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AN ACOUSTIC GUIDE FOR THE DESIGN OF PLANTS

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ABSTRACT
This guide provides a strategy for considering acoustic aspects in the design and construction of industrial investment projects. It is dedicated to health at work and environment. It is designed to be consistent with international regulations. It applies to all types of construction, production, installations, laboratories, formulating and packaging units and even offices. It is designed **for the non-specialist**. Attached with a data base, specific to each industrialist, it becomes an attractive tool for the management of a project. Economic and technical optimisation of noise control must be carried out of a first two key stages of a project. This guide offers a procedure for this based on impact analysis. It is a tool for aiding decision making. This guide received the special award the jury for the "Decibel d'or 1999" from the French Ministry of Environment.

1 - INTRODUCTION

This guide provides a strategy for considering acoustic aspects in the design and construction of industrial investment projects. It forms part of industrialists policy to protect the health of its employees and respect the environment, and more generally a part of its loss control strategy. This guide is thus subdivided into two sections: health at work, and environment. It applies to all types of construction: production installations, laboratories, formulating and packaging units, even offices. Although focused on the design of new or refurbished installations, it provides useful material for more ordinary development projects.
Throughout this approach, the assessment of acoustic impact and the technical and economic techniques for dealing with it go hand in hand. Economic and technical optimisation of noise control means that the subject has to be considered early on, and this guide offers a procedure based on an impact analysis in each of the first two key stages of a project.

2 - ORGANISATION OF THE ACOUSTIC GUIDE

This guide is designed for the teams responsible for industrial investment projects. Its purpose is to provide the various parties involved in a project with procedures, tools and information which will enable them to include noise factors at all stages in the progress of a project. It is a tool to help decision-making, which can be used by non-specialists.
Two folders are used in parallel; the information in part 2/Method (how to proceed) refers to the sections in part 3/Documentation (all required acoustic information, risk evaluation manual) and part 4/Databases (machine emission, material properties, typical installations data). A computer-aided version of this guide is under development.

3 - NOISE CONTROL DESIGN PROCEDURE

The procedure is applied by working through each of the project stages (**P**reliminary – **B**asic – **D**etailed – **C**onstruction – **O**peration). The starting point for the noise control aspects of a project has to be the first stage of the preliminary engineering in the procedure document.

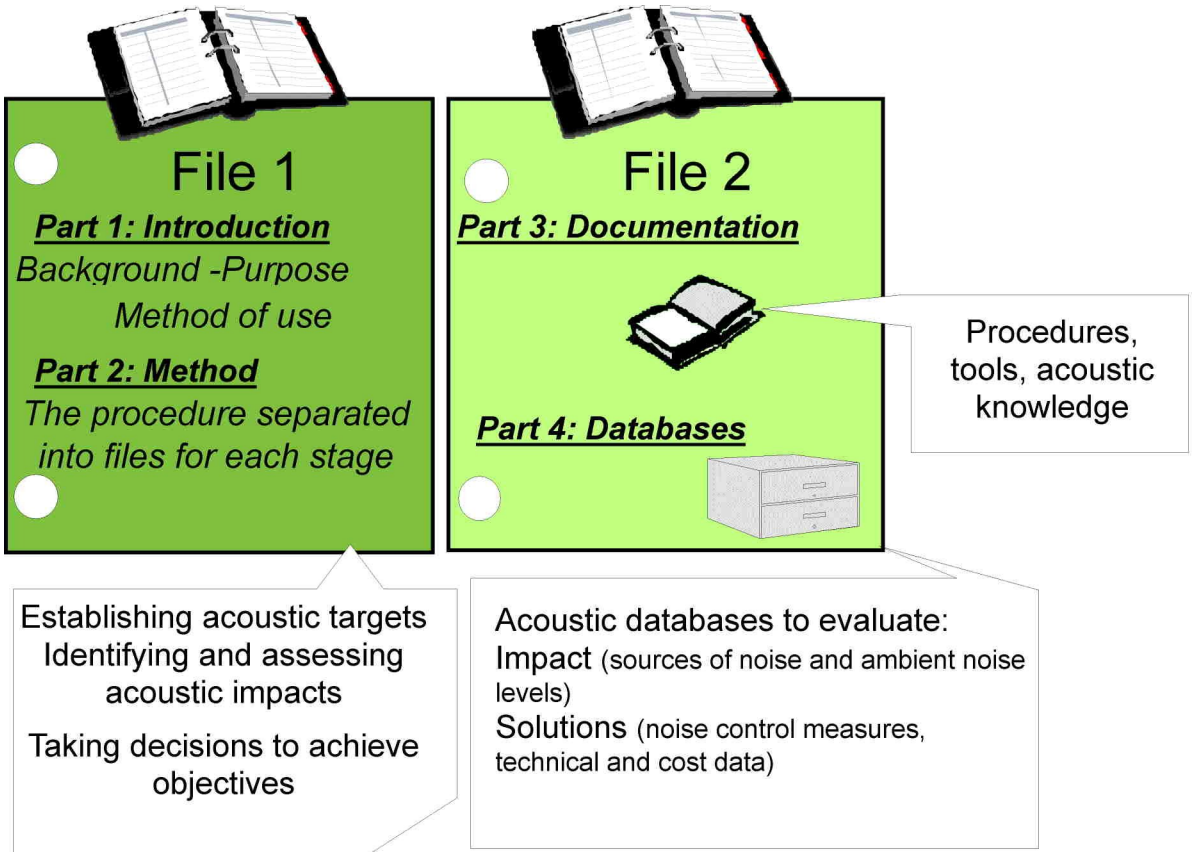

Figure 1: Organisation of the acoustic guide.

The procedure for evaluating the noise impact is broken down into files which follow the progress of a project.
When applying the procedure to the individual stages of a project, the project team will have a specific "sequence" table for the field in question (health at work or environment). This will describe what action has to be taken, which working and procedure sheets in the guide must be used, the output documents and the parties involved.
For each stage in a project, the project team will have PROCEDURE files (what action has to be taken where is the information) and WORK files (how to evaluate an impact and the risk to exceed a limit).

4 - A BASE OF DATA AND KNOWLEDGE

In the preliminary stage of an industrial project, little acoustic data is available. Sound sources like machines and equipments are not yet chosen, detailed construction not defined. However, know how and expertise in comparable situations do exist. It is mainly a problem of collecting and using efficiently such information which often leads to errors in the implementation, the selection of machines or equipments, the selection of materials and constructions.
This can be compensated for by using a structured base of data and knowledge and an associated decision making tool. The data base included in the proposed guide contains (parts 3 and 4):

- General information like, basic acoustic principles, a classification of insulation properties of typical walls, a classification of reverberation, performance and cost of typical technical solutions for noise control,
- Regulation and recommendations concerning noise at workplaces and noise in the environment,
- Specific acoustic data from existing plants relevant for the particular industrial field (specific to each industrialist) ie production parameters, dimensions, number of machines, reverberation class, complexity indice relative to the distribution of sound sources and sound pressure levels in halls, ranges of sound pressure level, scores relative to the possible sound reduction on sound sources.

- For machines and equipments: equipment definition, technical characteristics, operating conditions, dimensions, noise emission.

5 - DECISION MAKING TOOL

The first part of this tool helps in defining project acoustic goals from regulation requirements and recommendations of best practise. The requirements are defined to prevent hearing damage, sound quality adapted to typical working conditions and to fulfil community noise ordinances.
The second part on this tool consists in a simplified method to assess the acoustic impact of the project. Dedicated to non specialists, it provides estimates to help decision making. At an early stage of the project the most important thing is to know whether the choices madelead to a green light situation (the project is all right), an orange light situation (the project needs some modifications but they can be envisaged) or a red light situation (the project will not meet the requirements even after modifications). The developped method is based on score additions with hidden logarithm calculations. If the problem is too complex, a specialist using noise prediction programs (tools for the specialist) will join the project. The main steps of this simplified evaluation procedure are presented below:
Occupational health
If no data concerning similar halls is available in the data base and/or if the complexity index is high, then a warning is given to the non specialist. In other cases (data concerning comparable situations available in the data base and complexity index small), evaluation of a score is performed. It is based on acoustical comparison between the two halls (hall of the data base − hall of the new project) using the following parameters:

- ratio of dimensions
- ratio of number of machines
- difference between the reverberation class of the two halls
- noise level of the reference hall
- requirements concerning noise level and/or reverberation

Environment
A complexity index depending on the geometrical situation (dimensions of the plant and halls, distance between the plant and the resident areas), topographical and meteorological information is defined. If the complexity index is high or if there is a lack of acoustic information concerning ie the equipments or machine, a warning is given. In other cases, the maximal sound power for the whole plant is evaluated, knowing the acoustic situation before implementing the project. This evaluation takes into account the distance between the plant and residence areas, the residual noise level in residential areas, the attenuation of noise with distance. A score is calculated to compare the previsional sound power level with the maximal sound power allowed, taking into account:

- Noise levels in all different halls (calculated precedently)
- Transmission class of walls (from data base)
- Noise emitted from machines or equipments located outside (from data base)

The third part of this toll is an optimisation step. If the results obtained indicate an acoustical problem, then the guideline propose an optimisation method to choose solutions to minimise the risk.
The parameters involved are:

- the scores for the halls
- the action class on noise levels in halls (possible values are given in the database)
- the action class on machines or equipments (possible values are given in the data base)
- the action class on reverberation of halls
- the action class on transmission of walls

Moreover, the estimated cost of each solution can also be evaluated from information contained in the data base.

6 - CONCLUDING REMARKS

The combination of a base of data and knowledge together with a decision making tool provide an attractive guide to any project team member. Included in the management scheme of the project it ensures that acoustic design is introduced at each appropriate project steps. This work was initiated in combination with a large industrial group and provided to their engineering teams worldwide. It received a reward from the French Ministry of Environment.