ACRP Problem Statement No. 14-02-34  

**Recommended Allocation:** $300,000

*Guidance for Modeling Noise for Non-Standard Aircraft Profiles*

**ACRP Staff Comments:** Several ACRP studies are focused on enhancing the industry's air and noise models. The proposed research could be incorporated into Problem Statement 14-02-14, which seeks to develop a prioritized list of potential improvements to AEDT and to provide detailed documentation of select near-term, high-priority improvements.

**TRB Aviation Group Committees Comments:** ENVIRONMENTAL IMPACTS OF AVIATION: Support as a low priority. Narrowly focused. The AEDT raises issues for airports that can't really be addressed without this technical work.

**Review Panel Comments:** Recommended.—The proposed research provides an opportunity to more accurately model aircraft departures and arrivals. It could build off the existing research underway with ACRP 02-41, Estimating Takeoff Thrust Settings for Airport Emissions Inventories.
I. PROBLEM TITLE

Guidance for Modeling Noise for Non-Standard Aircraft Profiles

II. RESEARCH PROBLEM STATEMENT

The Aviation Environmental Design Tool (AEDT) is a prime example of the commitment of the Federal Aviation Administration (FAA) to improving aviation environmental assessment computational capabilities. The AEDT program will achieve an important milestone in integrating FAA legacy tools and improving on their accuracy and functional capability. For instance, improvements include changes in acoustic, emissions, and performance modeling capabilities, as well as improvements to noise-power-distance (NPD) curves, lateral attenuation algorithms, and relative-humidity absorption.

Continual improvement to the INM modeling capability saw the introduction of procedure step profile capability in INM version 5. This allows for performance based profile computation within prescribed limits for nonstandard airport environmental conditions. The associated aircraft specific coefficient database has also been expanded. ACRP recently contributed a key improvement to noise modeling tools through Projects 11-02, Taxi Noise Model System Design and ACRP 02-27, Aircraft Taxi Noise Database for Airport Noise Modeling. These projects produced the design and datasets for the integration of taxiway noise modeling into AEDT. Yet, other improvements in the modeling capabilities of the current tools are still needed; especially for the more accurate representation of aircraft climb and descent profiles.

A flight profile defines the altitude, speed, and thrust settings at many locations along a modeled three-dimensional flight path. The AEDT contains "standard" departure and approach profiles for every aircraft type in the AEDT database. The standard profiles and the associated INM aircraft performance data (in the form of coefficients) have been developed by the FAA in collaboration with the aircraft manufacturers to ensure valid three-dimensional flight trajectories that lie within the aircraft performance envelope. For departures, the standard profiles and AEDT modeling “procedure step” process do not account for the variations in thrust settings utilized at the majority of airports for the vast majority of aircraft operations.

Departure Modeling: The performance coefficients in INM/AEDT limit noise modeling to full thrust departures while research shows that over 90% of all aircraft departures use reduced thrust. Techniques have been developed to model reduced thrust departures using the “Assumed temperature Method” as well as by iteratively optimizing the existing INM procedure step process that relies on user-defined non-standard performance coefficients to better match measured aircraft positional data. [Page 2000, Forsyth 2006, Plotkin 2013]

Approach Modeling: The standard approach profile in AEDT is modeled as a continuous glide slope. The modernization of the national airspace system (NAS) will accelerate the introduction of non-standard profiles, such as CDAs. For years the standard INM/AEDT approach profile has in fact been a CDA approach, and airports have incorporated the CDA benefit into noise contours.

The current FAA policy [FAA 2009] requires APP-400/AEE review of all User-defined aircraft profiles, including noise abatement procedures such as AC91-53A ADPs for all Federal
environmental actions for airports. These actions include Part 150 Study Noise Exposure Maps and Noise Compatibility Programs, Environmental Impact Statements (EIS), and Environmental Assessments (EAs). As a result, standard profiles are often used for analysis due to time constraints and lack of technical guidance on the issue. Even though the forthcoming AEDT will provide users with additional tools for modifying profiles, airports and consultants will still need to decide whether such analysis is needed and is cost effective.

From the Airport perspective, the questions that naturally arise are:

- When is it appropriate for an Airport to model reduced thrust departures?
- How should an Airport compute the noise change between step down approach profiles and Continuous Descent Approaches?

III. OBJECTIVE

This Problem Statement proposes the development of guidance to identify situations when airports conducting environmental studies should use alternate performance modeling techniques in their analyses in order to better represent impacts and their tradeoffs to their stakeholders.

IV. RESEARCH PROPOSED

Previous studies (Forsyth 2006, Plotkin 2013) have shown that noise modeling results are more sensitive to matching the flight speed than the altitude. A possible source of error may be the effects of flight speed and duration adjustments on integrated SEL levels. Therefore, the problem is more complex than simply defining the correct altitudes along a flight trajectory. Thus, a decision making guideline will be helpful as AEDT users will need to determine the usefulness and cost-benefits of performing profile customization. Instead of addressing each specific situation individually the research team should approach the problem in whole, based on accumulated practical, theoretical, and experimental data.

The research goal is to supplement and enhance current tools such as AEDT with modeling guidance in the form of a “Decision Tree” tailored for airports and their consultants. Items to be considered include:

1. Identify typical radar approach and departure altitude/speed profiles not covered in the standard profiles. Identify importance and suggest priorities for considering the acoustic impact and frequency of occurrence.

2. Develop guidance for determining whether a radar profile constitutes a match to a standard profile, or is sufficiently different to warrant additional customization. Delineate and categorize profile modeling deficiencies according to such considerations as:
   - Operational procedures: thrust setting variations, differences in either altitude or velocity due to air traffic procedures (hold-downs, level segments), high speed operations, CDAs, additional performance coefficients or different performance.
   - Airport-specific modeling considerations: high altitude airport, terrain specifics, runway configuration and size.
   - Weather considerations: temperature extremes and the affect on aircraft performance and atmospheric propagation modeling.
   - Advanced noise modeling considerations: enroute noise, profile regimes where shock cell noise is important.
• Aircraft technology level: new engine technologies, (very high by pass ratio), new airframe technologies (BWB), new aircraft certification or aircraft substitution, future aircraft technologies.

3. Incorporate this information into a solution for the end user. Create a Decision Tree based on available modeling research. As branches in the Decision Tree are mapped, the recommend profile modeling procedures should undergo a peer review process by the SAE A-21 Aircraft Noise Committee with the ultimate goal of publishing an SAE Aerospace Information Report (AIR) and perhaps recommendations for inclusion in future versions of AEDT.

4. Develop a technical guidance on the specific modeling techniques and practices to carry out modeling of different types of customized profiles, including procedures for altitude adjustments, speed corrections, and thrust modifications for arrival and departure profiles.

References

V. ESTIMATE OF THE PROBLEM FUNDING AND RESEARCH PERIOD
Funding: $350,000
Contract Time: 18 months

VI. URGENCY AND PAYOFF PERIOD
The ability to model environmental impacts and tradeoffs more accurately and in a manner consistent with ongoing advances in NAS modernization and aircraft technology is an important issue for Airports. As the NextGen initiative introduces new methods for performance based navigation and profile management, and as AEDT advances aircraft performance modeling capabilities, guidance must be provided to the end user that they can adequately model the acoustic impacts from NextGen flight operational changes.

VII. RELATED RESEARCH
The FAA is developing AEDT as an integrated modeling platform for environmental analysis and provides improved ability to model environmental impacts of airport operations. The proposed guidance will provide a technical basis when customized profiles should be used. An existing ACRP project 02-44 “Estimating Takeoff Thrust Settings for Airport Emissions Inventories” is developing a simplified method for estimating aircraft takeoff thrust settings for commercial and general aviation aircraft, tailored for use in preparing airport emissions inventories. ACRP 02-44
does not specifically address approach modeling, nor does it address the decision criteria Airports and noise modelers need for determining whether standard profiles are sufficient. The takeoff thrust setting estimator may likely be leveraged in this project.

VIII. PERSONS DEVELOPING THE PROBLEM

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IX. PROCESS USED TO DEVELOP THE PROBLEM STATEMENT

This project proposal was developed as a collaborative effort by all the persons listed in Sec. VIII.

X. DATE AND SUBMITTED BY

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