AEDT NEWS

Welcome

The AEDT Development Team

Welcome to the first AEDT newsletter. As you know, the FAA is developing a new suite of tools that will allow for the evaluation of noise and emissions interdependencies, known as the Aviation Environmental Design Tool (AEDT). This will be accomplished by augmenting and integrating the existing noise and emission models. From this point on, the AEDT newsletter will cover the development of AEDT, as well as the points of interests of the existing tools such as INM and EDMS.

Anyone who has conducted both an aviation air quality and an aviation noise assessment realizes that a tremendous amount of common data exists between the two studies. In fact, a change in either noise or emissions is likely to result in a change in the other. By building the ability to model noise and emissions together, efficiencies are gained by reducing the total input required while simultaneously taking the first step toward understanding the interdependencies between noise and emissions. This in turn supports comprehensive policy planning and decisions in addressing aviation environmental issues. This newsletter discusses in detail several of the efficiency gains through the use of common airport, fleet, and operational data, and examples of the interdependencies that can be evaluated.

As part of the user community, you play a critical role in influencing the development of AEDT and phase-out of the existing tools. The FAA has invited a select number of companies to participate in the AEDT Design Review Group (DRG), with the intent of capturing the critical user perspective regarding AEDT functionality and usability throughout the development process. The inaugural AEDT DRG meeting took place last March; the group will meet periodically to ensure that our development efforts align closely with the needs of the user community.

This newsletter covers many points of interest in the wake of recent releases of INM 7.0 and EDMS5.0, such as version-to-version comparison and analysis, technical notes, news and policies. As you will read, EDMS 5.0 and INM 7.0 mark the first public release of many AEDT components.

As always, we encourage you to continue providing input to us. Your questions, suggestions and comments will help to shape the future functionality and features of the tool. In addition, it will help the FAA define priorities for development, and to help the development team understand how the tool might be used in practice.

Thank you.

AEDT Interdependencies

Why Integrate Noise and Emissions?

Ralph Iovinelli, FAA

Chris Roof, Volpe National Transportation Systems Center

Aviation noise and emissions have historically been modeled and analyzed separately. In reality, noise and emissions are highly interrelated phenomena that must be understood and mitigated together. The interdependent relationship between noise and emissions, and even between individual emissions pollutants themselves, warrants a more sophisticated approach to environmental modeling to support decisions related to aviation noise exposure, local air quality emissions, and climate issues.

Reduced thrust takeoffs provide an excellent example of how a single change in aircraft operations (reducing the throttle setting during take-off and climb-out) could lead to a multitude of changes in environmental parameters. A recent conceptual scenario, analyzing reduced thrust procedures, illustrated increases in CO_2 and SO_x, decreases in NO_x and particulate matter (PM) on the emissions side, and an overall reduction in noise exposure.

Fundamental flight information such as airframe/engine combinations and actual aircraft trajectories are common to both noise and emissions analyses. The use of a common analysis tool ensures consistency of these parameters.

Interdependencies (cont.)

Environmental regulations, airport and airspace redevelopment plans, and aviation policy decisions are the primary drivers that underscore the need to have an integrated assessment tool, capable of clearly articulating environmental trade-offs.

Table 1 illustrates that while some trade-offs are intuitive, others are not. Part of the goal for AEDT is to be able to educate decision makers, the general public, and others take holders regarding potential trade-off consequences. The tool will use the best available scientific data and methodologies, consistent with the INM and EDMS methodologies used in the past.

Table 1. Aviation Noise and Emissions Interdependencies; Examples of Trade-off Consequences

	Noise	Local Air Quality	Climate
Nacelle Modifications	• Reduced Noise	• Increased HC & CO	• More fuel burn/CO_2
Increased Engine Pressure Ratio & Temp		• Increased NOx • Reduced HC & CO	• Reduced fuel burn/CO_2
Reduce Cruise Altitude			• Increased fuel Burn/CO_2 • Increased NOx • Less increase in Ozone • Reduced Contrails
Increase Engine Bypass Ratio	• Reduced Noise	• Increase NOx	• Reduced fuel burn/CO_2
New Runways	• New Noise Exposures	• Reduced delay (fuel burn)	
Reduce Polar Flights	• Potentially Increased • Noise Exposures		• Less Effects on Stratosphere • More Fuel Burn/CO_2
Steep Climb	• Reduced Noise	• More Fuel Burn	• More Fuel Burn/CO_2
CDA	• Reduced Noise	• Reduced Delay (Fuel Burn)	• Reduced Fuel Burn/CO_2
Reduced Thrust Takeoffs	• Reduced Noise	• Reduced NOx • Reduced PM • Increased SOx	• Increased Fuel Burn/CO_2

Ordering EDMS and INM:

EDMS (EDMS 5.0.2 CD):

1. Send the completed EDMS order form (PDF) to edms@cssiinc.com or call (202) 863-2175.
   The link to the order form can be found at:
   http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model/

2. Request a free license from EUROCONTROL EDMS 5 uses the EUROCONTROL Base of Aircraft Data ("BADA") for fuel burn calculations. In addition to completing the EDMS Order Form, the user must also obtain a free license directly from EUROCONTROL for use of BADA by visiting the following website:
   http://www.eurocontrol.fr/bada/license

INM 7.0:

1. Send the completed INM order form (PDF) to ATAC Corporation by email or fax (on order form) The link to the order form can be found at:
   http://www.faa.gov/about/office_org/headquarters_offices/aep/models/inm_model/ ?

The Guts of AEDT

AEDT incorporates and expands upon the capabilities of existing AEE tools. It will have the ability to perform both local and global emission and noise analyses. The tool is composed of common modules and databases that are shared by both the emissions and noise analyses. As seen in Figure 1, the Aircraft Performance (APM), Aircraft Emissions (AEM), Aircraft Acoustics (AAM), and Fleet and Operations (FOM) modules are all core components within the existing tool suite. The figure also illustrates the evolution of AEDT from the legacy tools.
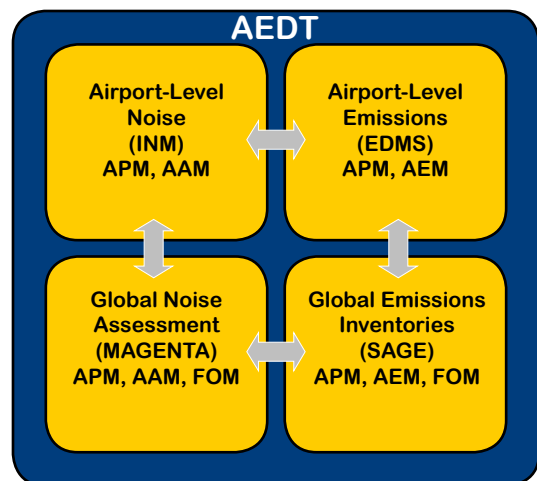

Figure 1. Illustration of Major AEDT Components

A Note on the "Modified NPD Curve" Checkbox

Eric Boeker, Volpe National Transportation Systems Center

Recently, several questions have been posed to the INM Technical Support Team concerning the "Modify NPD (Noise-Power-Distance) Curves" functionality found in the Case Setup menu of INM. This functionality was added in Version 6.0, and allows for the adjustment of NPD data according to user-specified meteorological data. Since this functionality will also be included in AEDT, a detailed description of the "Modified NDP Curves" functionality is presented below.

An unchecked "Modify NPD Curves" checkbox (the default) indicates that aircraft noise data are used "as-is", or unadjusted for study-specific atmospherics. As described in the INM Technical Manual, INM NPD data are calculated using the SAE-AIR-1845 average atmosphere. SAE-AIR-1845 specifies a hypothetical atmosphere using average atmospheric absorption rates. These average atmospheric absorption rates are used in the calculation of the AEDT (and INM) standard NPD data. Since these average absorption rates are inherent in the NPD data, SAE-ARP-866A is not applied when "Modify NPD Curves" is unchecked. Although the specific, user-defined atmospheric values are not used to modify noise data, they are used to calculate aircraft performance.

A checked "Modify NPD Curves" checkbox indicates an adjustment to aircraft noise data based on user-defined temperature and humidity values (see Figure 2). These user-specified, atmospheric parameters are used to calculate atmospheric absorption coefficients according to SAE-ARP-866A, which are in turn used to adjust standard NPD noise data to the study-specific airport conditions. These user-defined, atmospheric parameters are also used to calculate aircraft performance.
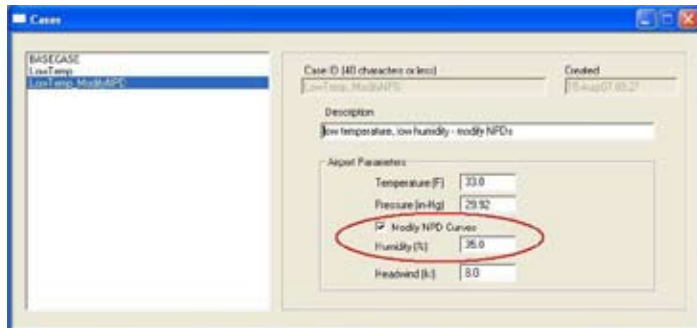

Figure 2. Setup -> Case Pulldown Menu (from INM 7.0)

Due to the inherent difference between these two atmospheric absorption implementations, there is currently no way to exactly match the hypothetical SAE-AIR-1845 atmosphere (default) in AEDT (or INM) when "Modify NPD Curves" is checked. Instead, good engineering judgment should be used when determining whether or not to modify the noise data for atmospheric conditions in a given study.

The following examples illustrate the use of different atmospheric values in INM 7.0, and are provided to better characterize the effects of these differences on noise and performance data (see Table 2).

Table 2. Example of Different INM Setup Parameters

Ex.	Temp. (°F)	RH (%)	Modify NPD Curves?	Performance Atm. (°F)	NPD Atm. (°F, %)
1	77°F	70%	No (unchecked)	77°F	SAE-AIR-1845 average absorption rate
2	77°F	70%	Yes (checked)	77°F	77°F, 70%
3	33°F	35%	No (unchecked)	33°F	SAE-AIR-1845 average absorption rate
4	33°F	35%	Yes (checked)	33°F	39°F, 35%

These parameters were implemented in INM examples study "test50", and the differences between these examples may be seen in Figures 3 and 4 below. The figures show DNL contours from 55 dB to 85 dB (in 10 dB intervals).
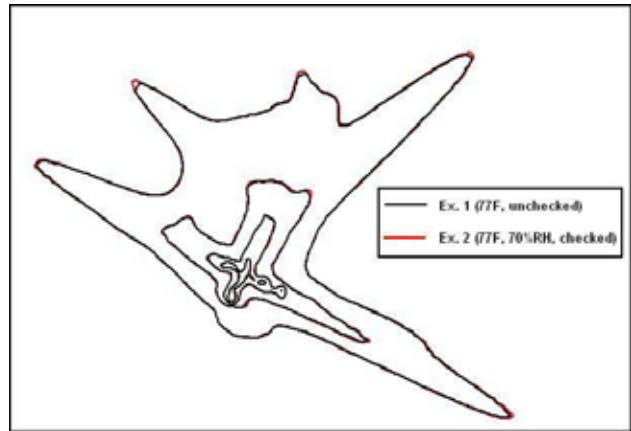

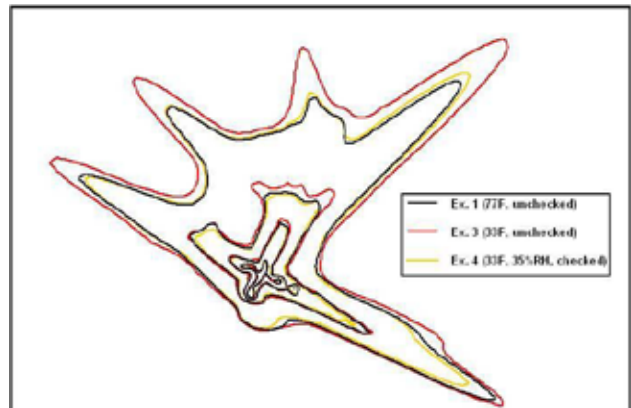**Figure 3. Comparison of Example 1 and 2 from Table 2**

Figure 4. Comparison of Example 1, 2 and 4 from Table 2

In general, for the conditions tested, user-modified atmospheric absorption results in similar noise levels as the standard, unmodified INM under minimum absorption conditions; e.g. ~70-80°F, ~70% RH (see Figure 2). However, user-modified atmospheric absorption results in slight reductions when compared to unmodified noise levels in most cases. These differences tend to increase with increasing slant range distance, and tend to be the largest for low humidity; low temperature cases (see Figure 3)[1]. In general, the use of the "Modify NPD Curves" feature is recommended for studies where there are significant variations from minimum absorption conditions (~70-80°F, ~70% RH).

Dynamic Runway Configurations

Panta Lucic and Alex Nguyen, CSSI

New AEDT functionality that was recently implemented in EDMS 5.0 offers users the flexibility to represent airport configurations based on either meteorological activation parameters, or user-defined distributions, expressed as the annual percentage of time a configuration is used. The user is able to choose the appropriate configuration method based on the goals of the study and the data available to represent the airport's operations.

Each configuration assigned to the study airport must include a corresponding range for at least one of the activation parameters. Runway configurations are selected by comparing the surface weather data for the hour and time of day with the activation parameters. The configurations can change only on an hourly basis, with at most 24 changes per day, which is consistent with the hourly weather information available.

The activation parameters are as follows, ranked based on their importance as suggested by terminal area air traffic controllers:

1. Wind direction
2. Wind speed
3. Time of day when the configuration applies
4. Ceiling
5. Visibility
6. Temperature

Configuration Selection by Ranking

In order to use this function, the user supplies EDMS with definitions for some or all of the above parameters that will cause a change in airport configuration as defined above. For example, if under calm weather conditions an airport uses more than one configuration due to a significant difference in the traffic flows for different daily time intervals (e.g. a heavier departure flow in the morning and heavier arrival flow in the afternoon, or restrictions imposed for noise abatement), then the user can assign ranges for weather-related activation parameters as well as time of day.

Furthermore, users can rank configurations based on their utilization preferences to help EDMS to determine the desired configuration in the case where multiple configurations are possible.

The configuration selection algorithm scans the list of configurations starting from the top of the list until it finds the first configuration for which the activation parameters fit the current meteorological condition. If the current weather condition fits with multiple configurations, the first viable configuration (closest to the top of the list) will be assigned.

If there is no configuration that fit the current conditions, the model will find a configuration that matches the conditions most closely. This method ensures that a configuration will be selected for every time bin. Since wind direction is the parameter that affects dispersion results the most, the model will first try to find a configuration that most closely matches the current wind direction. If none of the configurations have a range of wind directions specified, then the configuration selection algorithm will try to match the current conditions based on the remaining activation parameters.

Configuration Selection by User-Defined Distributions

Using airport configurations in the method discussed above does not guarantee that any particular configuration will be used for a given amount of time throughout the year, since the selection of the active configuration is based solely on weather conditions. However, the user can instead choose to explicitly specify the percentage of time that each configuration will be used throughout the year. When operating in this mode, an algorithm will select a configuration for each hour during the study period such that the overall time distribution of configurations corresponds to the specified percentages of time used and so that the selected configuration is reasonable given the wind direction.

The configuration assignment algorithm ranks all available configurations based on how closely their assigned wind ranges match the observed wind direction from the surface weather file, for each one hour time bin. The matching is done by examining how much the observed wind direction is outside the bounds specified in each configuration, which is the same method used to determine the closest match for the observed data with no fitting configuration discussed earlier.

EDMS Version Comparison

Version 4.5 and 5.0

Alex Nguyen, CSSI

EDMS has been re-engineered in the EDMS 5 series to include the following technical enhancements: the incorporation of an updated FOA3 aircraft PM estimation methodology, the introduction of a departure queuing model, the employment of an advanced airport configuration model, and the use of an aircraft performance model in conjunction with the Boeing Fuel Flow Method 2 methodology. The improvements incorporated into EDMS 5.0 represent a major step towards AEDT, which will enable simultaneous assessment of noise and emissions interrelationships. In addition, these improvements result in differences in the fuel burn and emissions results between EDMS 4.5 and EDMS 5.

A summary of the modeling changes in EDMS 5, as well as comparison of sample results between the two versions, are being documented and will be available soon from the EDMS website. This document will show differences in fuel burn and emissions for various pollutants by fleet mix / aircraft type, airport elevation, and ambient temperature, as well as highlight areas where significant changes in results might be expected between the two versions. For more information, visit the EDMS website at:

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model

INM 7.0 RELEASE NOTES

Eric Dinges, ATAC

INM 7.0 Release

As many users are already aware, version 7.0 of the Integrated Noise Model (INM) was released on April 30, 2007. Over 200 copies of INM 7.0 have been shipped to users in 36 countries since its release. This latest version of the INM includes many enhancements over the INM 6 series, perhaps the most notable being improved helicopter modeling capabilities based on version 2.2 of the FAA's Heliport Noise Model (HNM), new noise and flight performance modeling methods based on updated international guidance documents including ECAC Doc 29 and SAE-AIR-5662, and changes to the model's input data structure and other functionality to move it closer to the eventual structure and capabilities of AEDT. More information about INM version 7.0 can be sound on the FAA's website at:
http://www.faa.gov/about/office_org/headquarters_offices/aep/models/inm_model/

INM 7.0 Technical Manual Release

The INM 7.0 Technical Manual is scheduled for release in October, 2007. This manual describes in detail the methodology used by the INM for all of its flight performance and noise calculations. Specific items of interest that are new from the INM 6.0 Technical Manual include new sections related to:

- helicopter flight profiles and noise calculations
- new flight procedure steps
- bank angle calculations
- new thrust reverser modeling
- new lateral attenuation methods
- Line-Of-Sight blockage calculations
- Audibility metrics
- New database submittal forms, including separate versions for jets, propeller-driven airplanes, and helicopters

All registered INM 7.0 users will be shipped a copy of the INM 7.0 Technical Manual as soon as it is available.

AEDT Dynamic Aircraft Performance and Advanced Emissions Methodologies

Alex Nguyen and Cliff Hall, CSSI

To enhance emissions modeling accuracy and increase consistency between noise and emissions modeling, all AEDT components (including INM and EDMS) now use a common aircraft performance module based on SAE-AIR-1845, ECAC Doc 29, and BADA methodologies. Previously, aircraft flight profiles in EDMS were stored statically as points in a data table that was based on default assumptions and nominal conditions. With a shared algorithm, aircraft performance and flight paths are modeled identically in both the INM and EDMS. The dynamic aspect of the algorithm allows aircraft to be modeled under airport-specific meteorological conditions. Because some runway exits have speed limitations, when modeling landings, output from the AEDT Aircraft Performance Module (APM) is also used to select the inbound taxiway path that an aircraft follows as it returns to its gate.

In EDMS 4.5, the takeoff portion of a departure was assumed to end at an altitude of 1,000 feet Above Field Elevation (AFE). With the dynamic flight performance module, the transition from takeoff to climb out is now variable, depending on aircraft performance characteristics and weather.

For emissions calculations, the main source of data is the ICAO Engine Exhaust Emissions Databank, which stores fuel flow and emission indices that have been corrected to standard day. AEDT contains an Aircraft Emissions Module (AEM) that is common to both EDMS 5.0 and the FAA's System for assessing Aviation's Global Emissions (SAGE). The fuel burn output from the Aircraft Performance Module is used to compute the fuel flow, which is then fed into the AEM. Boeing Fuel Flow Method 2 (BFFM2) is then used by the AEM to adjust the aircraft engine emissions factors based on a standard day (such as those derived from ICAO's Engine Exhaust Emissions Databank) for the airport-specific conditions of ambient temperature, pressure and humidity, as well as aircraft speed and installation effects.

The AEM also includes a new First Order Approximation 3.0 (FOA3) that models three components of Particulate Matter using the sum of three separate equations: a power and polynomial function of smoke number for non-volatile PM, a constant factor for SO4, and a function of HC EI for fuel organics. This methodology is a significant improvement over the previous FOA2 methodology, for which the total PM was based solely on a factor of the non-volatile component. The FOA3a methodology is used for U.S. airports, and includes additional reasonable margins to accommodate uncertainties over the FOA3 methodology.

INM Version Comparison

Version 6.2 and 7.0

Rebecca Cointin, FAA

With the release of a new version of INM comes the inevitable question, "How will the contours change at the airport?" A study of the effects of the updates to INM 7.0 was undertaken by the development team. Four airports from across the country, with varying fleet mix and operation levels, were used in the analysis. The airports consisted of both a western and eastern airport, a large hub, and an airport dominated by propeller aircraft. Table 3 illustrates the fleet breakdown for each of these airports. The breakdown between jet aircraft with wing-mounted engines and propeller aircraft is shown because of the scope of changes to lateral attenuation in INM 7.0 (per SAE-AIR-5662). Those changes affect all jet aircraft, but the affect on jet aircraft with fuselage-mounted engines are minimal compared to wing-mounted engines, propeller-driven aircraft, and helicopters. The new implementation of lateral attenuation in INM 7.0 will generally be the most significant cause of differences in calculated noise levels between INM 7.0 and previous versions.

Table 3. Percentage of Operations by Airport

	Percent of Operations			
	Jet	Prop	Helio	Wing-Mounter Engine
Western	82.9	17.1	0.0	69.4
Eastern	73.5	26.5	0.0	63.5
Large-Hub	92.8	7.2	0.0	47.1
Heavy Propeller-use	31.0	67.0	2.0	25.1

Table 4 shows the 65 dB DNL contour area calculated by INM 6.2a and INM 7.0 for each of the four airports. Overall, this sensitivity study indicates that contour sizes did not greatly increase with the implementation of INM 7.0. With the implementation of INM 7.0, the 65 dB DNL contour areas for the four airports did not increase more than 10%, with most increased less than 6.0%. The largest increase in contour size was seen at the heavily propeller-use airport. Studies were modeled in both versions using terrain data, lateral attenuation set to "all soft ground", a temperature of 59 degrees Fahrenheit and an eight knot headwind. In INM 7.0, the studies were run with the bank angle turned on.

Table 4. 65 dB DNL Area in Sq. Miles

	Sq Mile area 65 db DNL		
	INM 6.2a	INM 7.0	% Diff
Western	12,764	13.306	4.2
Eastern	17.122	18.034	5.3
Large-Hub	24.936	25.648	2.9
Heavy Propeller-use	14.683	16.014	9.1

The percentage of jet aircraft with wing-mounted engines and propeller aircraft in the airport's fleet mix will directly affect the amount of increase that will be seen in the 65 dB.

DNL contour with the use of INM 7.0. Even though the Heavy Propeller-use airport has a small percentage of jet aircraft with wing-mounted engine in its fleet, the large amount of propeller aircraft led to the large increase (9.1%) in the contour area. Figure 5 shows the affect of the changes in the air-to-ground component of lateral attenuation for propeller aircraft between the INM 6.X series and INM 7.0.
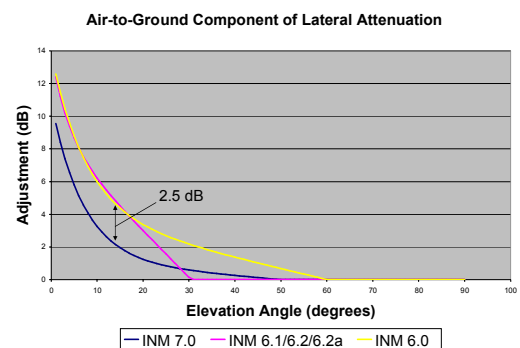

Air-to-Ground Component of Lateral Attenuation

Figure 5. Air-to-Ground Component of Lateral Attenuation for Propeller Aircraft1

For the other three airports studied, as the percentage of jet aircraft with wing-mounted engines in the fleet increased, the percent difference of the contour area also increased.

Overall, changes in the contour areas can be expected, but they will typically be below 10% with most being below 6%. These contour area changes are a direct result of the updated methodologies used in INM 7.0 to allow for more accurate modeling of real-life situations and to keep INM 7.0 compliant with international standards.

1 Note: Lateral attenuation in INM 7.0 is made up of a ground-to-ground component (dependent on slant range distance), an air-to-ground component (dependent on elevation angle) and an engine installation component (dependent on aircraft type and depression angle).

FAA Guidance on the Use of Model Versions

Bill He, FAA

FAA AEE and APP recently provided the following guidance in response to regional inquiries on the selection of versions of the AEE models such as INM, EDMS or AEDT.

"The responsible FAA officials and project analysts must use the most current version of the model when beginning a new environmental study or when there is a significant procedural change in a study (e.g., certain study reconstructions or written re-evaluations). If AEE issues a new version of a model after the environmental analysis for a project has begun, particularly after issuance of a draft environmental assessment or draft environmental impact statement, the officials and analysts are not required to use the newer version of the model or to redevelop the environmental analysis. However, officials and analysts have the discretion to update project methodology at any time to the newest model version if this would substantially improve or change the analysis and provide a stronger basis for informing decision-makers and the public.

In the case where a project is reconstructed with a new base year and forecast years, we would encourage the use of the most recent version of the AEE models".

Websites to Visit

These two websites provide information regarding AEE tools, including AEDT and the other tools in the AEE Tool Suite.

AEE Tools FAQ:
http://www.faa.gov/about/office%5Forg/headquarters%5Foffices/aep/models/toolsfaq/

AEE Conference Presentations:
//www.faa.gov/about/office_org/headquarters_offices/aep/models/history/

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