Aircraft Noise

Why Aircraft Noise Calculations?

Aircraft noise can be measured and simulated with specialized software like SoundPLAN. Noise monitoring and measurement can only measure the noise that is present. During the planning process for an airport or a new runway, simulations are used for the different scenarios and to evaluate different approach and departure procedures.

Measurements always measure the entire noise environment. It is not possible afterwards to do creative accounting and show that of the 67.5 dB the majority was car traffic and industrial noise and only 61 dB came from flying aircraft. This type of analysis is only possible with simulations.

Simulations are used to study and support a staged pricing structure for landing fees depending on the number of noise exposed persons. If a noisy aircraft wants to land at night, the landing fees should reflect the cost to the population. If a noisy aircraft wants to land, it should cost more than a quiet airplane landing.

Aircraft Noise

Aircraft noise is amongst the most annoying forms of noise! As everyone drives a car or takes a train, these forms of noise are much more willingly accepted by the population. Airports often install noise monitoring stations to produce noise maps as a measure of good will. If complaints are received, the airport administration can always say, "We are on it!" even if little is actually done.

Worldwide, the dominant standard to simulate aircraft noise is the ECAC Doc. 29 3rd edition. In Europe, there are some countries that use different forms of the AzB. Switzerland also has its own calculation standard. In Australia, aircraft noise is compared to the ambient noise levels.

SoundPLAN’s Aircraft Noise Module

SoundPLAN 7.3 fully integrates aircraft noise with transportation and industry noise. The calculations are in accordance to the European guideline for the calculation of aircraft noise, the ECAC Doc. 29 2nd edition (which is used as European interim method for noise mapping) and the 3rd edition. ECAC Doc
3rd edition is also the basis of the US INM software. As all noise types are in the same suite, it is possible to make a comprehensive noise study with flying aircraft, taxi operations, engine test and run-up, auxiliary power units, baggage handling, air conditioning and transportation noise to and from the airport. As all noise types are in a single software suite, there is no friction loss between different software products importing and exporting data and noise maps if you want a full scale noise evaluation.

With the possibility to import the public aircraft library from EUROCONTROL or the library from the American Integrated Noise Model (INM) and using the same algorithms, it becomes easy to calculate comparable results. All the existing tools such as various import and export possibilities, plus many, many GIS-functions to manipulate your data, and an advanced documentation, your work is made easy and efficient. There is no need to work with cryptic online commands to manipulate your data as all tools are embedded in our well-structured user interface.

### Noise Contour Maps

The main point of the aircraft noise modeling is to show the noise contours for an existing or planned airport or to show the variations in contours for different operations / plans / future aircraft / noise abatement restrictions and so on.

Parallel to the graphical representation of the noise contours, it is possible to get details in tabular form for single receivers and to create Facade Noise Maps, Cross-Sectional Noise Maps and Meshed Maps.

To the left are two examples of noise contour maps; the top one is for the Atatürk Airport in Istanbul, Turkey, the bottom one is a noise map on the basis of radar tracks for the Hannover, (Germany) airport.

The aircraft noise maps for Turkey were made on behalf of the European Union to introduce Turkey to the European Noise Directive. Amongst the other aircraft noise studies, SoundPLAN was used for the Norah study of the greater Frankfurt area. (NORAH - Study on Noise-Related Annoyance, Cognition and Health). This study compares the noise related influence factors of aircraft noise to those of other noise types for the wider Frankfurt area. The scope of this study involved over 2 million buildings, about 7500 km² of terrain and 36 gigabyte of...
terrain data. To cope with the amount of data, the project was done using SoundPLAN, a GIS system and an Oracle database.

**Evaluation of Aircraft Noise Versus Other Types of Noise**

The degree to which people in their residences are annoyed by noise depends on the magnitude of the noise level and the frequency of noise events and the maximum noise level. Psychoacoustic studies have revealed a relationship between the type of noise source, the magnitude of the noise event, and the percentage of people who are annoyed or highly annoyed by the noise.

In SoundPLAN, aircraft noise and noise from other sources can be evaluated separately and then subjected to the annoyance calculation to pinpoint how many residents are having problems with aircraft noise versus other forms of noise. A Facade Noise Map of residential areas delivers the feed stock of the calculation. It can be undertaken for aircraft noise and all other types of noise separately. In the SoundPLAN Spreadsheet, the formulas for % Annoyed (in the yellow box to the left) and % Highly Annoyed will reveal the ratio of people who have a problem with aircraft noise versus other types of noise. A total number of annoyed persons can easily be generated from the data.

The number of annoyed people can be used to run scenarios of aircraft noise in order to find a system of landing fees for noisy aircraft. It’s that easy!

**Definition of the Airport, Runways and Flight Track**

In SoundPLAN, studying aircraft noise begins by defining the airport with reference points for the runways relative to the airport. The airport to the left is the Hannover airport in Germany, EDDV. The influence radius for aircraft noise is customarily set to 20 km around the airport but simulations can be extended to whatever distance that the noise study requires. The data entry is for the definition in accordance to the AzB. The definition in accordance to ECAC would require additional environmental information. Runways are defined relative to the airport reference point.
Flight tracks are generated for each runway. For the flight tracks, the user must insert operational data of the aircraft type which is linked to an elevation profile and an acoustical profile. These data create the aircraft simulation.

**Flight Tracks and Corridors**

Flight tracks are usually followed up to a 30 kilometer radius. Aircraft do not follow a road or railway line; they are determined by air traffic control personnel who advise pilots to turn to a specific heading and fly in a certain direction for a specified time. The exact time and turn radius is the pilots discretion and therefore the flight tracks can be described as corridors rather than lines. Flight operations and weather conditions also add to the variability.

Around the airport there are mandatory reporting points, usually associated with a radio beacon that aircraft tend to fly over. For the calculation, the standards determine how the flight corridor is represented by individual line sources.

**Tracks and Traffic**

Flight tracks are specific to a runway. The tracks consist of the track name, the landing / take off direction, a glide path and the detailed description of the flight path.

The traffic data (how many planes for day/night) are also associated with the flight track.

Normally, commercial aircraft fly using instrument rules, meaning the track is more restricted than when flying with visual flight rules. SoundPLAN allows both IFR and VFR traffic as well as military traffic and helicopter entries.

**Radar Tracks - How to Import from Where?**
Naturally, SoundPLAN offers the typical approach for noise predictions based on the backbones of idealized flight tracks, which is ideal for future situations. In addition, SoundPLAN offers the possibility to calculate noise on the basis of imported radar tracks, which is the most efficient and precise procedure for the analysis of past situations. By using recorded radar tracks, it is possible to show noise maps for any single flight, or any user definable time frame.

Radar tracks are recorded as coordinates and time with information about the aircraft type. SoundPLAN not only imports the coordinates and connects them with a straight line, it also interpolates data and if the time discrete polling makes it necessary, it even extrapolates the path! Each imported flight path is assigned a specific aircraft and thus elevation profiles and power settings.

In SoundPLAN the module to import and calculate noise levels from recorded radar tracks is an addition to the aircraft noise module.

Even if you do not want to calculate the noise levels directly from recorded radar tracks, they are a useful tool to generate backbones for the regular modeling. As aircraft are not following a singular path but have a variation depending on side wind components, the commands of air traffic control and the exact timing when a turn is initiated, the flight path is rather a corridor than a track. The flight paths are statistically distributed in this corridor. For the calculation this distribution is approximated with multiple flight paths, for the conversion of recorded flight the reverse analogy is also true allowing the program to distill the backbones from the recorded paths.

**Elevation Profile**

Aircraft libraries set a standard elevation profile over distance from the airport. These profiles reflect the power and flap settings and will also influence the sound power definition for that profile and class of aircraft. The elevation profile depicted with the red dotted line is the elevation profile automatically assigned to the selected flight procedure when importing flights with radar tracks.
Noise Level Statistics

Aside from customary noise maps, the noise calculation for single receivers will create a noise level statistics where the distribution of noise events and the type of aircraft are coordinated.

Aircraft Noise with Other Noise Sources

Some noise studies are not just for aircraft noise, but are part of a wider environmental assessment study where all sources are evaluated. SoundPLAN does this by combining individually calculated noise maps for aircraft with maps of other noise sources. In the picture to the left, aircraft noise is visible along with noise from taxiing on the ground, train noise, the APU and the traffic noise in the community.

In some countries, (Australia, for example) aircraft noise is not evaluated by itself but in relationship to the background noise levels. This type of scenario is quickly evaluated in SoundPLAN.

Sound Power and Directivity
For each aircraft type there is a definition for the sound power over frequency plus the directivity associated with the aircraft. The performance related database can be edited and amended with aircraft not found in the database (experimental or new aircraft).

Most standards are delivered with their own aircraft noise and performance database. SoundPLAN can read the standard INM database and allow users to work in accordance to the INM performance database.

Moving noise-map of a military jet

With the SoundPLAN calculations of aircraft noise it is possible to create level/time histories. For a Grid Noise Map these time histories can be used to create the picture of the instant noise level. These animations are saved to an AVI file such as the animation on the left of a military aircraft that fly over the airport, enter the pattern and then
As the instant noise level is taking the speed of sound into account, the diagrams assume strange shapes when the aircraft is flying on a curved path.

**Noise from a Helicopter**

The SoundPLAN aircraft noise module is not only fit for the biggest airports (the Frankfurt, Germany airport has been modeled with SoundPLAN), it is also used to model smaller fields where VFR operations and pattern traffic are the standard, and it is used to show helicopter take-off and landing noise.

To the left you see typical scenarios for helicopter noise at a hospital. The top picture is the noise map on the ground; the next picture is the same thing in 3D with the buildings as solid objects. Noise map #3 is a cross-sectional noise map for a take-off. This track shows the helicopter back out of the landing pad and then assume regular flight.

In SoundPLAN the track is automatically generated from a few parameters like the departure direction, the elevation profile and the distance the helicopter "backs" out of the landing pad. The heli-pad is automatically set on top of the building. In contrast to regular aircraft noise, the screening of the building is regarded as in the near-field it has a significant influence on the noise levels generated by the helicopter.