

TOWARDS A STANDARDIZED METHOD FOR ASSESSING THE ACOUSTIC ENVIRONMENT IN RESIDENTIAL BUILDINGS THROUGH PERCEPTION SURVEYS

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Abstract

The acoustic classification methods for residential dwellings—and particularly the one developed in the ISO/TS 19488 technical specification—employ various performance indicators to characterize the acoustic quality of housing. To better correlate occupants' perceptions with these indicators and, ultimately, with acoustic classes, a new French guidance document, FD S30-109, defines a methodology for conducting perception surveys.

This paper outlines the entire methodology, beginning with the acoustic parameters upon which it is based. It then describes the survey's structural framework, supplemented by an outline of the various relevant contextual and psychosocial factors to be considered. Key principles and best practices are discussed, alongside recommendations for correlating survey results with acoustic measurements. Finally, selected excerpts from a sample questionnaire are presented and analyzed.

Keywords: *acoustic environment, residential buildings, perception, survey, standard*

1. Introduction

The acoustic performance of dwellings is typically determined using a number of measurable physical indicators. These indicators—which vary by country—are used in national regulations to set performance targets aimed at ensuring a minimum level

of acoustic comfort for occupants. However, expert assessments in France sometimes reveal that occupants experience noise-related annoyance even when their homes comply with regulations. This raises the question of whether the target values are poorly chosen, whether the indicators themselves are unsuitable, or simply whether it is possible to correlate annoyance with the acoustic performance of buildings. These questions all point to the same core issue: how can noise-related annoyance in a dwelling be characterized?

Addressing these questions requires conducting socio-acoustic surveys to gather a substantial amount of representative data. However, survey methodologies vary widely depending on the surveyor. To obtain usable data, a rigorous method or a standardized questionnaire must be established. This is the objective of the new French guidance document FD S30-109 [1] published in 2024; it proposes a method for creating a socio-acoustic questionnaire for residents, enabling the subsequent correlation of results with measured physical indicator values.

Following discussions at the European level concerning this subject, it has been decided in March 2026, to create a new working group CEN/TC126/WG13 “Indoor acoustic perception survey” and to register in the work program of CEN/TC126 a New Work Item (TS) Indoor acoustic perception survey in dwellings. The objective is to harmonize the assessment of indoor acoustic perception from the user/occupant perspective, while defining terminology, perception assessment methods, common scales/metrics, and a minimum metadata set (space, use, activity, time, sources).

Such assessment of indoor acoustic perception in dwellings is of importance when defining acoustic performance classes to inform the building occupants about the acoustic condition. Indeed, the classification levels as the one proposed in ISO/TS 19488 [2] can be

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adjusted from results of such building occupant's perception surveys rather than from national acoustic regulation or even the different acoustic specialists experience. Improving the acoustic quality of new and existing housing stock is necessary to limit the effect of noise on health of the dwelling occupants.

In this paper, the development and selected survey methodology of French guidance document FD S30-109 [1] are presented and will serve as a basis for the starting European work on this subject.

2. Survey methodology

2.1 General approach

To establish a coherent and effective methodology, the initial approach was based on general principles for designing psychosocial questionnaires [3-4], applying them to identify acoustic phenomena present in residential buildings.

The first step involved examining several existing questionnaires previously used in studies on residential building acoustics [5-7]. This analysis provided a baseline for evaluation, which was subsequently refined to retain only those questions capable of identifying noises that cause annoyance to occupants. Additions primarily focused on incorporating the frequency of perceived noise and contextual factors. For instance, the COVID-19 crisis — and the widespread adoption of remote work — prompted adjustments to questions regarding time spent at home and the activities performed there.

Key challenges included identifying and mitigating biases typical of this type of questionnaire. It was essential, for example, to consider the respondent's relationship with their neighbors, as well as to account for spatial distribution and respondent representativeness, particularly during the analysis of the results.

Question wording was also carefully considered to avoid comprehension issues arising from overly technical vocabulary. For example, to a lay person unfamiliar with building acoustics, the term “airborne noise” is almost invariably associated with noise from aircraft. In the approach adopted for this methodology, “airborne noise” refers to any noise produced and/or propagated through the air (as opposed to “structure-borne noise,” which characterizes a different type of noise propagation phenomenon within a building). Similarly, those applying the French acoustic regulation for housing [8] commonly refer to a building's “technical equipment” when discussing heating systems, mechanical ventilation, elevators, etc... Particular attention is therefore paid to the choice of terminology to ensure that questions are easily understood by any respondent and to avoid biases arising from the interpretation of specific terms.

2.2 Acoustic parameters

As the questionnaire aims to correlate the building's acoustic performance with the annoyance experienced by its occupants, the topics addressed were selected based on measurable physical parameters already used

in residential acoustic regulation [8].

The methodology therefore covers four categories of noise:

- Airborne noise originating outside the building in question,
- Airborne noise originating inside the building in question,
- Impact noise generated within the building but originating from a different dwelling or another part of the building,
- Noise resulting from the operation of various building service systems that are an integral part of the building.

The chosen approach also highlights the need to consider that, within a dwelling, the perceived noise level depends not only on acoustic insulation — both between internal spaces and against external noise — but also on the reverberation within those spaces.

Finally, it is worth noting that noise perception is not solely a matter of sound level; it can also be significantly influenced by the prominence of a noise relative to a stable background sound environment, the noise's frequency composition, or its temporal signature (continuous vs. impulsive noise).

Reiterating these parameters — even if they may seem self-evident to building acoustics specialists — is essential to ensure the creation of a usable questionnaire whose results can be correlated with quantifiable and measurable indicators.

2.3 Structuring the survey

To facilitate the creation of the questionnaire, the French guidance document FD S30-109 [1] proposes a number of principles to apply when structuring the survey.

As a first step, it is essential to identify the overall context of the dwelling and the respondent in order to select relevant questions and omit unsuitable topics. For instance, it is recommended to establish an initial set of questions to determine whether the respondent lives in a detached house or an apartment in a multi-unit building; whether the building contains service equipment that typically generates noise (such as an elevator); or whether the respondent's dwelling shares a wall with a noise-sensitive area, such as a shop or a parking garage.

Next, the questionnaire should include questions addressing each category of noise so that any reported annoyance can be correlated with the specific noise type and the building's acoustic performance (which allows the noise to be quantified). It is therefore recommended to ask questions covering the following topics, while adapting them to the specific environment of the building under study:

- Perception of noise generated by sources outside the building containing the respondent's dwelling (transportation infrastructure, activity from a street with a bar or restaurant, animal noise, etc.). The aim of this section is to correlate reported annoyance with the measured acoustic insulation of the dwelling's façades.

- Perception of noise generated by human activity inside another dwelling (within the same building). The aim of this section is to correlate reported annoyance with the measured airborne sound insulation between dwellings.
- Perception of noise generated by floor impacts (such as walking or dropped objects) occurring inside another dwelling (within the same building). The aim of this section of the questionnaire is to correlate the reported annoyance with the measured impact sound level.
- Perception of noise generated by the building's technical systems (air conditioning, heating, mechanical ventilation, elevators, etc.). The aim of this section of the questionnaire is to correlate the reported annoyance with the measured noise level of the specific service equipment involved.
- Perception of reverberation within the respondent's home, in order to assess whether this might influence their perception or indicate an "atypical" environment. In particular, it would be interesting to determine — given equal standardized sound insulation levels — how reverberation influences the annoyance experienced.

2.4 Contextual and psychosocial factors

Another key challenge in designing the survey is identifying contextual factors that may influence the respondent's experience but are beyond their control. These fall into two categories:

- Constant contextual factors, such as the respondent's dwelling sharing a wall with the building's elevator shaft or a gym, or the home's proximity to a busy road, etc.
- Exceptional contextual factors, such as construction work near or inside the building, a one-off festive event (e.g., the annual music celebration "Fête de la Musique" / Music Day), etc.

Ideally, the proposed questionnaire should make it possible to quantify the impact of these contextual factors on the respondent's experience, particularly in terms of their frequency and duration.

Finally, a major challenge for any questionnaire aiming to assess a person's experience is capturing the influence of psychosocial factors — such as individual noise sensitivity [9], the respondent's cultural and social background, the meaning attributed to the perceived noise, and the nature of social interactions with neighbors — all of which significantly affect noise perception. However, neither the questionnaire structure nor the analysis of responses should exclude data based on these factors.

2.5 Principles and best practices

Based on an analysis of existing literature regarding the development of questionnaires designed to assess subjective perception [3-4], the French guidance

document FD S30-109 [1] outlines several principles and best practices.

In particular, it adopts the "funnel" approach to questionnaire design — starting with general questions about perceived noise and gradually moving toward more specific questions (such as those addressing a particular noise source).

Several recommendations regarding question wording are provided, along with best practices for administering the questionnaire.

Finally, the document discusses the various options for response scales (verbal, numerical, or descriptive responses) and outlines key rules for their use.

3. Recommendations for correlating results

As previously mentioned, the objective of the French guidance document FD S30-109 [1] is to propose a methodology for developing a questionnaire designed to assess annoyance in residential buildings. In the longer term, the aim — based on feedback from this approach — is to be able to correlate expressed annoyance with the acoustic performance of the dwellings in question. It is therefore essential, whenever possible — either at the time the questionnaire is administered or within a representative timeframe — to link the questionnaire responses to measurable physical quantities.

To harmonize these quantities and link them to the five themes selected for the development of the questionnaire, the French guidance document FD S30-109 [1] lists the measurable quantities as shown in Table 1.

Table 1. Potential correlation between the questionnaire topic and measurable physical quantities.

Questionnaire theme	Parameter measured	Measurement standard
Outside airborne noise	$D_{nT,A,tr}$ [dB]	ISO 10052 or ISO 16283-3
Indoor airborne noise	$D_{nT,A}$ [dB]	ISO 10052 or ISO 16283-1
Impact noise	$L'_{nT,w}$ [dB]	ISO 10052 or ISO 16283-2
Equipment noise	$L_{ASmax,nT}$ [dB(A)]	ISO 10052 or ISO 16032
Reverberation time	Tr [s]	ISO 3382-2

4. Sample questionnaire

The development of the methodology described in the French guidance document FD S30-109 [1] inspired the creation of a sample questionnaire, which is presented in an appendix of the document.

It is recommended to use this questionnaire as frequently as possible to facilitate result comparisons between different projects; this allows for the establishment of correlations with measured physical values based on a larger dataset, thereby ensuring statistical representativeness.

However, this sample questionnaire can also serve as a foundation for developing a more specific questionnaire tailored to a particular situation, while still adhering to the methodological principles of the French guidance document FD S30-109 [1].

This example covers a full range of topics to provide a sufficiently comprehensive basis. Here are a few excerpts from the approximately fifty proposed questions:

- Are you ever disturbed by noise in your home?
- On a scale of A to E — where A means “not at all disturbed” and E means “extremely disturbed” — are you disturbed by road traffic noise when the windows are closed?
- On a scale of A to E — where A means “not at all disturbed” and E means “extremely disturbed” — are you disturbed by noise from common areas (hallways, stairwells, entrance halls, etc.)?
- Are you concerned about disturbing your neighbors by making noise at night?

To assist users wishing to draw inspiration from the sample questionnaire, several questions are accompanied by detailed explanations regarding their rationale or the reasoning behind the suggested response options. For instance, regarding the question: “Currently, on weekdays, how much time on average do you spend in your home (including all activities, such as resting)?”, the various response options are explained as follows:

- Less than 4 hours a day means the occupant spends very little time in the home, which may bias their perception.
- 4 to 8 hours a day implies that the occupant may not sleep in their own home every day.
- 8 to 12 hours a day is typical of an occupant who has daily activities outside the home and uses the dwelling primarily for rest.
- 12 to 20 hours a day is characteristic of an occupant who habitually spends time at home during both the day and the night.

5. Conclusion

Addressing the challenge of characterizing noise annoyance in the home, the French guidance document FD S30-109 [1] proposes a methodology for developing a questionnaire to assess how residents of a housing building perceive their acoustic environment.

Drawing on several questionnaires validated in France and Europe, the work leading to this methodology focused primarily on identifying questions that capture the acoustic phenomena at play within dwellings — thereby enabling the correlation of responses with measurable quantities — and on understanding the various factors that might influence the respondent.

The main objectives were to devise a methodology accessible to stakeholders who are not necessarily building acoustics specialists, while offering a tool linked to physical parameters that could, in the

future, be interpreted or even correlated with the annoyance expressed by residents.

This work thus represents a first step in an initiative aimed both at raising awareness regarding the issue of perceived noise in the home and, in the longer term, at gathering data to — hopefully — define indicators that better reflect expressed annoyance and, ultimately, lead to the construction of more comfortable housing.

The work that will start soon at the European level will hopefully lead to constructive discussions and in a few years to a useful European technical specification on this important subject.

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