

Regulation in Spain for in situ acoustic measurements in buildings and criteria for accredited laboratories.

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ABSTRACT

Royal Decree 1371/2007 approving the Basic Document “DB-HR Protection against noise” of the Spanish Technical Building Code, is the national regulatory framework for in situ acoustic tests as a part of “as built” certification.

Besides this framework, regional and local regulations coexist today in Spain. This article describes the criteria consider in these standards and their differences, from regulation to technical issues in their application. Critical issues such as sampling or selection of elements for testing are addressed in these specific documents, a lack of other general benchmarks. The accredited acoustic testing laboratories implement these building tests by using the recognized methods of their scope of accreditation, as well as the normative documents recognized in their Lists of Regulatory Documents, following the requirements established in the accreditation document NT-45.

Latest updates of some of the standards for acoustic testing in buildings require laboratories to adapt themselves to the state of the art, renewing their scope of accreditation according to criteria defined by the technical note NT-86.

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1. CTE DB-HR, national regulation

The Basic Document "DB HR Noise Protection" (DB-HR onwards) describes objective parameters and verification methods to meet basic requirements and achieve

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minimum quality levels of noise protection. As set out in the document, it will be applicable to public and private buildings, whose projects need to have the corresponding license or authorization required by law.

Among other requirements to achieve this objective, there is the on-site verification in the final phase of construction. It is recommended that these on-site tests are carried out by laboratories with the necessary technical competence to guarantee that, finally, the project has complied with the acoustic protection characteristics with which it has been designed and that it has the necessary features for its users. The document contains several sections on on-site tests:

- Section 1.1, which determines the type of tests to be carried out: airborne sound insulation between rooms, impact sound insulation of floors, reverberation time and levels of noise and vibrations from installations utilities.
- Section 2, which establishes the limit values that must not be exceeded, the parameters to be used, and the types of enclosures or construction elements to be measured (facades, dividing partitions, classrooms, horizontal separation elements, rooms affected by systems machinery rooms, etc.).
- Section 5.3.2: sets out the standard methods to measure, the overall indices against which conformity must be given (Annex H) and the decision rules.

CTE DB-HR is approved by means of Royal Decree 1371/2007, although the first is a technical document and the second is a legal one, and any of them make mandatory the use of on-site verification as a part of “as built” certification. That’s why in Spain there are other normative documents with local or regional scope with further requirements; e.g. the need to certificate the compliance with the limits of the DB-HR in order to grant license for new buildings, or some more specific criteria to select the samples to be tested, so that it is not necessary to evaluate the entire building; which is defined as sampling in ISO 17025:2017.

Sampling includes the sampling plan, which contains the selection of the samples to be tested (e.g. walls or floors that separate rooms, noise from utilities, class rooms where reverberation time measurements shall be made, etc.) and also the test performed in the selected samples. The next step is the comparison of their results against the limits set in the DB-HR, in order to provide an assessment of the general compliance of the building.

2. Regional and local regulations

The following are some representative cases of regional and local documents that regulate in situ measurements of the acoustic conditions as a part of “as built” certification and include guidelines for sampling.

2.1 País Vasco:

Decree 209/2014 of 28th October, which regulates quality control in construction, establishes when a Quality Control Plan is mandatory at the final stage of construction in País Vasco. It is completed with the Order of 15th June 2016, on Acoustic Control of Buildings. This Order regulates quality control in construction, laying down the

methods for the on-site verification of the acoustic performance of buildings in accordance with the DB-HR Basic Document

Sampling:

Annex 1 Epigraph 3 establishes the number of tests to be carried out depending on the number of functional units (dwelling in a private residential building, room + annexes in a public residential or hospital building, classroom or conference room + annexes in educational buildings).

Annex 1 Epigraph 4 gives the guidelines for the selection of samples, such as:

- Ranking for the selection of the premises of the building, associated with each type of test. For example, for airborne sound insulation and impact insulation, priority is given to:
 - the uses of adjacent rooms. E.g.: in airborne sound insulation test between rooms of different use units, the first case to be chosen would be a bathroom adjacent to a bedroom, the second would be a kitchen with a bedroom, etc.
 - the “volume/surface of shared partition” ratio of the adjoining rooms when they adjoin horizontally.
 - for the same conditions, premises without movement joints between them, because it is a more unfavourable situation.
 - in case that protected rooms are not affected, an inhabited room can be chosen.
- For the rest of the test types, criteria are established to also carry out a directed sampling, in order to test the theoretically most adverse conditions.
- Special circumstances are considered, such as rooms sharing partitions, staircases, elevators, etc.

In addition, the document sets the minimum content of the report for the on-site verification tests and the requirements for instrumentation.

2.2. Castilla y León:

Acoustic control in buildings is regulated by Chapter II of Noise Law 5/2009 of 4th June. The document requires a test report to be submitted in order to obtain the first occupation licence for buildings. Construction shall comply with the minimum insulation values required in Section 2.1 of DB-HR and with the maximum levels of environmental noise inside housing, permitted by Law 5/2009 itself.

Sampling:

- Article 29 establishes the number of measurements to be made, which is a percentage of the total number of dwellings in the whole development; for example, for insulation tests between dwellings the maximum will be between 1 and 20% of the total amount of dwellings.

- The sample must be representative of the most unfavourable cases. Specific guidelines for sampling are given in a support document, the subsidiary Order of Noise and Vibrations of Castilla y León (Municipal Ordinance Model). It gives indications about:

- the number of samples to be selected in each type of building (housing, educational or cultural use, hospital or healthcare use), depending on the testing method.
- the selection of specific samples depending on: the type of enclosure separating emitting and receiving rooms (horizontal, vertical), the location on the ground floor or first floor for façade insulation and the use (bedrooms as the most sensitive element).

The document considers special situations such as isolated or adjacent single-family dwellings, or the measurement of sound levels coming from sanitary drainage.

According to the Law, measures must be carried out by Acoustic Evaluation Entities, which are accredited laboratories recognised by Castilla y León authorities.

As for the standards used for carrying out acoustic measurements, Article 14 of Law 5/2009 refers to its Annex V.3 and this annex mentions the UNE-EN ISO 140 standards of 1999 "*or standards that replace them*"; which is inconsistent with the statements on CTE DB-HR.

2.3 City of Valencia

The Municipal Ordinance on Protection against Acoustic Pollution of Valencia City Council, establishes that it is mandatory to comply with the requirements of DB-HR for all new buildings, mainly for residential use, in order to obtain the occupancy permit.

Article 29 establish the content of the Acoustic Insulation Certificate, which is: airborne sound insulation tests of the facades, separating walls, horizontal enclosures (slabs) and walls which separate dwelling and rooms from building systems, as well as impact sound insulation tests.

Sampling:

The selection of samples is made for each construction category. The minimum number of tests will be either 10% or the square root of the number of dwellings in the building, the greater of both options.

In order to select the specific samples, in case of equality a guideline for the most unfavourable situation is given: the measurements should always be made, in those construction elements more susceptible to allow the acoustic transmission, either because it separates two incompatible uses or due to their position in the building. In order to guarantee this, the document adds "*The City Council will be able to verify if the diverse construction elements that compose the building fulfil the norms dictated in this Ordinance*".

Regarding the standards to be used for insulation tests, the reference is always DB-HR, as a document to evaluate compliance. However, Annex III of the document specifies that the standards to be used are the UNE-EN ISO 140 without dated version, which could contradict to a certain extent with DB-HR.

3. SAMPLING IN BUILDING and ISO/IEC 17025:2017

According to ISO/IEC 17025:2017 sampling is one of the activities performed by a laboratory and to which the standard's requirements apply. Considerations made in this standard are:

- The laboratory shall have a sampling plan and procedures for sampling and sample taking when it carries out sampling for subsequent testing.
- Sampling procedures shall describe the selection of samples/sites, sampling plan and preparation of samples to yield the required information in testing.
- Sampling plans shall, whenever reasonable, be based on appropriate statistical methods.

DB-HR together with normative documents such as the above mentioned, establish the guidelines for laboratories performing both the sampling and the on-site tests to determine acoustic performance of buildings, concerning:

- Type of test to be carried out and measurement methods.
- Parameters for quantifying the results and limits against which to declare conformity.
- Types of construction elements subject to sampling
- Minimum number of samples to be tested
- Criteria for the selection of samples within the same typology

Building sampling is therefore an activity that can be accredited by the National Entity of Accreditation (ENAC), necessarily linked to subsequent tests. Document NT-45 gives information about the scopes of accreditation, based on both DB-HR and regional and municipal regulations, which are more prescriptive and have more specific sampling specifications.

However, the variety of cases and the complexity of sampling in building make it an uneasy task, and technical development is still needed in aspects such as:

- Sampling uncertainty. The selection of a limited number of items within the total building must be considered as a contribution to the uncertainty of the results. Currently, there is no reference documentation that can quantify or give an indicative value.
- Intercomparisons (round robin test). For the results to be comparable, it is necessary to consider:
 - the influence of guidelines, that can be more or less complete and specific.
 - built elements. Construction elements identical during the project phase may differ once built.

4. TEST METHODS AND NT-86

According to ISO/IEC 17025:2017, “*the laboratory shall ensure that it uses the latest valid edition of a standard unless it is not appropriate or possible to do so.*”

In case of DB-HR, the last comments published in December 2016 specify that on-site measurements shall be made according to UNE-EN ISO 140-4, UNE-EN ISO 140-7, UNE-EN ISO 140-5 y UNE-EN ISO 140-14, despite they are replaced by UNE-EN ISO 16283-1, UNE-EN ISO 16283-2 y UNE-EN ISO 16283-3. Regional or municipal regulations don't always mention the edition to be applied, but in this cases the common rules of standardization states that for dated references, only the edition cited applies and for undated references, the latest edition of the referenced document applies.

Anyway, DB-HR is considered a national regulation with the higher category. Currently, there is a draft of Royal Decree amending the Spanish Technical Building Code in order to update the documents referred in it, including insulation standards considered by DB-HR.

According to Technical Note-86, accredited laboratories include always the last version of standards in their scopes, except in case there are regulatory requirements such as the current CTE requirements.

5. CONCLUSIONS AND REFLECTIONS

It is well known that on-site measurements in the final building ensure the quality of acoustic conditions. There is a national regulation to do so (DB-HR), but the requirements of real control are transferred to regional governments and town councils. The consequences are a lack of homogeneity, with different requirements in Spain, not only in the basic requirement to comply with the DB-HR to obtain a license, but also in the aspects to take into account to make a sampling plan when measurements are mandatory.

ISO is working in the standard ISO/FDIS 19488 *Acoustic classification of dwellings*. This document describes class criteria and procedures for acoustic classification of dwellings, which includes verification by means of measurements. An international standard could help authorities to define a specific class in building regulations as the minimum requirement for acoustic conditions in dwellings, but does not include specifications to make a sampling plan.

At the national level, a group of experts are working on the project PNE 74201: *Scheme of acoustic classification of dwellings*. The aim of the document is to be a reference for the design and construction stages, as well as to provide consumers with information about the level of acoustic quality in dwellings. So as to ensure the quality, the code describes the tests to be performed and some tips about sampling.

In future, standardization may bring a bigger harmonization to Spanish codes, stating similar minimum requirements throughout the territory for construction permitting. Moreover, further investigations about sampling in buildings are needed, in order to

improve the selection criteria and the knowledge about its consequences, trough, for example, uncertainty methods.

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