

LETTER REPORT

Workshop #3

**FAA Aviation Environmental Design Tool (AEDT)
and Aviation Portfolio Management Tool (APMT)**

January 31 – February 2, 2005
Washington, DC

May 25, 2005

Mr. Carl Burleson
Director, Office of Environment and Energy
Federal Aviation Administration (AEE-1)
800 Independence Avenue, SW
Washington, DC 20591

Dear Mr. Burleson:

This report is a summary of the results of a third workshop in a series that the Federal Aviation Administration (FAA) asked the Transportation Research Board (TRB) of the National Academies to conduct to assist in the ongoing development of a new aviation environmental design tool (AEDT) and an aviation environmental portfolio management tool (APMT). This third workshop focused on a review of the FAA initiative to develop APMT.

While AEDT is intended to provide a capability for identifying and computing interrelationships between noise and emissions at various levels, APMT will provide a capability to conduct related cost-benefit and other economic analyses. The input from this third TRB workshop is intended to help guide FAA as it develops APMT.

The first workshop in the series was held from March 31 to April 2, 2004. It focused on soliciting stakeholder input for initiating the development of AEDT, and its results were transmitted to FAA in a letter report dated October 14, 2004. The second workshop was held August 24-26, 2004, and its main purposes were to brief stakeholders on FAA's progress in developing AEDT, seek comments on the AEDT work plan, and introduce plans to integrate economic considerations into the design tools. The results of the second workshop were transmitted to FAA in a letter report dated April 20, 2005.

This letter report, prepared following the third workshop, describes the workshop's organization and presents the committee's summary of and comments on the workshop discussions. It also provides the committee's findings and recommendations to FAA on the proposed objectives for APMT, the resources and capabilities needed to develop an effective APMT, and the most appropriate next steps in the APMT development process.

ORGANIZATION AND CONTENT OF THIRD WORKSHOP

The third AEDT-APMT workshop was held at the National Academies from January 31 to February 2, 2005. A roster of committee members appears in Enclosure 1, the agenda for the workshop in Enclosure 2, and a list of workshop participants in Enclosure 3.

The workshop opened with a plenary session that included both presentations by FAA introducing its APMT development plan objectives and work to date and a briefing on International Civil Aviation Organization (ICAO) and its Committee on Aviation Environmental Protection (CAEP) processes and status. The plenary session was followed by the Breakout Session 1 with three breakout groups. This breakout session was devoted to discussing APMT uses and scope. Each group was asked to consider the FAA's conceptual chart and address questions about potential APMT users, how the analyses would be used, what type of analyses are needed, and whether the conceptual overview was appropriate. At the end of the first day, the moderators of each of the three breakout groups presented highlights of their discussions to a plenary session of all participants.

The second day began with a plenary session that included a combined summary of the previous day's breakout discussion results followed by two FAA presentations: one on a preworkshop survey of stakeholders about types and scope of analyses of most interest and the other on a review of existing economic models that might be relevant to APMT. This plenary session was followed by Breakout Session 2, with the same three breakout groups. Each group was asked to discuss the applicability of existing models to APMT and the modeling gaps that need attention. Following this breakout session was a plenary session of FAA presentations on AEDT and APMT interaction, results of the FAA-sponsored Center of Excellence literature review and related research, and an overview of the FAA's national vision statement for future air transportation. Then Breakout Session 3 met to discuss APMT scope and priorities.

The third and final day of the workshop began with a plenary session in which the results of the previous breakouts and other discussions were presented to all participants. The committee suggested and the group agreed to a redesign of the Breakout Session 4 to focus primarily on questions of, first, whether the APMT initiative had sufficient merit and should be pursued and, second, what technical and process steps were most important for FAA to consider when designing its APMT development program. The moderators of each group then presented the results of their discussions to a final plenary session.

SUMMARY AND COMMENTS ON WORKSHOP DISCUSSIONS

The following are brief summary overviews and comments from the four breakout sessions identified in the previous section, followed by a summary of common themes from the breakout group discussions.

Breakout Group Discussions

APMT Uses and Scope

Participants in the three breakout groups noted that the ICAO-CAEP process is likely to be a primary user of APMT, but a wide range of other potential users were identified and discussed, adding to those originally identified by FAA. The groups identified a range of specific policy or investment decisions the model should support. Many participants felt that the output of economic analyses met the needs for the CAEP process, first in the development process and then to meet other needs later. However, concern was expressed that other policy and investment decisions

should be considered early in tool development to ensure that tool architecture accommodates those analyses. The specific types of analyses listed did not match at least one group's concept of the possible types of economic analyses. Types of economic analyses addressed by APMT might include cost–benefit analysis, cost-effectiveness analysis, economic impact analysis (to understand overall impact on the group that will bear the costs), return on investment, alternatives or scenario analysis, and cost–risk exposure and risk analyses. Different types of analyses might be more suitable to answer different policy and investment questions. While these analyses may share common input data, it is necessary to use the right tool for each type of analysis desired.

APMT Models and Gaps

Workshop participants shared the belief that, before examining existing models for applicability to APMT development, more effort should be devoted to scoping APMT and identifying process needs for tool development. As a result, the breakout groups took widely different approaches to this session, with Group A focusing on identifying functional requirements for the APMT tool; Group B reviewing the models and identifying gaps, as had been planned for the breakout session; and Group C enhancing and rearranging the APMT chart presented by FAA. It was apparent that there is no single model or possible combination of existing models that can be drawn upon to completely fill the needs of APMT. What is likely needed when the APMT is being developed is a new framework for economic analysis that can draw upon existing tools or methods used in those tools. There is also a need to map the specific tools in APMT to the types of analyses that the tools can support.

APMT Scope and Priorities

Most groups sorted priorities listed in the questions for this breakout session. Noise, local air quality, and climate change were high among analysis priorities, with analysis of trade-offs between these and other elements recognized as important. Noise versus local emissions and noise versus all emissions were among the top trade-offs identified. One explanation for the fact that trade-offs were not listed universally higher is the participants' feeling that one needs to understand each item individually before being able to examine overall trade-offs. An appropriate scope of analyses was seen as being driven by CAEP process needs for global and regional analyses, with analysis of economic consequences for manufacturers and airlines equally important. Regarding choices between economic analyses for compliance, mitigation, health and welfare, and mobility, those for compliance and mitigation were generally identified as short-term priorities with respect to the APMT development program.

Harmonizing APMT Workshop Results and Recommending Next Steps to FAA

This breakout session was redesigned during the workshop to focus on APMT scoping and process needs (represented with a revised diagram) to define APMT and its relationship to AEDT. The discussion explored elements of system engineering analysis that could aid APMT development and identified next steps that should be completed in the near term. Participants responded favorably to the APMT vision statement and FAA's overall objectives. Many participants also favored the suggestions in the breakout questions for a requirements definition

study, an architecture study, a listing of all cost-contributing factors, a more in-depth assessment of available cost tools, and a prototype case study.

Common Themes from Discussions of APMT Initiative

The workshop discussions provided, first, overall comments on the FAA plans and on an approach for developing APMT and, second, specific concerns regarding the effects this new tool might have on the aviation community and individual stakeholders. In some cases, the breakout groups approached the questions posed by FAA in different manners or addressed specific concerns that were not directly raised by the questions. In particular, these concerns related to APMT structure and process needs and, as noted earlier, the questions for Breakout Session 4 were altered by the workshop participants to address the concerns. However, a number of themes that were of most concern or interest to the participants emerged during the breakout sessions. These were modularity and flexibility, variety, priorities, scope of analysis, transparency, treatment of uncertainty, credibility of data, new framework and models versus existing tools, and process needs. The committee offers the following comments to assist and complement the development process.

Modularity and Flexibility

Comments under this theme originated from several perspectives. The first perspective related to concerns that were originally raised in the AEDT workshops. That is, there is a wide array of current users for the legacy tools, such as the Integrated Noise Model and the Emission and Dispersion Modeling System, that will make up the AEDT tool. Current users do not want their ability to run these legacy tools to be affected, and they want these tools to continue to be supported. In addition, users do not want support of legacy tools to affect APMT tool development or to restrict the ability to conduct economic analyses linked to these individual modules.

A second perspective arose from discussions regarding the FAA's focus for initial AEDT-APMT use, namely guiding policy discussions and decisions within the ICAO-CAEP process. Participants expressed concern that all possible uses of AEDT-APMT should be considered in the early development stages to ensure appropriate decisions on program requirements and architecture. One way to address this concern is to develop a modular and flexible architecture (including a flexible database architecture) so that future functionality can be included as the uses and users of AEDT-APMT are expanded over time.

Finally, a number of comments were raised about the desire of different stakeholders (such as European countries) to insert their own modules for impact assessment, cost analysis, or other issues. Again, a modular, flexible architecture would support this variability, but it is necessary to identify the methods and assumptions required to use different modules than those in the base APMT model.

Variety

Questions posed by the FAA led to the recognition among workshop participants that there are many diverse potential uses and users of AMPT. Among potential users, a wide range of

sophistication exists, from knowledgeable experts in conducting cost–benefit analyses and trades to those who might use only the output of APMT. Users and types of organizations that would use APMT ranged from the public, including home owners and neighborhood organizations; academia; nongovernmental organizations; financial organizations; airports; airlines and manufacturers; and government research and regulatory (local, state, federal, and international) organizations. Uses included supporting decisions for aircraft and engine technology programs and applications, operational measures, stringency requirements, and phaseouts or operational bans.

Given this wide variety in uses and users, it was felt that the APMT requirements and effort could expand significantly and could result in little focus and a lower probability for success. FAA needs to prioritize APMT uses and identify the key users of the data. To some extent, FAA did this in real time during the workshop by stating that the ICAO-CAEP process had the highest priority and greatest near-term focus. However, the means for constraining the requirements and statement of work leading up to CAEP meetings and the priorities beyond CAEP are not clear. Again, when FAA applies additional requirements and recommendations for modularity and flexibility, more uses and users could be included in later APMT releases.

Priorities

Discussion of priorities focused in two areas: the different types of analyses the APMT tool must support and cost and benefit information, including the monetization of externalities. The FAA stated that ICAO-CAEP will be the primary focus of AEDT-APMT development in the near term. This position was accepted by many workshop participants as appropriate. It was also noted that past CAEP meetings and their outcomes could be used as trial cases to validate the tool. However, this near-term focus tended to limit breakout group discussions on priorities after functionality for CAEP analyses was addressed, and no clear solutions arose. The committee suggested that FAA define longer-term priorities for comment by the stakeholders.

Regarding cost and benefit information, participants noted the need to identify all costs and benefits in the early stages of APMT development. As it is expected that this could be a large list, participants also stated that costs and benefits should be prioritized on the basis of potential for influencing outcomes and decisions. One breakout group identified the concept of a balance sheet to aid in the identification of costs and benefits; this concept will be further addressed in the later section on scope of analysis. Monetization of all costs and benefits, including externalities, was seen as a critical capability of APMT and the best way to make and compare trade-offs between noise and emissions and within emissions. It was recognized that if some costs and benefits were left unmonetized the analysis may well focus on the wrong impacts—just because they have monetary values. However, a number of issues were identified that will make monetization a difficult task. For the tool to gain international acceptance, there must be some means of accounting for different value systems across regions and cultures. In addition, there are large ranges for damage assessments that must be accounted for in some way. Some specific examples provided by participants to illustrate differing values or ranges of damage assessments included damage estimates for sleep disturbance and differences in housing costs in the United States and India. Some flexibility to vary cost and benefit impacts is needed.

Scope of Analysis

Within the theme of scope of analysis, a number of areas were discussed, including cost-effectiveness analyses versus cost-benefit analyses, full versus partial accounting, and the concept of a balance sheet. The balance sheet concept, identified by one of the breakout groups, was popular with workshop participants. The balance sheet is an accounting financial statement to help ensure all costs and benefits are accounted for and allow for easier user recognition of the benefits and costs associated with a particular policy. The concept here was to prepare a series of balance sheets for the different parties so that the benefits and costs for each would be identified and the incentives for each would be understood. For example, if benefits in relation to costs from an action are positive for society overall but not for private parties, then market forces will not produce the desired action. This idea should be considered for inclusion in APMT. In addition, this accounting tool, combined with explicit recognition of the perspective from which the benefits and costs are accounted, addresses the need to show the distribution of costs and benefits among industry groups, countries, regions, and other relevant groups as an aid to understanding both the net social welfare costs and their benefits. The balance sheet is not a substitute for a cost-benefit analysis, but rather it is a way to understand how benefits and costs affect individual parties.

While participants recognized the need to monetize all costs and benefits to accomplish a complete cost-benefit analysis and to fully evaluate trade-offs between noise and emissions and within emissions, a number of other useful types of economic analyses were identified—such as cost-effectiveness, return on investment, and economic impact—that could be accomplished with fewer economic data inputs or could provide a more appropriate type of analysis for a particular policy. It was also recognized that some costs and benefits may be extremely difficult to monetize. Participants gave high priority to the identification of all costs and benefits and some accounting for them in a quantitative or qualitative sense.

Transparency

Transparency was seen as a critical requirement for APMT by many workshop participants. First, APMT will be a sophisticated tool, and all stakeholders and users of the results may not be users of the tool. Therefore, the methods, data, and calculations the tool uses must be transparent at some level to convince stakeholders of the validity of the results. Second, the FAA requires international acceptance of APMT for use in the CAEP process. Again, different stakeholders, particularly other member countries belonging to CAEP, may wish to compare assumptions and methodologies in APMT with tools that they are familiar with and have used in the past. Finally, the issue of proprietary data surfaced in a number of discussions; this issue prompted the question of how transparency is achieved while proprietary data are protected. FAA must devise some accepted means of describing proprietary data and methodologies without releasing the data or algorithms. This requirement is considered critical since the development and validation of AEDT-APMT relies on use of proprietary data. Without assurances that proprietary data will be protected, data owners will be reluctant to provide them to FAA.¹ And some proprietary data may also need evaluation by independent experts before those data can be accepted as valid.

¹ There will always be some concern about black boxes producing results that cannot be verified. However, the types of proprietary models that should be considered are those that produce measures of noise and emissions outputs for specific engines. In these cases it is the quantities and dispersion of emissions that are needed for APMT.

Treatment of Uncertainty

A number of areas of uncertainty that could have significant impact on model results and conclusions were identified by workshop participants. These included widely ranging values in studies of monetization of externalities as well as uncertainties in climate impact analysis and levels of aviation-related hazardous air pollutants and particulate matter in airport communities. Therefore, it is important that the AEDT-APMT tool explicitly identify and characterize uncertainties, and provide the capability to do sensitivity studies to explore the impact of uncertain values on the analysis. Any descriptive material and guidance on the use of APMT should contain a discussion of the ways uncertainty can be analyzed and describe the tools for such analyses.

Credibility of Data

A number of areas were discussed under the general theme of credibility of data, including proprietary information, differences in valuation, data quality, and ability to monetize. Most of these issues are also related to other common themes and have been discussed in earlier sections, particularly those on modularity and flexibility, transparency, and treatment of uncertainty. In addition, the analysis and tool framework should be sufficient for the FAA to meet its legal obligations related to the rigor of its analysis.

New Framework and Models Versus Existing Tools

FAA provided information on a survey of existing tools and methods for evaluating environmental costs that might be used for development of APMT. In addition, an AEDT, environmental design space, and APMT model conceptual overview chart was presented that placed existing tools in specific modules for discussion in Breakout Session 2. This model generated significant discussion among participants and a call for a systems engineering approach to defining APMT requirements and architecture. In summary, the degree to which existing models could be used was questioned. At best, according to participants, parts of existing models might be used, but it was felt that development of new analytic capabilities would also be required and that the effort at integration into an overall framework would be significant. Concerns were expressed that use of existing tools might affect framework decisions in a way that would have an adverse impact on modularity and flexibility or on the ability to develop a coherent economic context. Further, given the skepticism regarding use of existing tools, the economic expertise and resources of the specific FAA office [Office of Environment and Energy (AEE)] with the responsibility to build or direct the building of APMT seemed insufficient to many participants.

Process Needs

It was often noted throughout the first three breakout sessions that not enough detail was available to provide confidence that APMT goals and schedule can be accomplished. By comparison, significantly more detail and planning had been presented in the earlier workshops, where AEDT was the focus. More detail is possible in part because AEDT uses existing tools that have been specifically developed and used for aviation analysis. The feeling is that APMT is a large, complex project and that not enough up-front evaluation and prioritization of

requirements and scoping of effort had been accomplished by FAA before this workshop. This led to the redesign of Breakout Session 4 to focus on a revised APMT framework diagram, discussion of elements of a system engineering analysis, and identification of next steps to be completed in the near term. Many participants thought that the next steps should include a requirements definition study, an architecture study, a listing of cost-contributing factors, an assessment of available cost tools, and a prototype case study.

FINDINGS AND RECOMMENDATIONS OF THE COMMITTEE

The committee met in closed session following the workshop to deliberate on its findings and recommendations. Based on the input received at the workshop and the committee's experience and expertise, the committee offers the following findings and recommendations regarding the FAA's identified plans for the APMT.

Vision and Objectives for APMT

The committee finds that the basic case for developing APMT is strong given the FAA's near-term needs for CAEP. The ability to make informed trade-offs between levels of different types of engine emissions and aircraft noise is important for CAEP and other decisions that will be made by FAA, other domestic agencies, the international community, industry, and others. These trade-offs are best addressed using cost-benefit analyses, with economic benefits being reduced to a common numeric such as dollars. Understanding the impact of these trade-offs on the overall economics of the air transportation industry (on airlines, aircraft manufacturers, and passengers and shippers), while at the same time understanding the trade-offs on the economic well-being of society in terms of the levels of pollution they have to endure (economic harm), would represent a significant advance in the state of knowledge.

The committee also finds that, if APMT is developed, it must meet the following general requirements:

- **Consistency.** APMT must be based on consistent, coherent, and accepted economic theory.
- **Flexibility.** APMT should be flexible and modular, more of a framework than a single model or tool, to allow its development over time and use by diverse possible stakeholders.
- **Transparency.** APMT development must be transparent in general in relation to the data and methodologies employed.
- **Credibility.** APMT must be credible and accepted across a wide range of stakeholder interests, including the derivation of compliance costs and monetization of externalities. Similarly, APMT must be able to meet all requirements for use within the United States regulatory context. This criterion poses a major substantive challenge beyond the challenges of integrating many different models and data sources.
- **Capability to Address Uncertainty.** APMT must explicitly address the many layers of uncertainty in the analysis. The ways in which the model outputs can be used to drive

analyses of uncertainty should be covered in any descriptive material on the model and in its user manual.

- **Integration.** A robust modeling effort must consider that increased airline and manufacturer costs of compliance with new requirements would affect the demand side for air transportation and therefore the level of emissions. Thus, APMT needs some feedback loop to reach an equilibrium state.²
- **Distributive Effects.** In addition to providing summary information about overall social welfare impacts, APMT should be capable of providing data about the incidence of costs and benefits associated with aviation environmental issues.

The committee believes that it is critical for FAA to account for the considerable challenges associated with implementing APMT. The legacy models that will be used by AEDT are at a significantly greater level of maturity and have a proven track record in contrast to the models and methodologies contemplated for APMT. For AEDT, the risk is integration and improvement to known products. In the context of APMT, it is the development of new analytic capabilities and models as well as their integration into an overall framework. The economic models for APMT would use valuation methods that are not universally accepted and embody a level of uncertainty in the resultant values.

Despite the critical importance of having a coherent economic context, little evidence was presented at the workshop that FAA and its team have fully specified the methodologies that will be at the core of APMT. Defining the APMT architecture without considering the analytic and computational methods used for the economic analysis poses at least the following risks:

- First, APMT may be considerably overdesigned in that it will try to answer too many questions when the state of knowledge is not sufficient to do so.
- Second, it may omit important factors because it has not traced through the analytic processes. While a systems engineering approach to development of APMT is highly desirable, this is only valuable if performed in conjunction with a detailed specification of the economic calculations that will be made and with recognition of likely types and quality of data available to implement such a model.
- Third, it may seek to integrate economic data developed with different, potentially inconsistent methodologies, rendering the integrated results suspect.

Another critical question relates to the timing of the availability of such a tool. FAA has indicated to the committee that its primary immediate purpose is to have the tool available for use in the CAEP-8 process, which would require a model to be vetted within the next 2 years. FAA has also indicated that it is unsure that it would be able to monetize many of the externalities by that time. Thus, APMT would primarily focus on the costs of the regulation to manufacturers, airlines, and

² While it may not result in a global optimum, tracking feedbacks by considering cost and price changes and their associated elasticities will permit an understanding of changes in the market.

others. In light of constrained resources and the many challenges associated with developing APMT on a condensed schedule, the committee believes that FAA should carefully evaluate the approach of investing in this effort in the short term and focusing on the economic analyses necessary to support CAEP-8. The portfolio tool will have diminished value if it cannot reflect the full portfolio of costs and benefits, representing—in the analogy of some workshop participants—a balance sheet without all the assets and liabilities. FAA needs to make an informed choice on whether a framework with partial capabilities is better than no framework at all, especially given the cost. If FAA chooses to deploy APMT in phases, it will be important to note what is included or omitted so that users are aware of any limitations on results.

Resources and Expertise Available to Develop APMT

Like many workshop participants, the committee finds it improbable that, considering the currently identified resources and expertise, FAA will be able to succeed in implementing its vision for APMT. While the committee supports the general vision of APMT, there has been little definition of the requirements for APMT or even common terminology regarding its ends or means. This is of concern given the limited time and resources available to develop APMT before CAEP-8.

The identified level of financial resources for APMT appears inadequate to allow FAA to meet either its short-term or long-term objectives for APMT. Additional financial resources will be necessary if FAA is to have a reasonable chance of providing a useful tool set for CAEP-8 that could be accepted and embraced by critical stakeholders. It appears extremely unlikely that FAA-AEE could meet both its AEDT and APMT objectives on the proposed timelines within the budget currently available for this activity.

Further, AEE needs to bolster the economic expertise that can be deployed for the APMT project. The office has one highly capable senior economist who supports APMT only part time because of other duties. This level of staffing is not sufficient to oversee APMT development and to allow informed use of the model. This situation represents a considerable risk in the development of APMT.

The Committee offers the following specific findings:

- As stressed earlier, the development of a robust and credible APMT will rely on a sound integration of economic theory and robust software architecture.
- The PARTNER (Partnership for Air Transportation Noise and Emissions Reduction) Center of Excellence university members bring substantial aerospace and systems engineering capabilities to the team. However, there is limited economic expertise within the Center of Excellence university members.
- AEE has substantial expertise in operating the legacy models that estimate levels of noise and air pollution and locations of affected areas. Integrating these technical models with economic models to perform sophisticated trade-off analyses among various types of pollution—and to track the costs of these levels to airlines, manufacturers, and the public—is substantially more ambitious than what the existing models can do and may be

difficult to justify. The economic models rely on a firm understanding of airline and aircraft manufacturing economics and on measuring the economic impacts of various types of noise and air pollution on society.

- It is not only necessary to be able to develop a robust economic framework, it is also necessary to have staff within AEE that are capable of interacting with economic and technical experts from aircraft manufacturers, foreign regulatory agencies, airlines, and other stakeholders. The committee is concerned that AEE may not have sufficient human resources to oversee development of and to fully understand and use such models. Without adequate and dedicated economics expertise and staff to work on APMT, substantial development and implementation risk exists. Additional economic analysis capability resides elsewhere within FAA, but it is not committed to support APMT. There is a need to have economic analysts who understand and deal with the monetization of external effects (social costs), emissions trading, and other emerging issues. Given that one of AEE's objectives is to have APMT adopted by the international community, the model will undergo review by experts from that community. Even if APMT is developed by an outside party, FAA must have some level of resident expertise to use it and explain its results because FAA needs to understand thoroughly the appropriate applications for APMT as well as its limitations. FAA also needs to communicate these attributes to a wide range of users and stakeholders over an extended period.

On the positive side, the committee notes that the recent assignment of an experienced program manager for AEDT and APMT is a sound strategy. In particular, the committee finds it encouraging that FAA has identified for this project a manager with both a proven track record in developing, validating, and improving the various component models of AEDT and the requisite expertise and network that bodes well for success on the AEDT front. However, to develop and integrate APMT, the program manager will require additional support by staff with a thorough grounding in economics.

Recommendations Regarding Next Steps in APMT Development

Since FAA will need to move thoughtfully and quickly to have an APMT that could be useful for CAEP-8 and beyond, the committee recommends that FAA take the following actions with regard to next steps:

- **Work Plan.** FAA should immediately develop a more detailed work plan with specific milestones and schedule for the APMT project and its interface with AEDT. The work plan should identify the human and other resources needed to develop APMT to a level at which it can be accepted as a tool to support deliberations in the United States as well as in the international community.
- **Staffing.** Concomitant with the work plan, FAA should identify adequate economic capabilities within its project staff to advise or lead the APMT development effort.
- **Requirements Development.** FAA should develop detailed requirements for APMT as soon as possible. This product should include (a) detailed necessary and desirable outputs

for APMT; (b) specification of the economic framework to achieve these ends; (c) a map of the critical data needs and relationships; (d) identification of data and model availability and gaps; and (e) specification of architectural needs. FAA should define the requirements both for a long-term modeling framework and for the first version that would be available for CAEP-8. A useful exercise to lay out the economic methodology for APMT would be to create a flow chart of the economic analyses used in the prior CAEP. Capabilities can be added (such as for emissions trading), and the data and computational methods to implement these can be specified. Specification of the economic framework is critical for the requirements analysis. A more complete survey of the available literature, models, and data relating to the APMT elements is also necessary.

- **Prototype Study.** The committee believes that, after development of the detailed requirements, it would be useful for FAA and its partners to undertake a 6- to 9-month prototype study to explore the feasibility of the concept. It might be useful to demonstrate some features of APMT in a limited way within a working prototype. This study should use a scenario that captures the multipollutant and noise trade-offs.
- **Interaction with AEDT Architecture Study.** It will be difficult to develop architecture for APMT or the interfaces in AEDT with APMT without the detailed requirements discussed here. However, FAA should—to the extent possible—account for the likely requirements of APMT in the architecture study that will be needed soon for AEDT.

The committee offers these findings and recommendations with the expectation that they will be useful to the FAA as it meets the challenge of developing and implementing new aviation management tools that promise to bring about significant improvements in protecting the environment while allowing future system growth. The committee appreciates the opportunity to assist in this important endeavor and will be pleased to answer any questions.

Sincerely,

Wesley L. Harris
Chair, AEDT and APMT Study Committee

Enclosures:

1. Committee Roster
2. Workshop Agenda
3. List of Workshop Participants

**TRANSPORTATION RESEARCH BOARD
Committee Roster**

**Committee for Developing Aviation Environmental Design Tools (AEDT) and Aviation
Environmental Portfolio Management Tools (APMT)—A Workshop Series**

(Membership and member affiliations are as of January 31, 2005)

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	Mr. James L. Henderson Senior Economist Stratus Consulting, Inc.	Ms. Mary Lee Vigilante President Synergy Consultants, Inc.

**AGENDA: AVIATION ENVIRONMENTAL DESIGN TOOL (AEDT) AND
AVIATION PORTFOLIO MANAGEMENT TOOL (APMT) WORKSHOP No. 3**
January 31 – February 2, 2005

Day	Time	Room	Event	Moderator, Speaker or Group Leader	
Day 1: Monday, January 31	10:00–11:30 a.m.	101	<i>Administrative planning session, Committee members only</i>	<i>Wes Harris</i>	
	11:30–12:30 p.m.	101	<i>Lunch meeting for Committee members and FAA: Preworkshop coordination</i>	<i>Wes Harris & Tom Connor, Brief 1</i>	
	12:30–2:30	Workshop Session 1			
	12:30–12:45	100	Welcome and administrative items	<i>Wes Harris</i>	
	12:45–2:00	100	APMT Introduction: What is APMT? What are the drivers and the FAA objectives? Context of APMT to AEDT and EDS, overview of elements and work to date	Carl Burleson, Brief 2 Lourdes Maurice, Brief 3	
	2:00–2:30	100	ICAO CAEP analyses briefing: Technical and economic	Tom Connor, Brief 4	
	2:30–5:00	Breakout 1: Breakout groups discuss APMT uses and scope			
		101	Group A	John Putnam & Mary Vigilante	
		110	Group B	Larry Craig & Mike Benzakein	
		201	Group C	Ian Jopson	
5:00	100	Breakout group leaders submit results	<i>Wes Harris & Group Leaders</i>		
Day 2: Tuesday, February 1	7:30–8:00 a.m.	<i>Continental Breakfast, Room 100</i>			
	8:00–10:00	Workshop Session 2			
	8:00–8:30	100	Combined results of Day 1 breakout groups	<i>Wes Harris & Committee</i>	
	8:30–9:00	100	Preworkshop survey results and priorities reviewed	Maryalice Locke, Brief 5	
	9:00–10:00	100	APMT: Models and relation to analysis elements reviewed	Joe DiPardo, Brief 6	
	10:00–11:30	Breakout Session 2: Breakout groups discuss models and gaps and agree upon recommendations (with supporting rationale)			
		101	Group A	John Putnam & Mary Vigilante	
		110	Group B	Larry Craig & Mike Benzakein	
		201	Group C	Ian Jopson	
	11:30	100	Breakout group leaders submit results	<i>Wes Harris & Group Leaders</i>	
11:30–12:30 p.m.	<i>Lunch, Refectory, 3rd Floor</i>				

Day	Time	Room	Event	Moderator/Speaker or Group Leader	
Day 2: Tuesday, February 1 (Cont.)	12:30–3:00 p.m.	Workshop Session 3			
	12:30–1:15	100	Combined results of morning breakout groups	<i>Wes Harris</i> & Group Leaders	
	1:15–1:45	100	AEDT overview with inputs and outputs and relevance to APMT	Gregg Fleming , Brief 7	
	1:45–2:30	100	Center of Excellence relevant research projects and results of literature review	Ian Waitz , Brief 8 Stephen Lukachko , Brief-9	
	2:30–3:00	100	JPDO overview and relevance	Carl Burleson , Brief 10	
	3:00–5:00	Breakout Session 3: Breakout groups discuss APMT scope and priorities			
		101	Group A		John Putnam & Mary Vigilante
		110	Group B		Larry Craig & Mike Benzakein
		201	Group C		Ian Jopson
5:00	100	Breakout group leaders submit results		<i>Wes Harris</i> & Group Leaders	
Day 3: Wednesday, February 2	7:30–8:00 a.m.	<i>Continental Breakfast, Room 100</i>			
	8:00–9:00	Workshop Session 4			
		100	Results of Day 2 APMT breakout groups		TRB designee
	9:00–10:30	Breakout Session 4: Breakout groups harmonize prior breakout results and recommend next steps			
		110	Blue harmonizing group		John Putnam & Mary Vigilante
		201	Green harmonizing group		Ian Jopson & Larry Craig
	10:30–11:00	100	Results of harmonizing breakout groups		Wes Harris designees
	11:00–noon	101	AEDT Committee members meet and summarize		<i>Wes Harris</i>
	Noon–1:00 p.m.	<i>Lunch, Refectory 3rd Floor</i>			
1:00–2:00	100	TRB AEDT-APMT Committee: APMT outbrief		<i>Wes Harris</i>	

**AVIATION ENVIRONMENTAL DESIGN TOOL (AEDT) AND
AVIATION PORTFOLIO MANAGEMENT TOOL (APMT) WORKSHOP No. 3**

Sponsored by
TRANSPORTATION RESEARCH BOARD and
FEDERAL AVIATION ADMINISTRATION
January 31–February 2, 2005
Washington, DC

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