

SPANISH BUILDING ASSESSMENT REPORT (IEE). IMPROVEMENT SUGGESTIONS

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ABSTRACT

Part IV of the Spanish Building Assessment Report (IEE) allows to carry out a preliminary assessment about the acoustic conditions of a building, helping to identify critical points and decisive factors. Although it is considered a good initiative, the final assessment simplicity implies a wide margin of uncertainty and may reduce the importance of the report.

This article is intended to address the IEE acoustic part, incorporating integrating improvement suggestions that facilitate the procedure for technicians, to carry out, in a simple and less qualitative point of view, the preliminary acoustic assessment and classification regarding apartment building blocks in Spain.

RESUMEN

La parte IV del Informe de Evaluación del Edificio (IEE) permite realizar una evaluación preliminar de las condiciones acústicas del edificio, ayudando a identificar los puntos críticos o factores determinantes. Pese a considerarse una buena iniciativa, la sencillez en la valoración final entraña un amplio margen de incertidumbre y puede reducir la importancia del informe.

El presente artículo pretende abordar la parte acústica del IEE, incorporando propuestas de mejora integradoras que faciliten el trabajo a los técnicos para poder realizar, de forma sencilla y menos cualitativa, la evaluación y clasificación acústica PRELIMINAR en edificios de viviendas en bloque en España.

1. INTRODUCTION

Building acoustics quality has been acquiring a considerable attention in recent in the last years. Although the basic document for protection against noise (DB-HR, Technical Building Code CTE) requires minimum values of acoustic insulation in Spain, these are below the European average, and may be a problem to the advance in this field.

Nowadays there is no recognized scheme of acoustic classification in Spain while in Europe already several neighbouring countries are employing them. Some initiatives regarding assessment and certification systems, or sustainability systems, assimilate issues related to the noise protection, or research groups that combine efforts to reach a European consensus in addition to the initiatives in the field of acoustics.

The Spanish Ministry of Public Works has published the "part IV: protection against noise", on a voluntary basis, within the Building Assessment Report (IEE). While the IEE tries to ensure the quality and the sustainability of buildings in Spain and serve as an element of awareness, part IV enables to carry out a preliminary assessment of the acoustic conditions of the building, helping to identify the critical points. Although considered a good initiative, the simplicity in the final valuation implies a wide margin of uncertainty and may reduce the importance of the report.

The so-called "Model PVA-IEE" or "Model PVA: Points of Acoustic Assessment" is born as an integrating proposal that facilitates the work to building technicians in Spain, conceived as the draft of a model to preliminary evaluate and classify the acoustics of buildings (blocks of flats or apartments).

On the basis of the Building Assessment Report (IEE) - part IV-, and incorporating a number of improvements inspired by other assessments or classification models and schemes, as well as European initiatives, the PVA model defines a methodology, criteria and scale trying to break the subjectivity in the results interpretation and the absence of fast and useful acoustic tools in Spain.

It is expected to continue this work, improving these proposals to find a possible and future application to European level, in collaboration with professionals and researchers from neighbouring countries.

2. MODEL APPLICATIONS

Using the PVA Model you will be able to obtain preliminary acoustic assessments and classifications, partial and global ones alike.

- PRELIMINARY ASSESSMENT: Assessment procedure by using points system, without the need of acoustic measurements in situ. It helps the technician to assume the real assessment in an approximate perspective and identify critical points in the building, but it does not serve to justify the current state of a building or to justify current regulations compliance.

- PRELIMINARY CLASSIFICATION: Once the preliminary assessment procedure is completed, the PVA model allows to calculate the "preliminary classification" to provide a guide for the technician regarding possible outcomes of the building, according to the established criteria and scale. The preliminary classification may be partial (by categories) or global (the entire building).

- PARTIAL: The partial assessment or classification refers to a single part OR category regarding the “protection against noise”, which may be:

- EXTERIOR protection against noise: Including airborne noise insulation.
- INTERIOR protection against noise: Including airborne noise and impact noise.
- SYSTEMS: protection against building systems.

- GLOBAL: The acoustic assessment or classification refers to the entire building, due to the application of weighting coefficients according to the allotted influenced to each category.

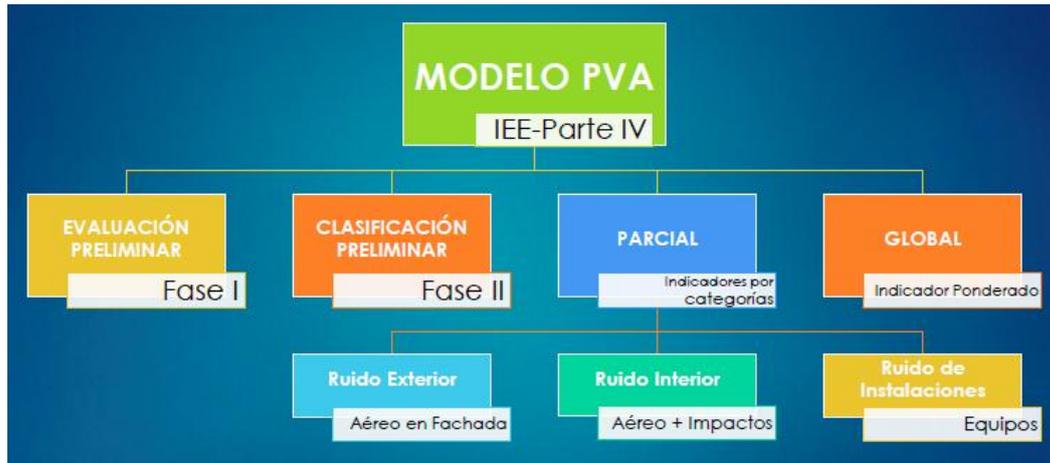


Figure 1. PVA Model applications scheme.

3. REQUIREMENTS, RATES AND PARAMETERS

The basic document for protection against noise (DB-HR) collects the mandatory acoustic insulation requirements within the Spanish Technical Building Code (CTE). Since the scope of this model is for building housing blocks in the Spanish territory, the PVA model will use these requirements as the minimum acceptable level for the assessment and classification.

As you can appreciate in the following figures about Spanish regulations, the requirements of our interest can be summarized as follows:

- OUTDOOR NOISE ($L_d \leq 60$ dB): Minimum 30 dB
- INDOOR NOISE, AIRBORNE SOUND: Minimum 50 dB
- INDOOR NOISE, IMPACT SOUND: Minimum 65 dB

Tabla 2.1 Valores de aislamiento acústico a ruido aéreo, $D_{2m,nT,Atr}$, en dBA, entre un recinto protegido y el exterior, en función del índice de ruido día, L_d .

L_d dBA	Uso del edificio			
	Residencial y hospitalario		Cultural, sanitario ⁽¹⁾ , docente y administrativo	
	Dormitorios	Estancias	Estancias	Aulas
$L_d \leq 60$	30	30	30	30
$60 < L_d \leq 65$	32	30	32	30
$65 < L_d \leq 70$	37	32	37	32
$70 < L_d \leq 75$	42	37	42	37
$L_d > 75$	47	42	47	42

Figure 2. DB-HR regulation requirements regarding Exterior Noise, Airborne sound, according to L_d levels.

EXIGENCIAS DE AISLAMIENTO ACUSTICO			
	RECINTO EMISOR	Aislamiento acústico a RUIDO AÉREO	Aislamiento acústico a RUIDO DE IMPACTOS
EN RECINTOS PROTEGIDOS	Cualquier recinto de una unidad de uso diferente	$D_{nT,A} \geq 50$ dBA Si comparten puertas y ventanas: - R_A puerta o ventana ≥ 30 dBA - R_A muro ≥ 50 dBA	$L'_{nTw} \leq 65$ dB
	Zona común	$D_{nT,A} \geq 50$ dBA Si comparten puertas y ventanas: - R_A puerta o ventana ≥ 30 dBA - R_A muro ≥ 50 dBA	$L'_{nTw} \leq 65$ dB
	Recinto de instalaciones o actividad	$D_{nT,A} \geq 55$ dBA	$L'_{nTw} \leq 60$ dB
	Exterior	$D_{2m,nT,A,tr} \geq 30 - 51$ dBA	

Figure 3. Summary of the regulation requirements DB-HR regarding interior noise, including airborne sound and impact sound levels.

As the PVA model adapts to the demands of the Spanish regulations, it is obvious to assume that the same rates used in the DB-HR should be applied to avoid incompatibilities and error in the definition or adaptation of parameters.

Tabla 1.1. Resumen de índices de aislamiento utilizados en el DB HR.

	Índices de aislamiento acústico	
	En el edificio	De elementos constructivos.
Ruido aéreo entre recintos	$D_{nT,A}$ (dBA)	R_A (dBA)
Ruido de impactos	$L'_{nT,w}$ (dB)	$L_{n,w}$ (dB)
Ruido aéreo entre un recinto y el exterior	$D_{2m,nT,A,tr}$ (dBA)	$R_{A,tr}$ (dBA)
	índices que expresan el aislamiento exigido en el DB HR	índices utilizados en las opciones de aislamiento del DB HR
	SE PUEDEN ENSAYAR IN SITU'	NO SE PUEDEN ENSAYAR IN SITU SON INDICES QUE SE OBTIENEN EN LABORATORIO

Figure 4. Used rates in a building, according to DB-HR regulation.

4. CLASSIFICATION SCALE, VALUATION AND IMPROVEMENT RATES

Points of Acoustic Assessment PVA are granted by making the assessment process, responding to the forms under the points system. The sum of obtained points leads to partial results in each category. Subsequently, by means of weighting coefficients, it gets the overall result, giving the corresponding building classification.

Right below you can see the proposed classification scale for this model, including the Points of Acoustic Assessment (pva) associated with each of them, which mark the intervals and 6 classes (represented by letters and in descending order).

ESCALA (Clase)	PUNTOS DE VALORACIÓN ACÚSTICA (pva)	VALORACIÓN (Nivel)
A	≥ 50 pva	EXCELENTE
B	≥ 40 pva	BUENO
C	≥ 30 pva	RAZONABLE
D	≥ 20 pva	SUFICIENTE
E	≥ 10 pva	DEFICIENTE
F	≥ 0 pva	PÉSIMO

Figure 5. Scale and Assessment Levels according to PVA model.

The scale relates each class with an assessment level, using terms to describe the quality, being the "class D" with "Sufficient" level the established as minimum under regulation compliance:

- (A) EXCELENT: Beats high levels of acoustic comfort.
- (B) GOOD: It enjoys a considerable level of acoustic comfort.
- (C) REASONABLE: It meets a superior level to that required by the regulations.
- (D) SUFFICIENT: It complies with the minimum conditions required by the regulations.
- (E) INSUFFICIENT: It does not comply with the minimum conditions.
- (F) DISASTROUS: The acoustic comfort level is much lower than those required.

In addition to the scale with 6 kinds and levels (A, B, C, D, E and F), for buildings which have undergone restoration or refurbishment interventions, a simple additional scale is added giving an Improvement Rate (IM), that will accompany the obtained class, consisting of the following details:

- (IM) 1 – COMPLETE BUILDING IMPROVEMENT: Intervention throughout the building, including the envelope and façades, protected and habitable rooms, shop activities and building systems.
- (IM) 2 – IMPROVEMENT OF A UNIT (SINGLE HOUSING WITHING THE BUILDING): Complete intervention in a single or few housing units within the building (but not the entire building).
- (IM) 3 – PARTIAL IMPROVEMENT: Singular intervention of one or several enclosures of the building, without completing the improvement of at least one unit or the building completely.

For a better understanding regarding the definition and representation of this scale, below some examples are showed, using the improvement rates only when necessary:

- Old building without restoration intervention or improvement: F
- Old building with partial improvement: E3
- Building with one or more units improved: D2
- Complete building improvement: B1
- High quality building built in the last decade (previous to CTE): C
- Middle or low quality building built in the last decade (pre. CTE): D

5. PVA MODEL CRITERIA

On the basis that the regulations must be met, the model has established a "standard level" or "minimum" according to the values required by the DB-HR regulation in Spain. It has been assigned to this standard level the level of "Sufficient" rating, in turn linked to the "class D".

[PVA 1.1.] CRITERIOS DEL "MODELO PVA": Puntos de Valoración Acústica						
CLASIFICACIÓN (Clase)	PUNTOS DE VALORACIÓN ACÚSTICA (pva)	VALORACIÓN (Nivel)	PROTECCIÓN FRENTE AL RUIDO EXTERIOR	PROTECCIÓN FRENTE AL RUIDO INTERIOR		PROTECCIÓN FRENTE AL RUIDO DE INSTALACIONES
			AISLAMIENTO A RUIDO AÉREO (D _{2m,nT,A,tr})	AISLAMIENTO A RUIDO AÉREO (D _{nT,A})	AISLAMIENTO A RUIDO DE IMPACTOS (L' _{nT,w})	AISLAMIENTO A NIVEL SONORO CONTINUO EQ. (Leq _{A,T})
A	≥50 pva	EXCELENTE	≥ 42 dBA	≥ 62 dBA	≤ 45 dB	≤ 20 dBA
B	≥40 pva	BUENO	≥ 38 dBA	≥ 58 dBA	≤ 50 dB	≤ 24 dBA
C	≥30 pva	RAZONABLE	≥ 34 dBA	≥ 54 dBA	≤ 55 dB	≤ 28 dBA
D	≥20 pva	SUFICIENTE	≥ 30 dBA	≥ 50 dBA	≤ 65 dB	≤ 32 dBA
E	≥10 pva	DEFICIENTE	≥ 25 dBA	≥ 45 dBA	≤ 68 dB	≥ 36 dBA
F	≥0 pva	PÉSIMO	< 25 dBA	< 45 dBA	> 68 dB	> 40 dBA

Figure 6. PVA Model. Proposed criteria regarding DB-HR regulation.

[PVA 1.1.] CRITERIOS DEL "MODELO PVA": Puntos de Valoración Acústica						
CLASIFICACIÓN (Clase)	PUNTOS DE VALORACIÓN ACÚSTICA (pva)	VALORACIÓN (Nivel)	PROTECCIÓN FRENTE AL RUIDO EXTERIOR	PROTECCIÓN FRENTE AL RUIDO INTERIOR		PROTECCIÓN FRENTE AL RUIDO DE INSTALACIONES
			AISLAMIENTO A RUIDO AÉREO (D _{2m,nT,A,tr})	AISLAMIENTO A RUIDO AÉREO (D _{nT,A})	AISLAMIENTO A RUIDO DE IMPACTOS (L' _{nT,w})	AISLAMIENTO A NIVEL SONORO CONTINUO EQ. (Leq _{A,T})
A	≥50 pva	EXCELENTE	≥ 42 dBA	≥ 62 dBA	≤ 43 dB	≤ 20 dBA
B	≥40 pva	BUENO	≥ 38 dBA	≥ 58 dBA	≤ 48 dB	≤ 24 dBA
C	≥30 pva	RAZONABLE	≥ 34 dBA	≥ 54 dBA	≤ 53 dB	≤ 28 dBA
D	≥20 pva	SUFICIENTE	≥ 30 dBA	≥ 50 dBA	≤ 58 dB	≤ 32 dBA
E	≥10 pva	DEFICIENTE	≥ 25 dBA	≥ 45 dBA	≤ 63 dB	≥ 36 dBA
F	≥0 pva	PÉSIMO	< 25 dBA	< 45 dBA	> 63 dB	> 40 dBA

Figure 7. PVA Model. Ideal proposal tending to the European trend.

The difference between both proposals lies on the requirements of impact noise insulation, since the current value of 65 dB required by the Spanish legislation is actually considered insufficient. Despite having to adapt to the regulations, the proposed ideal and desirable for the near future can be one that fits the European trend with consensual values. Work already done by the COST ACTION TU0901 (European initiative).

6. PARTIAL AND GLOBAL ASSESSMENT INDICATORS. WEIGHTING COEFFICIENTS.

As you have quoted previously, the procedure applies to each part or category, providing a single classification related to a partial indicator. To obtain the global one, and therefore the overall classification of the building, the influence of each category (partial indicator) is weighted by the corresponding weighting coefficients.

Such weighting has been established after analysing the studies and surveys on the public perception of noise in residential buildings. These studies, conducted by the National Institute of Statistics (INE) in Spain, show a clear trend of concern by the poor quality of insulation against indoor noise between different homes in Spain, and especially impact noise. Outdoors noise also gets attention but only in part, since the majority of complaints are concentrated only in a percentage of Spanish real estate Park, especially in those buildings with light walls in mass and low exterior carpentry performance.

Following the next example, to obtain the global flag, making use of the influence of each category and its partial corresponding indicator (expressed in "pva", acoustic assessment points), resulting from the preliminary assessment. Assuming that the partial results of each part of protection against noise were 37, 34 and 25 respectively. Being the weighting coefficients: (0,35) regarding Outdoor Noise; (0,40) regarding Indoor noise; (0,25) regarding Systems noise.

[PVA 2.2.] CLASIFICACIÓN PARCIAL PRELIMINAR - VALORACIÓN POR CATEGORÍAS				
INDICADOR	VALORACIÓN	PROTECCIÓN FRENTE AL RUIDO EXTERIOR	PROTECCIÓN FRENTE AL RUIDO INTERIOR	PROTECCIÓN FRENTE AL RUIDO DE INSTALACIONES
≥50 A	EXCELENTE			
≥40 B	BUENO			
≥30 C	RAZONABLE	37	34	
≥20 D	SUFICIENTE			25
≥10 E	DEFICIENTE			
≥0 F	PÉSIMO			

Figure 8. PVA model. Preliminary Partial Classification.

[PVA 2.3.] OBTENCIÓN DE LA CLASIFICACIÓN ACÚSTICA PRELIMINAR, DEL EDIFICIO, SEGÚN LA INFLUENCIA DE CADA CATEGORÍA

	PROTECCIÓN FRENTE AL RUIDO EXTERIOR	PROTECCIÓN FRENTE AL RUIDO INTERIOR	PROTECCIÓN FRENTE AL RUIDO DE INSTALACIONES
INFLUENCIA en el indicador global (%)	35 %	40 %	25 %

PVA GLOBAL, APLICANDO LOS CORRESPONDIENTES COEFICIENTES DE PONDERACIÓN:			
PVA Parcial =	37	34	25
Coefficientes de Ponderación =	0,35	0,40	0,25
INFLUENCIA =	12,95	13,6	6,25
PVA GLOBAL =	32,80		
ÍNDICE DE MEJORA	1		

Figure 9. PVA model. Obtaining the global classification according to the influence of each category.

7. CASE STUDIES AND TEST PHASE

After the conception of the PVA-IEE model in March 2016, the author performed 7 case studies in the city of A Coruña (Spain) on various buildings to test the first draft of the tool. Below is a summary of the results with the intention to revise the model, contrasting aspects in the methodology as well as the established scoring or points system.

CASE I	32,25	C1	19 th century building. Full restoration in 2015.
CASE II	28,55	D2	Housing unit from 1913. Full unit restoration in 2016.
CASE III	18,20	E3	Housing unit from 1979. Partial Improvement in 2013.
CASE IV	13,90	E	1963 Building.
CASE V	30,25	C	2005 Building.
CASE VI	25,35	D	2004 Building.
CASE VII	8,70	F	1964 Building.

SÍNTESIS DE RESULTADOS - CASOS DE ESTUDIO SEGÚN MODELO PVA								
INDICADOR GLOBAL	VALORACIÓN	CASO I	CASO II	CASO III	CASO IV	CASO V	CASO VI	CASO VII
≥50 A	EXCELENTE							
≥40 _{pva} B	BUENO							
≥30 _{pva} C	RAZONABLE	32,25 C1				30,25 C		
≥20 _{pva} D	SUFICIENTE		28,55 D2				25,35 D	
≥10 _{pva} E	DEFICIENTE			18,20 E3	13,90 E			
≥0 _{pva} F	PÉSIMO							8,70 F

Figure 10. Summary results regarding the original case studies according to the PVA model.

After these cases some modifications could be done, what ended up assuming the first revision of the model, having carried out a test phase last year that includes a total of **36 cases** both in A Coruña like other locations throughout the Spanish territory. Making a total of 43 cases assessed by the PVA model.

This testing phase will be presented in another paper and speech during the Conference.

8. CONCLUSIONS

- The PVA-IEE model presents itself as improvement measures for the IEE part IV, as well as serving as an initiative to promote the development of acoustics in Spain. A tool of easy access and use for any professional, without needing previous knowledge and without having to perform acoustic measurements in situ.
- It may be useful to other European countries that do not have a similar tool.
- The proposed model should be improve, testing it in all Spain through various professionals and researchers, chasing a proven approach that can refine and harmonize the scoring system.
- Currently in Europe there is a wide variety of acoustic schemes and regulations. From these we can acquire positive aspects and incorporate them into ours, while working for a greater consensus.
- Although the initiative COST Action TU0901 has not reached its main objective, it serves as precedent for future options.

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