Federal Aviation Administration

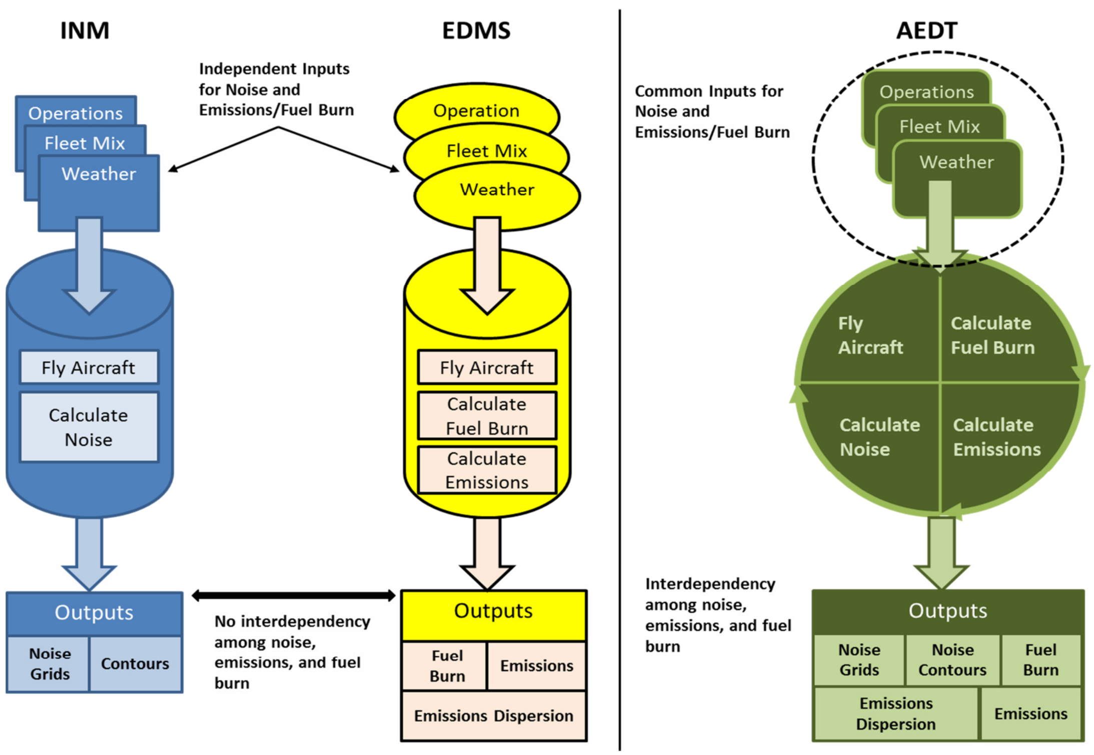
Release Date: 3 June 2016

AEDT & Legacy Tools Comparisons

The FAA's Aviation Environmental Design Tool (AEDT) has been developed to replace a series of legacy FAA tools for modeling noise, emissions, and fuel consumption. These legacy tools include the Integrated Noise Model (INM), Emissions and Dispersion Modeling System (EDMS), and Noise Integrated Routing System (NIRS). Although there is significant overlap in functionality and underlying methodologies between AEDT and the legacy tools, AEDT has a fundamentally different system architecture, design and capabilities which allow the user to simultaneously model aviation noise, fuel consumption, and emissions within a common interface and common inputs.

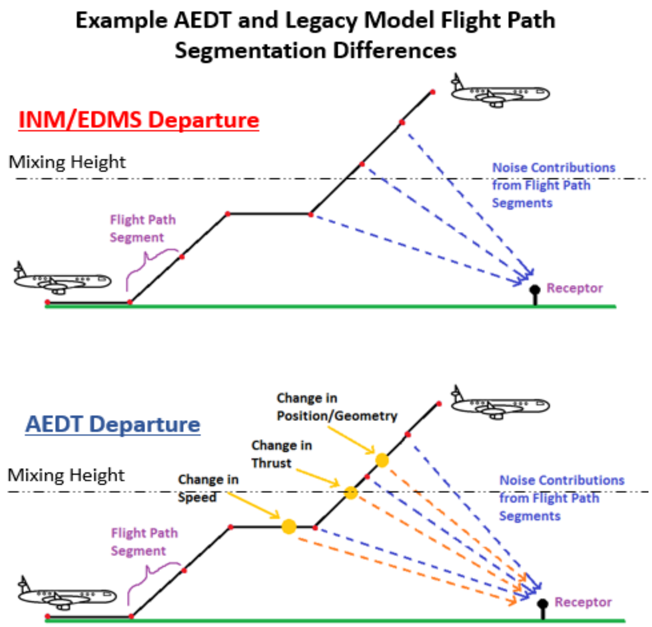
Many updates and corrections representing the best available science have been incorporated into AEDT, which will result in differences when comparing results from AEDT with the legacy tools. During AEDT development extensive work of verification and validation was performed against both the legacy tools and gold standard data such as Cockpit Flight Data Recorder data to ensure AEDT is capturing the aircraft performance and positioning correctly. These types of validation exercises are captured as part of the AEDT documentation to build confidence that AEDT is a more accurate model than legacy tools.

Improved algorithms in AEDT will lead to differences in noise calculated at receptor locations, noise contour areas, emissions output, and fuel burn over the legacy models. These differences are expected and should not cause concern as the methods employed in AEDT are based on the best available science and result in more accurate environmental outputs. This document provides a high level summary of the improvements to AEDT and the expected differences in output. For a more detailed description of the differences in modeling methodologies, the AEDT user should review the AEDT2a Uncertainty Quantification report and the AEDT2b Technical Manual, available on the FAA AEDT website. In the event that an AEDT user encounters results that look out of the ordinary, after performing quality control measures, they should contact AEDT support.



Noise, Emissions, and Fuel Burn Calculations

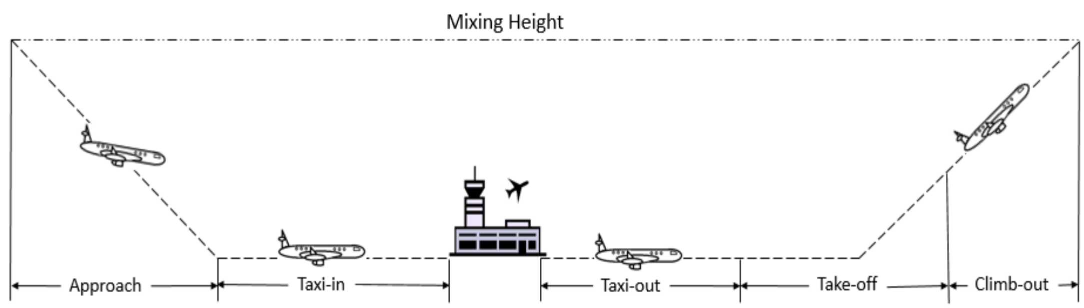
The calculation of noise, emissions, and fuel burn can be affected by the aircraft flight path, local weather, and aircraft characteristics. Updates to AEDT from the legacy models in these areas will lead to some differences between the noise, emissions, and fuel burn calculated in AEDT and the legacy models. The updates to AEDT in flight path, weather, and aircraft characteristics are summarized below.



Flight Path Comparisons

AEDT and the legacy tools model aircraft along a flight path. AEDT and INM/EDMS break up flight paths into smaller pieces, called flight path segments. Each flight path segment contains specific aircraft data including: *engine power setting, aircraft state (bank angle, flap setting, etc.), aircraft speed, and position.* These values are used to compute noise, fuel burn and emissions.

AEDT flight paths typically have more segments than INM/EDMS flight paths. More segments (e.g., shorter segment lengths) have been shown to better approximate changes in aircraft state, and therefore better predict noise when compared with measured data. An example of flight path segmentation differences between AEDT and the legacy tools is shown to the left.



747-200 Time in Mode Comparison (sec)		
Mode	**EDMS**	**AEDT**
Taxi-out	1,140	1,140
Take-off	154	118
Climb-out	6	63
Approach	204	222
Taxi-in	420	420
Fuel Burn Comparison (kg)		
Mode	**EDMS**	**AEDT**
Taxi-out	705	705
Take-off	1,705	1,419
Climb-out	52	535
Approach	612	663
Taxi-in	278	278

Aircraft performance modeling improvements also directly impact time in a particular mode (i.e., take-off, climb-out, and approach) and fuel burn. These improvements cause differences in fuel burn and emissions which vary by aircraft. The figure above depicts the various modes associated with an aircraft operation, and the adjacent table provides an example of the differences in time in mode and fuel burn between AEDT and EDMS.

Weather Data Comparisons

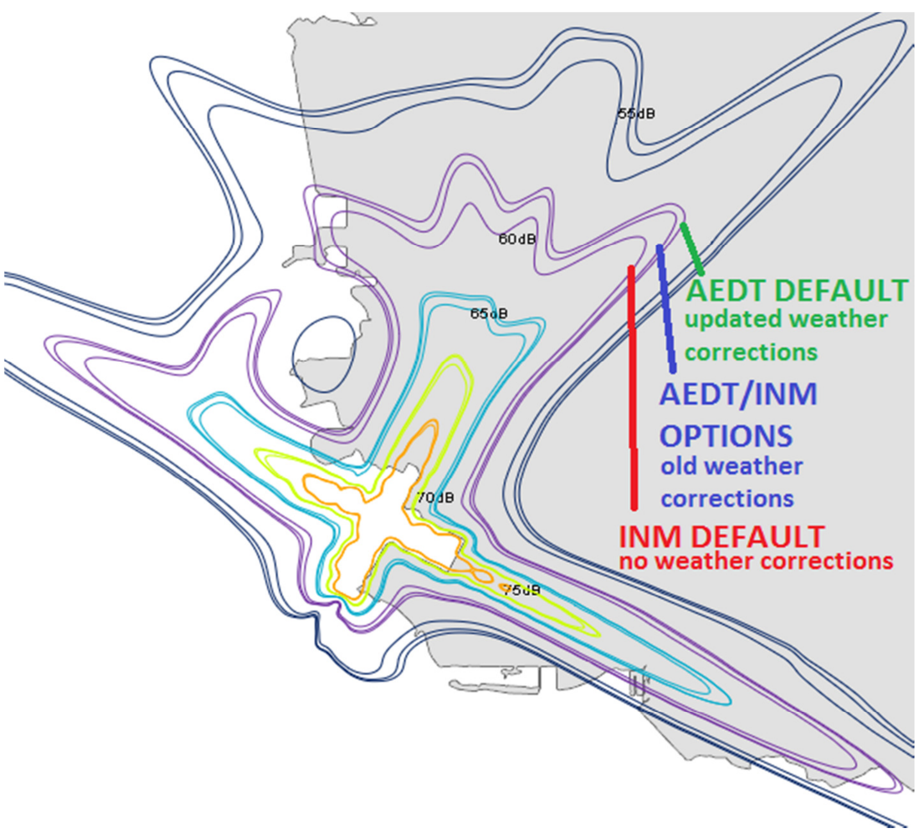
Both AEDT and the legacy models allow users to input weather data into a study (temperature, atmospheric pressure, relative humidity, and wind). Aircraft performance along a flight path and noise, emissions, and fuel burn calculations are dependent on these weather parameters. For example, temperature can affect engine thrust, wind can affect aircraft climb, and humidity can affect how noise travels from the aircraft to the ground. Sound levels tend to be lower in low humidity environments as compared to high humidity ones due to the increased atmospheric absorption associated with the lower humidity.

AEDT includes several improvements over INM and EDMS related to:

Default Weather Data - *Default weather data in AEDT differ from INM because AEDT default weather data are specific to the airport being modeled (may be customized by the user if necessary). This is consistent with EDMS in that the data draw from the same 30-Year Normals data as EDMS.*

Ground based vs. High Fidelity Weather - *Weather data for aircraft performance in AEDT differ from INM and EDMS because AEDT allows the use of data that vary according to the altitude and position of the aircraft ("high fidelity" weather), whereas the legacy tools only use ground-based weather data.*

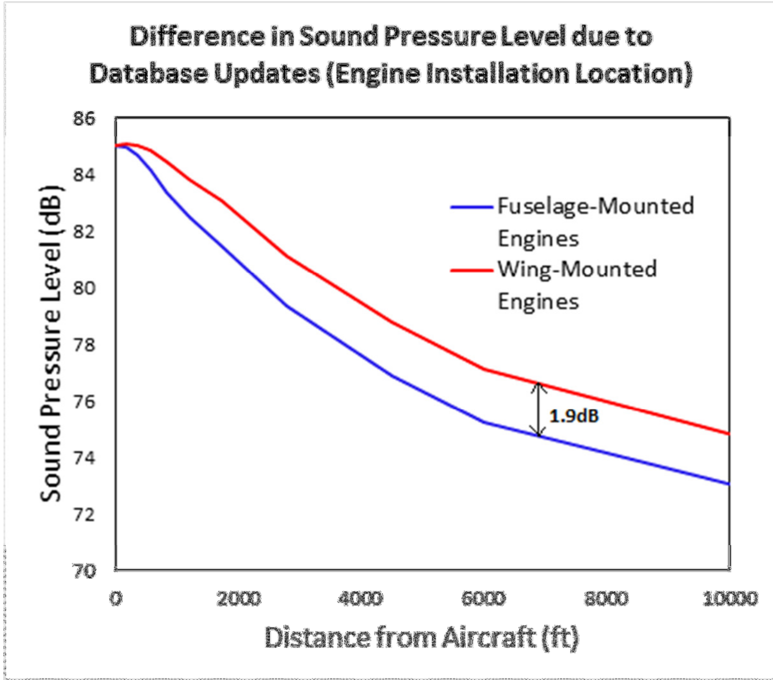
Methods for Computing the Effects of Weather on Noise - *INM includes two methods for computing the effects of weather on noise: methods for unadjusted weather (SAE-AIR-1845) and airport-specific weather (SAE-ARP-866A). AEDT differs from INM, because in addition to these two methods, AEDT includes a new method for airport-specific weather (SAE-ARP-5534), which represents the best available science. FAA requires modeling with SAE-ARP-5534 for noise analyses of FAA Actions. Example atmospheric absorption differences are depicted below.*



Noise Contour Differences due to Atmospheric Absorption

Aircraft Characteristics

AEDT has aircraft data updates that result in changes to noise levels, fuel burn, and airframe and engine mapping for a small number of aircraft.



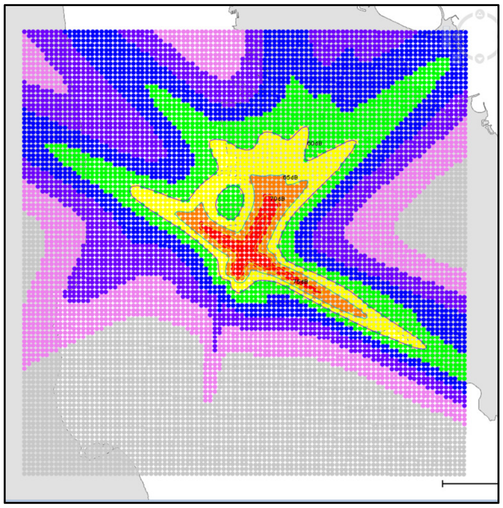
The noise to the side of the aircraft flight path is dependent on the location of the aircraft engines, because the aircraft airframe can partially shield one of the engines to a receiver on the opposite side of the aircraft. This effect is modeled in AEDT as part of the lateral attenuation adjustment, and is different for aircraft with engines mounted underneath the wings than those with engines mounted to the fuselage (see adjacent figure). The difference between these two engine locations can be as large as 1.9 dB to the side of the aircraft flight path, dependent on the geometry. The engine location was updated for three aircraft in AEDT (737QN, MD81 and SABR80) because it was misidentified in INM. Other aircraft in AEDT are unaffected by this update, which improves the accuracy in AEDT. Studies with significant contributions from those aircraft will be particularly impacted by this change.

As with EDMS, each aircraft in AEDT is assigned data associated with an airframe and engine. For both AEDT and EDMS, when data are not available for a specific airframe, data that best represent the aircraft are utilized. The same approach is applied for aircraft engines. Some aircraft airframe and engine mappings have been updated in AEDT based up newly obtained airframe or engine data. For those limited numbers of aircraft that have updated airframe and engine mappings, the fuel burn and emissions results are different in AEDT and EDMS.

EDMS had erroneous fuel flow and emissions rates for some engines. Erroneous fuel flow and emissions rate data that have been identified have been corrected in AEDT. Most of these errors are limited to non-ICAO certified engines (i.e., piston engines and turbo-props).

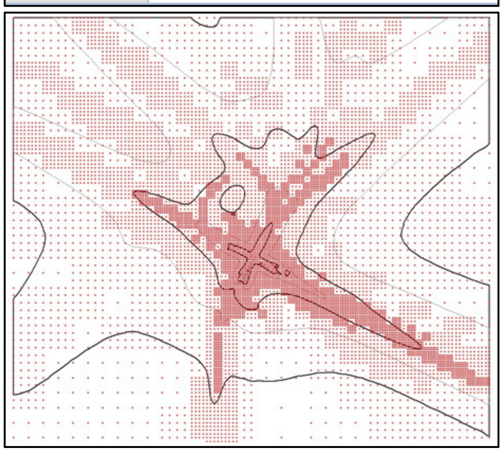
Noise Contours

Contours are computed differently in AEDT than in INM. In both tools the area in which noise is computed, and consequently contours are drawn, is based on a grid of receptors. AEDT and INM use different methods for computing contour grids. Some of these methods use variably-spaced contour grids in order to decrease computational runtime and to increase contour quality. These methods are summarized as:



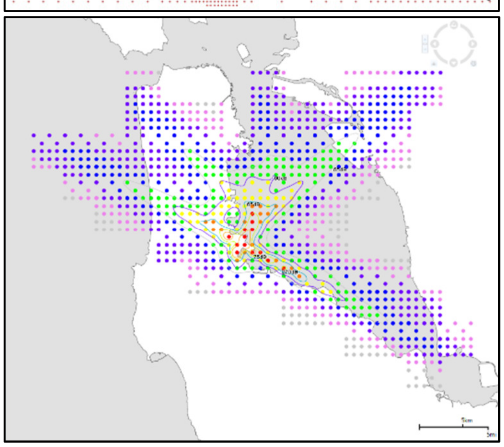
Fixed Grid (AEDT & INM)

- equally spaced contour grid
- can result in contours that do not close in INM
- AEDT will not output contours that do not close.
- available in both AEDT and INM



Recursive Grid (INM only)

- irregularly spaced contour grid
- outer edge of the grid is defined
- start with large grid, and add in additional points in areas with noise level changes
- can still result in contours that do not close
- available in INM only



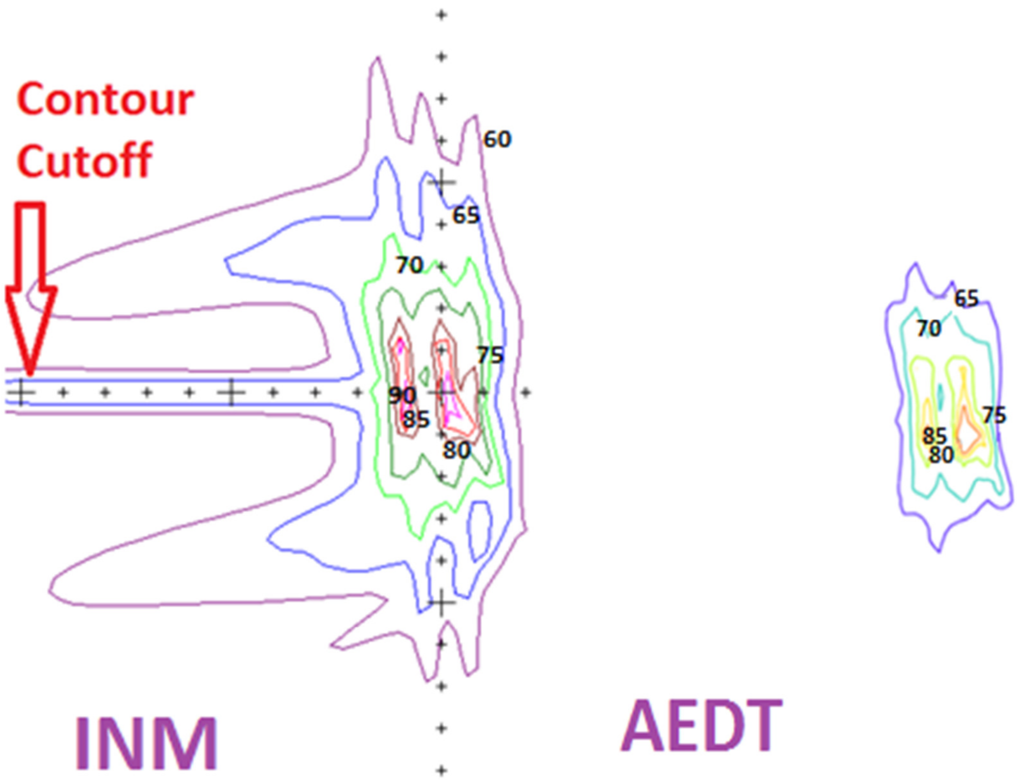
Dynamic Grid (AEDT only)

- irregularly spaced contour grid
- start with small grid, and expand grid points until the contours close
- ensures contours selected for analysis will close
- Available in AEDT only

Note: Due to the inherent differences between INM recursive grids and AEDT dynamic grids, only fixed grids should be imported from INM into AEDT.

Noise Contours Closure

When using a fixed grid or a boundary file, there is a possibility that the noise contours will extend beyond the receptor grid. AEDT and INM handle this scenario differently.



When noise extends beyond the grid:

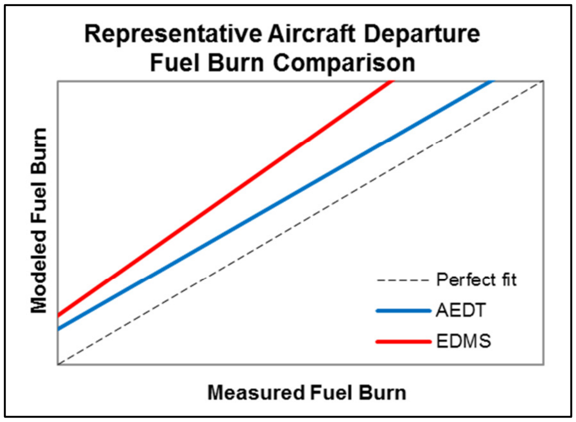
- INM plots these extended contours producing erroneous areas (known as contour cutoff) - this can be avoided by expanding the contour grid size
- AEDT plots only those contours which have successfully closed - this can be avoided by expanding the contour grid size or using dynamic grids

Fuel Burn and Emission Comparisons

For fuel burn and emissions analyses, differences between EDMS and AEDT results can be caused by the following items:

Updated Fuel Consumption Models

AEDT uses a specialized set of fuel consumption methods and data when modeling fuel burn and emissions below the mixing height. These are more accurate than the older methods and data in EDMS. The more up-to-date method and data utilized in AEDT are based upon analysis of flight recorder data obtained from actual flights. As can be seen in the adjacent graphic, AEDT results better match measured data than do those from EDMS.



Procedural Profiles Defined by the User

Procedural profiles determine the weight of the aircraft and provide information on parameters such as flap and power settings associated with aircraft performance modeling. When creating an operation in AEDT, the user assigns a procedural profile to an aircraft operation. EDMS provided default procedural profiles based upon take-off and arrival weights for each aircraft operation. Fuel burn and emissions results will differ between AEDT and EDMS if the user selects procedural profiles in AEDT different from the defaults used in EDMS.

Helicopter Emissions Modeling

Mode	Power Setting	EDMS Time in Mode (sec)	AEDT Time in Mode (sec)
Take-off	100%	2	0
Climb-out	85%	0	887
Approach	30%	405	0
Taxi	7%	480	0

- For EDMS, all helicopters were modeled utilizing a time-in-mode approach. For example, in EDMS helicopters spend fixed amounts of time in taxi, climb-out, and approach modes, with specific fuel flow and emissions rates associated with each of these modes.
- For AEDT, all helicopters are modeled utilizing the climb-out mode approach.

The table below is an example of how the time in mode is applied in EDMS and AEDT. Fuel flow rates are higher in the climb-out mode than they are in approach mode (dominant mode in EDMS). Therefore, AEDT fuel burn results will be higher than EDMS for modeling helicopters.

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