11. Noise and Noise-Compatible Land Use

Sound is a physical phenomenon consisting of pressure fluctuations that travel through a medium, such as air, and are sensed by the human ear. Noise is considered unwanted sound that can disturb routine activities (e.g., sleep, conversation, student learning) and can cause annoyance. Aviation noise primarily results from the operation of fixed and rotary wing aircraft, such as departures, arrivals, overflights, taxiing, and engine run-ups. Noise is often the predominant aviation environmental concern of the public. Aircraft noise in communities around airports historically generated most of the noise issues. There are increasing concerns in suburban and rural areas farther from airports where ambient noise is lower than it is in the more urbanized areas that tend to surround many commercial service airports. There are also special noise sensitivities with respect to certain resources such as national parks.

The compatibility of existing and planned land uses with proposed aviation actions is usually determined in relation to the level of aircraft noise. Federal compatible land use guidelines for a variety of land uses are provided in Table 1 in Appendix A of 14 Code of Federal Regulations

(CFR) part 150, *Land Use Compatibility with Yearly Day-Night Average Sound Levels*. These guidelines are included later in Section 11.6 of this chapter.

For aviation noise analyses, the Federal Aviation Administration (FAA) has determined that the cumulative noise energy exposure of individuals to noise resulting from aviation activities must be established in terms of Day Night Average Sound Level (DNL)[1], the FAA's primary noise metric. The Community Noise Equivalent Level (CNEL) may be used in lieu of DNL for FAA actions needing approval in California.

DNL and CNEL account for the noise levels of all individual aircraft events, the number of times those events occur, and the period of day/night in which they occur. Both noise metrics logarithmically average aircraft sound levels at a location over a complete 24-hour period, with a 10-decibel (dB) adjustment added to those noise events occurring from 10:00 p.m. and up to 7:00 a.m. the following morning. The 10-dB adjustment has been added because of the increased sensitivity to noise during normal night time hours and because ambient (without aircraft) sound levels during nighttime are typically about 10-dB lower than during daytime hours. In addition, CNEL includes a 4.77-dB adjustment added to noise events occurring during the evening from 7:00 p.m. and up to 10:00 p.m.

11.1. Regulatory Setting

Exhibit 11-1 lists the primary statutes and regulations related to noise and noise-compatible land use impacts.

Exhibit 11-1. Statutes and Regulations Related to Noise and Noise-Compatible Land Use

Statute or Executive Order	Location in U.S. Code or *Federal Register*	Implementing Regulation(s) or Instructions	Oversight Agency[a]	Summary[a]
Airport and Airway Improvement Act of 1982	49 U.S.C. § 47101 et seq.	Not applicable	FAA	Authorizes funding for noise mitigation and noise compatibility planning and projects, and establishes certain requirements related to noise-compatible land use for federally-funded airport development projects.
Airport Noise and Capacity Act of 1990	49 U.S.C. §§ 47521-47534 §§ 106(g), 47523-47527	14 CFR part 161	FAA	Mandated the phaseout of Stage 2 jet aircraft over 75,000 pounds, and establishes requirements regarding airport noise and access restrictions for Stage 2 and 3 aircraft.

[1] **Average Sound Level** means the level, in decibels, of the mean-square, A-weighted sound pressure during a specified period, with reference to the square of the standard reference sound pressure of 20 micropascals. **Day-Night Average Sound Level (DNL)** means the 24-hour average sound level, in decibels, for the period from midnight to midnight, obtained after the addition of ten decibels to sound levels for the periods between midnight and 7 a.m., and between 10 p.m., and midnight, local time. **Yearly Day-Night Average Sound Level (YDNL)** means the 365-day average, in decibels, of the day-night average sound level.

Statute or Executive Order	Location in U.S. Code or *Federal Register*	Implementing Regulation(s) or Instructions	Oversight Agency[a]	Summary[a]
Aviation Safety and Noise Abatement Act of 1979	49 U.S.C. § 47501 et seq.	14 CFR part 150	FAA	Directs the FAA to establish, by regulation, a single system for measuring noise and determining the exposure of people to noise; which includes noise intensity, duration, frequency, and time of occurrence; and to identify land uses normally compatible with various noise exposures.
Prohibition on Operating Certain Aircraft Weighing 75,000 Pounds or Less Not Complying with Stage 3 Noise Levels (Section 506 of the FAA Modernization and Reform Act of 2012)	49 U.S.C. §§ 47534	14 CFR part 91	FAA	After December 31, 2015, a person may not operate a civil subsonic jet airplane with a maximum weight of 75,000 pounds or less unless the Secretary of Transportation finds that the aircraft complies with stage 3 noise levels.
The Control and Abatement of Aircraft Noise and Sonic Boom Act of 1968	49 U.S.C. § 44715	49 CFR part 821, 14 CFR parts 21, 36, 91, 119, 135, and 150	FAA	Authorizes the FAA to prescribe standards for the measurement of aircraft noise and establish regulations to abate noise.
The Noise Control Act of 1972	42 U.S.C. §§ 4901-4918	40 CFR part 209	EPA	Amends the Control and Abatement of Aircraft Noise Sonic Boom Act of 1968 to add consideration of the protection of public health and welfare and to add the EPA to the rulemaking process for aircraft noise and sonic boom standards.
State/Local Noise Laws/Ordinances	Not applicable	Not applicable	Not applicable	There may be state or local laws or ordinances that apply to noise from a proposed project (e.g., construction noise).[2]

[a] CFR = Code of Federal Regulations; EPA = U.S. Environmental Protection Agency; FAA = Federal Aviation Administration; U.S.C. = United States Code.

11.1.1. Consultations, Permits, and Other Approvals

Most FAA actions do not involve any required federal consultation processes, permits, or other approvals related to noise and noise-compatible land use. However, standards and regulations under 49 U.S. Code (U.S.C.) § 44715(a), including regulations to control and abate aircraft noise and sonic boom, require consultation with the Administrator of the U.S. Environmental Protection Agency (EPA).

[2] With limited exception, state and local regulation of aircraft noise is federally-preempted.

11.1.2. Projects Not Requiring a Noise Analysis

No noise analysis is needed for projects involving Design Group I and II airplanes (wingspan less than 79 feet) in Approach Categories A through D (landing speed less than 166 knots) operating at airports whose forecast operations[3] in the period covered by the National Environmental Policy Act (NEPA) document do not exceed 90,000 annual propeller operations (247 average daily operations) or 700 annual jet operations (2 average daily operations). These numbers of propeller and jet operations result in DNL 60 dB contours of less than 1.1 square miles that extend no more than 12,500 feet from start of takeoff roll. The DNL 65 dB contour areas would be 0.5 square mile or less and extend no more than 10,000 feet from start of takeoff roll.

Also, no noise analysis is needed for projects involving existing heliports or airports whose forecast helicopter operations in the period covered by the NEPA document do not exceed 10 annual daily average operations with hover times not exceeding 2 minutes. These numbers of helicopter operations result in DNL 60 dB contours of less than 0.1 square mile that extend no more than 1,000 feet from the pad. Note that this rule applies to the Sikorsky S-70 with a maximum gross takeoff weight of 20,224 pounds and any other helicopter weighing less or producing equal or less noise levels.

11.1.3. FAA Aircraft Noise Screening Tools and Methodologies

Aircraft noise screening may rule out the need for more detailed noise analysis and provide documented support for a Categorical Exclusion (CATEX) if screening shows no potential for significant noise impacts. The FAA has multiple noise screening tools and methodologies. A list of available FAA screening tools is provided below. To use screening tools or equivalent screening methodologies not listed below, prior written approval from the Office of Environment and Energy (AEE) is required.

Area Equivalent Method (AEM)[4]

For use in evaluating proposed actions and alternative(s) at an airport which result in a general overall increase in daily aircraft operations or the use of larger/noisier aircraft, as long as there are no changes in ground tracks, flight profiles or runway use. If the AEM calculations indicate that the action would result in less than a 17 percent (approximately a DNL 1 dB) increase in the DNL 65 dB contour area, there would be no significant impact over noise sensitive areas and no further noise analysis would be required. If the AEM calculations indicate an increase of 17 percent or more, or if the action is such that use of the AEM is not appropriate, then the noise analysis must be performed using the Aviation Environmental Design Tool (AEDT) to determine if significant noise impacts would result.

Guidance for Noise Screening Air Traffic Actions

For use in evaluating when proposed air traffic procedure actions may warrant additional review for potential noise impacts. This is accomplished by performing the following five tests as documented in Mitre's 2012 *Guidance for Noise Screening of Air Traffic Actions* (available

[3] Landings and take-offs are considered separate operations.

[4] http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/aem_model.

at: https://www.faa.gov/air_traffic/environmental_issues/Environmental_TETAM/media/guidance_noise_screening_air_traffic_actions.pdf) and the 2013 *Technical Addendum to the Guidance for Noise Screening of Air Traffic Actions* (available here: https://www.faa.gov/air_traffic/environmental_issues/Environmental_TETAM/media/technical_addendum_to_guidance_document.pdf):

- Operations Test
- Traffic Test
- Lateral Movement Test
- Altitude/Operations Test
- Overlay Test

As detailed in this document, these tests are designed to step the user through a series of consistent, repeatable pre-screening reviews in order to determine whether the potential for noise impacts exists and whether additional screening or noise analysis should be recommended.

Terminal Area Routing Generation, Evaluation and Traffic Simulation (TARGETS) AEDT Environmental Plug-in

For use in evaluating potential noise impacts[5] as a result of airspace changes above 3,000 feet above ground level (AGL). The TARGETS AEDT Environmental Plug-in can be used for evaluation of air traffic airspace and procedure actions where the study area is larger than the immediate vicinity of an airport, incorporates more than one airport, and/or includes actions above 3,000 feet AGL. For changes below 3,000 feet, Air Traffic may use the TARGETS AEDT Environmental Plug-in or the *Air Traffic Guidance for Noise Screening Air Traffic Actions* (discussed above). This is accomplished by screening the proposed changes to determine whether there is the potential to increase noise levels over communities beneath the aircraft route. The tool may only be used to identify the following noise level changes:

- For DNL 65 dB and higher: ± DNL1.5 dB
- For DNL 60 dB to <65 dB: ± DNL 3 dB
- For DNL 45 dB to <60 dB: ± DNL 5 dB

The TARGETS AEDT Environmental Plug-in must also refer to the most current version of AEDT as described in Section 11.1.4 below.

11.1.4. FAA-Approved Models for Detailed Noise Analysis

AEE has approved models for detailed noise analysis. Prior written approval from AEE is required to use another equivalent methodology or computer model. When requesting the use of an alternative model, justification of appropriateness of the use of that model over the use of the models below is required. Unless it can be justified, all noise analyses must be performed using the standard and default data. Modification to standard or default data in AEDT requires prior

[5] Targets AEDT Environmental Plug-In is not approved for evaluation of emissions or fuel burn.

written approval from AEE. Guidance for submitting changes to the AEDT standard or default data can be obtained at: https://aedt.faa.gov/Documents/guidance_aedt_nepa.pdf.

AEE has approved the following models for use for detailed noise analysis:

- **The FAA's AEDT** at: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/AEDT/. The most current version of AEDT must be used when evaluating new project actions.[6]
- **U.S. Department of Defense's NOISEMAP** is used to model noise exposure due to military aircraft flights and engine run-up activities. It should be used when the study consists predominantly of military operations. NOISEMAP must be used for modeling military aircraft noise in conjunction with AEDT for civil aircraft noise at joint-use airports. NOISEMAP includes a suite of noise modeling tools where the following are approved when used to produce Yearly DNL results:
  - **NMap** for military aircraft flight and run-up noise near airports
  - **MRNMap** for subsonic military aircraft noise within specified airspace boundaries e.g., Military Operations Areas and Military Training Routes
  - **Rotorcraft Noise Model (RNM)** for military helicopter and tilt-wing aircraft

  Note that while NOISEMAP may include or add additional modules, only those specified above are approved as standard noise models by the FAA. All other NOISEMAP modules should be considered as non-standard and require further review and approval by AEE on a case-by-case basis.
- **PCBOOM** is used to calculate the location and magnitude of sonic-boom overpressures on the ground from collections of individual supersonic flight and commercial space operations.
- **BOOMAP** is used to calculate the cumulative sonic boom exposure from statistical representation of tactical military operations over pre-defined geographic area, such as a Military Operations Area.

All computer model input data should be collected early in the environmental process and the data should reasonably reflect current and forecast[7] conditions relative to the proposed action and alternative(s). Input documentation for the noise analysis with one copy of the input data files and corresponding output files used in the noise analyses and the corresponding AEDT Administrative File should be provided to the responsible FAA official on electronic media specified by that official. If other equivalent methodologies or the use of non-standard or non-default data are approved, a description of the methodology or additional, non-standard or non-default data, along with a copy of AEE's approval, must be appended to the environmental document.

Noise monitoring data is not required for FAA noise analyses, but may optionally be included in a NEPA document as supplemental information. Noise monitoring data should not be used to calibrate the noise model or to make a finding of significance.

[6] Further information on AEDT versions is available at: https://aedt.faa.gov/Documents/AEDT_Version_Guidance_Memo.pdf.

[7] Aviation forecasts should be consistent with guidance provided in the latest version of FAA Order 5050.4.

11.2. Affected Environment

The steps generally required to describe the affected environment for noise and noise compatible land use for NEPA documents are as follows:

- Determine the study area for noise analysis;
- Identify noise sensitive areas in the study area and pertinent land use information; and
- Describe current noise conditions in the study area.

The study area for noise is the three dimensional geographic area with the potential to be impacted by noise from the proposed project. The study area can vary in size from an airport's environs to a larger scale airspace redesign that includes multiple airports. An airport environs study area must be large enough to include the area within the DNL 65 dB contour, and may be larger. The study area for the noise analysis of a proposed change in air traffic procedures or airspace redesign may extend vertically from the ground to 10,000 feet AGL, or up to 18,000 feet AGL if the proposed action or alternative(s) are over a national park or wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.

A noise sensitive area, as defined in Paragraph 11-5.b.(8) of FAA Order 1050.1F, is:

> "[a]n area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, and parks, recreational areas, areas with wilderness characteristics, wildlife refuges, and cultural and historical sites. For example, in the context of noise from airplanes and helicopters, noise sensitive areas include such areas within the DNL 65 dB noise contour. Individual, isolated, residential structures may be considered compatible within the DNL 65 dB noise contour where the primary use of land is agricultural and adequate noise attenuation is provided. Also, transient residential use such as motels should be considered compatible within the DNL 65 dB noise contour where adequate noise attenuation is provided. A site that is unacceptable for outside use may be compatible for use inside of a structure, provided adequate noise attenuation features are built into that structure (see Table 1, *Land Use Compatibility with Yearly Day-Night Average Sound Levels,* in Appendix A of 14 CFR part 150, *Airport Noise Compatibility Planning*). The FAA recognizes that there are settings where the DNL 65 dB standard may not apply. In these areas, the responsible FAA official will determine the appropriate noise assessment criteria based on specific uses in that area. In the context of facilities and equipment, such as emergency generators or explosives firing ranges, but not including aircraft, noise sensitive areas may include such sites in the immediate vicinity of operations, pursuant to the Noise Control Act of 1972 (See state and local ordinances, which may be used as guidelines for evaluating noise impacts from operation of facilities and equipment)."

Noise compatibility or non-compatibility of land use is determined by comparing the aircraft DNL values at a site to the values in the land use compatibility guidelines (see Exhibit 11-3). Special consideration needs to be given to noise sensitive areas within Section 4(f) properties (including, but not limited to, noise sensitive areas within national parks, national wildlife and waterfowl refuges and historic sites, including traditional cultural properties) where the land use compatibility guidelines in 14 CFR part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the land use categories in the guidelines are not sufficient to determine

the noise compatibility of areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.

Local land use jurisdictions may have noise and land use compatibility standards that differ from the FAA's land use compatibility guidelines with respect to DNL 65 dB in 14 CFR part 150, Appendix A, Table 1 ("the part 150 guidelines," see Exhibit 11-3). Such local standards must be disclosed to the extent required under 40 CFR 1502.16(c) and 1506.2(d). However, the FAA does not use local standards to determine the significance of noise impacts. Pertinent land use plans and a general overview of existing and planned uses of the land should be described.

The description of current noise conditions includes:

- DNL contours or noise grid points showing existing aircraft noise levels. Noise exposure contours must include DNL 65, 70, and 75 dB levels (additional contours may be provided on a case-by-case basis). Noise grids are sized to cover the study area for noise analysis. Multiple grids may be created, but at least one grid consists of population centroids from the U.S. Census blocks. The differences in noise analysis for proposed airport development and other actions in the immediate vicinity of an airport and for air traffic airspace and procedure actions in a larger study area are described more fully in this guidance under the environmental consequences section. U.S. Census data may be supplemented by higher resolution data at the local municipality level, when available. Parcel level data may be available from the local property appraiser's office and is often updated at least once a year. Population and household information can be estimated at the parcel level provided that the local municipalities maintain current estimates of people per household and a housing unit count for multi-family parcels.
- The number of residences or people residing within each noise contour where aircraft noise exposure is at or above DNL 65 dB; or for a larger scale air traffic airspace and procedure action, the population within areas exposed at or above DNL 65 dB, at or above DNL 60 but less than DNL 65 dB, and at or above DNL 45 dB but less than DNL 60 dB.
- The location and number of noise sensitive uses in addition to residences (e.g., schools, hospitals, parks, recreation areas) that could be significantly impacted by noise; and
- Maps and other means to depict land uses within the noise study area. The addition of flight tracks may be helpful. Illustrations should be sufficiently large and clear to be readily understood.

The description of current noise conditions is usually confined to aircraft noise. However, the inclusion of other noise data, such as background or ambient noise or notable levels of noise in the study area from other sources (e.g., highways, industrial uses) is appropriate where such noise data is pertinent to understanding the affected environment and to considering the environmental impacts of the proposed action and alternative(s).

11.3. Environmental Consequences

The environmental consequences section of the NEPA document will include the analysis of the potential noise impacts of the proposed action and alternative(s) for each timeframe evaluated.

> ***Noise Contours*** – Lines on a map that represent equal levels (usually expressed in units of DNL/dB) of noise exposure.

The noise analysis will include DNL noise contours (see text box), grid points, and/or change-of-exposure analysis for the proposed action and each alternative compared to the no action alternative for the same future timeframe. Comparisons should be done for appropriate timeframes. Timeframes usually selected are the year of anticipated project implementation and 5 to 10 years after implementation. Additional timeframes may be desirable for particular projects.

For proposed airport development and other actions in the immediate vicinity of an airport, AEDT is used to provide noise exposure contours at the DNL 65, 70, and 75 dB levels (additional contours may be provided on a case-by-case basis). For all comparisons analyzed, the analysis will identify noise increases of DNL 1.5 dB or more over noise sensitive areas that are exposed to noise at or above the DNL 65 dB noise exposure level, or that would be exposed at or above the DNL 65 dB level due to a 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe.

For actions in the immediate vicinity of an airport, the following information must be disclosed for each modeled scenario that is analyzed:

- The number of residences or people residing within each noise contour where aircraft noise exposure is at or above DNL 65 dB and the net increase or decrease in the number of people or residences exposed to that level of noise;
- The location and number of noise sensitive uses in addition to residences (e.g., schools, hospitals, parks, recreation areas) exposed to DNL 65 dB or greater;
- The identification of noise sensitive areas within the DNL 60 dB contour that are exposed to aircraft noise at or above DNL 60 dB but below DNL 65 dB and are projected to experience a noise increase of DNL 3 dB or more, only when DNL 1.5 dB increases are documented within the DNL 65 dB contour;
- Discussion of the noise impact on noise sensitive areas within the DNL 65 dB contour; and
- Maps and other means to depict land uses within the noise study area. The addition of flight tracks is helpful. Illustrations should be sufficiently large and clear to be readily understood.

For a detailed noise analysis of air traffic airspace and procedure actions where the study area is larger than the immediate vicinity of an airport, incorporates more than one airport, and/or includes actions above 3,000 feet AGL, AEDT should be used. The noise analysis will focus on a change-in-exposure analysis, which examines the change in noise levels as compared to population and demographic information at population points throughout the study area. This is normally a noise grid analysis. Multiple grids may be created, but at least one grid must consist

of population centroids from the U.S. Census blocks. Discrete receptor points[8] can also represent select noise sensitive area(s) or comprise a general receptor grid over the study area, either densely or sparsely spaced. Noise contours may be created at the FAA's discretion; however, noise contours are not required and are not normally used for the analysis of larger scale air traffic airspace and procedure actions. If the study encompasses a large geographical area, it is not recommended that contours be created for the representation of results below DNL 55 dB due to fidelity of receptor sets needed to create an accurate representation of the contour.

For air traffic airspace and procedure actions evaluated as described above, change-of-exposure tables and maps at population centers are provided to identify where noise will change by the following specified amounts:

- For DNL 65 dB and higher: $\pm$ DNL 1.5 dB
- For DNL 60 dB to <65 dB: $\pm$ DNL 3 dB[9]
- For DNL 45 dB to <60 dB: $\pm$ DNL 5 dB[9]

The location and number of noise sensitive uses (e.g., schools, churches, hospitals, parks, recreation areas, etc.) exposed to DNL 65 dB or greater must be disclosed for each modeling scenario that is analyzed.

The noise compatibility of land use is determined by comparing the aircraft DNL values at a site to the values in the land use compatibility guidelines in 14 CFR part 150, Appendix A, Table 1. Environmental Assessments (EAs) and Environmental Impact Statements (EISs) must disclose newly non-compatible land use regardless of whether there is a significant noise impact (see FAA Order 10.50.1 F, Paragraph B-1.5). Special consideration needs to be given to noise sensitive areas within Section 4(f) properties (including, but not limited to, noise sensitive areas within national parks; national wildlife and waterfowl refuges; and historic sites, including traditional cultural properties) where the land use compatibility guidelines in 14 CFR part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the land use categories in the guidelines are not sufficient to determine the noise compatibility of areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.

11.3.1. Significance Determination

Exhibit 4-1 of FAA Order 1050.1F provides the FAA's significance threshold for noise: The action would increase noise by DNL 1.5 dB or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB. The determination of significance must be obtained through the use of noise contours and/or grid point analysis

[8] Receptors are locations where noise is modeled. A collection of receptors are known as receptor sets. Grid points are an example of a receptor set.

[9] The FAA refers to noise changes meeting these criteria as "reportable."

along with local land use information and general guidance contained in Appendix A of 14 CFR part 150.

Special consideration needs to be given to the evaluation of the significance of noise impacts on noise sensitive areas within Section 4(f) properties (including, but not limited to, noise sensitive areas within national parks; national wildlife and waterfowl refuges; and historic sites, including traditional cultural properties) where the land use compatibiliy guidelines in 14 CFR part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the DNL 65 dB threshold does not adequately address the impacts of noise on visitors to areas within a national park or national wildlife and waterfowl refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.

When the proposed action or alternative(s) would result in a significant noise increase and the proposed action or any alternative is highly controversial on this basis, the EIS should include, as appropriate in light of the specific proposal under analysis, information on the human response to noise. Inclusion of data on background or ambient noise, as well as other noise in the area, may be helpful.

Compatible or non-compatible land use is determined by comparing the aircraft DNL values at a site to the values in the part 150 land use compatibility guidelines (see Exhibit 11-3). The part 150 guidelines include uses that may be protected under Section 4(f). The part 150 guidelines may be used to determine the significance of noise impacts on properties protected under Section 4(f) to the extent that the land uses specified in the guidelines bear relevance to the value, significance, and enjoyment of the lands in question. Special consideration needs to be given to noise sensitive areas within Section 4(f) properties (including, but not limited to, noise sensitive areas within national parks, national wildlife and waterfowl refuges and historic sites, including traditional cultural properties) where the land use compatibility guidelines in 14 CFR part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the part 150 land use categories are not sufficient to determine the noise compatibility of areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute, or to address noise impacts on wildlife. When instances arise in which aircraft noise is a concern with respect to wildlife impacts, established scientific practices, including review of available studies dealing with specific species of concern, should be used in the analysis. Noise impact studies of similar species, where similarity may be judged on physiological, phylogenetic, or ecological criteria, and published theories of noise impacts that pertain to these species should be used to obtain the best estimate of potential impacts. This estimate should be qualified by a discussion of the biological uncertainties that arise from gaps in theory and distinctions between the studied species and the affected species. With respect to historic sites, the FAA may rely upon the part 150 guidelines for residential use to determine noise impacts on historic properties that are in use as residences. However, the part 150 guidelines may not be sufficient to determine the impact of noise on historic properties where a quiet setting is a generally recognized purpose and attribute (i.e., where it has been determined to be a contributing factor to the property's historic significance), such as a historic village preserved specifically to convey the atmosphere of rural life in an earlier era or a traditional cultural property.

If the noise and noise-compatible land use analysis concludes that there is no significant impact, usually a similar conclusion may be drawn with respect to land use in general. However, if the proposal would result in other impacts which have land use ramifications, for example,

disruption of communities, relocation, or induced socioeconomic impacts, the impacts on land use should be analyzed in this context and described accordingly under the appropriate impact category (see Chapter 9, Land Use).

11.4. Supplemental Noise Analysis

The Federal Interagency Committee on Noise (FICON) report, "Federal Agency Review of Selected Airport Noise Analysis Issues[10]," dated August 1992, concluded that the DNL is the recommended metric and should continue to be used as the primary metric for aircraft noise exposure. Subsequent review has confirmed there are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric. However, DNL analysis may optionally be supplemented on a case-by-case basis to characterize specific noise impacts. Because of the diversity of situations, the variety of supplemental metrics available, and the limitations of individual supplemental metrics, the FICON report concluded that the use of supplemental metrics to analyze noise should remain at the discretion of individual agencies.

Supplemental noise analyses are most often used to describe aircraft noise impacts for specific noise sensitive locations or situations and to assist in the public's understanding of the noise impact. The selection of supplemental analyses will depend upon the circumstances of each particular project. In some cases, public understanding may be improved with a more complete narrative description of the noise events contributing to the DNL contours with additional tables, charts, maps, or metrics. In other cases, supplemental analyses may include the use of metrics other than DNL. There is no single supplemental methodology that is preferable in all situations and these metrics often do not reflect the magnitude, duration, or frequency of the noise events under study.

Exhibit 11-2 below describes metrics that have been used in developing supplemental noise analyses for a variety of reasons such as sleep disturbance, speech interference, building sound insulation, and analysis for special areas such as national parks.

[10] https://fican1.files.wordpress.com/2015/10/reports_noise_analysis.pdf.

Exhibit 11-2. Potential Metrics for Supplemental Noise Analyses

Metric	Description
Sound exposure level (SEL)	A single event metric that takes into account both the noise level and duration of the event, referenced to a standard duration of one second.
Maximum sound level (L_{max})	A single event metric that is the highest A-weighted sound level measured during an event.
Equivalent sound level (L_{eq})	A cumulative level of a steady sound level that provides an equivalent amount of sound energy for any specific period.
Time above (TA)	A time-based metric that gives the duration, in minutes, for which aircraft-related noise exceeds a specified A-weighted sound level during a given period.
Number Above Noise Level (NANL)	The total number of events where the noise exceeds a defined threshold level.
Time Audible	The duration that a time-varying sound level may be detected in the presence of ambient noise as audible by a human observer with normal hearing, who is actively listening for aircraft noise. This metric may be used, if appropriate, for projects within or involving national parks.

A comprehensive listing of acoustical terminology and definitions is available in the American National Standards Institute's (ANSI) "Acoustical Terminology" standard (ANSI S1.1-1994).

The type and nature of activity potentially impacted should be considered. The FICON report identified sleep disturbance and speech interference as two areas where it is appropriate to consider supplemental metrics. In the case of sleep disturbance the predicted number of awakenings in the United States may be calculated using the ANSI Noise Standard, ANSI S12.9-2008/Part 6, Quantities and Procedures for Description and Measurement of Environmental Sound – Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes. To examine speech interference (also used as a surrogate for children's learning), FICON recommended using a cumulative A-weighted metric that is limited to the affected time period hours or a Time-above analysis. Additionally, the FICON report provides a table that relates DNL to speech interference. The Federal Interagency Committee on Aviation Noise (FICAN) also provided updated background on these findings in their 2018 report *Review of Selected Aviation Noise Research Issues.*[11]

If the FAA identifies one or more Section 4(f) properties within the study area (including, but not limited to, noise sensitive areas within national parks, national wildlife and waterfowl refuges, and historic sites including traditional cultural properties) where a quiet setting is a generally recognized purpose and attribute, the FAA will consider use of appropriate supplemental noise analysis. This supplemental noise analysis will be considered in consultation with the officials having jurisdiction over the Section 4(f) properties. Such supplemental noise analysis is not, by itself, a measure of adverse aircraft noise or significant aircraft noise impact. Lines of Business/Staff Offices within the FAA must consult with and receive approval from AEE in determining the appropriate supplemental noise analysis for use in such cases.

[11] https://fican1.files.wordpress.com/2018/04/fican_research_review_2018.pdf.

Supplemental analyses may be accomplished using the various capabilities of AEDT for specific grid point analysis. Noise analyses can be used in combination with Geographic Information System (GIS) programs such as ArcGIS and the U.S. Census Topologically Integrated Geographic Encoding and Referencing databases to determine various population impacts within specified geographic areas.

11.5. Additional Noise Analysis Guidance

11.5.1. Noise from On-Airport Sources Other Than Aircraft Departures and Arrivals

For some noise analyses, it may be necessary to include noise sources other than aircraft departures and arrivals in the noise analysis. This can be determined by examining the action and determining the potential impacts caused by noise other than aircraft departures and arrivals. Some examples are engine run-ups, aircraft taxiing, construction noise, and noise from related roadway work and roadway noise. The inclusion of these sources should be considered on a case-by-case basis, as appropriate.

If engine run-ups or aircraft taxiing noise are analyzed as part of the study, an FAA-approved model must be used. If an alternative model or methodology is desired, prior AEE approval is needed (see Section 11.4 for details). If appropriate, an analysis of surface transportation impacts, including construction noise, should be conducted using accepted methodologies from the appropriate modal administration, such as the Federal Highway Administration (FHWA) for highway noise.

For information on facility and equipment noise impact emissions see Section 11.5.5 below. For noise associated with commercial space actions see Section 11.5.4 below.

11.5.2. 14 CFR Part 150 Noise Proposals

If the proposal requiring an EA or EIS is the result of a recommended noise mitigation measure included in an FAA-approved part 150 noise compatibility program, the noise analysis developed in the program will normally be incorporated in the EA or EIS. The responsible FAA official must determine whether this is sufficient for EA or EIS noise analysis purposes.

11.5.3. Airport Actions

For airport actions, documentation must be included to support the required airport sponsor's assurance under 49 U.S.C. § 47107(a)(10) that appropriate action, including the adoption of zoning laws, has been or will be taken, to the extent reasonable, to restrict the use of land adjacent to or in the immediate vicinity of the airport to activities and purposes compatible with normal airport operations, including takeoff and landing of aircraft. The assurance must be related to existing and planned land uses. The NEPA document should address what is being done by the jurisdiction(s) with land use control authority, including an update on any prior assurance.

The Airport Development Grant Program (see 49 U.S.C. § 47101) requires that a project may not be approved unless the Secretary of Transportation is satisfied that a project is consistent with plans (existing at the time a project is approved) of public agencies for development of the area in which the airport is located (see 49 U.S.C. § 47106(a)(1)).

FAA Advisory Circular 150/5020-1, *Noise Control and Compatibility Planning for Airports*, presents guidance for airport operators and planners to help achieve compatibility between airports and their environs.

Guidance on Procedures for Evaluating the Potential Noise Impacts of Airport Improvement Projects on National Parks and Other Sensitive Park Environments provides FAA regional offices and airport sponsors with appropriate methodology and procedures for evaluating proposed airport projects that could affect the sound environment of National Parks and other U.S. Department of Transportation (DOT) Section 4(f) and cultural properties.

For airport actions, in addition to the guidance provided here, see FAA Order 5050.4B and the Environmental Desk Reference for Airport Actions available at: http://www.faa.gov/airports/resources/publications/orders/environmental_5050_4/.

11.5.4. Commercial Space

Noise analyses and evaluations of potential impacts for commercial space launch vehicles and sites can vary substantially from approaches used by the FAA for civil aircraft and airports for several reasons. One reason is the low-frequencies component of the spectral characteristics of the launch vehicle noise. Such low-frequency noise can propagate for much longer distances than noise from jet or propeller aircraft, and can be perceived as a "rumbling" noise. Also, commercial space launch vehicles create sonic booms when they operate above the speed of sound. Launch vehicles also differ in their operational procedures, which may have near-vertical trajectories in contrast to the horizontal flight paths of civil aircraft.

As a result, noise modeling and assessment for launch vehicles and sites differs from noise modeling and assessment for civil aircraft and airports. Nevertheless, the basic elements of FAA noise assessment for NEPA, including the DNL 65 dB significance threshold, apply.

The below sections provide guidance on modeling and assessment of launch vehicle noise for the purpose of FAA NEPA reviews.

11.5.4.1. Significant Impact Criteria as Applied to Launch Noise

Given the infrequent number of launch events per year at a particular site, the DNL metric may not fully describe the noise experienced during a commercial space launch. Hence, supplemental noise metrics in conjunction with DNL should be used to describe and assess noise effects for commercial space operations.

11.5.4.2. Noise Prediction Modeling

Launch Noise Modeling

Using a noise model to develop noise contours is generally warranted when the proposed commercial space launch operations would affect a populated area. If the proposed launch vehicle is in the conceptual phase and does not exist yet, the preferred approach is to calculate its noise generation characteristics on the basis of thrust, size of nozzles, and other parameters using a noise model.

As there is no standard FAA-approved launch noise model, AEE must approve the use of specific launch noise models for environmental analysis of FAA actions.

A candidate launch noise model must address the following elements:

- Rocket noise source characteristics consistent with current knowledge for sound power level, spectrum, and directivity, adjustable for rocket type and exhaust flow characteristics;
- Propagation that accounts for the current sound absorption standard, and proper application, accounting for Doppler-shifted propagating wavelength and atmospheric layering;
- Incorporation of variable ground impedance in the affected environment, in particular acoustically soft ground areas and acoustically hard water areas; and
- Ability to compute a variety of metrics, on a grid suitable for construction of contours and mapping to a local or geographic coordinate system.

Sonic Boom Modeling

PCBOOM, discussed in Section 11.1.4, is a computer program that calculates the location and magnitude of sonic booms from supersonic vehicles including sonic boom focal zones. PCBOOM generates noise contours presented in term of pounds per square foot (psf). Prior approval from AEE is required to use other models or methodologies.

Sonic boom noise predictions should include the launch and re-entry sonic boom footprints, including any focal zones. Since sonic boom measurements results are typically presented in terms of psf, a conversion is needed to obtain C-weighted DNL (CDNL)[12] values. This allows for a comparison to FAA's significance threshold in DNL. It should be noted that both psf and CDNL results are usually needed for most commercial space launch proposals. The psf metric is used to determine potential structural damage to buildings, while CDNL is applied during the assessment of potential human annoyance.

The following section describes how to convert psf to CDNL.

Calculation of CDNL[13]

The first step is a simple conversion of psf to Pascals to obtain peak Sound Pressure Level L_{pk}:

1. $L_{pk} = 127.6 + 20\log(psf)$.

For N-wave shaped sonic booms, Equation 2 below provides a relationship between L_{pk} and C-weighted Sound Exposure Level (CSEL) to within 2 dB. CSEL normalizes sound energy associated with a noise event of any duration as if it occurred in one second. The CSEL is useful for comparing the noise energy of two noise events with different durations:

2. $L_{pk} - CSEL = 26$ dB.

Finally, equation 3 can be used to calculate CDNL:

3. $CDNL = CSEL + 10\log(N_d + 10N_n) - 49.4$,

[12] C-weighting is preferred over A-weighting for impulsive noise sources with large low-frequency content such as sonic booms.
[13] P.D. Schomer, "Growth Functions for Human Response to Large-Amplitude Impulse Noise," J. Acoust. Soc. Am., 64, 1627-1632, 1978. The conversions are based on published sonic boom spectra found in this report: K.D. Kryter, P.L. Johnson, and J.R. Young, "Psychological Experiments on Sonic Booms Conducted at Edwards AFB," Final Rep. Stanford Res. Inst. ETU-6065 (1968).

where N_d is number of events per day, and N_n is number of events per night.

11.5.4.3. Noise Metrics

Supplemental Metrics

The following supplemental metrics may be helpful to include in NEPA documents to describe launch noise and sonic boom. The metrics may be portrayed graphically as contour maps indicating relative location:

- Lmax
- CSEL
- Overall Sound Pressure Level (OASPL)
- C-weighted day night average sound level L_{Cdn}
- Sound level time history plots
- Number-of-Events Above (NA) a Threshold Level (L)
- Time Above (TA) a Specified Level (L)
- Peak sound pressure Level (L_{pk})[14]
- Sonic Boom (including focus boom) Overpressure (psf) footprints and contours
- Sonic boom loudness Perceived Level (PLdB)[15,16] footprints
- Day-night sonic boom loudness levels (PLDN)[17] for cumulative daily operations.

Indications that Occupational Safety and Health Association (OSHA) hearing damage criteria[18] and/or structural damage criteria[19] for launch and sonic boom noise (i.e., levels well above noise levels causing annoyance) may be exceeded should also be included.

11.5.4.4. Mixed Use Launch Facility

For a proposed commercial space launch site at an existing airport, existing baseline noise conditions for the Affected Environment should include noise from existing on-airport sources (e.g., aircraft operations).

[14] The Peak Sound Pressure Level is the highest instantaneous level assessed from typically a 20 microsecond sampling rate meter. L_{pk} is based on unweighted or linear response.

[15] Stevens, S.S., "Perceived Level of Noise by Mark VII and Decibels (E)", *J. Acoustical Soc. Am.*, **51**(2) (Part 2), 575-601, 1972.

[16] Shepherd, K.P., and Sullivan, B.M., ''A loudness calculation procedure applied to shaped sonic booms,'' NASA Technical Paper 3134, 1991.

[17] McCurdy, D.A., Brown, S.A., and Hilliard, R.D., "Subjective response of people to simulated sonic booms in their homes," *J. Acoust. Soc. Am.*, Vol. 116, No. 3, September 2004, pp. 1573-1584.

[18] 29 CFR § 1910.95.

[19] "Guidelines for Preparing Environmental Impact Statements on Noise", Committee on Hearing, Bioacoustics, and Biomechanics, National Academies of Science, 1977.

To conduct the impact analysis, the results of existing DNL noise conditions for on-airport sources should be considered in conjunction with the results of the launch noise model. This comparison would be followed by determination of the change in noise levels for the alternatives that include new launch activities.

Construction activities related to launch facilities are similar to those for airport facilities, and therefore the construction noise mitigation techniques described in Section 11.6 of this Desk Reference are appropriate.

11.5.4.5. Launch Facility and Equipment Noise Emissions

For launch facility and equipment noise emissions, the provisions of the Noise Control Act of 1972 (42 U.S.C. §§ 4901-4918), as amended, apply. State and local standards can be used as a guide for particular activities if these standards are at least as stringent as federal standards. The Act's provisions apply to all land uses. Special attention should be given to noise sensitive areas in developing mitigation (e.g., scheduling machinery operations near hospitals).

11.5.5. Flight Standards

11.5.5.1. Operations Specifications

Flight Standards actions that are normally subject to EAs include the approval of operations specifications or amendments that may significantly change the character of the operational environment of an airport. The person responsible for approving the operations specifications is also responsible for assuring the EA is prepared. Thorough coordination among Flight Standards District Office (FSDO) personnel and the Regional Flight Standards Division is essential. Coordination among regions is expected if an action crosses regional boundaries or lines of businesses (LOBs).

In preparing a noise analysis, the FSDO personnel normally will collect information from the operator that includes the airport, types of aircraft and engines, number of scheduled operations per day, and the number of day/night operations. The information should also include the operator's long-range plans and operation assumptions that are sufficiently conservative to encompass reasonably foreseeable changes in operations.

If the carrier declines to furnish the information, or if the furnished information on operations at the airport does not realistically address night operations (in view of the carrier's proposal and pattern of activity at that airport), or if the information otherwise patently understates the potential operations (when compared with carrier's operations at other airports or with other carrier's operations at that airport), the responsible FAA official will develop an operational assumption which includes night operations and which is otherwise consistent with the typical operations of similar carriers at similar airports. This operational assumption will be used in the NEPA review after coordination with the affected air carrier. If the air carrier objects to the use of this operational assumption in the NEPA review, the carrier may specify that a lesser level of operations be used in the analysis, provided that the carrier agrees that this lesser level will serve as a limit on the operations specifications. If the carrier refuses such a limitation, the FAA will include all reasonably foreseeable operations in the analysis. In this situation, the NEPA document should state that the operational assumption was developed solely for the purpose of environmental analyses and that it is not to be viewed as a service commitment by the carrier.

If an EIS is required, the affected operator should be advised as soon as possible and should be requested to provide any additional required information. District Office personnel will coordinate, as necessary, any activity with the operator. The operations specifications will not be approved until all issues and questions associated with the EIS are fully resolved and the regional Flight Standards Division manager has concurred with the approval.

11.5.5.2. Aerobatic Practice Areas

Due to the unique nature of the practice routines used in aerobatic practice areas (APA), the standard and default data in AEDT is not appropriate for use when modeling the noise consequences of the aircraft performing in the APA. For guidance on performing noise analysis for APAs, see the October 17, 2012 FAA guidance memorandum titled, "Approval of Aerobatic Practice Area (APA) noise equivalent methodology" available at: www.faa.gov/go/1050deskreference.

11.6. Mitigation

Any mitigation measures that are in effect at the time of the proposal or are proposed to be taken to mitigate the action should be described in the NEPA document.

Local land use actions are within the purview of local governments. The FAA encourages local governments to take actions to reduce and prevent land uses around airports that are not compatible with airport operation and aircraft noise. Airports receiving grant funding have a compatible land use obligation, as described in Section 11.5.3, Airport Actions. The NEPA document should address what is being done regarding compatible land use by the jurisdiction(s) with land use control authority.

Common operational measures to mitigate noise include:

- preferential runway use; and
- noise abatement flight procedures.

Common mitigation measures related to noise and noise-compatible land use include:

- acquisition of land or land interests, including air rights, easements, and development rights, to ensure the use of property for purposes compatible with noise exposure;
- sound insulation of residences and other noise sensitive structures; and
- construction of noise barriers or acoustic shielding to mitigate ground-level noise.

Common construction mitigation measures include:

- use of proper mufflers for construction equipment; and
- measures to limit noise from machinery or trucks as they traverse streets in noise sensitive areas.

When a noise analysis in the immediate vicinity of an airport identifies noise sensitive areas that would have an increase of DNL 3 dB or more from DNL 60 dB up to DNL 65 dB noise exposure, the potential for mitigating noise in those areas should be considered, including consideration of the same range of mitigation options available at DNL 65 dB and higher and

eligibility for federal funding. This is not to be interpreted as a commitment to fund or otherwise implement mitigation measures in any particular area.[20]

Exhibit 11-3. Land-Use Compatibility* with Yearly Day-Night Average Sound Levels

Land Use	Yearly DNL Sound Level (decibels)					
	<65	65-70	70-75	75-80	80-85	>80
Residential						
Residential, other than mobile homes and transient lodgings	Y	N (1)	N (1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N (1)	N (1)	N (1)	N	N
Public Use						
Schools	Y	N (1)	N (1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y (2)	Y (3)	Y (4)	Y (4)
Parking	Y	Y	Y (2)	Y (3)	Y (4)	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail – building materials, hardware, and farm equipment	Y	Y	Y (2)	Y (3)	Y (4)	N
Retail trade, general	Y	Y	25	30	N	N
Utilities	Y	Y	Y (2)	Y (3)	Y (4)	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y (2)	Y (3)	Y (4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y (6)	Y (7)	Y (8)	Y (8)	Y (8)
Livestock farming and breeding	Y	Y (6)	Y (7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y

[20] Federal Interagency Committee On Noise: Federal Agency Review of Selected Airport Noise Analysis Issues (August 1992), page 3-7.

Land Use	Yearly DNL Sound Level (decibels)					
	<65	65-70	70-75	75-80	80-85	>80
Recreational						
Outdoor sports arenas and spectator sports	Y	Y (5)	Y (5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Source: 14 CFR part 150, Appendix A, Table 1

Note: Numbers in parentheses refer to the notes at end of the exhibit.

* The designations contained in this exhibit do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. The FAA determinations under 14 CFR part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

Y = Land use and related structures compatible without restrictions

N = Land use and related structures are not compatible and should be prohibited

25 or 30 = Land use and related structures generally compatible; measures to achieve Noise Level Reduction of 25 or 30 dBA (i.e., a weighted sound level) must be incorporated into design and construction of structure. Noise Level Reduction is the amount of noise reduction in decibels achieved through incorporation of building sound insulation treatments (between outdoor and indoor levels) in the design and construction of a structure (14 CFR § 150.7). Building sound insulation treatments typically consist of acoustical replacement windows and doors.

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor noise level reduction of at least 25 dBA and 30 dBA should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a noise level reduction of 20 dBA, thus, the reduction requirements are often stated as 5, 10 or 15 dBA over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of noise level reduction criteria will not eliminate outdoor noise problems.

(2) Measures to achieve noise level reduction of 25 dBA must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(3) Measures to achieve noise level reduction of 30 dBA must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(4) Measures to achieve noise level reduction of 35 dBA must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(5) Land use compatible provided special sound reinforcement systems are installed.

(6) Residential buildings require noise level reduction of 25 dBA.

(7) Residential buildings require noise level reduction of 30 dBA.

(8) Residential buildings not permitted.