Appendix A
Background, Including Noise Terms and Definitions

Noise definition

Noise is defined as "unwanted sound," and, therefore, has both an objective and a subjective component. Whether or not a sound is considered as noise depends both on its acoustical properties and its interference with intended activities. For example, attendees of a rock concert likely do not perceive the music as noise despite very high SPLs. In contrast, residents living in the vicinity of the concert hall may perceive the music as noise despite much lower levels, as it may interfere with activities like reading a book or learning for school.

Aircraft noise characteristics

In contrast to, e.g., continuous road traffic noise from a busy road, aircraft noise is intermitted noise, i.e., consecutive aircraft noise events are usually separated by a noise-free period. During take-off, noise is predominantly generated by aircraft engines, while aerodynamic noise generated at flaps, gears, etc. may be more prominent than engine noise during landing.

Noise mitigation

The best noise mitigation measure is noise reduction at the source. Engineers were able to substantially reduce aircraft noise over the past decades (e.g., through high-bypass engines). Over the same period, air traffic volume increased substantially. Thus, people are exposed to a higher number of less noisy aircraft today. As it takes many years for new quieter aircraft designs to penetrate the market, different solutions are needed to reduce the number of people affected by relevant levels of aircraft noise. Potential measures include restricting how land is used near airports, changing how and where aircraft operate, limiting aircraft operations based on noise levels, limiting the hours that aircraft are allowed to operate, and providing sound insulation of homes and schools.

Noise monetization

Some states monetize the impacts of noise as a part of their policy making process. Within the U.S., the monetization of noise is based on the willingness of individuals to pay to avoid exposure to noise.[67] This method was used instead of observed differences in housing value as it is easier to gather income information than it is housing data. Within the U.K., Interdepartmental Group on Cost and Benefits (noise), IGCB(N), has developed guidance, which includes methods to quantify and monetize adverse health impacts, i.e., sleep disturbance, myocardial infarction, hypertension and dementia. During the ISG workshop, it was noted that even where methods exist to monetize these impacts, there is significant uncertainty in the results.

Noise monitoring

Many airports monitor noise levels on a regular basis. The equipment includes aircraft noise monitors, devices containing sound level meters, computer memory, and possibly communication equipment. The noise monitors are placed at strategic locations in the airport vicinity, often to assess the noise impact on selected neighborhoods or specific noise-sensitive locations such as hospitals or schools. By regular noise monitoring, an airport can ensure that the great majority of aircraft operations are within established noise limits.

Noise prediction

One of the additional tools used by airports and regulatory authorities are sound level contour maps, often just called noise maps. Using a combination of sound level measurements and appropriate sound mapping software, an airport can establish expected noise levels and determine, for example, locations where noise mitigation is needed. Looking down upon a map of the airport, the highest sound levels occur immediately next to the runways and along the primary aircraft takeoff and descent ground tracks. Moving away from these highest levels, decreased noise is found. Such noise maps can be very useful for assessing current and future noise exposure within several kilometers of airports.

Noise levels

This section will only provide the most basic information. For those who wish to dig deeper, there are a number of available references that explain the finer points.[68-70] Noise, or any type of sound, consists of fluctuations in pressure, p, measured in pascals (Pa), which is a force per unit area. Human hearing is extremely sensitive, and people hear very well over a wide range of pressures. Hence, to put this wide range into a more reasonable scale, logarithms are used. The SPL is defined as

$$L_p = \mathrm{SPL} = 20\log_{10}(p/p_{\mathrm{ref}}).$$

As you can see the logarithm to the base 10 is used, and the symbol utilized is L_p, indicating the level of the pressure. The reference pressure p_{ref} is a threshold of human hearing and equals 20 μPa. A much larger pressure corresponding to a loud sound might correspond to 100 dB or higher. Very often to measure noise, an additional frequency weighting is used. Human hearing is not equally sensitive across all frequencies, and the most popular method to at least partially compensating for this is the A-weighting curve. A-weighting emphasizes the frequencies to which the human ear is most sensitive and attenuates the low frequency and very high frequency components of the sound. The A-weighted SPL is denoted L_A. This metric is used commonly in assessing a wide variety of noise types, and is often described with the unit dB(A) or dBA.

Aviation noise metrics

Specific to aviation noise, a number of additional metrics are widely used. For single events, such as the passage of aircraft overhead, with its characteristic rising and falling of noise level over a minute or so, the A-weighted sound exposure level captures all of the energy of the event, and is given the symbol L_{AE}. The maximum level heard during the passage of the aircraft is denoted $L_{A\text{-max}}$. For multiple events, the average of those events is denoted L_{Aeq}, and sometimes the duration is specified (e.g., $L_{Aeq24hours}$ if the average is over an entire day).

Aircraft noise can occur at any time, and sometimes the distinction is made between daytime and nighttime sound levels using the metrics L_{day} and L_{night}. To broadly account for the additional sensitivity to nighttime operations the day–night average level is often used, denoted L_{DN}. It includes a 10 dB(A) penalty for any sounds occurring between the hours of 22:00 and 07:00. A 5 dB(A) penalty can be applied to operations in the evening hours, and this is called the day evening night sound level, denoted L_{den}. These metrics are all based on A-weighted noise levels. An alternative approach is to use the effective perceived noise level, which has a more complicated definition found in the References.