time and money. Complaints from residents damage airport relations with the surrounding communities.

Active Noise Reduction (ANR), the next step in ground noise mitigation, uses loudspeakers to strategically cancel LF noise and, offers the ability to target specific areas of the community exposed to LF noise generated behind aircraft at the start of takeoff. ANR has the potential to be less costly than a fixed run-up facility, more effective than barriers, and provide greater flexibility in the selection of run-up locations. Applying ANR to GREs or in free space around run-up operations and runway ends may decrease noise levels and impact in communities surrounding airports.

New research is needed to determine the feasibility of using active noise reduction of such operations and to perform a cost/benefit analysis.

III. OBJECTIVE

The objectives of this research are to:

- Determine the pervasiveness of noise complaints from aircraft initiating takeoff (start of takeoff roll engine noise) and conducting run-up operations at US airports and
- Determine whether active noise reduction is a viable solution to alleviate the noise problem with or without GREs.
IV. PROPOSED TASKS

To conduct this research, the following overall tasks are recommended:

1. Conduct a survey of US airports to find the percentage of noise complaints that are caused by aircraft initiating takeoff and conducting run-up operations,
2. Determine the efficacy of active noise reduction for decreasing noise levels of run-up operations in terms of area and population, and
3. Outline the design of a system with and without an accompanying GRE including costs, configuration, and operation (if warranted).

V. ESTIMATED FUNDING

Recommended Funding: $300,000

VI. ESTIMATED RESEARCH DURATION

Research Period: 18 Months

VII. RELATED RESEARCH

In the 1990s, ANR system development, analytical modeling and testing was conducted for the US Air Force investigating the feasibility of applying ANR to the jet exhaust noise from aircraft operations in 'hush houses' and run-up areas (Gibson et al 1994). An ANR system was tested both at a small scale hush house constructed at a jet engine test facility and at a full-scale Air Force hush house (Gibson and Stusnick 1995a; Gibson and Stusnick 1995b). The potential for applying ANR to unsuppressed jet aircraft noise was investigated during further development of a simulation model to predict the performance of an ANR system (Hobbs et. al. 2000).

Tests at the small-scale hush house used one or more standard off-the-shelf loudspeakers as control sources. Broadband jet exhaust noise was reduced over a wide frequency range, and a large area of noise reduction was achieved. Listeners in the area where ANR was applied could subjectively notice a remarkable reduction in the overall exhaust noise, since the low-frequency energy which dominated the noise spectrum was considerably attenuated. One-third octave band attenuations of up to 15 dB were achieved. Testing of a similar system applied to noise from a stationary jet aircraft also resulted in significant noise reduction, sufficient to demonstrate that the technique has potential application to unsuppressed ground run-up noise.

Tests at the full-scale hush house, using a single low-frequency control source, resulted in even larger areas of noise reduction. One-third octave band attenuations of up to 8 dB were achieved, and low-frequency attenuation of 4 to 8 dB was achieved over at least 45,000 square feet. Cancellation of noise behind a jet engine on a test stand at Virginia Tech's airport (aka Montgomery Executive Airport) confirmed the accuracy of the simulation model developed in 2000.

The noise levels generated by aircraft takeoff and run-up operations have been measured and reduced with ANR in free space by the author. Utilizing the noise emissions characteristic of jet aircraft run-ups with a model predicting the performance of an ANR system with and without a GRE, the reduced noise levels will be estimated. Seeing the percentage of run-up operations that occur at night by airlines with hubs at an airport in conjunction with research on sleep disturbance may indicate the efficacy of an ANR system.
VIII. PROCESS USED TO DEVELOP PROBLEM STATEMENT

The problem statement was developed solely by Wyle Laboratories, Inc. and Jerry Trantow.

IX. PERSON SUBMITTING PROBLEM STATEMENT and DATE

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References


