

# Noise Mapping and Noise Quota Application to an Industrial Park

Luís Conde Santos

*Grupo Absorsor, Taguspark - Edifício Tecnologia I, n.º 11,2780-920, Oeiras, Portugal, [www.absorsor.pt](http://www.absorsor.pt)*

**ABSTRACT:** Industrial parks are often promoted by local authorities, to bring new industrial investments and to relocate factories installed in urban areas. However, sensitive receivers can already exist or be planned to the surroundings of the proposed industrial location, imposing limits to the noise levels which can be emitted by the industries. If careful noise planning is not implemented, noise limits may be reached far before all areas of the park are built up, making it difficult for new industries to fit in the reduced noise margin available. This can even severely bring down the market value of the unbuilt areas and threaten the success of the industrial park.

With a noise mapping tool, one can simulate the installation of the industries in the available areas in the park and establish a Noise Quota for each area, in a fair and optimized manner. Noise quota can be specified as sound power levels per m<sup>2</sup>, and from this, one can derive simpler specifications, in terms of partial noise level limits, at given receivers, from each noise emitting area in the industrial park. This paper describes the practical application of this technique, to an industrial park in Palmela, to the south of Lisbon.

## 1. INTRODUCTION

Typical noise assessment of industrial sites are made by means of short term noise measurements, at a limited number of points within a certain area around the site. Experience has shown that, often, specially in complex situations of large industries or industrial parks, with a large number of sources, this approach does not produce reliable results neither a clear vision of the noise impact. Moreover, it does not produce enough information for decision taking on what to do to reduce noise, as it does not enable source identification and ranking and prediction of expected results from this or that noise control solution.

Other limitation is that, with this “typical” approach, it is difficult to present results which can be understood by non-specialists, which makes it difficult to have an effective communication of results from noise control programmes to those interested, like the surrounding community, governmental agencies, local authorities, shareholders, clients, ecologist NGO’s, etc., not taking full advantage of the potential benefits from the investments in noise control to the image of the organization.

In our days, the recent developments on the techniques for noise emission and propagation modelling, enable one to model, with good precision and in an effective way, the most complex situations of noise generation and propagation outdoors. This is what is called “Noise Mapping”, due to the most common way of presenting the results from such models: a map with coloured areas, each colour corresponding to a given noise level interval, typically with 5 dB(A) steps.

Above all, such a model can become a real noise information and management system, from which one can rank the noise sources, estimate the individual contribution of each source to

any receiver, easily update the information when changes occur on the site, and establish action plans for noise reduction, predicting the results of each noise control action.

This paper focuses on the special case of industrial or commercial areas, which are generally developed step by step, in the vicinity of existing or planned residential areas, or other sensitive areas, where more or less stringent limits are imposed. In such situations, if careful noise planning is not implemented, noise limits may be reached far before all areas of the park are built up, making it difficult for new industries to fit in the reduced noise margin available. With a noise mapping tool, one can simulate the installation of the industries in the available areas in the park and establish a Noise Quota for each area, in a fair and optimized manner. Noise quota can be specified as sound power levels per m<sup>2</sup>, and from this, one can derive simpler specifications, in terms of partial noise level limits, at given receivers, from each noise emitting area in the industrial park [1].

## 2. CASE STUDY: INDUSTRIAL PARK IN PALMELA

### 2.1 Description

Palmela is a district to the south of Lisbon which has become, during the last decade, a very attractive area for investment in all kinds of fields: industrial, commercial, touristic developments and residential building. Its geographical location, close to Lisbon, with large natural areas with pine forests, some classified as natural park, still low population density (around 53.000 inhabitants on 460 Km<sup>2</sup>), together with recent developments on transportation facilities (Vasco da Gama bridge, new motorway and railway line) as well as one of the largest industrial investments made in Portugal during the last 20 years (the AutoEuropa car factory and associated automotive related industries) have contributed to a fast growing population (more than 20% rate) and some pressure on land use.

In this context, the Municipality of Palmela is quite aware of the need for land use planning, taking into account the various environmental aspects, including noise, so all its land use planning, at the various scales (district level, urbanization level and detail level), is now being made with the support of noise modelling techniques.



Figure 1 – Location of Palmela region, south of Lisbon, between rivers Tagus and Sado

The example we will describe in this paper is the case of an industrial park, developed by the Municipality, with the following characteristics:

- 42 lots, from which only 8 were already built up with industries operating, all others being still completely empty
- in the surroundings there are 2 motorways (A2 and A12), 2 municipal roads and local roads of the park, as well as some sparse houses and an area classified for future residential constructions
- noise limits in the neighbouring houses and future residential areas are still below noise limits according to regulations

The objective of the Municipality is to guarantee that noise limits will not be exceeded after the industrial park is fully occupied with running industries.

Portuguese environmental noise regulations impose two types of limits:

- Maximum exposure criterion, which states that  $L_{Aeq}$  of the total environmental noise shouldn't be higher than 55 dB(A) during day time (07:00-22:00h) and 45 dB(A) for night time (22:00-07:00h), for areas classified as Sensitive, and 10 dB(A) more than this for both periods, for areas classified as Mixed.
- Annoyance criterion, which states that the difference between  $L_{Aeq}$ , with tonal and impulsive penalty factors of total environmental noise and the  $L_{Aeq}$  of residual noise should not exceed 5 dB(A) for the day time and 3 dB(A) for the night time

Figure 2 shows the model of the area to be studied, depicting the industrial area, the chosen calculation area (several hundred meters for each side of the park limits), the motorways and roads, as well as existing houses.

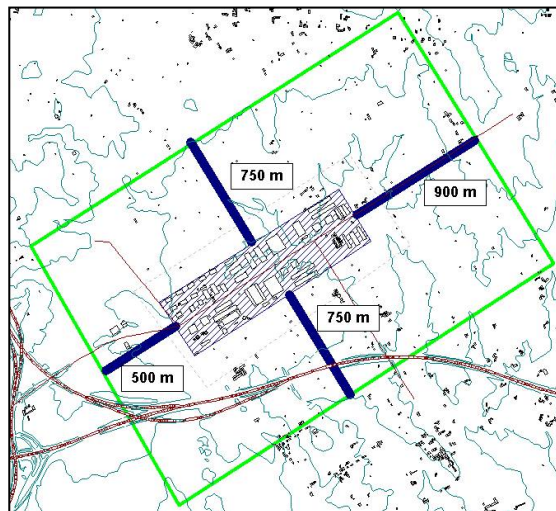


Figure 2 – Computer model of the situation, showing the calculation area for noise mapping

The development of an industrial park normally occurs step by step: the first industry is installed and starts running, than another one starts, and so one, in such a way that, typically, the annoyance criteria may not be exceeded, each industry adding just a few dB's to the existing noise. But if the maximum exposure limits are reached before the park is full, the problem arises that new industries which want to come to the park cannot produce any

increase in noise level. Often what happens is that new industries are installed anyway and, some time later, when someone notices that maximum limits have been exceeded, it is very complicated to determine who is responsible for that situation, as many different companies produce noise to the neighbourhood. This was what the Municipality wanted to avoid

## 2.2 Model of the Present Situation

First thing to do is to identify existing noise sources and model the actual situation, including industries and roads. This model can be supported and validated by noise measurements – this was done close to the sources and close to some sensitive receivers, like closest houses.

Industries already installed where modelled, taking into account its actual main noise sources, as depicted in figure 3, using vertical area sources and point sources [1].

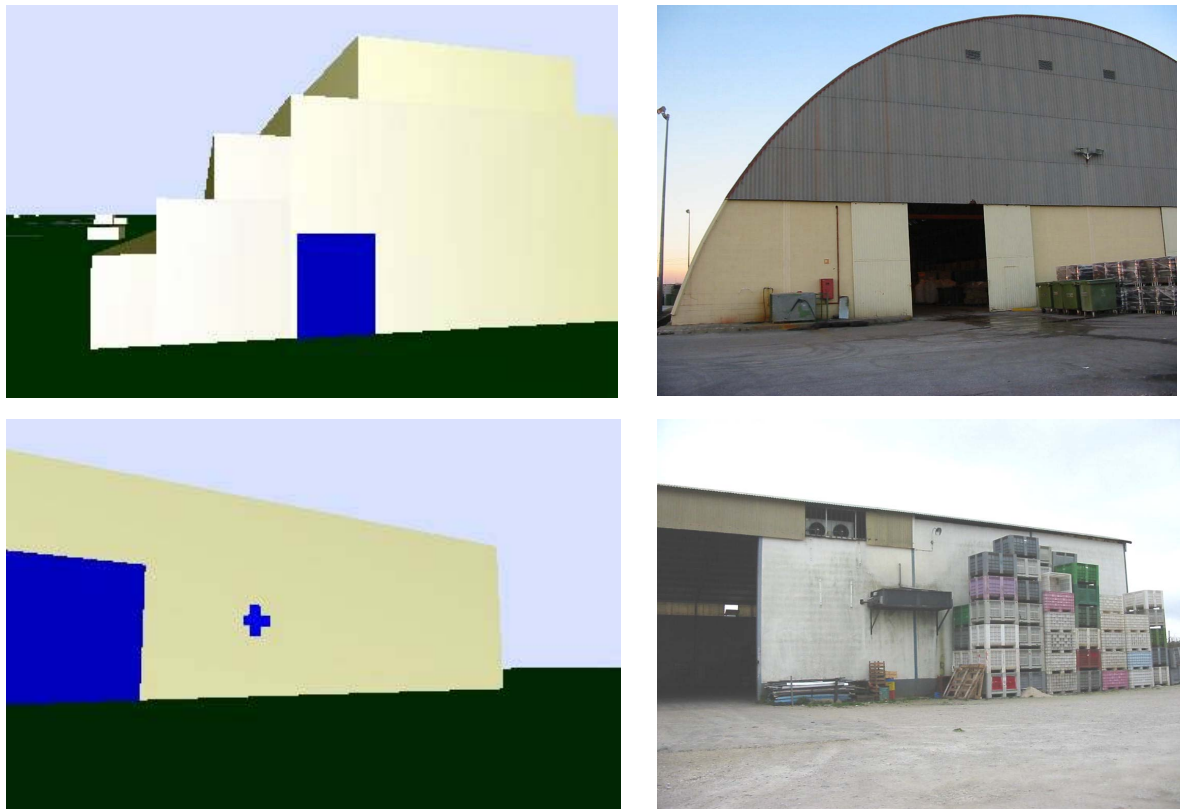


Figure 3 – *Examples of modelling already existing industries*

Roads were modelled, based on existing traffic data for the motorways, and on traffic counts for other roads, together with measurements taken at a certain distance from the roads.

Separate computations were performed for industrial sources and road sources. The total noise map for the present situation is presented in figure 4.

Control points were defined close to existing houses and around the border between the area classified for industrial use and the area classified for residential use, according to land use planning of the municipality, as shown in figure 5.

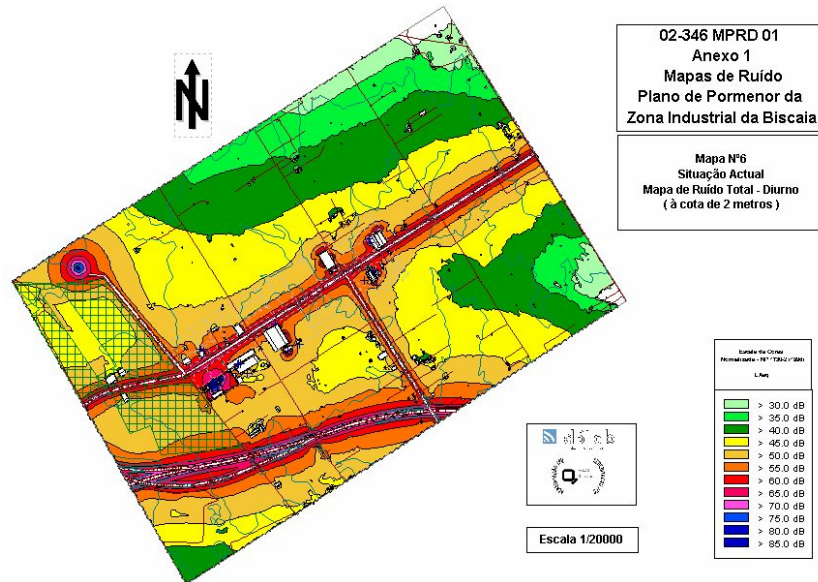


Figure 4 – Total day time noise map of the present situation

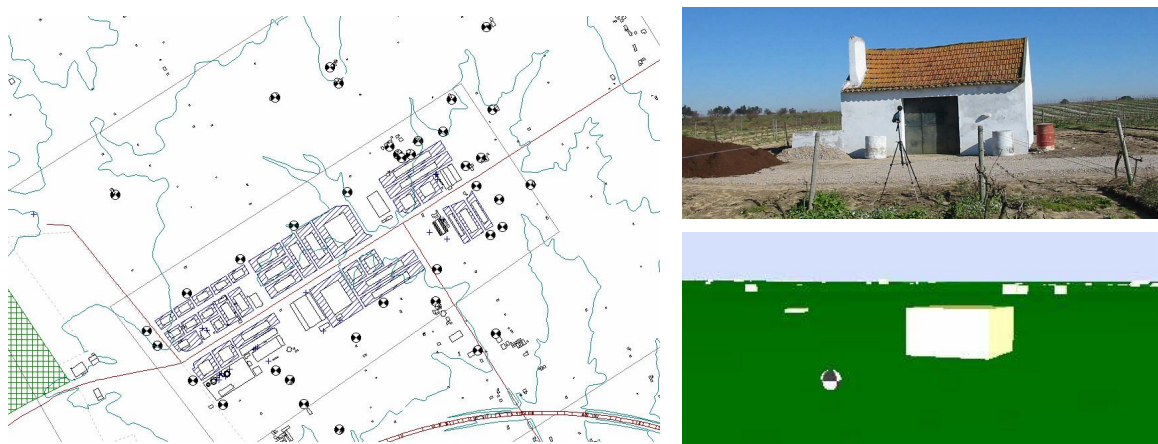


Figure 5 – Control points for present and future control of noise levels

### 2.3 Model of the Future Situation

To model the future situation, with all lots in the industrial park built up and running, 34 area sources were defined, placed 1.5 m above the ground, corresponding to the yet unoccupied lots. The acoustical modelling software used in this project (cadnaA) allows these area sources to be defined as “optimizable sources”, meaning its area related sound power, in  $\text{dB/m}^2$ , can be optimized together in order to comply with given limits at any number of control points. Knowing what the permitted maximum building areas were for each lot, an industrial building was placed at the centre of each lot in the model, with the maximum area and a typical height of 7 m.

The municipality provided the estimated traffic for the future situation, and this was also introduced in the model.

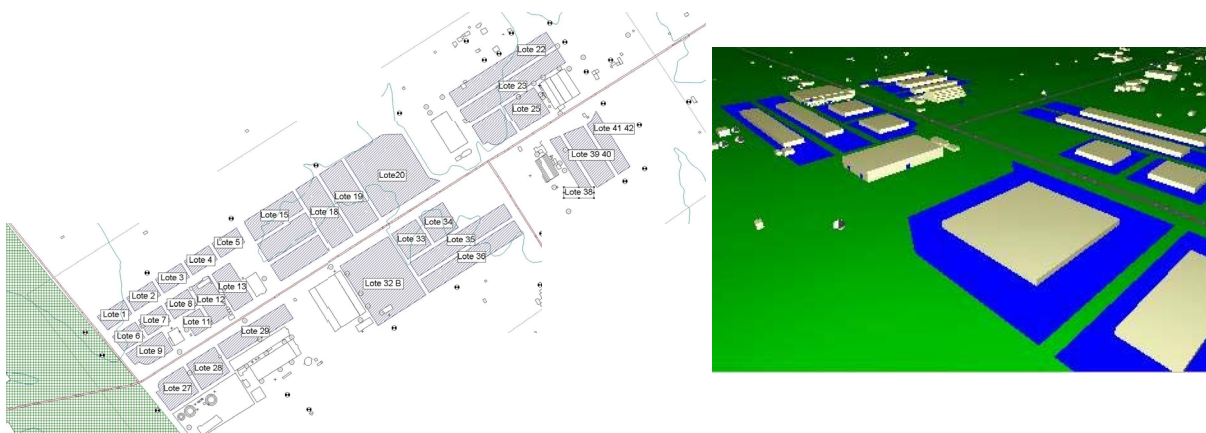


Figure 6 – *Optimizable area sources: one for each empty lot*

As the residential areas closer to the industrial park are classified as a “Mixed Zone”, the corresponding limits of 65 dB(A) for day time and 55 dB(A) at night were set to the control points, and an optimization was performed in the model. In this way, the maximum allowed sound power level per square meter for each lot was defined.

Figure 7 shows the noise map obtained for the future situation, with existing industries operating as they are now, with roads with the expected traffic in some years time and with all other lots occupied by industries, producing the maximum noise level which still complies with legal limits at the perimeter of the park.

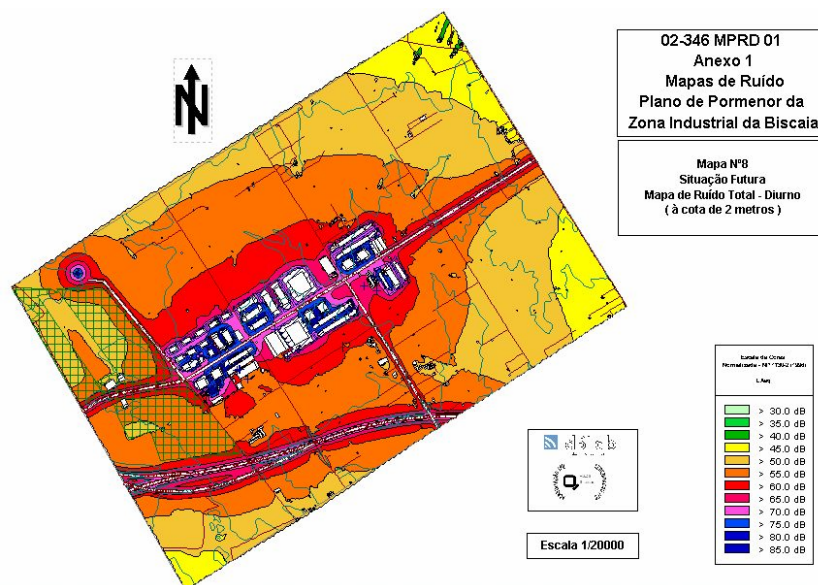


Figure 7 – *Total day time noise map for the future “worst case within limits” situation*

## 2.4 Setting Noise Limits for new Industries to be Installed

Specification of noise emission limits for the future industries to be installed can be made, in terms of the maximum SWL per m<sup>2</sup>, as calculated with the afore mentioned optimization. This type of specification, however, may not be very clear for a company which is going to be installed on a lot. A better specification would be to state maximum immission levels at some control points.

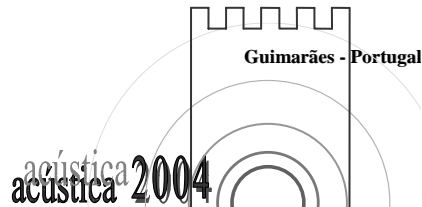
The modelling software enables one to calculate individual contributions of each noise source to each receiver and therefore tables can be output from the programme with the particular contributions of all the lots to each control point. These results were obtained from the model with the optimized sources and, therefore, the contribution of a given optimized source, i.e. an industrial lot, at a given control point is exactly the maximum noise level which that lot is allowed to produce at the given point, as shown in figure 8.

Nome Lote	Ruído Particular no RecOpt016		Nome Lote	Ruído Particular no RecOpt017		Nome Lote	Ruído Particular no RecOpt018	
	Diurno (dBA)	Nocturno (dBA)		Diurno (dBA)	Nocturno (dBA)		Diurno (dBA)	Nocturno (dBA)
Nível Total ->	<b>65</b>	<b>54.5</b>	Nível Total ->	<b>64.9</b>	<b>53.8</b>	Nível Total ->	<b>56.9</b>	<b>46.8</b>
Lote 25	55.4	44.4	Lote20	62	51.7	Lote 29	48.4	39.6
Lote 24	54.6	40.7	Lote 34	54.9	38.9	Lote 12	47.7	39.4
Lote 41 42	54.6	44.9	Lote 33	53.4	35.9	Lote 13	46.1	38.8
Lote 39 40	54.5	43.1	Lote 35	51.9	34.7	Lote 17	45.5	34.3
Lote 38	51.9	41.1	Lote 23	50.1	38.4	Lote 28	45.3	35.6
Lote20	46.5	36.2	Lote 29	49.6	40.8	Lote 16	42.8	31.6
Lote 34	46.3	30.3	Lote 17	49.2	38	Lote20	42.7	32.4
Lote 23	45.5	33.8	Lote 25	47.9	36.9	Lote 33	41.6	24.1
Lote 17	44	32.8	Lote 22	46.9	35.9	Lote 09	40.5	27.8
Lote 35	43.1	25.9	Lote 16	46.8	35.6	Lote 01	40.1	26.5
Lote 33	41.4	23.9	Lote 13	46.3	39	Lote 25	39.7	28.7
Lote 16	40.8	29.6	Lote 32 B	46.2	32.4	Lote 11	39.4	31.3
Lote 22	40.1	29.1	Lote 28	45.4	35.7	Lote 24	39.3	25.4
Lote 32 B	39.4	25.6	Lote 12	45.3	37	Lote 35	39.2	22
Lote 13	38.8	31.5	Lote 24	44	30.1	Lote 34	38.6	22.6

Figure 8 – Example of noise immission limits at given receivers (RecOpt016-018), showing the global noise (first line, in bold) and the particular limit for the contribution from each lot.

In this way, the maximum immission noise levels that each new industry is allowed to produce at a set of control points were defined.

When, in the future, a company plans to install its operations in this industrial park, and intends to choose a certain lot, it will know exactly what are the maximum noise levels it can produce at the control points. On the other hand, the Municipality, will be able to control the build up of noise in order to guarantee that, in the end, maximum exposure noise limits will be respected, and that Noise Quota is distributed in a fair way between the lots.



### 3. CONCLUSIONS

Noise Mapping for industrial sites, by computer modelling, is a powerful tool. An application was presented where an industrial park, surrounded by residential areas, is being developed and where, if not properly planned and controlled, an excessive build up of noise could take place. This example shows how effective and straightforward this technique can be, by specifying noise quota for each industry which intends to install its operations in the park, both in terms of area related sound power levels, as well as in terms of maximum allowed levels produced by each particular industry at given control points. By clearly setting these limits, the municipality can easily plan and control the development of the industrial park, and make it more attractive for investors which, ever more, do not want to take too much risks concerning noise for neighbours. Moreover, the municipality can be assured that its planned residential areas close to the park can proceed its development, without being put at risk by conflicts with national noise regulations. Also, people already living in the vicinity of the park, can be assured that, in spite of a certain build up of noise which will occur, it will not get out of control and will be kept within the legal limits.

### ACKNOWLEDGMENTS

We would like to thank Câmara Municipal de Palmela for its cooperation in this project, and for allowing us to publish these paper.

### REFERENCES

- [1] W. Probst and B. Huber – *Noise Quota for Industrial Sites – an Application of Noise Mapping Projects*. In Proceedings of InterNoise 2000, Nice, France.
- [2] W. Probst – *Modelling of Industrial Plants in the Framework of Sound Immission Plans*. In Proceedings of ICSV, Hong Kong, 2001.