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Vibro-acoustic airport and port modeling process

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Abstract: The article presents process of modeling and generating noise contours and focuses on how to calculate aerodynamic noise levels around ports and airports. In order to have information about the magnitude and magnitude of the impact caused by aircraft noise around airports / ports, maps that have marked outline contours are needed. A noise contour is generated by the mathematical calculation of the areas where there are noise indices and is marked by a line along which the index value is constant. Calculation of the value of the noise index is made by summing up all the acoustic events caused by the aircraft (individual) occurring over a period of time, normally expressed in days or months.

In daily life, aircraft are one of the most disturbing noise sources, due to globalization, the interest in air transport has increased. Noise reduction measures can only be taken in compliance with the rules on air safety and technical possibilities. The way noise is perceived in airport and port ground points depends on several factors: aircraft type, engine type, engine power, flaps, and air speed control procedures.

The recommended method for aviation noise is the provisional calculation method. Airplane noise levels generated during operations are calculated using the segmentation technique. The flight paths of military aircraft, either rectilinear or curved, are divided into segments each being approximated by a straight segment, with a constant setting for power and speed. The minimum length of a segment is 3m. For each elemental arc, 3 points (x, y) are calculated. These three points define two segments; the first point is at the beginning of the elemental arc, the second point at half the length of the elemental arc and the third is at the end of the elemental arc. The method of estimating the amount of noise that a finite segment contributes to the integrated event nivell is purely empirical. One reason a simple empirical method is appropriate is that usually the majority of the noise comes from the closest segment, usually adjacent to which the closest receiver approach point is in the segment.

The noise received from a flight segment depends on the segment geometry in relation to the aircraft's observer and flight configuration. But they are interdependent - a change of one produces a change of the other and it is necessary to ensure that at all points on the trajectory, the configuration of the aircraft is consistent with its movement along the trajectory.

Calculation of noise for one event. The sound produced by an aircraft's movement at the observer's position is expressed as ,,a single sound level (or noise) of the event”. The perceived sound is measured in terms of noise using a base scale of decibels L (t) that applies a frequency share to mimic a characteristic of human hearing. The scale of the most important aircraft outline contouring is the weighted sound pressure level on the A, LA curve.

$$L_E = 10 \ \lg\left[\frac{1}{t_0}\int_{t_1}^{t_2} 10^{L(t)/10} dt\right] \quad (1)$$

L_E is the sound energy of events; t_0 is the reference time.

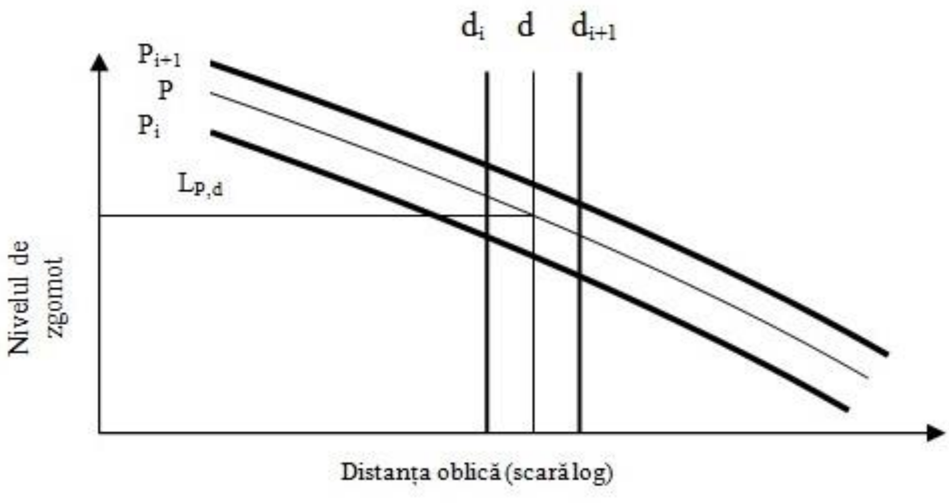
The integration interval [t_1, t_2] is chosen to ensure all event sounds. The limits t1 and t2 are chosen to divide the period for which L (t) is within the 10 dB limit of Lmax. This period is known as the "10 dB lower" time period. The noise exposure levels in the ANP database are lower than 10 dB.

Sound exposure level L_{AE}:

$$L_{AE} = 10 \ \lg\left[\frac{1}{t_0}\int_{t_1}^{t_2} 10^{L_A(t)/10} dt\right], \ t_0\text{=1 sec} \quad (2)$$

When the entire history of L (t) is known, the above equation levels can be used to determine levels. Within the recommended noise modeling methodology, exposure levels are calculated by summing the segment values, each of the partial levels defines the contribution of a single delineated flight path segment.

Determination of noise levels using NPD data. The main aircraft noise and performance data is provided by the NPD database. This catalogs L_{max} and L_E as propagation distance functions d. These are related to the specific V_{ref} reference speeds along the straight flight path. Knowing the parameters P (engine noise power) and d (propagation distance), the basic levels L_{max} (P, d) or L_E (P, d) (for the infinite flight path) can be determined. An exception is when the values P and d are accurately mapped, the estimation of the noise level will be achieved by the interpolation process. A linear interpolation is used between the tabulated power configurations, since the logarithmic interpolation is used between the listed distances, the figure below.



1. *Interpolation in noise curves, distance power*

If P_i and P_{i+1} are engine power values for which the noise level versus distance data are cataloged, the L_P noise level at a distance given by the intermediate power P between P_i and P_{i+1} is given by:

$$L(P) = L(P_i) + \frac{L(P_{i+1}) - L(P_i)}{P_{i+1} - P_i}(P - P_i) \quad (3)$$

and at any configuration of d_i, d_{i+1} are distances for which the noise data is cataloged and the noise level L_d is:

$$L(d) = L(d_i) + \frac{L(d_{i+1}) - L(d_i)}{\lg d_{i+1} - \lg d_i}(\lg d - \lg d_i) \quad (4)$$

Using the equations (3) and (4), a noise level L (P, d) can be obtained for any P-configuration and any distance d that is in the NPD database packet. At short distances d, noise levels increase very rapidly, with decreasing propagation distance, it is not recommended that a lower limit of 30 m be imposed on the distance d, dmax = 30m.

When obtaining noise contours by interpolating index values at rectangular rectangular mesh points, their accuracy depends on the grid spacing (or the side of the square). Interpolation errors are reduced by decreasing network space, but the computing time is higher, as this increases the number of points in the network.Optimizing the spacing of a regular network involves striking a balance between the accuracy of the modeling and the computation time.A marked improvement in computational efficiency provides more accurate results is the use of irregular grids to improve interpolation in critical cells.

In conclusion by modeling, reduction scenarios such as changing the overflight gauge in the sense of distancing these colors to sensitive areas can be simulated, simulating the removal of major categories of aircraft with significant acoustic emissions. A knowledge of population exposure influences a series of decisions on exposure reduction, such as: redistribution of air traffic at different intervals of the day, regulations on the composition of air traffic.

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