


Noise Fundamentals



October 2022



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Topics


- Aircraft Noise Regulations
- Aircraft Noise Sources
- Sound Propagation
- Aircraft Noise Terminology
- Measurements vs. Modeling
- Annoyance and Land Use Compatibility

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Noise Regulation - Federal

Statute	Aircraft Noise Related Purpose	Most Relevant FAA Regulation(s)
Aircraft Noise and Sonic Boom Act of 1968	Authorizes FAA to prescribe standards for measurement of aircraft noise and establish regulations to abate noise.	14 CFR parts 36 and 91
National Environmental Policy Act of 1969 (NEPA)	Directs all federal executive agencies to assess all environmental effects of proposed federal agency actions.	FAA Orders 1050.1F, 5050-4B
The Noise Control Act of 1972 (Noise Act)	Amends 1968 act to add consideration of public health and welfare and to add EPA to the rulemaking process for aircraft noise and sonic boom standards.	None directly; EPA responsibility
Aviation Safety and Noise Abatement Act of 1979 (ASNA)	Directs FAA to establish single system to measure noise and determine exposure of people to noise, and identify land uses normally compatible with various noise levels.	14 CFR part 150
Airport and Airway Improvement Act of 1982	Authorizes FAA funding for noise mitigation/compatibility planning and projects and establishes noise compatibility requirements for FAA-funded airport development.	FAA Airport Improvement Program
Airport Noise and Capacity Act of 1990 (ANCA)	Mandates phase out of Stage 2 jet aircraft over 75,000 pounds, and established requirements regarding airport noise and access restrictions for Stage 2 and 3 aircraft.	14 CFR part 161
Section 506 of the FAA Modernization and Reform Act of 2012	Prohibition after 12/31/2015 of operation of civil subsonic jet airplanes with maximum weights of 75,000 pounds or less that do not meet stage 3 noise standards.	14 CFR part 91



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NEPA Implementation (Federal Action - FAA)

Three levels of environmental analyses:

- Categorical Exclusion – CatEx
- Environmental Assessment – EA
- Environmental Impact Statement – EIS


Noise Thresholds

- Significant Impact
 - 1.5 dB increase within 65 DNL
- Less than significant impact
 - 3 dB increase between 60 and 65 DNL
 - 5 dB increase between 45 and 60 DNL triggers additional analyses for air traffic actions

CatEx List


The FAA has determined that the following actions do not individually or cumulatively have a significant effect on the human environment (FAA Order 1050.1F, Section 5-5)

- **Administrative/General** - Actions that are administrative or general in nature
- **Certification** - Actions concerning issuance of certificates or compliance with certification programs
- **Equipment and Instrumentation** - Actions involving installation, repair, or upgrade of equipment or instruments necessary for operations and safety
- **Facility Siting, Construction, and Maintenance** - Actions involving acquisition, repair, replacement, maintenance, or upgrading of grounds, infrastructure, buildings, structures, or facilities that generally are minor in nature
- **Procedural** - Actions involving establishment, modification, or application of airspace and air traffic procedures
- **Regulatory** - Actions involving establishment of compliance with, or exemptions to, regulatory programs or requirements




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Land Use Compatibility Federal – Part 150



- Federal Aviation Administration (FAA) developed the Part 150 Program in response to the federal Aviation Safety and Noise Abatement Act of 1979 (“ASNA”)
- Codified under Title 14 of the Code of Federal Regulations (CFR) Part 150
 - Formal citation is “14 CFR Part 150,”
 - Formal title is “Airport Noise Compatibility Planning”
- Voluntary FAA-defined process for airport noise studies
 - 250+ airports have participated
- Why do airports participate? Primary reasons include:
 - Provides access to FAA funding of some approved measures
 - Well-established, understood, accepted, and comprehensive process




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Land Use Compatibility Federal – Part 150







- Part 150 results in two primary elements:
 - Noise Exposure Map (NEM)
 - Inventories land use associated with aircraft noise (current and five-year forecast)
 - All land uses compatible with aircraft noise less than 65 dB (DNL or CNEL)
 - Noise Compatibility Program (NCP)
 - Airport recommendations to address incompatible land uses
- Noise abatement, land use and program management measures
- Detailed FAA guidance at: www.faa.gov/airports/environmental/airport_noise/
- Consultation required with
 - All local, state, and federal entities with control over land use within DNL/CNEL 65+ dB
 - FAA regional officials, regular aeronautical users of the airport
 - All parties interested in reviewing and commenting on the draft document(s)



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Aircraft Noise Sources

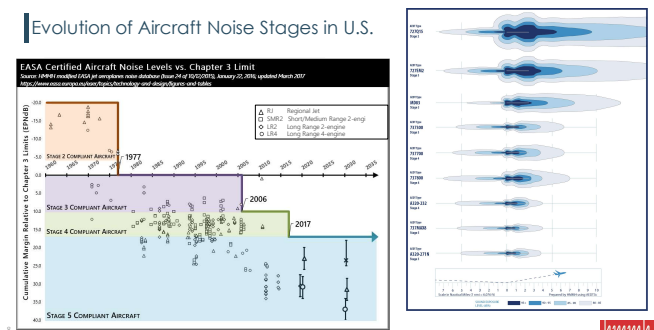

- Departure Noise 
- Arrival Noise 
- Ground Noise 



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Evolution of Aircraft Noise Stages in U.S.

EASA Certified Aircraft Noise Levels vs. Chapter 3 Limit
Source: EPA/FAA/NOAA/CASA Jet airplane noise database, Issue 24 of 10/2019, January 12, 2020, updated March 2022
 https://www.epa.gov/air/noise/aircraft-noise-database

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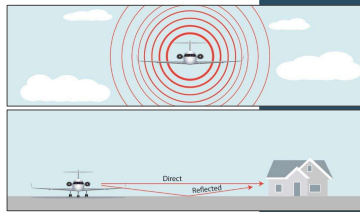

Sound Propagation

Spherical Spreading:

- Sound level decreases by 6 dB per doubling of distance
- Additional losses due to atmospheric absorption

Ground Effect:

- Sound levels are lower when reflected off soft ground vs. hard ground

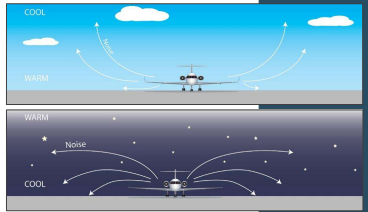




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Sound Propagation

Refraction due to Temperature:

- Gradients in temperature cause the bending of sound paths
- Sound bends upward during a temperature lapse (cool air over warm)
- Sound bends downward during a temperature inversion (warm air over cool)

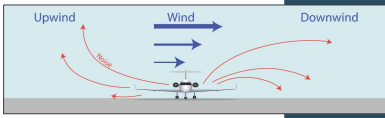




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Sound Propagation

Refraction due to Wind:

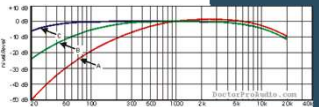
- Gradients in wind speed cause the bending of sound paths
- Sound bends upward causing sound shadows in the upwind direction
- Sound bends downward increasing sound levels in the downwind direction
- Differences between upwind and downwind directions can be 20 dB

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Noise Terminology

- Noise is "unwanted" sound
- Sound results from small and rapid changes in air pressure our ears detect
- We characterize and judge sounds by:
 - Magnitude (loudness) in decibels (dB)
 - Frequency (pitch) in hertz
- The EPA has adopted the A-weighted sound level for environmental analyses
 - All sound levels presented in aircraft noise studies are A-weighted unless otherwise specified



Studies have resulted in loudness curves:

- A-weighted noise levels correlate to loudness of sounds in our everyday environment (relatively low energy)
- B-weighted noise levels correlate to medium energy sounds
- C-weighted noise levels correlate to high energy sounds



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Noise Terminology

- Maximum A-weighted Sound Level (Lmax)
- Sound Exposure Level (SEL)
- Equivalent Sound Level (Leq)

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Noise Terminology

- Day-Night Average Sound Level (DNL)
 - Describes the noise dose for a 24-hour period
 - Accounts for event "noisiness" (SEL)
 - Accounts for number of noise events
 - Provides an additional weighting for nighttime operations
 - Nighttime is defined as 10:00pm to 7:00am

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Noise Terminology

- Number of aircraft operations resulting in noise levels exceeding a threshold noise level (NA)
 - N90= 1
 - N70= 3
 - N60= 6
- Time Above (TA) can refer to seconds or minutes in which an aircraft operation exceeded a threshold noise level

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Measurements

- Provide historical noise levels at discrete points
- Difficult to attribute noise entirely to aircraft operations
- Report noise levels from individual aircraft operations

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Modeling

- Provides past or future noise levels throughout the study area
- Produces results from only aircraft operations
- Generates noise levels from average daily aircraft operations
- Calculates consistent, comparable outputs (if consistent inputs)
- Satisfies federal requirements

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Annoyance vs. Land Use Compatibility

- FAA confirmed through the Neighborhood Environmental Survey (NES) that people are highly annoyed with aircraft noise well outside of the land use compatibility thresholds of 65 DNL
- Noise compatibility measures (sound insulation, land acquisition, etc.) are intended to address incompatible land uses
- DNL is correlated to annoyance

SCHULTZ CURVE

NATIONAL CURVE

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