Aircraft Noise 101

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Presented by:
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Presentation Overview

- Background of Today's Presenter
- Evolution of Aviation Noise
- Quantifying Aviation Noise
- Regulating Aviation Noise
- Questions and Answer Session

Steven R. Alverson, Senior Vice President

- 37 years of aviation noise and land use compatibility planning experience
- 32 years as a consultant and 5 years as an airport noise officer
- Over 200 aviation noise studies
- Facilitator of airport community roundtables/noise forums
- Frequent presenter on the topic of aviation noise

Evolution of Aviation Noise

What is noise?

- Noise is unwanted sound
  - What is music to my ears, may be noise to you
- While noise is subjective on an individual basis, social surveys indicate a relationship between noise level and community annoyance
- Federal regulations set acceptable levels of aircraft noise for environmental assessment, land use planning, and noise mitigation purposes

Evolution of Aviation Noise

Community Noise Annoyance is Not New

- In 6000 BCE, the Sybarites banned blacksmiths and cabinets makers from working in residential areas due to the noise
  - First recorded zoning ordinance
- Julius Caesar banned chariots from the streets of Rome after dark to reduce nighttime noise
  - Oldest recorded noise ordinance

Evolution of Aviation Noise

Community Noise Annoyance is Not New

- Concerns regarding community noise levels and sleep disturbance have continued to modern times
- Noise was the most cited reason for moving in the 2000 United States census

Evolution of Aviation Noise

1918

Photo Credit: Skyways Journal Magazine

1935

Photo Credit: Flightglobal.com

Evolution of Aviation Noise

1957

Photo Credit: Air-Review.com

1958

Photo Credit: Airliners.net

Federal Aircraft Noise Regulations – 1950s

- Federal Aviation Act of 1958
  - Congress gave the Federal Aviation Administration (FAA) the authority to regulate the use of the navigable airspace
  - Congress recognized that the public has a basic right to air transit, which was declared “a right of national sovereignty”

Federal Aircraft Noise Regulations – 1960s

- Amendment of the Federal Aviation Act of 1968
  - Congress recognized aircraft noise as a problem and authorized FAA to establish standards of measuring noise as well as regulations to control and abate aircraft noise
  - Required the regulations be “consistent with the highest degree of safety” and be “economically reasonable, technologically practicable, and appropriate for the particular type of aircraft.”
  - Aimed at controlling noise at the source (i.e., aircraft) not airport proprietors

Evolution of Aviation Noise

1963

Photo Credit: RuthAS

1967

Photo Credit: Boeing

Federal Aircraft Noise Regulations – 1960s

- FAA Promulgates Federal Aviation Regulation (FAR) Part 36 in 1969
  - Established uniform measurement system for aircraft noise certification
  - Established maximum allowable aircraft noise limits for *newly manufactured aircraft*
  - Permitted heavier aircraft to have higher noise levels

Federal Aircraft Noise Regulations – 1970s

- Noise Control Act of 1972
  - Prohibits FAA from issuing type certificates for aircraft not meeting the Part 36 noise limits
  - Added the Environmental Protection Agency (EPA) to the regulatory process, but did not require FAA to adopt EPA's regulations

Federal Aircraft Noise Regulations – 1970s

- FAA Amends FAR Part 36 in 1976
  - Required *currently operating aircraft* to comply with Part 36 noise limits
  - Allowed for phased compliance with the requirements by January 1, 1985, which was extended to January 1, 1988
  - The 1988 amendment also added the requirement for foreign carriers to comply with the regulations
- Established the noise-related “Stages”

Federal Aircraft Noise Regulations – 1970s

- FAA's Aviation Noise Abatement Policy of 1976
  - Identified the various roles and responsibilities for aircraft noise abatement
    - FAA, airport proprietors, airlines, state and local governments, and prospective residents
- This policy remains in effect today
  - Highly recommend that folks interested in aviation noise read the 1976 policy

Evolution of Aviation Noise

1979

Photo Credit: Boeing

Federal Aircraft Noise Regulations – 1970s

- Aviation Safety and Noise Abatement Act of 1979
  - Required FAA to establish a method of quantifying and assessing the impact of aircraft noise at airports
  - Provided for federal funding of voluntary airport noise and land use studies
- Resulted in FAR Part 150 Airport Noise and Land Use Compatibility Planning in 1984
  - Approved Noise Compatibility Programs measures are eligible for federal funding (e.g., sound insulation, land acquisition, ground run-up enclosures, noise monitoring systems)

Evolution of Aviation Noise

1981

Photo Credit: Boeing

Photo Credit: Boeing

Federal Aircraft Noise Regulations – 1990s

- Airport Noise and Capacity Act (ANCA) of 1990
  - Established the phase-out of Stage 2 aircraft greater than 75,000 pounds by January 1, 2000
  - Grandfathered existing airport-specific noise limits
- Resulted in 14 CFR Part 161- Notice and Approval of Airport Noise and Access Restrictions
  - Study of last resort
  - Many have tried, but only one restriction was approved since 1991

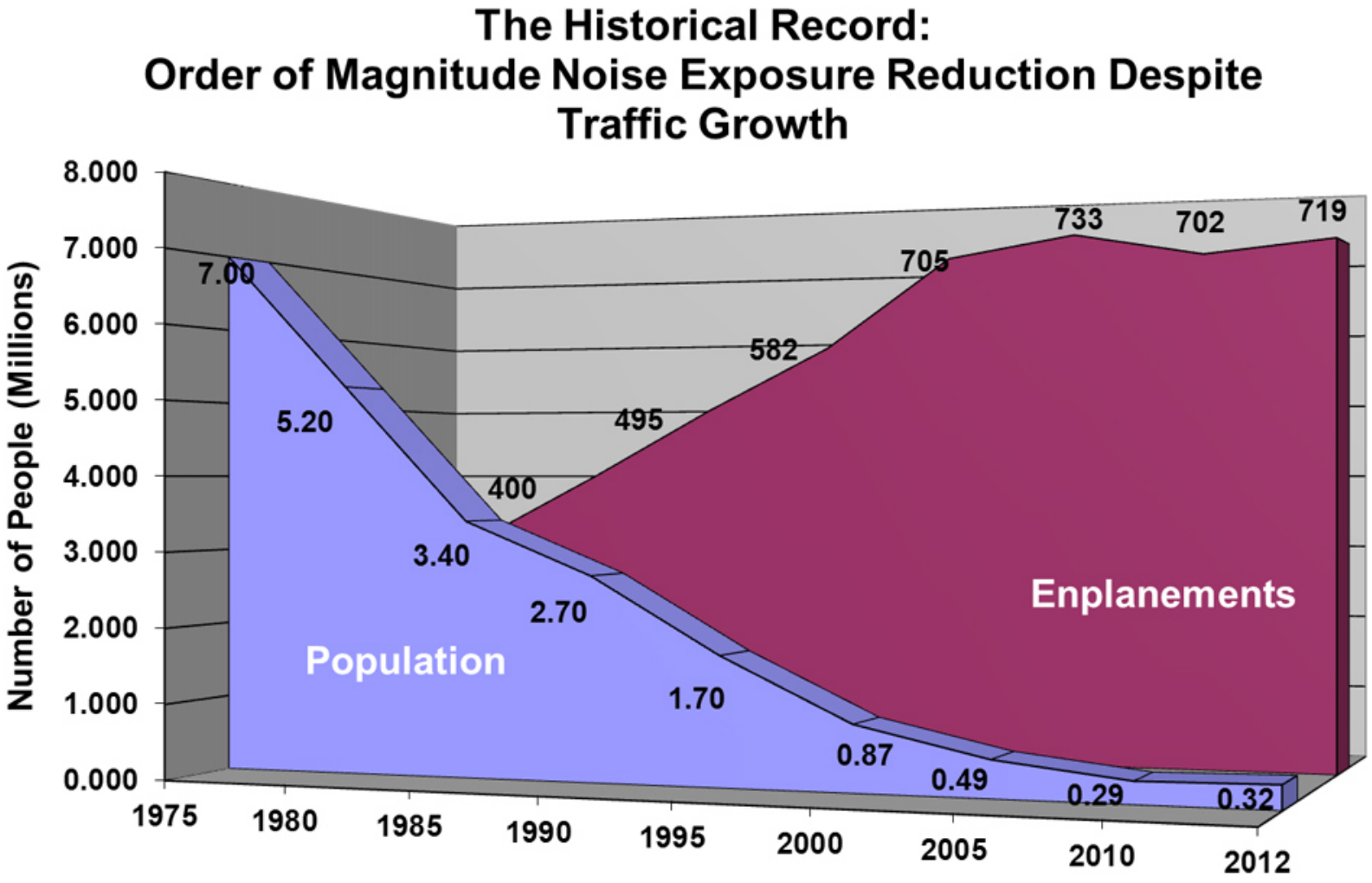
Evolution of Aviation Noise

Photo Credit: Museum of Flight

Technological Improvements

- At many airports, the average aircraft size is increasing as airlines “upgauge” their fleets
  - More passengers are carried with fewer operations
- As a result, aircraft operations have increased modestly as passenger volume has gone up dramatically
- These technological improvements and airline practices have resulted in millions of people being removed from noise impact areas near airports

Evolution of Aviation Noise



Source: FAA

Evolution of Aviation Noise

Photo Credit: Lufthansa

Photo Credit: Aviation Partners

Airline Fleet Changes

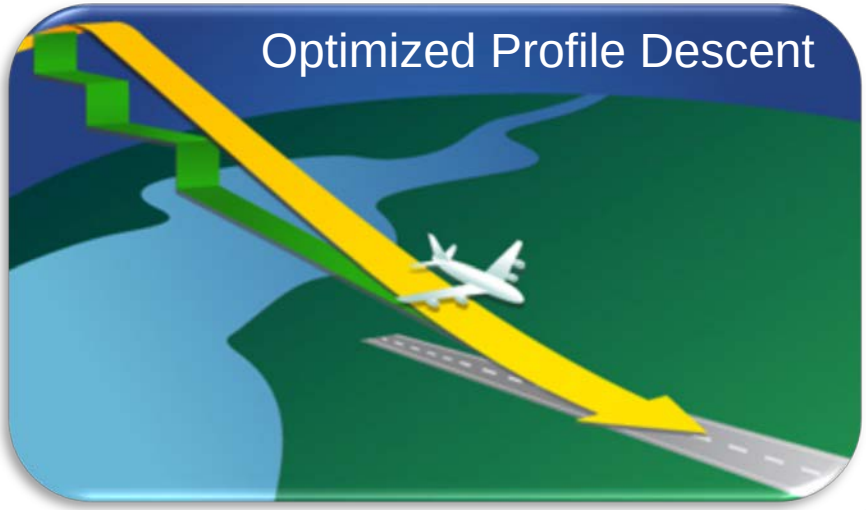
- For improved fuel efficiency, airlines are replacing four-engine long-haul aircraft (e.g., A-380s and B-747s) with twin-engine widebody aircraft (e.g., B-787s and B-777s)
- These aircraft look very similar to their much smaller twin-engine narrowbody counterparts such as the A-320 and B-737
- As a result, these widebody twin-engine aircraft often appear to be lower at the same altitude

Evolution of Aviation Noise

Comparison of a Boeing 737-900 to a Boeing 787-900 at an altitude of 2,500’ Above Ground Level

Source: Environmental Science Associates

Evolution of Aviation Noise



Source: FAA

Source: FAA

Recent National Trends in Aircraft Noise

- Concerns
  - Aircraft altitudes
  - Frequency of overflights
  - Increased nighttime flights
  - Concentrated flight tracks over noise sensitive land uses
  - New noise sensitive areas exposed to aircraft overflights and noise
  - Impact of aircraft noise on human health

Recent National Trends in Aircraft Noise

- Reaction
  - Increased community activism
  - Requests for the establishment of lower national aircraft noise standards (i.e., 55 DNL)
  - Formation of a congressional caucus on aircraft noise
  - Independent aircraft noise complaint websites and automated noise complaint filing apps
  - Threats of litigation

Quantifying Aviation Noise Exposure

Aircraft noise can be measured and modeled

- Measurements and modeling can describe historical noise levels, but only modeling can predict *future* noise levels
- Measured and modeled noise levels can be compared
- Federal regulations require the use of noise models, not measurements, to quantify aircraft noise exposure

Quantifying Aviation Noise Exposure

- Measuring sound levels will accurately tell us:
  - The sound levels at a specific location for the time period the measurements were made
  - The historical record of the sound levels at a specific location
  - Historical trends; but measurements do not predict future noise levels

Quantifying Aviation Noise Exposure

- Modeling sound exposure accurately tells us the sound levels:
  - Over broad geographic areas as well as at specific locations for a specific time period
  - Modeling can produce a historical record
  - Modeling can be predictive by showing expected trends in aircraft noise exposure
  - Modeling can be used to prepare “What If?” scenarios

Noise Measurement Standards

- Noise monitoring equipment and the field measurements must be made in accordance with all applicable standards
  - Federal
  - State
  - Local

Noise Measurement Standards

- 14 CFR FAR Part 150 establishes the noise measurement methods and metrics for conducting aircraft noise measurements

- Local municipalities often specify noise measurement standards in noise ordinances or general plans

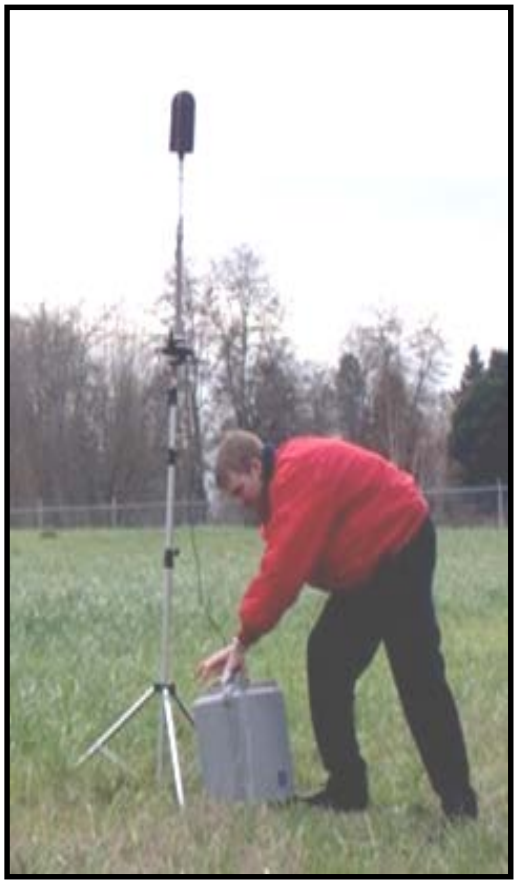
Noise Measurement Equipment

- Permanent noise monitors cover a limited area, but provide long-term noise measurement data for analyzing trends
  - Operation is automated requiring very little staff labor
- Portable noise monitors can be moved from location to location for short periods of time and may be returned to the same location to analyze trends
  - Very labor intensive for noise office staff

Noise Measurement Equipment

- Measured noise events can be correlated with aircraft flight track and identification data in an airport's airport Noise and Operations Management System (NOMS)
  - Both portable and permanent noise measurement sites can be entered into an airport's NOMS
  - Noise levels can be tracked over time and can be analyzed by:
    - aircraft type, type of operation, time of day, and noise measurement site

Noise Measurement Equipment



Portable Noise Monitor

Permanent Noise Monitor

Aircraft Noise Modeling Concepts

- Mathematical models are used everyday to depict a variety of real-life situations such as:
  - Bridge loading, aerodynamic performance, fuel economy, and computer animation
- Model accuracy is a function of the modeling algorithms, the empirical databases, and user sophistication
- When used properly, aircraft noise models have proven to be highly accurate

Aircraft Noise Modeling Tools

- Commonly used aircraft noise modeling tools:
  - FAA's Aviation Environmental Design Tool (AEDT)
  - FAA's Integrated Noise Model (INM) (Superseded by AEDT)
  - FAA's Noise Integrated Routing System (NIRS) (Superseded by AEDT)
  - US Air Force's NOISEMAP
  - US Air Force's BOOMAP
- Modeling tools quantify aircraft noise exposure in the vicinity of airports as well as at more distant locations

Aviation Environmental Design Tool (AEDT)

- AEDT replaced INM at the end of May 2015
  - INM had been the FAA-approved noise modeling tool since 1978; INM's noise modeling engine is in the AEDT
  - INM's results have been validated on several occasions with overall modeled and measured levels falling within a couple of decibels of each other
- AEDT combines the capabilities of the Emissions Dispersion Modeling System (EDMS) and INM in a single model
  - AEDT allows for assessing the trade offs between air emissions and noise impacts

Aviation Environmental Design Tool (AEDT)

- The AEDT is the FAA approved model for use in preparing:
  - Noise elements of airport master plans
  - Noise exposure maps for 14 CFR Part 150 and 14 CFR Part 161 studies
  - Noise elements of federal environmental assessments and environmental impact statements
  - Noise contours for state environmental impact reports

Aviation Environmental Design Tool (AEDT)

- AEDT can also predict noise at a specific location that may be sensitive to noise impacts (school, hospital, noise measurement sites, etc.)

- 17 predefined noise metrics are supported, including:
  - DNL
  - CNEL
  - Lmax
  - Leq
  - SEL
  - SENEL

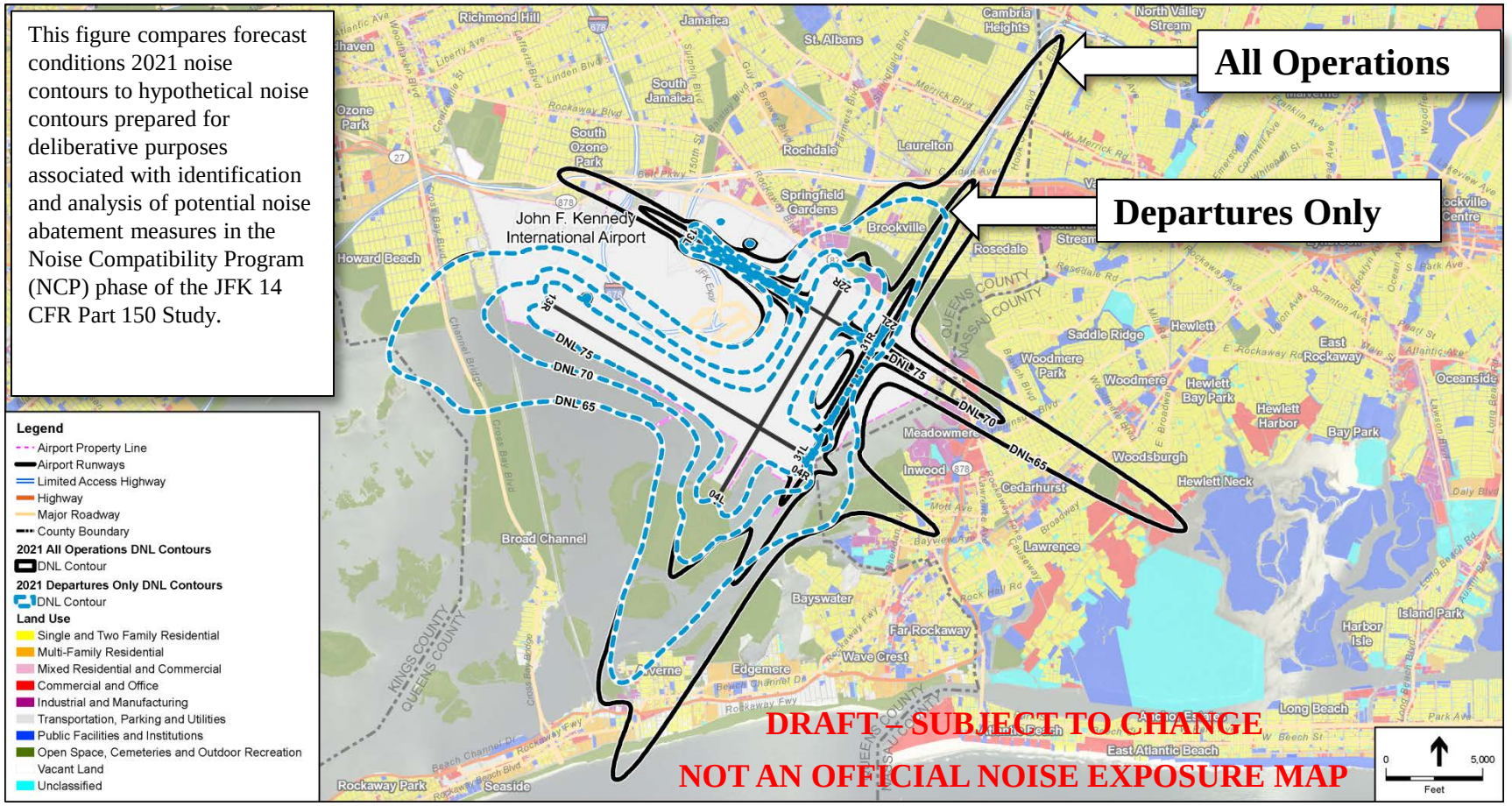
AEDT Process: Computation

- AEDT computes the exposure of each operation:
  - as it would be measured in the airport environs accounting for the annual-average use
- The noise exposure of each aircraft operation is:
  - energy-summed over a user-specified grid to determine the annual average noise exposure
- Values of equal noise exposure are connected using “contour lines”

Noise Model Output: DNL Contours

Noise Contributions: 2021 Departures Only (Excluding Arrivals)

This figure compares forecast conditions 2021 noise contours to hypothetical noise contours prepared for deliberative purposes associated with identification and analysis of potential noise abatement measures in the Noise Compatibility Program (NCP) phase of the JFK 14 CFR Part 150 Study.



SOURCE: New York City Department of City Planning, MapPLUTO 15V1-Tax lot/land use geographic information database, March 2015-June 2015 (adapted by ESA); Nassau County Department of Public Works Planning Division; Property classification and geographic information database, September 2015; ESRI Mapping Services; Environmental Science Associates, 2016; Planning Technology, Inc. 2016.

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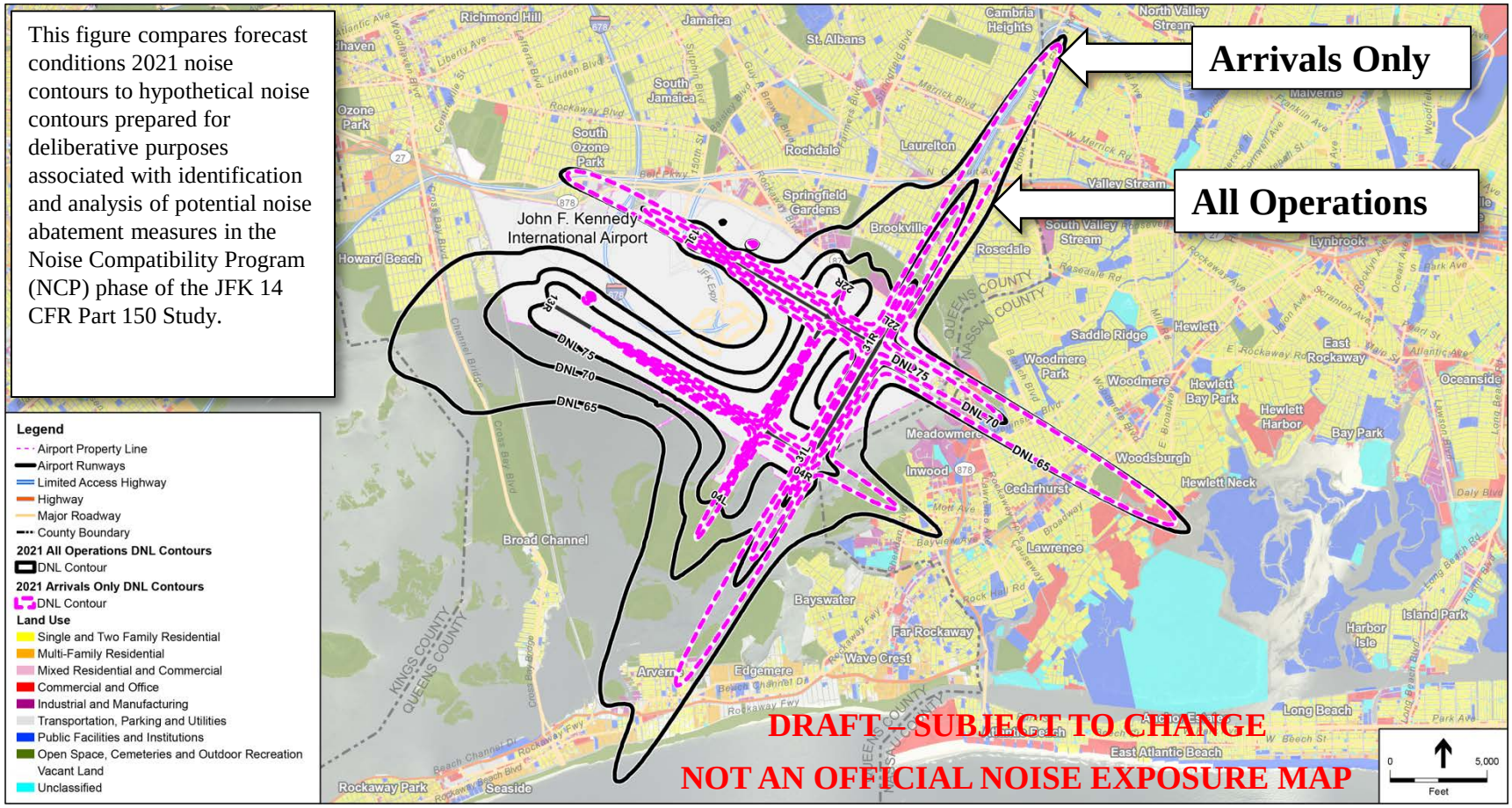

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Comparison of Common Commercial Aircraft Types

EMB-190

CRJ9-ER

A320

737-800

MD-88

757-200

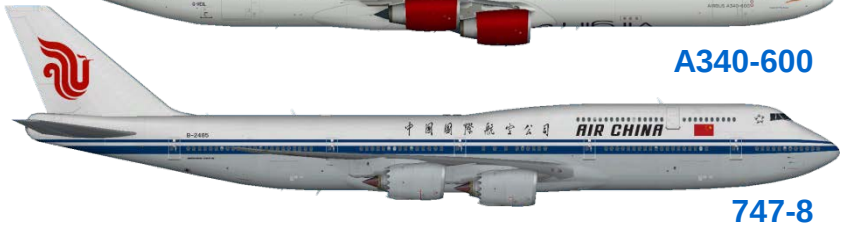
787-8

767-400

A380-800

777-300ER

A340-600



747-8

Quantifying Aviation Noise Exposure

The Commercial Aircraft Fleet is Diverse

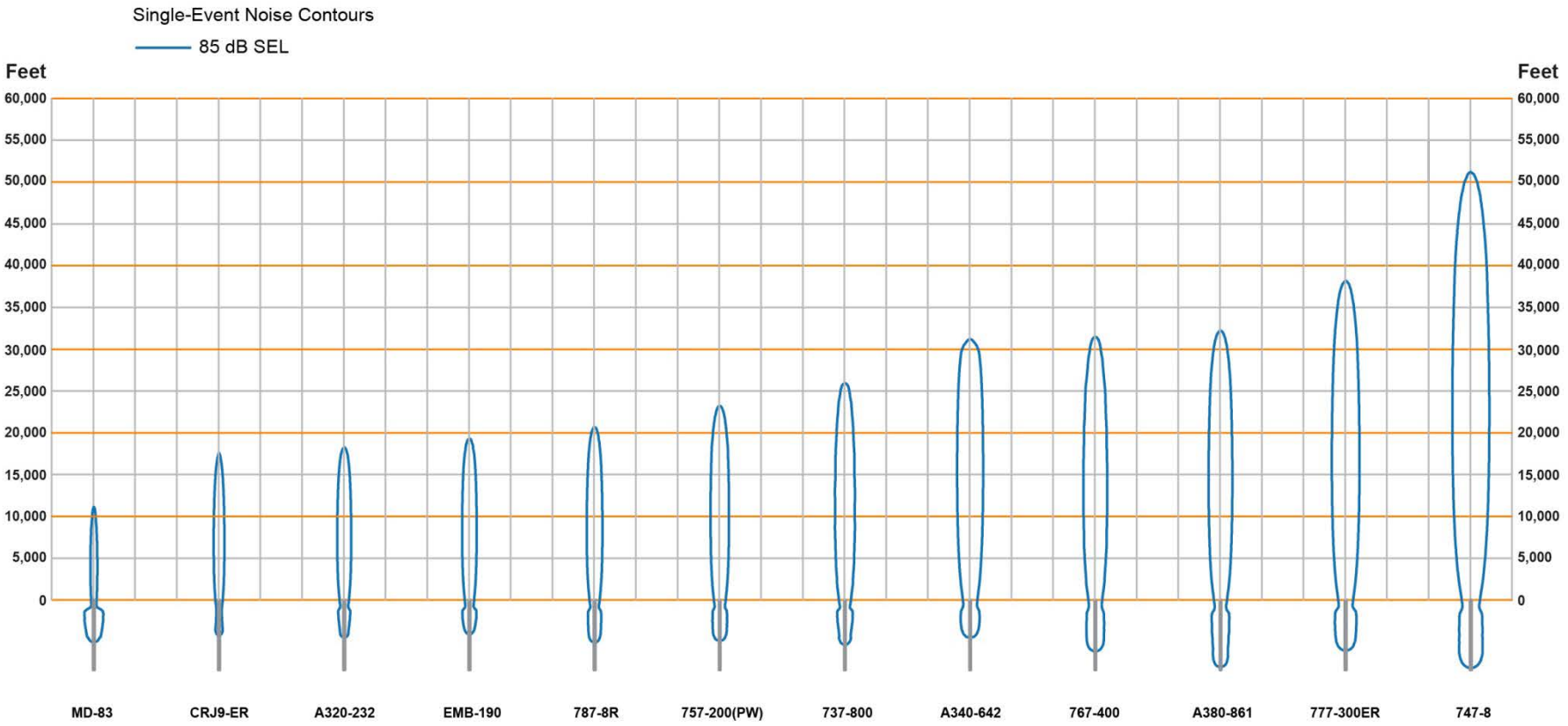
A380-800

EMB-190

	A-380	EMB-190
Seats (two-classes)	644	94
Length	239’	119’
Wingspan	262’	94’
MTOW	1,268,000 lbs	105,000 lbs
MLW	869,000 lbs	95,000 lbs
Range	8,200 nmi	1,850 nmi
Source: Airbus and Embraer		

Quantifying Aviation Noise Exposure

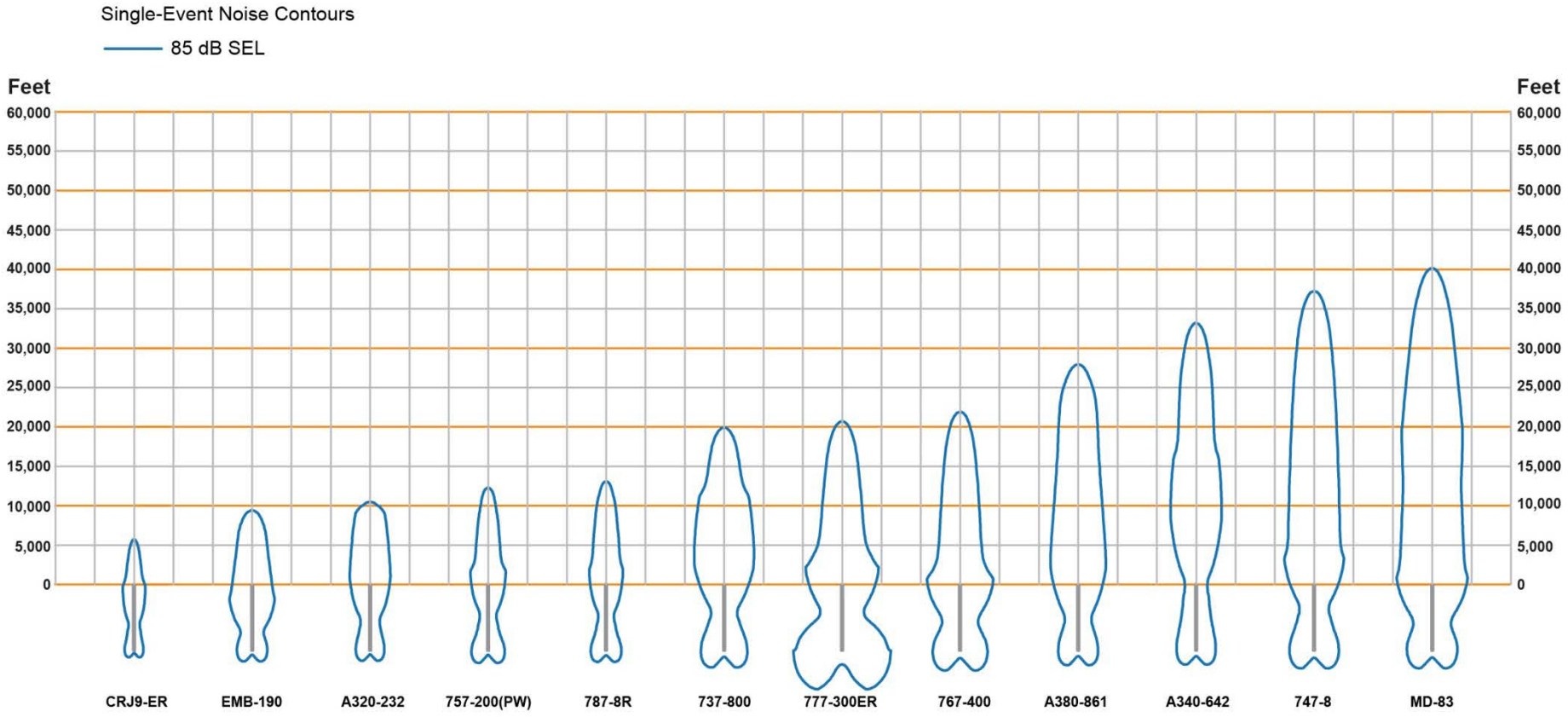
Arrival Sound Exposure Level (SEL) Contour Comparison



Source: INM 7.0d

Quantifying Aviation Noise Exposure

Departure Sound Exposure Level (SEL) Contour Comparison



Source: INM 7.0d

Comparing Measured and Modeled Levels

- Measured single event levels (Lmax and SEL) can be compared to the single event levels predicted by the model
  - Measurements should be observed or correlated with radar data and of sufficient quantity
- Measured cumulative noise levels (DNL) can be compared to modeled cumulative levels
  - Ideally, compare one year of aircraft noise measurement data to the same year modeled

Comparing Measured and Modeled Levels

- Modeled annual-average day DNL contours will not always match short-term measured values due to variables such as:
  - Runway use
  - Fleet mix
  - Wind and weather conditions
  - Pilot/controller techniques

Regulating Aviation Noise

Presentation Outline

- Introduction
- Airport Noise – Roles and Responsibilities
- Regulatory Framework
- Federal Noise Regulating Aviation Noise
- Summary

Introduction

- Aircraft/Airport noise regulations and policies are not static
- Careful balance between federal and local authority
- FAA sets many rules and controls funding
- Local governments have an important role to play through the regulation of land use

Roles and Responsibilities

- Roles and Responsibilities – Airport Noise Control
  - Federal Aviation Administration
  - Airport Proprietor
  - Local Governments
  - Aircraft Operators
  - Others

Roles and Responsibilities

Federal Aviation Administration

- Sets noise level requirements for aircraft
- Provides funding for, and approval of, noise compatibility planning (when appropriate and/or when funds are available)
- Manages the air traffic control and airspace system

Roles and Responsibilities

Federal Aviation Administration

- Exclusive authority to certify aircraft and pilots
- Exclusive authority to control aircraft in the air and on runways/taxiways*

*Control of aircraft in flight is shared with the pilot-in-command

Roles and Responsibilities

Airport Proprietors

- Plan and implement actions designed to reduce the adverse effects of noise on residents of the surrounding area including:
  - Improvements in airport design
  - Noise abatement ground procedures
  - Land acquisition
  - Restrictions on airport use (reasonable, nonarbitrary and not unjustly discriminatory restrictions)

Roles and Responsibilities

Local Governments

- Can
  - Promote compatible land use through zoning
  - Prohibit incompatible land uses
  - Require real estate disclosure
  - Include current noise data in municipal code
- Cannot
  - Directly restrict aircraft operations or regulate “routes, rates or service” of air carriers
  - Tax airport passengers

Roles and Responsibilities

Aircraft Operators

- Fly quieter aircraft

- Fly responsibly
  - Safety first and foremost
  - Use industry recommended noise abatement procedures
  - Use preferred noise abatement runways
  - Follow airport's published noise abatement procedures
  - Follow noise abatement flight tracks

Roles and Responsibilities

Others

- Pilot in command has sole responsibility for the safe operation of his or her aircraft
- Aviation system users pay for the entire aviation system including the adverse impacts of noise
- Users finance the cost of noise-reducing measures such as:
  - New quieter aircraft
  - Research and development into noise reducing technologies
  - Planning and land use compatibility studies
  - Land acquisition, sound insulation, ground run-up enclosures

Roles and Responsibilities

Others

- Prospective residents should become informed about aircraft noise impacts and should act accordingly

Regulatory Framework

- Federal law sets aircraft noise standards, prescribes operating rules, establishes the compatibility planning process, and limits airport proprietor's ability to restrict aircraft operations

- State law sets forth compatibility planning guidelines and noise standards, but aircraft in flight are exempt

- Local noise ordinances set local noise standards and provide for compatible land use planning, but aircraft in flight are exempt

FEDERAL LAW PREEMPTS STATE AND LOCAL REGULATIONS

FAR Part 36 – Noise Standards: Aircraft Type and Airworthiness Certification

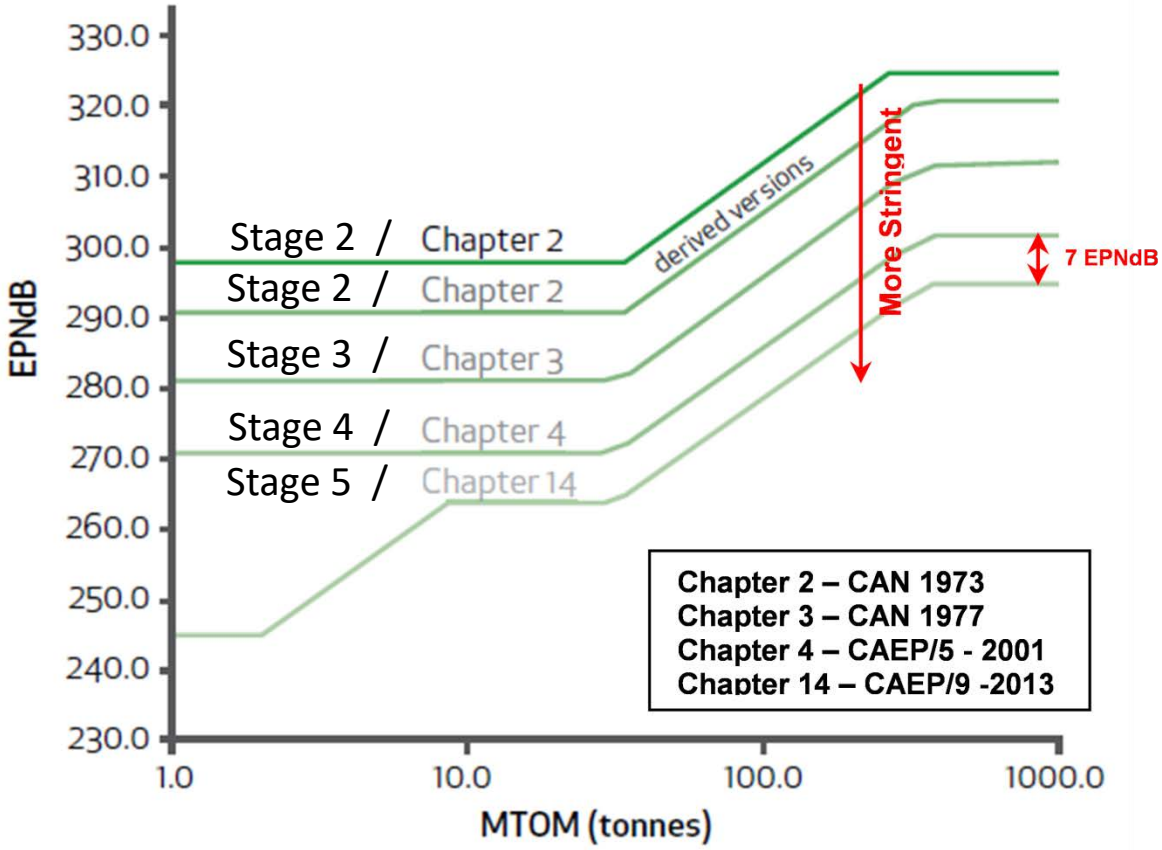
- Aircraft may be certified as Stage 1, Stage 2, Stage 3, Stage 4 or Stage 5 based on their noise level, weight, number of engines, and in some cases – number of passengers
- Stage 1 and Stage 2 are no longer permitted to operate in the United States
- FAA has indicated it does not intend to propose a phase out of Stage 3 aircraft in the foreseeable future

International Civil Aviation Organization (ICAO)

- Committee on Aviation Environmental Protection (CAEP) promoted more stringent noise certification standards
- CAEP agreed on and forwarded to the full ICAO assembly new Chapter 14 (Stage 5) noise levels
- The new levels went into effect for newly manufactured large aircraft on January 1, 2018
- The new standard is 7 EPNdB below the Stage 4 standard

Regulating Aviation Noise

International Civil Aviation Organization (ICAO)



Source: ICAO

FAR Part 91 – General Operating and Flight Rules

- Addresses the operation of aircraft in flight
- Establishes airspace classifications
- Establishes operating conditions (IFR, VFR, etc.)
- Addresses the operation of supersonic aircraft within the United States
- Amended in 1990 to address the phase-out of large Stage 2 aircraft

Aviation Safety and Noise Abatement Act of 1979

- Further strengthened FAA's supporting role in noise compatibility planning
- Stated purpose "To provide assistance to airport operators to prepare and carry out noise compatibility programs."
- Established funding for noise compatibility planning
- Sets requirements by which airport operators can apply for funding
- Does not require an airport to develop a noise compatibility program

14 CFR Part 150 – Airport Noise Compatibility Planning

- Adopted FAA regulations for implementing the Aviation Safety and Noise Abatement Act of 1979
- Published noise and land use compatibility charts to be used for land use planning with respect to aircraft noise
- Residential land use deemed acceptable for noise exposure up to 65 dB DNL (CNEL in California)
- Allows airport sponsors to access federal funds for noise mitigation programs

Airport Noise and Capacity Act of 1990 (ANCA)

- Established a method to review aircraft noise, airport use, or access restrictions imposed by airport proprietors
- Instituted a program to phase-out Stage 2 aircraft over 75,000 lbs. by December 31, 1999
- The FAA Modernization and Reform Act of 2012 instituted a phase-out of Stage 1 and Stage 2 aircraft under 75,000 lbs. by January 1, 2017

Airport Noise and Capacity Act of 1990 (ANCA)

- Applies to all local noise restrictions that were proposed after October 1990
- Grandfathered all aircraft noise and access restrictions that existed prior to November 1990
- Restrictions that were in place at a number of airports prior to November 1990 would not be implementable now
  - Single-event limits, curfews, noise budgets, etc.

14 CFR Part 161 – Notice and Approval of Airport Noise and Access Restrictions

- Defines the requirements for enacting noise and access restrictions on Stage 2 and Stage 3 aircraft greater than 75,000 lbs.
- Severely limits an airport proprietor's ability to enact restrictions on aircraft operations
- Encourages voluntary agreements to control aircraft noise
- Airport proprietor imposed restrictions must be considered a last resort when all other efforts have failed to eliminate the incompatible land uses

FAA Orders 5050.4B and 1050.1F

- Guidelines developed by the FAA pertaining to environmental analysis under the National Environmental Policy Act (NEPA)
- FAA Order 1050.1F provides overall NEPA guidance for all FAA divisions
- FAA Order 5050.4B provides guidance to the Airports Division of the FAA which oversees the review of airport development projects
- The FAA's 1050.1F Desk Reference provides additional information regarding compliance with NEPA and special purpose laws

FAA Orders 5050.4B and 1050.1F

- FAA considers only those noise impacts that occur at 65 dB DNL/CNEL or greater
  - Increases in noise levels for noise sensitive areas over 1.5 dB DNL/CNEL, within the 65 dB DNL/CNEL contour, are considered “significant”
- If an action causes a significant impact over noise sensitive areas, additional analysis should be conducted between 60 dB DNL/CNEL and 65 dB DNL/CNEL to determine if an increase of 3 dB DNL/CNEL occurs
  - A 3-dB increase is not considered “significant”, but must be disclosed for informational purposes

Questions and Answer Session