NOISE METRICS AND ZONING AROUND BRAZILIAN AIRPORTS

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Abstract. *Noise zoning around airports is performed using usually Day Night Sound Level (DNL) metric. Noise footprints based on this metric are calculated and from that, zoning of urban space is defined. Day Night Sound Level is the A-weighted equivalent sound level for a 24 hour period with an additional 10 dB imposed on the equivalent sound levels for night time hours of 10 pm to 7 am. Another noise metric exists, the Equivalent Sound Level (LAEQ) which is formulated in terms of the equivalent steady noise level which in a stated period of time would contain the same noise energy as the time-varying noise during the same time period. When the time period is all the day period, this metric is LAD, and when it is the night period it is LAN. The application of the two types of noise metrics is discussed and a strategy of airport zoning, based on the use of LAD is presented. Example of application to the case of Brazilia Airport is presented.*

Keywords: *Noise metrics, Airport zoning, NBR 10151*

1. INTRODUCTION

The growth of movement in airports and the associated noise in its surroundings has become a widely known, if not common, environmental issue in the present day. People travel much more, and demand from airports much more infrastructure, but at the same time doesn't allow the airports to grow accordingly because of the annoyance this growth will represent in the surrounding communities.

Even worse is the problem that, in many countries, the acoustical legislation defining airport and urban standards for land use and zoning do not agree. People complain about levels that are in concordance with the legislation, but in fact do not agree with the annoyance generated in their neighborhood.

Airport regulation in Brazil is given by the standard *Portaria 1141GM5* that establishes the Day Night Level - DNL as the metric governing noise zoning around the airports. The DNL is, as we call it, a single criterion metric. That means it is a single number, the equivalent sound level for a 24 hour period with an additional 10 dB imposed on the sound levels for the night period, which is from 10 p.m. to 7 p.m. Figure 1 shows DNL contours for different levels for Brasilia airport.

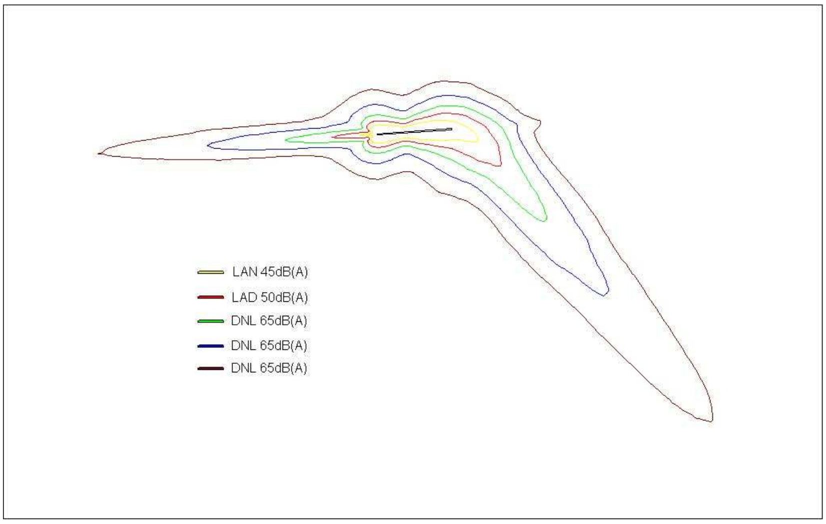

Figure 1. DNL contours for Brasília airport.

The Brazilian standard for urban acoustical engineering, *NBR 10151*, is ruled by a different metric, the LAEQ, or

Equivalent Level. This is the equivalent sound level formulated in terms of the equivalent steady sound level which, in a stated period of time, would contain the same noise energy as the time-varying noise during the same time period. The period of time is source dependant, and should be long enough in order to be representative of the source. In the case of airports, it is useful to consider the whole day period for evaluating the LAEQ, and we call it Equivalent Day Noise Level - LAN. The same works for the night period, and we call it Equivalent Night Noise Level - LAN. A comparison between DNL, LAEQ, LAD and LAN was realized on Revoredo and Slama (2005).

We have simulated LAD and LAN noise curves for the city of Brasilia, using the software Integrated Noise Model - INM. We plotted the noise curves on the city's zoning map, and through that determined what will be the airport zoning in accordance to the urban standard.

The implementation of these metrics, LAD and LAN, in airport zoning intends to adapt it to the city's urban acoustical standard, NBR10151, promoting an understanding between airport and urban zonings. This can reduce or even eliminate annoyance problems in neighborhoods around the airports, and improve communication between airport and city authorities concerning this issue, helping both, the city and it's airports, to achieve a healthy growth.

2. METHODOLOGY

As described above, the objective of this work is to present a methodology to develop an airport zoning compatible with urban zoning in the neighborhoods around the airport. This method is described and inspired by the table on *NBR 10151* containing evaluation criterion levels for that matter, as shown on Tab. 1.

Table 1. Equivalent noise levels criterion for day and night periods according to NBR 10151.

Area Types	Maximum noise level (day)	Maximum noise level (night)	Class
Predominantly industrial areas	70	60	A
Mixed areas, with recreational tendency	65	55	B
Mixed areas, with commercial and administrative tendencies	60	50	C
Mixed areas, predominantly residential	55	45	D
Strictly urban residential areas, hospitals or schools	50	40	E
Farmland areas	45	35	F

The initial idea is to generate a series of LAD noise curves in the surroundings of the airport, using the software INM, with 5 dB(A) difference from each other, starting in 70 dB(A) and going down to 40 dB(A), and a series of LAN curves in the same way, starting from 60 dB(A) and going down to 35 dB(A), according to the levels on Tab. 1. Figures 2 and 3 show the noise contours for LAD and LAN for Brasilia airport.

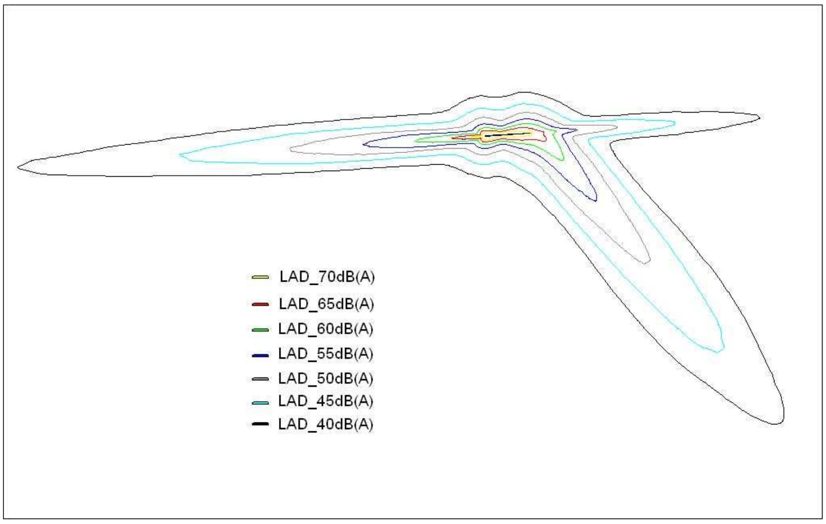

Figure 2. LAD contours for Brasília airport.

We consider that each determined area from Tab. 1 is associated with a logical condition that may be expressed in function of LAD and LAN. For example, for an area to be strictly urban residential, or contain hospitals or schools, we

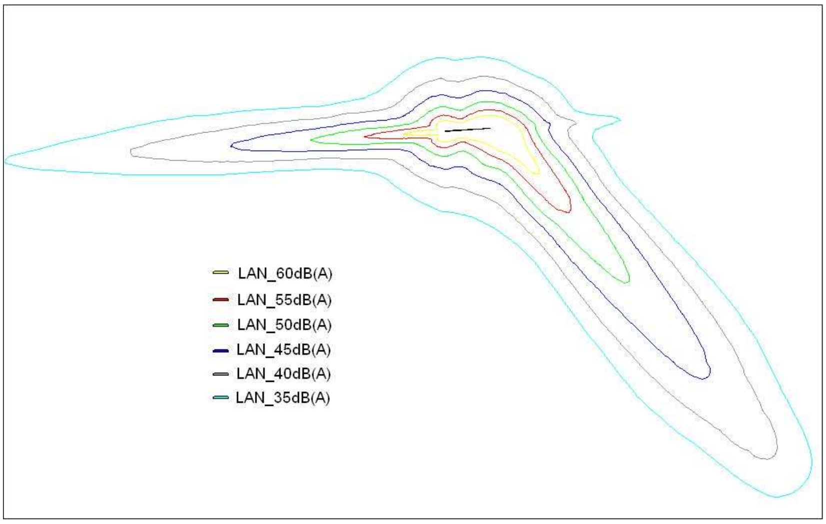

Figure 3. LAN contours for Brasília airport.

must have $LAD \leq 50dB(A) \wedge LAN \leq 45dB(A)$, where the symbol $\wedge$ represent logical **And**. The LAD = 50 dB(A) and LAN = 45 dB(A) noise curves are generated using INM. The interior of each of these curves are the areas ruled by the equations LAD > 50 dB(A) and LAN > 45 dB(A). So, the union of these areas can be represented by the following logical condition: $LAD > 50dB(A) \vee LAN > 45dB(A)$ where the symbol $\vee$ represent logical **Or**. The Complimentary of these areas will represent exactly the condition to strictly urban residential, hospitals or schools areas.

Based on the above explanation, we can describe the following conditions:

- Predominantly industrial: $\overline{LAD > 70dB(A) \vee LAN > 60dB(A)}$
- Mixed areas, with recreational tendency: $\overline{LAD > 65dB(A) \vee LAN > 55dB(A)}$
- Mixed, with commercial and administrative tendencies: $\overline{LAD > 60dB(A) \vee LAN > 55dB(A)}$
- Mixed, predominantly residential: $\overline{LAD > 55dB(A) \vee LAD > 50dB(A)}$
- Strictly urban residential, hospitals or schools: $\overline{LAD > 50dB(A) \vee LAD > 45dB(A)}$
- Farmland: $\overline{LAD > 40dB(A) \vee LAD > 35dB(A)}$

The areas defined on *NBR 10151* on the surroundings of airports will be defined as the exterior of the areas limited by the union of day and night conditions. Figure 4 represents the zoning according to the *NBR 10151* standard for the Brasilia Airport. It is seen that the permitted area according to the noise level criterion of the *NBR 10151* is much greater than the area permitted by *Portaria 1141* for residential land use (DNL > 65dB(A)).

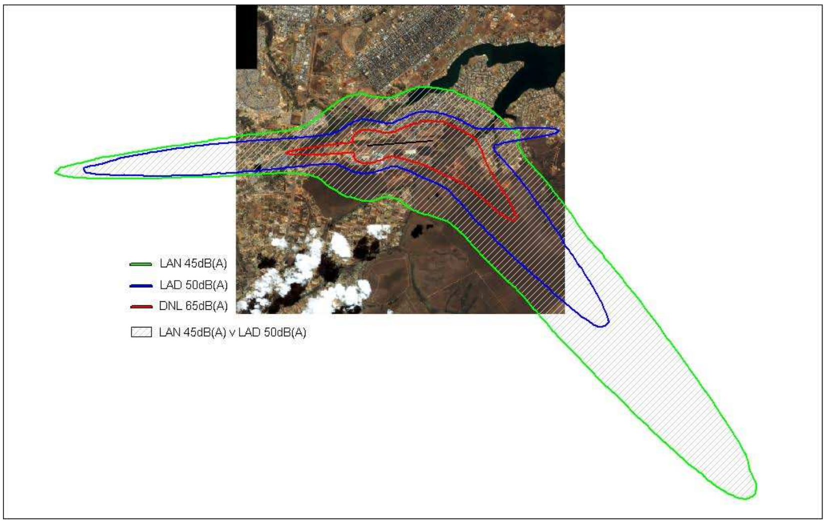

Figure 4. Zoning according to *NBR 10151* fo Brasília airport.

3. CONCLUSION

This paper presents the basic concepts for the development of noise zoning around airports that takes into consideration both, the brazilian airport noise regulation and urban noise regulation. These regulations takes into account different noise levels criterion and the proposed methodology establishes a relationship between *Portaria 1141* and *NBR 10151* in order to improve communication between airport and city authorities. This relationship is easily accomplished through the use of the Integrated Noise Model, a FAA software for the determination of noise levels around airports. Results based on Brasilia airport are presented as an example of the use of the proposed methodology. It is shown that the use of DNL levels alone are not representative of the annoyance generated in an airport surroundings.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

Revoredo, T.C. and Slama, J.G., 2005, "Metrics Convertion in Airport Noise", Proceedings of the 18th International Congress on Mechanical Engineering, Ouro Preto, Brazil.

6. Responsibility notice

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