# Analysis & Tools Development

Presented to:

#### REDAC E&E Subcommittee

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Federal Aviation Administration

плинициции

- Data and tools infrastructure development implementation
- Tools Development
  - AEDT
  - EVT
  - FLEET-Builder
- ASCENT Projects



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# FAA's vision on data and information

#### resources



#### Enterprise Information Management (EIM) Strategic Framework

#### Vision Statement

Enable seamless flow and access of timely, reliable, and relevant information, which supports evidence-based decision-making and innovation for the FAA enterprise and aviation stakeholders.

#### Value Proposition

- Improve the speed and quality of decision-making
- Improve efficiencies while reducing costs
  - Harness innovation through timely access to relevant data and information

Strategic Thrusts					
Improve Data Access and Controls	Improve Data Exploitation Capability	Enable Innovation and Efficiencies			
<ul> <li>Goal 1: Visibility into available data sets throughout the agency</li> </ul>	<ul> <li>Goal 1: Enable adoption of Data-as- a-Service</li> </ul>	<ul> <li>Goal 1: Support rapidly changing business needs</li> </ul>			
<ul> <li>Goal 2: Improve data governance</li> <li>Goal 3: Improve data guality</li> </ul>	<ul> <li>Goal 2: Enable in-time decision support tools</li> </ul>	<ul> <li>Goal 2: Improve the innovation environment</li> </ul>			
RUN	<ul> <li>Goal 3: Enable advanced analytic capabilities</li> <li>GROW</li> </ul>	<ul> <li>Goal 3: Achieve cost efficiencies</li> <li>TRANSFORM</li> </ul>			
	Policy & Guidance				



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#### FAA polices and infrastructure for data have been shifting to support sharing, availability, and capitalization of resources

# Importance of supporting FAA's vision on sharing resources

- AEE has developed a variety high quality and high fidelity tools and databases
- Those resources are used for analysis to support
  - Internal and external decision making
  - Public communication
- Agency-wide use of these data and information will improve agency consistency on environmental issues
- Consistency is key given the high visibility of these issues, it will ensure better outcomes for the Agency





# **Technology Welding and Deployment Plan (TWD)**

#### Reference data infrastructure fabrication

- Identify authoritative data sources
- Link authoritative sources and reference databases
- Automation of updates, validation, and maintenance

#### Data processes infrastructure fabrication

- Identify existing processes agency-wide
- Continue development of AEE's processes
- Plan the integration into a single system

#### Tools infrastructure fabrication

- Ensure all environmental tools are linked to the infrastructure
- Support linking of other tools (e.g. TARGETS)
- Provide access through a portal

#### Integrated infrastructure is to reside on the FAA Enterprise Information Management (EIM) system



### **Progress toward TWD**

#### Reference data infrastructure fabrication

- AEDT FLEET database has been moved to the EIM
  - Coordination initiated to add Inventory DB and FLEET to the FAA catalog
  - Joining the FAA the EIM Aircraft Stewardship Community of Practice (SCoP) which will provide the FAA wide coordination on authoritative data
- AEDT NAS-wide inventory data on the EIM: 2019, 2020 and working on 2021
- The LADD\* data has also migrated to the EIM

#### Data processes infrastructure fabrication

- Set up VPC resources to support the FLEET database maintenance processes
- AEDT-TT<sup>+</sup> dataset now managed on the FAA EIM System
- FAA Tech Center developed a service to flag sensitive and LADD flights as the AEDT-TT data are ingested into the EIM
- Continued to improve the automation tools for Aircraft Fleet Assignments and Flight Track data refinement/management

#### Tools infrastructure fabrication

 Continuing to integrate automated EIM data processes and storage infrastructure for the management of the inventory noise and emissions results



### **Realizing the Benefits of TWD**

Our vision and concept are turning into implemented systems with improved performance

The newly achieved efficiencies will allow us to begin producing noise and emissions inventories on a quarterly basis instead of annually:

- Rolling annual noise results based on the preceding four quarters
- Quarterly and annual results for emissions









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### **AEDT 3e Current Status**

- AEDT 3e Planned Release April 24, 2022
- Usability Improvements
  - Allow selected tracks to be edited
  - CSV import of aircraft operations and tracks data
  - Improved speed of generating AERMOD input files
- Emissions Modeling
  - Update to latest AERMOD/AERMET versions
  - AERMOD source characterization
  - Aircraft lead emissions and dispersion modeling
  - Revised stationary source modeling
    - Latest EPA AP-42 & improvements to User Interface



## **AEDT 3e Status - Usability Improvements**

#### Allow Selected Tracks to be Edited

- Default zoom to show tracks, not just zoom to runways
- Airport Designer highlighting more than just the selected track
- In Airports tab, Tracks grid, lat/long values of the backbone track for dispersed track are not displayed
- CSV Import of Aircraft Operations and Tracks Data
  - Added the ability to import tracks and aircraft operations
  - Associated APU and GSEs
  - Through AEDT user interface as well as the command line.

#### Improved Speed of Generating AERMOD Input Files

- Optimize hourly emissions generation of ground sources
- Retrieve emissions results without paging
  - $\circ~$  Recommended for computers with 64 GB of RAM or more



# **AEDT 3e Status - Emissions Modeling**

### Update to Latest AERMOD/AERMET

- AERMOD/AERMET versions 21112
- NO<sub>2</sub> modeling two new alpha options
- Alpha low wind modeling options

# AERMOD Source Characterization (alpha)

- Model aircraft exhaust emissions as volume sources
- Short-term improvement to airport air quality analysis

 $\circ~$  Improves hourly modeled  $NO_2$  predictions



# AEDT 3e Status - Emissions Modeling, Cont'd

- Aircraft Lead Emissions & Dispersion Modeling (alpha)
  - Designed for fixed-wing piston engine aircraft & helicopters
  - Provides lead emissions and dispersion modeling capabilities
    - For all lead emissions generating activities
    - For fuels with different lead content
  - Dispersion modeling
    - Aircraft emissions can be modeled as a series of volume sources
    - Night time urban boundary layer
    - Wet and dry deposition



# **AEDT External Feedback**

### **AEDT User Review Group (URG)**

- Third Annual URG Meeting to be held April 2022
- AEDT 3e usability and fleet database improvements
- Seeking feedback on DSQM implementation and usage of ASIF import utility

## **AEDT Development Process Improvement**

- Agile Development training near completion
- Selected recommendations implemented in AEDT 3e development cycle
- Full implementation of recommendations planned for AEDT 3f development cycle



# **AEDT 3f Development Plan**

Public release planned for 2023

#### Aircraft Performance

- Implement Supersonic Aircraft full flight performance and fuel burn capability
- Harmonize AEDT performance model workflows

#### Emissions & Dispersion Modeling Features

- Update to the latest AERMOD/AERMET
- Provide necessary data for plume rise computations in AERMOD/ADM

#### Software Maintenance

- Upgrade ESRI GIS Software
- Upgrade to .NET 6



### **AEDT Future Development Timeline**

ASCENT 10 A Assessment ASCENT 19 E Impact Asses ASCENT 46 S Development ASCENT 54 A Support	Aircraft Techi Development Ssment Surface Analy t AEDT Evalua	nology Mod of ADM for ysis to Supp tion and De	eling and Airport Air ( port AEDT A velopment	Quality PM	ACRP 02-52 N ACRP 02-79 A Structures ACRP 02-27 A ASCENT 19 - Impact Asses ASCENT 43 N ASCENT 46 S Development ASCENT 54 A ASCENT 60 A Aircraft Fleet	loise Modelin Aircraft Noise Development sment oise Power D urface Analys EDT Evaluatio nalytical Meth Database	g of Mixe with Terra oise Data of ADM f distance F sis to Sup on and Do hods for I	ed Grou ain and base for Airp Re-Eval oport A evelop Expand	und Surfaces d Manmade bort Air Quality luation EDT APM ment Support ding the AEDT
2023	П	11	Ш	2024	Ш	П			2025

- Supersonic Aircraft performance modeling
- Harmonize AEDT performance model workflows
- Update to the latest AERMOD/AERMET
- Provide necessary data for plume rise computations in AERMOD/ADM
- Software maintenance
- Updated Delay and Sequencing Model

- Higher fidelity aircraft noise characterization
- Mixed ground impedance and terrain modeling capability
- Non-standard modeling report for regulatory analysis
- Taxiway Noise
- Updated Standard Profiles
- Updated Fleet Mapping
- New Air Quality model

#### **AEDT 4 series – Updates Annually**

AEDT 3f

AERMOD: American Meteorological Society/Environmental Protection Agency Regulatory Model AERMET: Meteorological data preprocessor for AERMOD APM: Aircraft Performance Model ADM: Aircraft-specific Dispersion Model



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# **Environmental Visualization Tool (EVT)**

- A Web-mapping application to quickly and easily create customized 2D and 3D maps using uploaded or built-in data layers
- Support Environmental Specialists in viewing and creating customized maps to assess environmental impacts



- Available within the FAA network via a web browser (<u>http://evt.faa.gov/</u>)
- Can help maintain consistency of information and presentation in community outreach activities
- Links to over 100 layers from a variety of authoritative sources
- Allows user-data upload in a variety of formats
- PIV Controlled Access now implemented in the Development version



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# FLeet Evolution, Estimation and evaluaTion Builder (FLEET-Builder)

- FLEET-Builder is a fleet evolution tool developed to model the composition of the future fleet of aircraft and output operational, economic, and environmental data
- It is the primary tool used by the ICAO/CAEP\* MDG/FESG<sup>†</sup> working groups in developing the global Trends and Scenarios analyses data



- It is as a desktop application integrated in the AEE Tools Suite and can directly interface with AEDT
- A domestic version has also been developed that relies on the 2020 AEE Annual Inventory data and the 2020 APO TAF-M<sup>‡</sup> forecast
- Domestic version being used by Volpe for a NASA economic study on a new aircraft type/technology and its viability in the commercial marketplace



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  - Noise Screening
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## ASCENT Project 9: Geospatially Driven Noise Estimation Module

Institution: Georgia Institute of Technology

Funding: \$250,000/yr. planned for 3 years (currently in year 2)

**Objective:** Develop a novel geospatially driven noise estimation module to support computation of noise resulting from the operation of Unmanned Aircraft Systems (UAS) and other upcoming vehicle concepts.

#### Approach:

- Leverage emerging computational technologies
- Develop a module that can be connected to other applications
- · Concept of precomputed noise grid tiles addition

#### **Expected Impact:**

Develop a tool to evaluate noise exposure from UAS/UAM vehicles to provide decision-makers with insight on where the noise might be distributed or concentrated.

- Developed a set of potential open source GIS applications for AEDT to replace the current ESRI software. Several may be used to target specific functionalities.
- Developed prototype model for eCommerce analysis
- Testing prototype model on various sample problems
- Developing stochastic methods for noise assessment





# ASCENT Project 54: AEDT Evaluation and Development Support

Institution: Georgia Institute of Technology Funding: \$700,000/yr. planned for 3 years (currently in year 2)

**Objective:** Provide data and methods to continue to improve the aircraft weight, takeoff thrust, and departure and arrival procedure modeling capabilities within the FAA's Aviation Environmental Design Tool (AEDT).

#### Approach:

- Improve AEDT modeling assumptions through the use of industry and airport flight operational data
- Utilize real-world data flight and noise monitoring data to improve departure, full flight, and arrival modeling
- Evaluate and assess AEDT's software releases

**Expected Impact:** Improve AEDT's accuracy by modernizing its departure profiles and arrival procedures to reflect current airport operations and enroute modeling and by providing recommendations for enhancements to the AEDT APM\*.

- Finalizing recommendations for standard departure profiles
- Continuing to provide critical system level testing of new AEDT features
- Working on final draft of AEDT 3 series V&V documentation
- Drafting report on full flight fuel burn method





#### ASCENT Project 60: Analytical Methods for Expanding the AEDT Aircraft Fleet Database

Institution: Georgia Institute of Technology Funding: \$150,000/yr. planned for 3 years (currently in year 2)

**Objective:** improve the accuracy of Aviation Environmental Design Tool (AEDT) noise and emissions modeling of aircraft not currently in the Aircraft Noise and Performance (ANP) database.

#### Approach:

- Study the characteristics of the aircraft currently missing from the AEDT database and identify distinct types
- Use quantitative and qualitative analytical methods to develop the aircraft ANP and noise data and validate them against flight data and physics-based modeling data
- Develop recommendations and guidelines for how to implement the developed data in AEDT

**Expected Impact:** Enhance AEDT's environmental modeling accuracy by expanding the AEDT FLEET database to include the noise and performance data of aircraft types that are currently missing

- Literature study completed on statistical learning methods to formulate analytical methods to develop ANP data for target aircraft.
- Demonstrated representative aircraft model portfolio as one of the possible analytical methods for developing ANP data.
- Developing second analytical method based on mixture models





#### ASCENT Project 62: Noise Model Validation for AEDT

**Institution:** Georgia Institute of Technology & Pennsylvania State University **Funding:** \$375,000150,000/yr. planned for 3 years (currently in year 2)

**Objective:** This project focus is to assess the accuracy of AEDT in estimating noise in both the vicinity of airports as well as further afield.

#### Approach:

- Quantify the new noise modeling capabilities based on comparison to field measurement data from airport monitoring systems.
- Include in the validation the effects of noise propagation, ground terrain, and meteorological conditions using data from low-earth-orbit satellites.

**Expected Impact:** Provide a noise model validation benchmark that can be used not only to respond to questions on AEDT noise prediction accuracy, but also to allow the tool development team to prioritize further development of modeling features and enhancements that will improve the predictive capability with respect to real world measurement data.

- Compared AEDT prediction at multiple noise monitors at San Francisco International Airport
- Used fight trajectory, flight data recorder data, and detailed weather data in the modeling
- Improved visualization tool and expanded comparison capability to include flight parameters
- Expanded data set for bulk studies in comparisons
- Refined understanding of how high resolution weather data influences accuracy



