



Mixed Industry and Traffic Noise Mapping

Céline Boutin and Alexis Bigot

Acouphen Environnement, Campus de la DOUA, 66, BD Niels Bohr, BP 52132, 69603
Villeurbanne, France
celine.boutin@acouphen-environnement.com

The authors have a large experience on noise mapping of both transportation sources and industrial plants. This paper provides examples of noise maps for communities of different sizes with road, railway and industrial sources. The difficulties to estimate noise emission from industrial sites are discussed. Recommendations are provided. A methodology to create the industry data base for a noise map with a large number of industrial sites in the territory is presented. It is shown how noise maps can be an attractive tool to be used in the environmental management system of the plant manager to communicate on the plant environmental integration and noise abatement plan.

1 Introduction

Since 2002, and the publication of the European Directive 2002/49/EC on Assessment and Management of Environmental Noise, member states are obliged to produce noise maps for the major roads, railways, airports and industrial activities. For large communities (more than 250.000 residents), noise maps should be produced by 30th June 2007.

The goal of this paper is to describe the method used for integration of the industrial noise in noise maps in about 10 projects of large communities in France).

In the European Directive, industrial noise is based on the list of the Integrated Pollution Prevention and Control (IPPC) categories.

However, in the French transposition of the European Directive (“décret n°2006-361 du 24 mars 2006”) the industrial noise to be taken into account is based on the list of the “authorized” industrial sites, called ICPE (“Installations Classées pour la Protection de l’Environnement”).

This list concerns a much larger number of sites than the IPPC categories, without restriction regarding the position (industrial zone, countryside, etc.). This list concerns about 60 000 ICPE in France (24.000 rearing installations and 36.000 industries).

Consequently, the method for implementation of industrial sources in noise mapping of cities must provide guidelines on the following aspects:

- Method of identification and ranking of the most sensible industrial sites, in line with the spirit of the European Directive.
- Definition of a simplified method based on generic data or database. It is impossible to measure the noise emission of all industrial sites within a city mapping project.
- Definition of a more accurate method for the most critical industrial sites, with an accuracy in line with the European Directive.

2 Standards for industrial noise measurements

For noise emission of industrial sources there is a comprehensive set of standards from ISO, DIN and other national organizations. For example the ISO 3744 [1] and ISO 3746 [2] describe how to calculate the sound power level from the sound pressure level, for “small” noise sources only.

Such methods are not adapted here since limited to small sources and limited to applications where the measurements

can be done within the industrial sites. This is the method used by consultants for plant noise prediction and action plan. This method is not acceptable within noise mapping projects for large territories except if the noise model is provided by each industrial site.

Another standard is the ISO 8297 standard [3]. Sound power level of a whole plant is estimated using acoustic measurements on a shaped closed path surrounding the plant. This standard is more adapted because it doesn’t need the access into the industrial site, but it remains too complicated for a systematic use on a large number of sites.

3 Proposed method

3.1 Principle

The proposed method is adapted from the ISO 8297, and is already described in the CERTU guide [4]. The sound power level of a plant can be estimated **with OR without acoustics measurements**, using data like :

- Sound pressure level measured on the boundary of the plant (when available).
- Limit sound pressure level on plant boundary. The French legislation (“arrêté du 23 janvier 1997” or more rarely “arrêté du 20 août 1997”) specifies that the sound pressure level in LAeq can not exceed 70 dB(A) during day period and 60 dB(A) during night period.
- The averaged sound pressure level observed on the boundary of a class of activity. This data is useful when no data is available, or when data is not reliable.

3.2 Method

The step by step method is described in the flow chart in Figure 1.

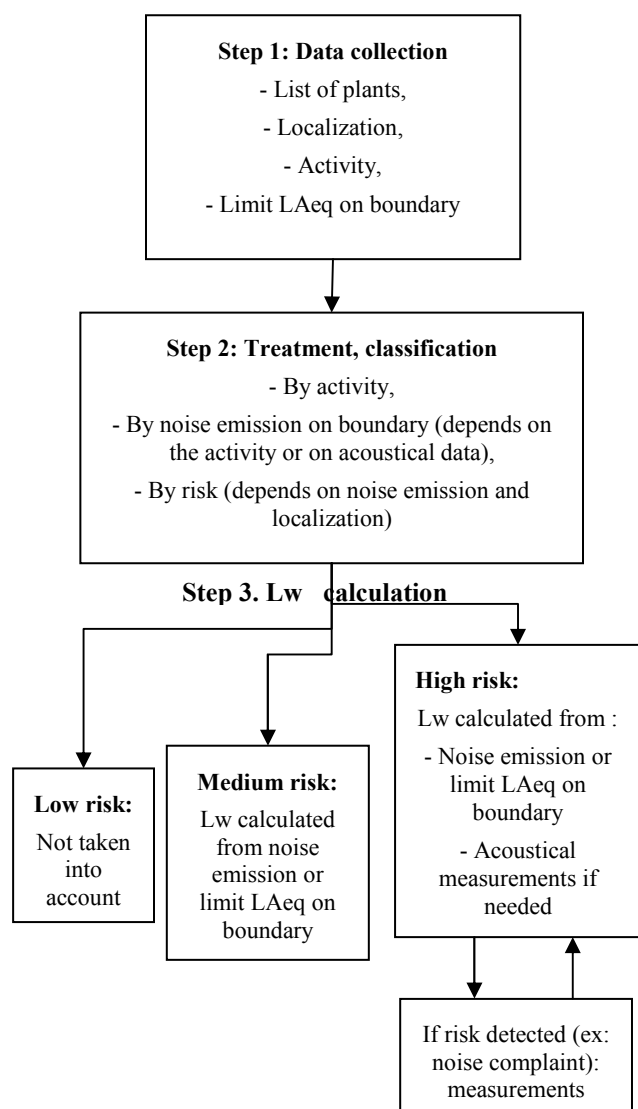


Fig.1 Different steps of the method

3.3 Data collection

The required data is usually:

- List of plants.
- Activity (the activity should be “homogeneous” in terms of noise emission).
- Location (address, coordinates).
- Boundaries of the industrial site described in a GIS.
- Working periods (Day / Evening /Night), because the L_{DEN} indicator works in 3 periods, and not only day/night. This data can be expressed in % of hours of the period, for long term periods (if available but rare).
- Acoustical limits on boundary (if available).
- Acoustical data form measurements on boundary (if available, but rare).

3.4 Treatment of the database and classification of activities

Because of the large number of industrial sites to be taken into account in France, many of them must be eliminated (ex: low noise plants like storehouse, offices, hospitals, or sites away from housing). The French legislation (“Circulaire du 7 juin 2007”) recommends the following classification:

- **Installations with low risk** (low noise, or far from housing like in industrial estates): about 50% of the total list in France.
- **Installations with medium risk** (small plants or low noise plants near housing): about 35-40% of the list.
- **Installations with high risk** (high noise plants, or with noise complaints): about 10-15% of the list.

The classification is made:

By activity. If an activity is not homogeneous in terms of noise emission, it should be reconsidered (ex: activity “Energy” is too large, and should be for example divided in “power plants”, usually high noise and “heating boilers”, usually low noise).

By noise emission. When the classification by activity is done, the plants are classified by noise emission on boundary. In fact, each activity can be addressed an average noise emission level on boundary like:

- Low noise installations: ≤ 50 dB(A),
- Medium noise emission: ≤ 55 dB(A),
- High noise emission: ≤ 60 dB(A), that is the maximum noise level allowed on night period.

The high noise emission plants are for example:

- Aluminium production
- Carcass disposal installations
- Cement works
- Chemical plants
- Concrete production
- Foundries (ferrous metals)
- Non ferrous metal processing
- Mineral oil and gas refineries
- Paper mills
- Petrochemical plants
- Power plants
- Timber plants
- Waste incineration installations
- ...

By risk. When the classification by noise emission is done, the plants are classified in relation with the surroundings. If the localization data is not provided or not reliable, only the emission data should be taken into account.

At this stage, the following treatments of the data are done :

- Compile all the plant information in a database (name, address, noise emission, risk, etc.).
- Design in the GIS a layer with the boundaries of the plants.

- Make a jointure between the GIS and the database.

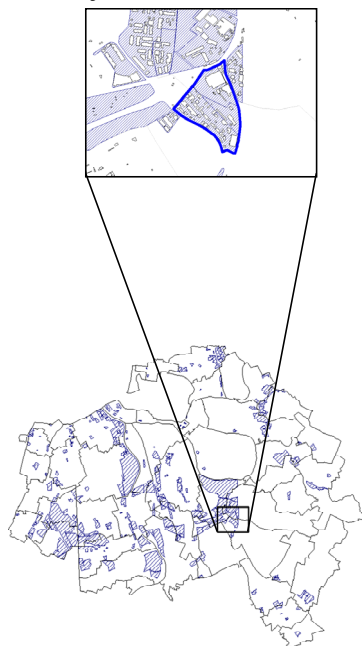


Fig.2 Design of the plant boundary in the GIS

3.5 Sound power level (L_w) calculation

The method for sound power level (L_w) calculation of the plant is an inverse calculation: the L_w is adjusted in order to fit with the sound power level required in different points around the plant (it can be a default one, or a result of a measurement).

The sound source is designed as a horizontal surface (imported from GIS), by default over all the surface of the plant. The receivers are designed on the boundary around the plant.

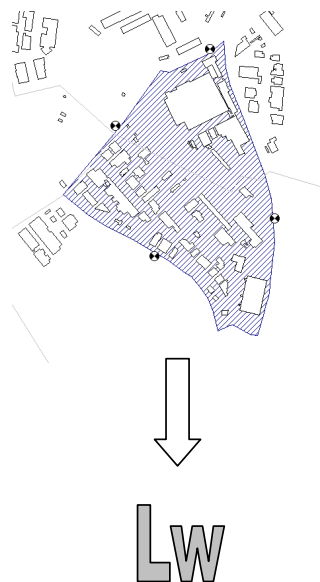


Fig.3 Design of the horizontal noise source and receivers around the plant in the 3D acoustic model

If one sound level is required by default for all the boundary (ex: 55 dB(A) over all the boundary), only one horizontal noise source is needed. The L_w will be around 55 dB(A) per m^2 , but has to be verified by calculation, because of screening effects of buildings.

If different sound level are required for different points (ex: 54 dB(A) measured for P1, 59 dB(A) for P2, etc.), the number of sound sources should be greater or equal than the number of receivers.

$$\text{Number of horizontal sources} \geq \text{Number of receivers}$$

In this case, the design of the sound sources shall be done using the experience of the user. The calculation is OK when the calculation fits with the searched sound levels.

4 Limits and reliability of the method

4.1 Limits of the method

This method should be used with caution, because it works better with continuous noise and fixed sources, and for open plants.

It may give less good results:

- If noise sources are mobile sources (ex: trucks).
- If noise is not stable.
- If noise sources are mainly inside of buildings, or located on the roof.
- If the directivity of sound sources are significant (ex: chimneys).

It is difficult, for noise mapping of cities to use a “push button” technique for industrial sites. The estimation of the sound power of plants requires expertise in industrial noise modelling.

4.2 Uncertainty inherent in the method

The ISO 8297 standard, on which the proposed method is based, specifies the uncertainty inherent in the method: It depends mainly on the average distance (d) between the measurement contour and the boundary of the plant, in relation to the square root of the plant area (S_p).

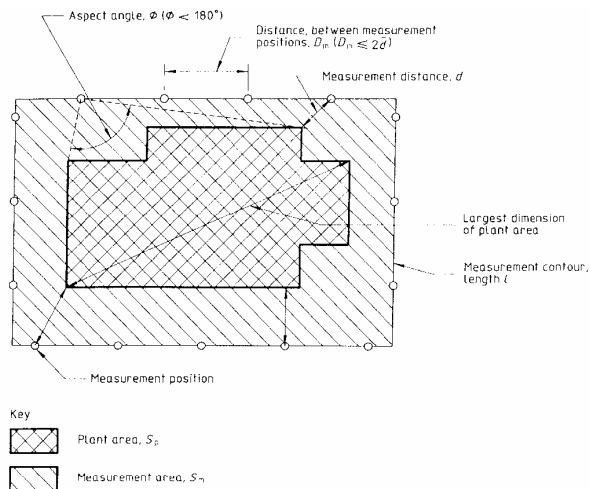


Fig.4 General set up of measurement positions, issued from the ISO 8297 standard

This uncertainty does not exceed 3 dB, but does not include:

- Uncertainties due to variations in the noise emissions of the sources over a period of time.
- Uncertainties due to variations in the noise propagation (ex: meteorological effects) over a period of time. This uncertainty depends on the distance source/receiver, and is influent from about 100m to the source.

In the case of the method described in this paper, the uncertainty is clearly higher than 3 dB.

4.3 Reliability of the method

This method can be compared to the expertise method used by acoustical consultants, comparing the results in terms of sound power between:

- A model built from acoustics measurements of sound sources inside the plant (about 5 to 15 days of work).
- A model built with the method described in this paper (less than one day of work, including measurements).

The results of this tests show that the difference can be low (less than 3 dB) for homogeneous open plants, but can be greater (+/- 7-10 dB) for plants of great area and inhomogeneous repartition of sound sources.

Greater accuracy of the model can be possible, but will need a special survey inside of the plant, made by an expert in industrial acoustics.

The method described in this paper remains the best solution to handle industrial sites in city noise mapping projects.

5 Perspectives

The advantage of this method is that it can be carried out with or without on site measurements.

In the case of a large territory, with many industrial activities very different one from the other, this method allows to adapt the methodology of sound power estimation of plants with regard to the noise importance of the site in the map.

The European Directive focuses on people noise exposure and main contribution sources. Industry is only a local effect compared with traffic. The method to tackle industrial noise in city noise mapping should be adapted to that situation. More detailed modelling could be considered in local action plants.

The development of a database of homogeneous activities and average noise levels should be encouraged. The work carried out in the Work Package 7 of IMAGINE project [5] is a good start.

References

[1] ISO 3744: 1994: Acoustics -- Determination of sound power levels of noise sources using sound pressure --

Engineering method in an essentially free field over a reflecting plane.

- [2] ISO 3746:1995: Acoustics -- Determination of sound power levels of noise sources using sound pressure -- Survey method using an enveloping measurement surface over a reflecting plane.
- [3] ISO 8297:1994 – Acoustics – Determination of sound power levels of multisource industrial plants for evaluation of sound power levels in the environnement.
- [4] Guide CERTU “Comment réaliser les cartes de bruit stratégiques en agglomération – Mettre en œuvre la directive 2002/49/CE.
- [5] IMAGINE project - Guidelines for producing strategic noise maps on industrial sources – Deliverable 14