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Agenda Item 3: FESG
Agenda Item 4: Noise Technical Issues – WG1
Agenda Item 5: Operations – WG2
Agenda Item 6: Emissions Technical Issues –WG3

DEVELOPMENT OF A COMPREHENSIVE SOFTWARE SUITE TO ASSESS AVIATION ENVIRONMENTAL EFFECTS

(Presented by the U.S. Member)

SUMMARY

The U.S. Federal Aviation Administration (FAA) is developing a comprehensive suite of software tools that will allow for a thorough assessment of the environmental effects of aviation. The main goal of the effort is enabling a new, critically needed capability to assess the interdependencies between aviation-related noise, emissions, and cost valuations.

The building block of this new suite of software tools that integrates existing noise and emissions models and facilitates the assessment of interdependencies is the Aviation Environmental Design Tool (AEDT). Also within AEDT is the integration of a robust, aircraft and engine analysis tool, entitled Environmental Design Space (EDS). To complete the suite of tools, AEDT and EDS will interact with an economic analysis capability in the form of the Aviation environmental Portfolio Management Tool (APMT).

The FAA wants to work with the other CAEP members and observers to incorporate modeling assumptions, procedures, and CAEP objectives into the development of this toolset, with the goal that this toolset will be part of ICAO's assessment of future aviation environmental standards and policies.

1. INTRODUCTION

1.1 Aviation is a critical part of the world's economy, providing for the movement of people and goods throughout the world, and enabling economic growth. However, concern over aviation's environmental impact, namely noise and emissions, has accompanied its growth.

1.2 Over the last several decades, the aviation industry has made great progress reducing the impact of aircraft noise and aviation emissions. Advanced technology, new operational procedures, and prudent land use practices have each contributed to these reductions. Jets today are 75% quieter (20 decibels) than early jets. New operational procedures and sensible land use practices have also contributed to mitigating the impact of aircraft noise. Engine and airframe advances, and enhanced operating procedures have also dramatically improved aircraft fuel efficiency. Despite this dramatic progress in reducing the environmental effects of aviation, environmental concerns remain strong and growing. Because of growth in air transportation, emissions of many pollutants from aviation activity are increasing against a background of reductions from many other sources. In addition, progress on noise reduction has slowed; a paradigm-changing breakthrough such as the turbofan is not foreseen. Environmental issues are likely to impose a limitation on aviation capacity in the 21st century.

1.3 Delivering continuing reductions in noise and emissions is increasingly challenging. Passenger and cargo aircraft and gas turbine engines are maturing technologies, and the complexity of aerospace systems necessitates an interdisciplinary approach to the design process to achieve new performance advances – including noise and emissions reductions. Although manufacturers have long understood the interrelationships between various aircraft design parameters, reliance on empirical design approaches and lack of computing power hindered significant optimization. However, design advances and increasing computing power offer tremendous optimization possibilities. There is an increased recognition in the regulatory community that complex interdependencies exist amongst aircraft noise and emissions and amongst various emissions. This is true not just with certification standards, but also operational measures. Consideration of interdependencies is necessary to achieve mitigation along with efficiencies.

1.4 To consider interdependencies there is a critical need for robust, transparent analytical tools, which can account for interrelationships amongst noise and emissions, and amongst all types of emissions. In addition, these tools must consider the interrelationships between various measures that might be taken under the elements of a balanced approach (e.g., noise and emissions reductions at source, land use planning and management, operational procedures, operating restrictions, market-based options, etc.) and take into account the costs and benefits of various measures. Such an approach is essential to allow the management of a portfolio of the various aviation measures in a manner that cost-effectively maximizes overall environmental benefit.

2. FRAMING THE PROBLEM

2.1 Determining appropriate noise and emissions standards and recommended practices applicable to a global industry has always been challenging. It requires a number of diverse expertise, data, and models from wide-ranging experts including engineers, environmental specialists, scientists, and economists.

2.2 At CAEP/6 in 2004, participants clearly recognized that to achieve effective mitigation requires consideration of interdependencies between noise and emissions and amongst individual pollutants. CAEP/6 recommended and ICAO's 35th Assembly subsequently adopted three environmental goals, to limit or reduce noise exposure, local air quality emissions, and greenhouse gas emissions. In addition, the U.S. has recently adopted a goal in its Next Generation Air Transportation System (NGATS) Plan to reduce in absolute terms community noise and local air quality emissions while enabling sustained aviation growth. Analytical tools and supporting databases that could account for interdependencies amongst these goals and potentially optimize the environmental benefit of mitigation measures would greatly facilitate and enhance meaningful progress on these goals.

2.3 In assessing the scope of future analytical tools, it is important to consider the potential decisions that policy makers are likely to face in the future. The complexity of decisions has increased over time as the remit of CAEP has gone from a primary concentration on standard setting applied to aircraft to providing policy advice on operational issues and consideration of potential market-based options to reduce the impact of aviation on the environment. In seeking to meet the ICAO goals to limit or reduce aviation environmental impacts, FAA believes that CAEP may consider the following in a future work program:

- More stringent noise standard(s)
- A more stringent NOx landing and take-off (LTO) standard
- A new NOx cruise standard
- A new particulate matter (PM) standard
- Realizing environmental gains through technological advancements in CNS/ATM
- Use of market-based options, operational procedures, and land-use measures to complement more stringent environmental standards

3. TOOL DESCRIPTION

3.1 Existing aircraft noise and aviation emissions analytical tools cannot effectively assess interdependencies between noise and emissions or analyze the cost/benefit of proposed actions. Accordingly, the FAA has launched an ambitious program to develop a robust new comprehensive framework of aviation environmental analytical tools and methodologies to perform these functions. The long-term aim is enabling a comprehensive set of tools to address all aspects of noise and emissions. The elements of this framework include:

- **Environmental Design Space (EDS)**, which will provide integrated analysis of noise and emissions at the aircraft level.
- **Aviation Environmental Design Tool (AEDT)**, which comprises EDS and the integration of existing or new aviation noise and emissions analytical modules to provide an integrated capability of assessing interrelationships between noise and emissions and amongst emissions at the local and global levels.
- **Aviation Environmental Portfolio Management Tool (APMT)**, which interacts with AEDT, EDS and economic modules to provide the common, transparent cost/benefit methodology, needed to optimize aviation policy in harmony with environmental policy.

3.2 This framework of tools will allow aviation stakeholders such as government agencies, industry and the public to:

- Understand how proposed regulatory actions and policy decisions impact aviation noise and emissions on local , national, regional and global levels
- Understand how operational decisions affect noise and emissions and their potential impact on aviation projects
- Understand the cumulative effects of regulatory and non-regulatory actions that affect both noise and emissions

3.3 Anticipated benefits of this initiative include:

- Ability to optimize environmental benefits of proposed actions and investments
- Quantify uncertainty associated with complex policy decisions
- Improved data and analysis on airport/airspace capacity projects
- Increased capability to address noise and emissions interdependencies in the resolution of community concerns
- More effective Research and Development (R&D) portfolio management
- Ability to analyze and accommodate environmental constraints to capacity growth

3.4 The FAA development plan is divided into three aspects being considered simultaneously: the vehicles and their engines, worldwide inventories and fleet operations, and the micro and macro economic impacts of environmental stringencies. The tools will interact within a strategic policy decision-making environment, shown in Figure 1, to provide benefit/cost assessments of policy and operational options. The development schedule for EDS-AEDT-APMT is shown in Figure 2. The schedule is closely coupled to the CAEP cycle. Although the timeline is long (2010), intermediate capabilities will be available as soon as 2006. The following paragraphs provide more details on the development of the 3 major elements of this new toolset.

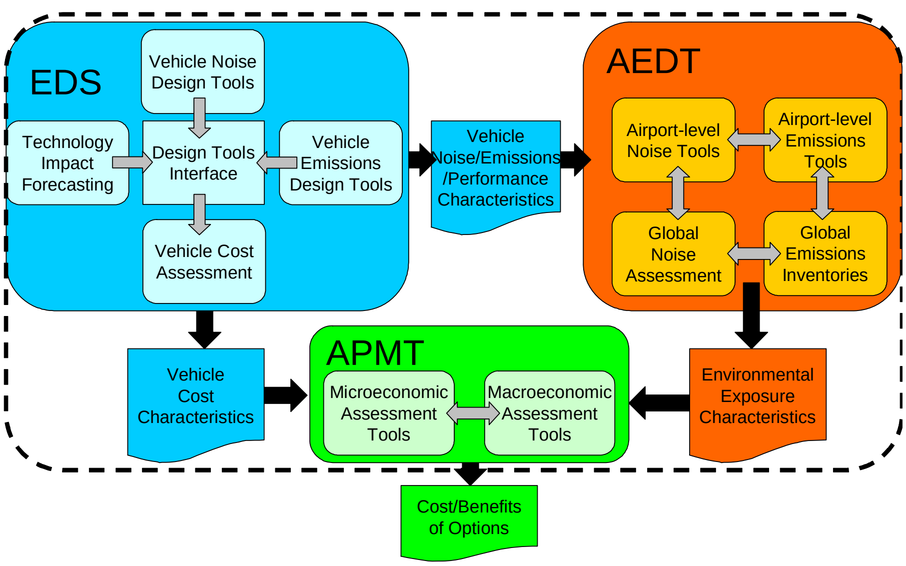

Figure 1. High-Level Schematic of the Components of the New Aviation Environmental Tool Suite

End of CY	CAEP Cycle	AEDT Deliverable
2004	End CAEP/6 CAEP/7	AEDT Work Plan Completed and Development Effort Initiated
2005		EDS Requirements and Architecture Defined APMT Requirements and Architecture Defined AEDT Prototype Demonstration (v 0.0)
2006		AEDT Version 1.0 for CAEP/7 Introduction EDS (v1) and APMT (v1) Capability Demonstration
2007	CAEP/8	EDS (v2), AEDT Version 1.1, and APMT (v2) for CAEP vetting
2008		EDS (v2), AEDT Version 1.2, and APMT (v2) applied for CAEP/8
2010	CAEP/9	AEDT Version 2.0 for Airport Planning Application *Meets criteria for seamless and publicly available* APMT (v3) Capability Demonstration

Figure 2. Conceptual Development Schedule for the Toolset

3.5 *EDS*

3.5.1 EDS is intended to analyze aircraft noise, emissions and performance simultaneously considering both economic and technical performance. Additional functional requirements beyond this primary goal are imposed by EDS's intended use in support of CAEP and NGATS. The functional requirements can, therefore, be summarized as follows:

- The primary functional requirement for EDS is to provide quantitative estimates of the noise, emissions, performance and cost of potential future aircraft
- EDS must be able to consider different assumptions for technological capabilities, design choices, market scenarios, and noise and emissions policies
- The estimates EDS produces should be provided in a manner that enables the trade-offs and interdependencies between technology, economics and environmental impacts at the aircraft level
- EDS must have sufficient flexibility to be employed in a parametric mode to explore potential variations within an aircraft class
- The estimates produced by EDS must include quantitative statements of uncertainty associated with both model fidelity, and with the inputs required
- EDS must function within the overall policy-making environment, interacting with AEDT and APMT by taking appropriate inputs and providing appropriate outputs
- EDS methods and assumptions must be non-proprietary and data generated must be accessible to the international community

3.5.2 EDS will continue to evolve into the standardized generator of aircraft source data for AEDT including noise, emissions, and performance. The intent is to replace the current, separate methods subscribed by FAA's current legacy models, Integrated Noise Model (INM), System for assessing Aviation's Global Emissions (SAGE), and Emissions and Dispersion Modeling System (EDMS), to turn data provided by the airframe and engine manufacturers into the aircraft source databases associated with these legacy models.

3.5.3 EDS input requirements pertain to the type of specifications typically required to design an aircraft and its engine as well as to determine technological impacts. These include:

- Vehicle specifications - The parameters to be considered under this category are those typically used to size an aircraft for a particular mission including class definition, mission definition, material structural selections, aerodynamic inputs, and constraints, such as, maximum field length and maximum approach speed.
- Engine cycle variables - Engines are a subsystem from the vehicle perspective, but they are a complex system in their own right, and an environmental impact assessment is not truly possible without a detailed definition of the engine used.
- Economic influences - Since a vehicle economic analysis is to be included in EDS to facilitate the link with APMT, economic parameters must also form part of the input requirements. The economic parameters generally center on a market scenario includes, but not limited to, such things as production schedule and fuel costs.
- Technology impacts - The parameters under this heading are intended to capture the impact of technology infusion. They may be generic in nature such as factors used to affect aerodynamic efficiency, or they may be introduced to model specific technologies, for example, new materials or cooling techniques that allow for a higher turbine inlet temperature.

3.5.4 EDS output requirements pertain to the type of assessments to be carried out at the vehicle level, as well as to the types of vehicle level inputs required by the other tools in the FAA development plan, AEDT and APMT.

3.5.4.1 AEDT requires data about the aircraft source in order to calculate the noise and emissions generated by the aircraft operation. The initial version of AEDT draws upon the existing aircraft and engine databases used by FAA's legacy tools, INM, SAGE, and EDMS. As it evolves, EDS will provide the necessary data including the following:

- General aircraft characteristics, such as, maximum take-off gross landing weights, maximum operating mach number, maximum operating altitude climb rate, landing and take-off distance, wingspan, fuselage length, and number of engines.
- Aerodynamic performance parameters, such as, lift, drag (induced and parasite) and roll coefficients for each flap setting.
- Engine specifications such as combustor type, bypass ratio, pressure ratios and maximum rated thrust
- Engine thrust settings for various phases of flight
- Fuel burn as a function of power setting, and thrust-specific fuel consumption coefficients
- Noise-Power-Distance curves

- Emission indices for all emissions of interest at each power setting including engine startup

3.5.4.2 APMT will ultimately use a variety of information provided by EDS to determine the effectiveness of proposed environmental regulation portfolios. Much of this information will be passed to and acted upon by AEDT. However, there is a set of EDS information that is needed for fleet and operation planning and cost assessment directly within APMT including airframe/engine combination costs and aircraft performance.

3.6 *AEDT*

3.6.1 AEDT development is guided by two major factors, CAEP and the current user communities for the FAA legacy models. FAA's development plan requires that a preliminary version of AEDT be available in time for the ICAO CAEP Seventh meeting (CAEP/7), which will take place in January 2007, and for AEDT to exist as an integrated, transparent tool available for comprehensive analyses in support of CAEP/8, scheduled for 2010. FAA's proposes to replace current global models, MAGENTA and SAGE, with an integrated capability in the global version of AEDT. There is also a large community that relies on FAA's publicly available models, INM and EDMS, comprising over 1000 users in over 50 countries throughout the world. These models will become modules of AEDT, but their user community cannot be negatively impacted as AEDT development progresses. More importantly, these models are required to meet the regulatory requirements of all aviation infrastructure projects that are in progress or will commence within the development cycle of AEDT. Some of these projects are millions of dollars in magnitude and span over three years in preparation. The FAA understands that the user community and the progress of current project evaluations will demand continued support and a seamless migration to the new AEDT system.

3.6.2 The current AEDT development project devotes a considerable effort to the harmonization of databases and processes. The components being harmonized are summarized in the following paragraphs.

3.6.2.1 <u>Input databases</u>. The AEDT system consists of common input databases, which will be harmonized and expanded to support the requirements of both SAGE and MAGENTA, and where applicable INM and EDMS. For example, all modules require a comprehensive airports database. The aircraft database is another important element and is also the interface by which EDS will be integrated into the AEDT system. The movements database will require the integration of global OAG information, radar data and simulation data from the various ICAO regions, such as the Enhanced Traffic Management System (ETMS) in the US. Similarly all available flight plan data will be integrated in an effort to overcome the weaknesses in using just the OAG. Meteorology, terrain, and population databases will be required by all modules within AEDT.

3.6.2.2 <u>Common processes</u>. There are many functions that currently exist within the local tools that are similar. Individual processors that perform these functions will be incorporated into AEDT and will be used by both of the existing local modules as well as the global modules, as appropriate until those tools are replaced by the fully integrated AEDT. Work is well underway to develop a common processor for calculating flight trajectories, speed, and thrust. This processor will allow the use of dynamically-created flight profiles within emissions analyses. EDMS taxi and queuing methodologies will be incorporated into the common flight processor allowing for consistent calculation of surface movements and adding a new capability for calculating noise from aircraft operations on the ground. The aircraft performance module encompasses two main elements, terminal area performance and enroute performance drawing from methods currently found primarily in INM and SAGE with the incorporation of other best practices, such as, found in the EUROCONTROL BADA (Base of Aircraft DAta) model. Weather data will be handled by a common processor. This will allow the analyst to process a set of meteorological data only once for both a noise and an emissions analysis. Similarly, the terrain data processing will also be common. A common GIS import/export processor will assist in both calculating potential impacts using the same population and geographical data, and also in presenting the results of noise and emissions analyses in a common format.

3.6.2.3 Core computations. The common input databases and common processes will provide the elements necessary to perform the core computations within AEDT. These computations consist of the core acoustics module, which by definition is common to INM, and the core fuel burn and emissions module, which is being harmonized between SAGE and EDMS to ensure a single, core computational module for emissions inventories and dispersion.

3.6.2.4 Output databases. Similar to the need for a common set of input databases, it is equally important to have common output formats in order to achieve the goal of being able to perform an integrated noise and emissions analysis. The output database consists of noise data, fuel burn data and emissions data. These data will be linked as necessary to support the many and varied analysis requirements expected by FAA and CAEP. For example, these output data will need to support stringency analyses, both for noise and emissions. A common way of presenting the implications of various stringency requirements is by aggregating results on various geographic levels (e.g., airport, country, region, etc.). Producing common output will also be facilitated by the development of a common contouring module processor, as well as a common report processor. The report processor will generate reports on the AEDT-Local's input and output data in flexible, user-defined formats rather than making users rely on a small number of standard report formats.

3.6.3 Developing AEDT is extremely complex. While the foundation for building it lies largely in existing modules with established histories and user bases, these legacy tools followed disparate development paths. Developing an integrated noise/emissions modeling capability requires a fundamentally different approach to software management. Because the schedule is closely coupled to the CAEP cycle, the development timetable is extremely ambitious. In addition, prior to integration it is essential to fully scope sub-systems and identify gaps in data and software. To deal with these challenges, FAA has chosen a graduated approach using a series of prototype studies. The prototypes focus on the decisions CAEP is likely to face (see Paragraph 2.3), such as, noise and emission standards, abatement procedures, and airspace changes. FAA has selected the evaluation of NOx stringency as the lead prototype study, and recently presented this initiative to WG2 TG2 in Paris. The AEDT Development Team is constructing a system that can produce the NOx trends using a process that has been enhanced since CAEP/6. This system applies the FESG forecast to the in-service fleet as given by Campbell-Hill, and maps this in-service fleet to unique identification (UID) codes given in the ICAO emissions databank. Thorough validation and verification (V&V) is a critical constituent of the effort. The prototypes will gradually increase in complexity and integration, eventually leading to AEDT. The concept is analogous to building a puzzle using pieces from various components.

3.7 *APMT*

3.7.1 The future analysis needs are driven by a desire to improve the decision making process. This implies taking a step towards developing an environmental benefit-cost analysis capability for aviation, which should establish a new understanding of trade-offs and better interpret risks and guide research agendas. Sought-after capabilities include the following points:

- Model has to produce overall benefits and costs to society (welfare economics), as well as record benefits and costs to each party to understand incentives and market responses (e.g., benefits of emissions trading)
- Full benefit-cost model accounting for differences in global CAEP, regional, national, and local areas
- Model should cover benefits and costs to all parties from aircraft manufacturer to society as a whole—an end-to-end approach that accounts for everything even if all impacts cannot be quantified
- Model has to record results for each identified user and affected party including: manufacturers, airlines, air navigation service providers, airports, military, General Aviation, passengers and shippers, society impacted, etc. ("balance sheets")
- Account for design constraints of aircraft and engines
- Assess cost effectiveness and return on investment of emissions and noise regulations
- Analysis of strategies to introduce a policy and alternatives or scenario analysis
- Cost risk exposure and risk analysis
- Ability to conduct sensitivity analysis

3.7.2 The initial version of APMT is expected to encompass existing CAEP assessment capabilities that focus on the cost-effectiveness of policies only within the primary aviation markets. APMT will also allow for the assessment of interdependencies among noise and various emissions. It further must provide for sensitivity and uncertainty assessments that are difficult to accomplish with the current CAEP approach. Because of the immediacy of upcoming global decisions and the need to adequately inform these decisions, the highest priority for the geographical and economic scope for all of these analyses is global and regional (or national). The primary environmental concerns that must be addressed are local air quality, community noise, and climate change.

3.7.3 Funding permitting, FAA will start to develop the capabilities for benefit-cost analysis within the primary aviation markets, to include monetization of benefits and partial-equilibrium modeling of the consumers and producers in the primary market. Due to availability of data, it is expected that this capability would be developed first for application within the U.S. (within 1-3 years) and then expanded internationally through partnerships and collaborations (4-6 years). The objective is for benefit-cost analysis to ultimately supplant the near-term reliance on cost-effectiveness analysis.

3.7.4 To address longer-term needs (3-8 years), APMT development will expand the above capabilities first to include the addition of indirect and induced costs within the broader economy. This will be done through developing a general equilibrium model, which would also allow for a greater range of distributional analyses. Then as environmental economics research continues to mature, it will be necessary to include indirect and induced benefits to provide a complete capability for environmental economics analyses. Table 1 shows the APMT development timeline.

Table 1. APMT Development Timeline

Development Time Frame	Title	Scope	Capabilities
Years 1-3	APMT v1 Enhanced Cost-Effectiveness Capability	National/ Global	Cost-effectiveness analysis which replicates existing CAEP practice, but uses inputs from AEDT to provide integrated assessment of noise, local air quality and climate variables
Years 1-6	APMT v2 Benefit-Cost Assessment Capability	National/ Global	Add monetized benefits and partial equilibrium modeling of the primary markets enabling limited distributional assessments
Years 3-8	APMT v3 Benefit-Cost Assessment Capability with Indirect and Induced Costs	National/ Global	Indirect and induced cost assessment using a general equilibrium model to enable more complete distributional assessments
Years 6-8+	APMT v4 Benefit-Cost Assessment Capability with Indirect and Induced Costs and Benefits	National/ Global	Addition of indirect and induced benefits
Years 6-8+	APMT-Local v1	Local/ Regional	Perform benefit-cost assessment on local/regional scale

4. CAEP CONNECTION

4.1 FAA is committing significant amounts of research funding to the development of the new aviation environmental toolset to assist the ICAO/CAEP decision-making process. The above work plan is extremely comprehensive and is based on resources which may vary over time. CAEP on the other hand works within fixed time constraints that are not as flexible. Recognizing this dynamic, FAA will continue to actively engage CAEP in the development through participation within the CAEP technical groups, WG1, WG2, WG3, and FESG. Similar to the MAGENTA process of CAEP/4 and 5, this engagement will be essential in establishing stakeholder buy-in and prioritizing the essential elements that will most influence a CAEP decision. In the interest of providing CAEP with the best possible tools, FAA objective is to have each of these working groups recommend CAEP's formal involvement in the toolset development at the last meeting of the Steering Group before CAEP/7.

4.2 FAA's most extensive engagement is occurring in WG2, specifically TG2 and TG4. For example, the WG2 report on operational interdependencies (CAEP-SG20051-WP/24) describes TG2 progress on interdependencies including model assessments and analyses reviews. Paragraph 3.3.1 of WP/24 notes the AEDT development work that supports the TG2 activity. As WG2 TG2 continues is work on interdependencies, FAA will continue to align AEDT development tasks to create a tool that fulfills the modeling requirements that WG2 described in WP/11 at SG20041. For the remaining WG2/TG2 meetings leading up to CAEP/7, FAA and its AEDT Development Team will support TG2 in the following areas:

1) Maintain Common Inputs for CAEP Analysis List: Continue to document assumptions arising from the NOx prototype study (see Paragraph 3.6.3) and from a review of past CAEP analyses.

2) Identify Software Model Gaps: Where gaps exist, propose AEDT tasks that would address these gaps. For example, the AEDT project is developing a common operations database which TG2 has already identified as a need.

3) Perform Verification: Construct a validation and verification program for AEDT that builds upon the modeling and scenario assumptions that TG2 agreed at the last meeting in Paris (See TG2-5/WP05).

4) Demonstrate Performing a CAEP Analysis: Demonstrate AEDT initial capability through prototype studies that demonstrate the multi-dimensional nature of CAEP requirements. A NOx prototype study is currently in progress,

4.3 While less extensive then the WG2 engagement, FAA continues to keep the FESG apprised of the APMT development and of any issues requiring FESG assistance. For example, the APMT Development project leader gave an in-depth presentation on the architecture and requirements work at the last FESG meeting in Iceland. In addition, the APMT Development Team has established coordination with other experts who have participated in past economic analyses for CAEP and is reviewing economic models previously used in CAEP. For the remaining FESG meetings leading up to the last Steering Group meeting, FAA and the APMT Development Team will continue to engage the group as it progresses the tool with the objective to demonstrate a basic cost-effectiveness capability before CAEP/7 as noted in Table 1 above.

4.4 In the joint technologies interdependencies report (CAEP-SG20051-WP/10), the rapporteurs of WG1 and WG3 reported on the agreement of the two groups to establish a common philosophy for assessing the impact of noise, NOx, CO2 and cost of technological responses to future policy options based on the work of the ad hoc group (See CAEP-SG20051-IP/15). WG1 and WG3 also recognize that the effort would require considerable input from ICCAIA, with the support of other members. FAA intends to introduce EDS into the future WG1 and WG3 discussions beginning with the next meeting of WG1/TTG. FAA envisages EDS as the modeling platform to realize the common philosophy proposed by the ad hoc group. Like WG1 and WG3, the EDS Development Team recognizes the need for considerable input from industry and has created a technical advisory board drawing representatives from the manufacturers and ICCAIA.

4.5 As indicated in the opening paragraph of this section, FAA hopes that bringing AEDT, APMT, and EDS development to the CAEP workgroups would produce recommendations from these groups to the Steering Group to involve CAEP in the toolset development just as CAEP was directly involved in the development of MAGENTA for CAEP/5. FAA envisages that the recommendations from the working groups for future terms of reference would look something like the following:

- From WG2: “Fully develop and validate the Aviation Environmental Design Tool for assessment of optimal noise and emissions control strategies including interdependencies. Work with FESG to integrate environmental exposure assessments and interdependencies into the CAEP cost/benefit modeling.”
- From WG1 and WG3: “Evaluate the Environmental Design Space concept as the basis for an overall process to assess technological responses and identify technology trade-offs. Work with WG2 and FESG to integrate technology responses and trade-offs into the CAEP cost/benefit modeling.”

- From FESG: "Fully develop and validate the Aviation Portfolio Management Tool for the conduct of economic analyses of policy proposals, such as, stringency proposals, operational measures, market-based options, and the economic consequences of interdependencies."

4.6 FAA's goal is the development of the toolset that meets CAEP needs. Therefore the toolset should complete the CAEP interdependencies framework to assess both noise and emissions simultaneously when considering stringency and non-stringency policy options as jointly proposed by the rapporteurs of WG1, WG2, WG3, and FESG (See CAEP-SG2005-WP/11). Appendix A of the joint WP/11 shows a schematic of the framework. Figure 3 is FAA's vision of how that framework would look with the components of the new toolset.

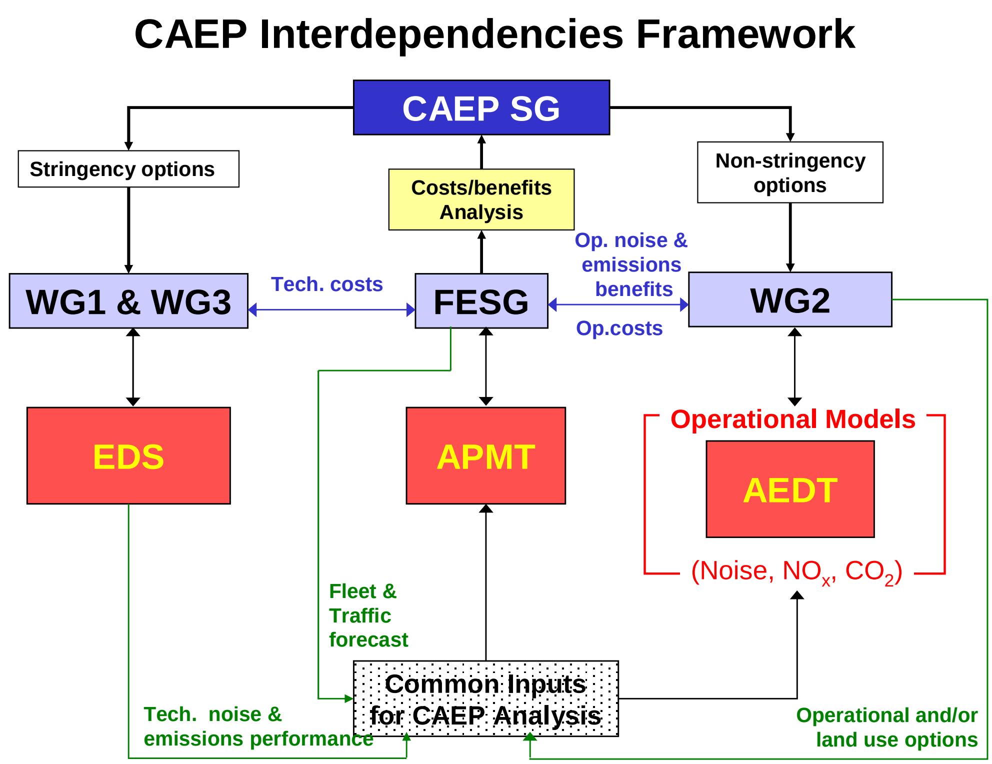

Figure 3. Coordination Framework for CAEP Assessment of Interdependencies

5. SUMMARY

5.1 Aviation must continue its record of becoming one of the quietest, cleanest, and most fuel-efficient modes of transportation to avoid a constraining effect on the ability of the air transportation system to respond to market demands and provide the system required in the future. Success requires an interdependent approach to aviation environmental regulation. In 2004, the FAA, in collaboration with NASA and Academia, initiated a long-term (2010), strategic effort to develop analytical tools to address the relationship between noise and emissions and different types of emissions. Current analytical tools focus on noise or emissions; however noise and emissions are interdependent phenomena. The long-term goal of the effort is to develop comprehensive, transparent aviation environmental analytical tools to enable an interdisciplinary approach to assessing impacts and interrelationships between noise and emissions and amongst different types of emissions. The immediate goal is to extend the collaboration to the wider international aviation community through CAEP.

5.2 The core of the new suite of software tools and databases is the Aviation Environmental Design Tool (AEDT), which will integrate existing national and potentially international, noise and emissions models with a new aircraft and engine analysis tool, referred to as the Environmental Design Space (EDS). To complete the suite of tools, AEDT and EDS will work with an economic analysis and monetizing capability, entitled the Aviation Environmental Portfolio Management Tool (APMT). This suite of tools will enable assessments of global, regional, national, and airport-specific environmental impacts of aviation and associated economic costs and societal benefits. Specifically, the tool set will model aviation system technology changes, operational impacts of aviation noise and emissions abatement procedures and policies, manufacturer and operator costs of noise and emission reduction, environmental and health related costs associated with noise and emission exposure, and broader societal macroeconomic effects. These tools should be useful at local, regional, national and international levels, particularly in informing the work of CAEP. Ultimately, these tools are an essential strategy to meet the aviation environmental goals adopted by ICAO, as the well as the revolutionary vision of net reductions of both noise and emissions, despite projected growth, contained within the U.S. NGATS.

— END —