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GANTHA
GROUPE ARTELIA

Renovation programme for single-family houses
Acoustic diagnosis - Existing house in Morangis

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CONTENTS

1. SUBJECT 5

2. PRESENTATION OF STUDIES 5

3. OBJECTIVES 5

3.1. Acoustic quality in an Active house 5
3.2. Acoustic regulations 7
3.3. Internal correction 7
3.4. Noise from technical equipment towards the interior 8
3.5. Neighbourhood protection 8

4. HOUSE INVENTORY 9

4.1. Location plan of the house 9
4.2. Constructive measures 9
4.3. Measurement results 12
4.4. Internal correction 15
4.5. Noise level of technical equipment 15
4.6. Internal noise 16

5. MODELLING TOOL 17

6. AIRBORNE NOISE CONTROL BETWEEN HOUSES 17

6.1. Principles for renovation work 17
6.2. Proposals for additional acoustic treatments 17
6.3. Calculation results with additional treatment 17
6.4. Analysis 18

7. INSTALLATION FOR THE TRANSMISSION OF IMPACT NOISE BETWEEN HOUSES 18

8. AIRBORNE SOUND INSULATION ON FACADES 18

8.1. Principles for renovation work 18
8.2. Analysis 19

9. EQUIPMENT NOISE MANAGEMENT 19

9.1. Principles for renovation work 19
9.2. Proposals for additional acoustic treatments 20
9.3. Analysis 20

10. SUMMARY TABLE OF RESULTS 20

List of appendices:

APPENDIX 1 - Airborne sound insulation calculation notes 21
APPENDIX 2 - Terminology and definition of acoustic terms 25

List of tables:

Table1 : Presentation of the agency 5
Table2 : Indoor airborne sound insulation targets 7
Table3 : Noise level targets for individual heating or air-conditioning equipment 8
Table4 : Noise level objectives for individual and collective equipment 8
Table5 : Current floor plan of the house 9
Table6 : View of the facades and joinery on the garden side 9
Table7 : Views of external joinery 10
Table8 : View of the air inlets in the kitchen 10
Table9 : View of the attic 11
Table10 : Location of interior airborne sound insulation measures 12
Table11 : Airborne noise insulation results 12
Table12 : Location of impact noise measurements 13
Table13 : Impact noise insulation measurement results 13
Table14 : Location of insulation measures against external noise 14
Table15 : Results of measurements of insulation against external noise 14
Table16 : Location of equipment noise measurements 15
Table17 : Results of equipment noise measurements 15
Table18 : Location of internal noise measurements 16
Table19 : Results of indoor noise measurements 16
Table20 : Airborne sound insulation modelling results 17

1. SUBJECT

As part of the work carried out with Velux on the definition of renovation programmes for individual houses, the GANTHA design office will study the acoustic comfort aspect.

The aim of this renovation programme is to improve the building's design in terms of both energy performance and user comfort: thermal, acoustic, air quality, etc. The programme is based on the assessment system presented in the guide "The Active House Specifications", 3rd edition. It is based on the assessment system presented in the guide "**The Active House Specifications"** 3rd edition.

In this context, a semi-detached house on one side, located at 18 rue Jules Hardouin in Morangis (91) was studied. This report presents:

- the various acoustic objectives relating to the building restructuring project,
- Acoustic diagnosis of the existing house as part of its restructuring,
- recommendations for improving acoustic performance.

The objectives of the acoustic requirements are to

- Ensuring that building components comply with acoustic regulations and, if necessary, improving the level of performance in accordance with Velux's "**The Active House Specifications**" guide,
- ensure that the premises are comfortable to use.

2. PRESENTATION OF STUDIES

Name and address	GANTHA 16 rue Simone Veil 93400 Saint-Ouen-sur-Seine
Research Manager	Clotilde GAUDET, Acoustics Engineer
Qualification	OPQIBI qualification no. 12 08 2488

Table1 : Presentation of the agency

3. OBJECTIVES

3.1. Acoustic quality in an Active house

❖ *Environment*

- **Importance:** A quiet environment is crucial for a healthy house, as noise can cause discomfort, stress and disturb sleep (Haut Conseil de la santé publique Niveaux acceptables d'expositions aux niveaux sonores élevés de la musique. Website: HCSP. Paris)
- **Noise protection:** The Active house protects against unwanted noise from internal and external sources by providing acoustic insulation against external noise.

❖ *Qualitative criteria*

- **Internal noise:** Particular attention will be paid to rooms that need to be quieter, such as sleeping areas (bedrooms) and concentration areas.
- **Acoustic privacy:** Walls and floors designed to reduce noise transmission between rooms.
- **Outdoor areas:** Measures to create a calm environment in outdoor areas such as gardens or balconies.

❖ *Quantitative criteria*

Scores are established based on a scoring system from 1 to 4, with 1 being the best performing and 4 the worst.

- **Internal noise:**

Noise levels from technical installations (HVAC) measured in the premises in $L_{nA,T}$:

- **1 point: < 25 dB(A)** or noise level less than or equal to background noise.
- **2 points: < 30 dB(A)**.
- **3 points: < 35 dB(A)**.
- **4 points: < 40 dB(A)**.

Measurement: After construction, the noise from technical installations in continuous operation is measured in all the main rooms. If an adjustable mechanical ventilation system is present, the noise levels must be respected at the ventilation rate that meets the level of ambition for indoor air quality.

- **External noise:**

Indoor noise levels from external sources, measured at the centre of the room in $L_{Aeq,10min}$:

- **1 point: < 25 dB(A)**.
- **2 points: < 30 dB(A)**.
- **3 points: < 35 dB(A)**.
- **4 points: < 40 dB(A)**.

Measure: Noise from external sources such as traffic or neighbouring activities must be attenuated so as not to disturb the atmosphere inside the house. Local data on external noise levels is generally taken from online information provided by the government (noise classification, noise map, PEB, etc.). Calculations/measurements are carried out with windows and external doors closed.

Acoustic privacy

Limitation of noise propagation in connected houses:

- Airborne noise ($D_{nT,w}$+ C) between two living areas in two different dwellings :

- **1 point: ≥ 62 dB**.
- **2 points: ≥ 57 dB**.
- **3 points: ≥ 52 dB**.
- **4 points: ≥ 47 dB**.

- Impact noise ($L'_{nT,w}$) perceived in living quarters when the standardised impact machine is positioned in another dwelling :
    - **1 point: ≤ 43 dB**.
    - **2 points: ≤ 48 dB**.
    - **3 points: ≤ 53 dB**.
    - **4 points: ≤ 58 dB**.

❖ *Evaluation*

Average score: The average total score is based on multiplying the acoustic quality score for each room by the number of hours of use and the number of people in that room during a week, then divided by the total person-hours.

3.2. Acoustic regulations

Acoustic objectives for new houses are defined based on the official reference documents cited in the paragraph entitled "**Official reference documents**".

❖ *Airborne sound insulation interiors*

Expressed in terms of standardised weighted sound insulation $D_{nT,w}+ C$ ($\equiv D_{nT,A}$) in dB :

		Reception room: room in another dwelling	
Emission room		Main room	Kitchen and shower room
Premises other than garages		53	50
Public or private car park		55	52
Business premises		58	55
Common interior circulation with:	Landing door only or landing door + distribution door	40	37
	In other cases	53	50

Table2 : Indoor airborne sound insulation targets

❖ *Impact sound transmission*

The construction of horizontal walls, including floor coverings, and vertical walls, must be such that the weighted sound pressure level of standardised impact noise **$L'_{nT,w}$**, perceived in a main room of a given dwelling does not exceed **58 dB** when impacts are produced on the floor of premises outside this dwelling by the standardised impact machine.

❖ *Insulation against external noise*

The objectives depend directly on the location of the project in relation to areas affected by noise from land transport and airport infrastructures.

The insulation to be guaranteed for living rooms (bedrooms and lounges) against noise from the outside is at least **$D_{nT,w}+ C_{(tr)}$ ($\equiv D_{nT,A,tr}$) ≥ 30 dB.**

3.3. Internal correction

Not applicable to single-family houses.

3.4. Noise from technical equipment towards the interior

Expressed in terms of standardised sound pressure level L_{nAT} in dB(A).

❖ *Individual heating or air-conditioning equipment inside the dwelling examined*

Type of equipment	Reception area	Regulatory objective
Heating	Main room closed	$L_{(nAT)} \leq 35$ dB(A)
	Main room opening onto a kitchen	$L_{(nAT)} \leq 40$ dB(A)
	Kitchen	$L_{(nAT)} \leq 50$ dB(A)
Air conditioning	Main room	$L_{(nAT)} \leq 35$ dB(A)
	Main room opening onto a kitchen	$L_{(nAT)} \leq 40$ dB(A)
	Kitchen	$L_{(nAT)} \leq 50$ dB(A)

Table3 : Noise level targets for individual heating or air-conditioning equipment

❖ *Individual and collective equipment*

- The $L_{(nAT)}$ value must not exceed:

	Reception area	
Type of equipment	Main room	Kitchen
Individual equipment installed in a dwelling other than the one under examination	$L_{(nAT)} \leq 30$ dB(A)	$L_{(nAT)} \leq 35$ dB(A)
Individual ventilation equipment installed in the dwelling being examined		
Individual thermodynamic DHW equipment installed in the dwelling under review		
Collective facilities in the case of a housing estate		
Double-flow ventilation (collective or individual) and air-conditioning in bedrooms or main rooms		

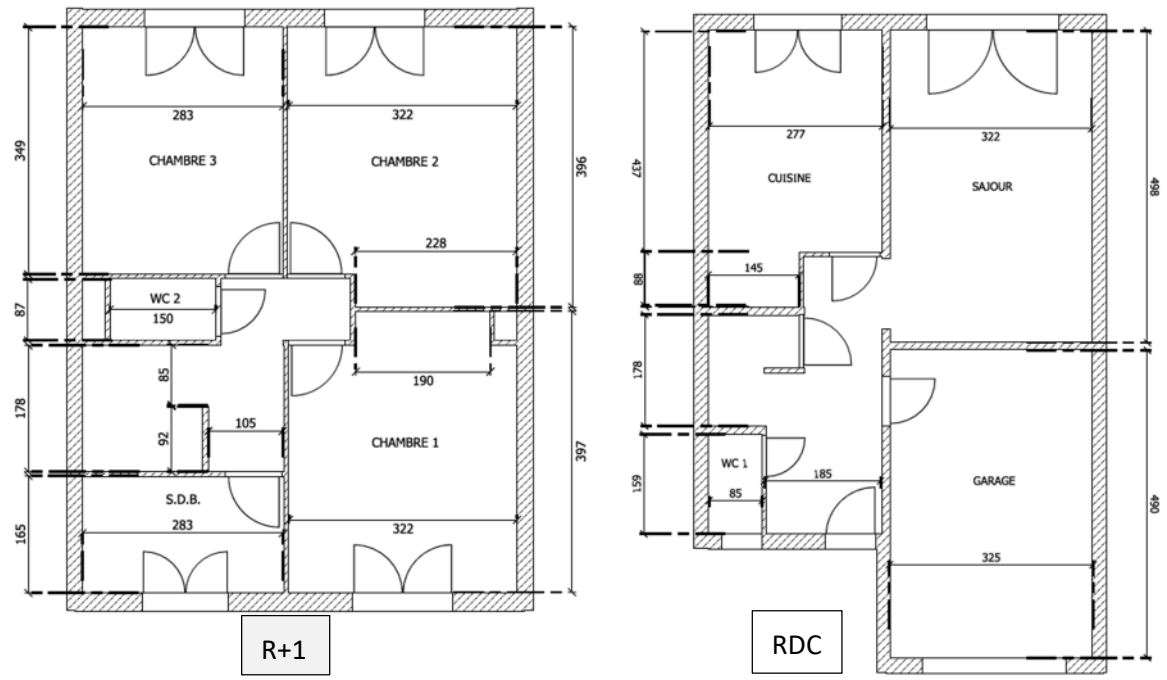
Table4 : Noise level objectives for individual and collective equipment

3.5. Neighbourhood protection

Not applicable to this study (parameter not considered in the scoring criteria).

4. HOUSE INVENTORY

4.1. Location plan of the house



Plan view - Location plan of the various rooms in the dwelling

Table5 : Current floor plan of the house

4.2. Constructive measures

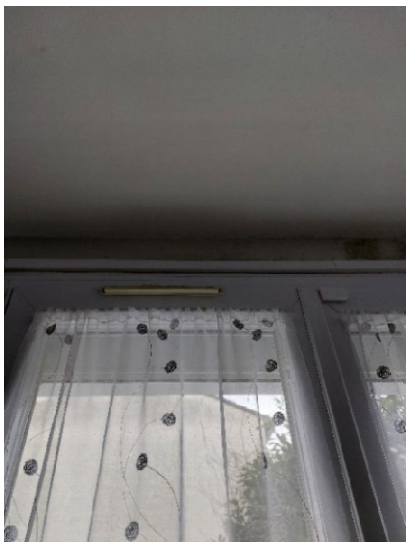
The main construction principles are as follows:

- Front wall:
  - 20cm thick rendered breezeblock,
  - no thermal lining inside or out.

Facade and external joinery

Table6 : View of the facades and joinery on the garden side

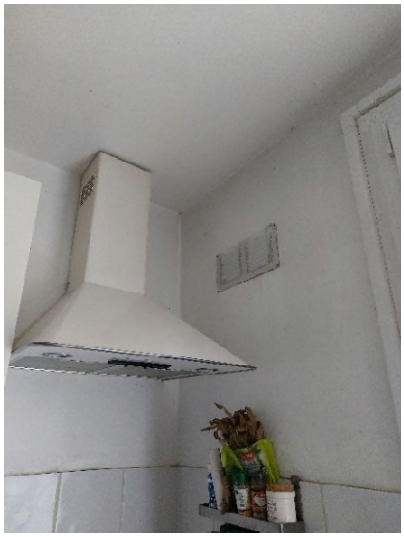
- External joinery:
    - PVC with double glazing, in good condition and generally airtight
    - air intake in joinery,
    - external roller shutter boxes.
    - ***Location**:* *All joinery except entrance door.*

External joinery

Table7 : Views of external joinery

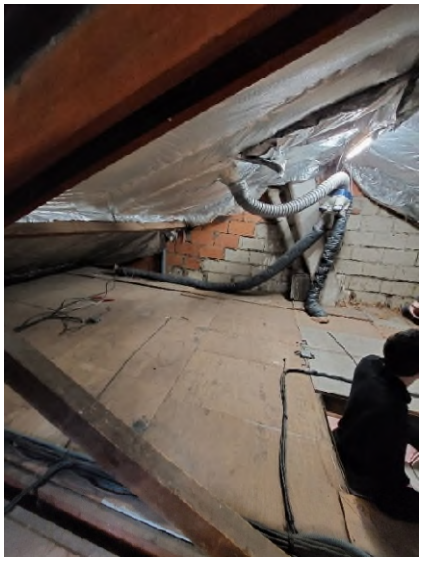
- Wall air inlets:
    - top and bottom ventilation grilles in the kitchen,
    - lower grille blocked by a chipboard element.
    - ***Location:*** *Kitchen and bathroom.*




Wall-mounted air inlets

Table8 : View of the air inlets in the kitchen

- Cover:
    - Tiled roof over traditional timber frame with insulation under slope and ceiling over insulated plywood floor.



Tiled roof over insulated traditional timber frame

Table9 : View of the attic

- Party walls with neighbouring house:
    - rendered breeze-block wall,
    - no lining or insulation.
    - ***Location:*** *All party walls separating from the neighbouring dwelling.*

- Concrete floor:
    - solid concrete slab.
    - ***Location:*** *Ground floor.*

- Wooden floors:
    - wooden floor on wooden joist,
    - underfloor plaster cladding fixed to wooden lath, in poor condition,
    - laminate flooring.
    - ***Location****:* *Ground floor R+1.*

- Floor coverings:
    - glued-down hard floor tiles.
    - ***Location****:* *Kitchen, bathroom, sanitary facilities*

    or

    - Laminate flooring with or without underlay.
    - ***Location****:* *All other premises except those listed above.*

- Technical equipment:
    - Mechanical ventilation running intermittently, non-functional / incorrectly installed.
    - ***Location****:* *First floor bathroom and sanitary facilities.*

4.3. Measurement results

❖ *Special measurement conditions*

The measurements were carried out in accordance with standards NFS 31-057 and NF EN ISO 717-1 & 2 relating to the "Verification of the acoustic quality of buildings" without departing from any of its provisions.

Airborne sound insulation measurements were carried out using a pink noise source.

Measurements were taken at1,2 m above ground level.

Measurements were taken in 1/3 octave bands over the interval [50 Hz; 5,000 Hz].

For the attenuation and impact noise measurements, the noise sources were placed in the neighbour's house, on the other side of the party wall.

❖ *Insulation against interior airborne sound*

Location of measurement points

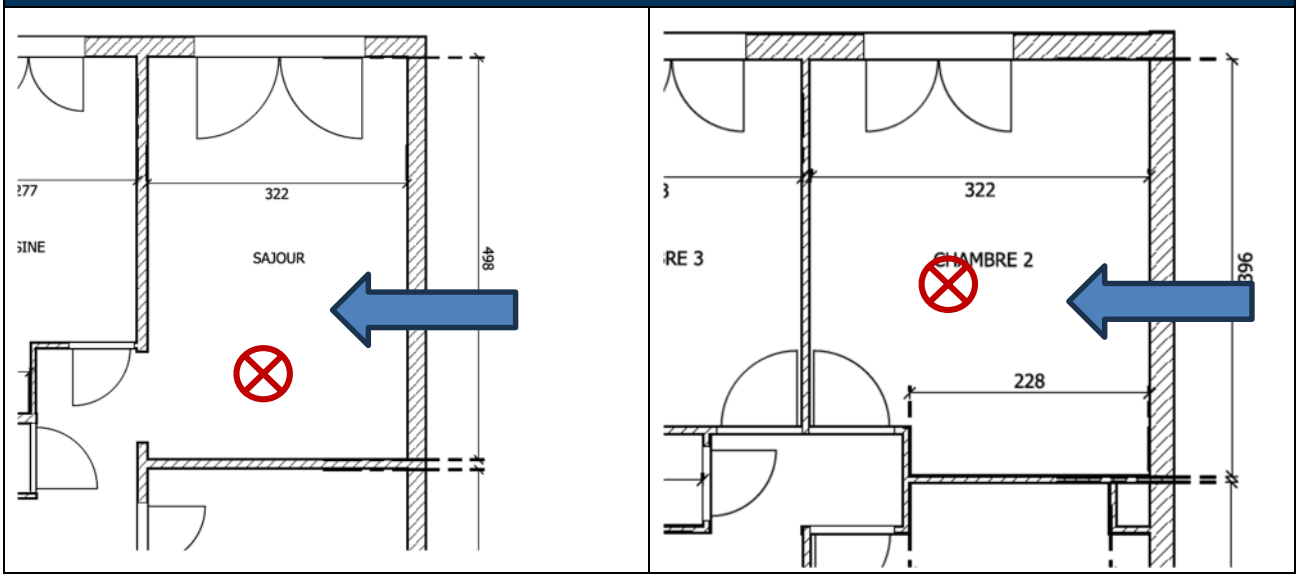


Table10 : Location of interior airborne sound insulation measures

Measurements of insulation against interior airborne noise were carried out; the results are presented in the table below:

Local emission	Reception area	Type of separator	Isolation $D_{nT,w}$+ C		Observations regarding regulations	Rating according to guide
			Measurement results	Regulatory objectives		
Living room n°16	Living room n°18	Single masonry wall with hollow breezeblock rendered on both sides	**49 dB**	**≥ 53 dB**	**Insufficient**	**4 points**
Bedroom 2 n°16	Bedroom 2 n°18	Single masonry wall with hollow breezeblock rendered on both sides	**48 dB**			**4 points**

Table11 : Airborne noise insulation results

- Analysis of existing construction principles

The separating wall is **insufficient** from an acoustic point of view to ensure an insulation target greater than or equal to **53 dB** between the two dwellings. The performance of the partition wall is classified in the lowest category of the guide.

❖ *Noise transmission*

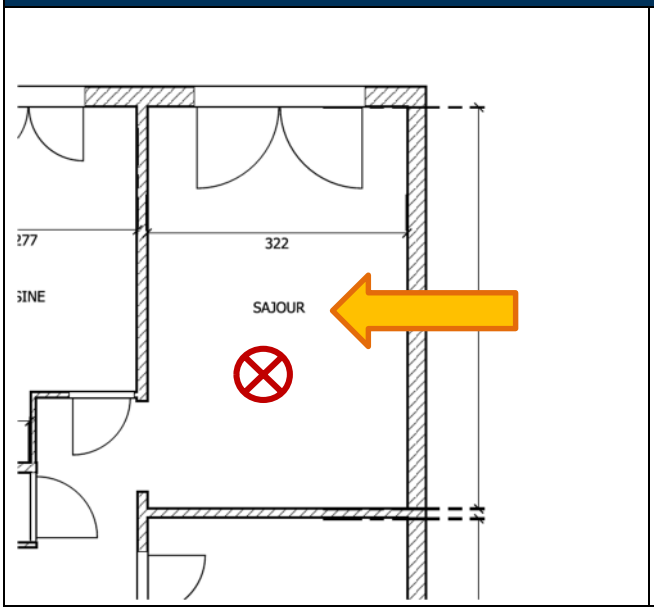
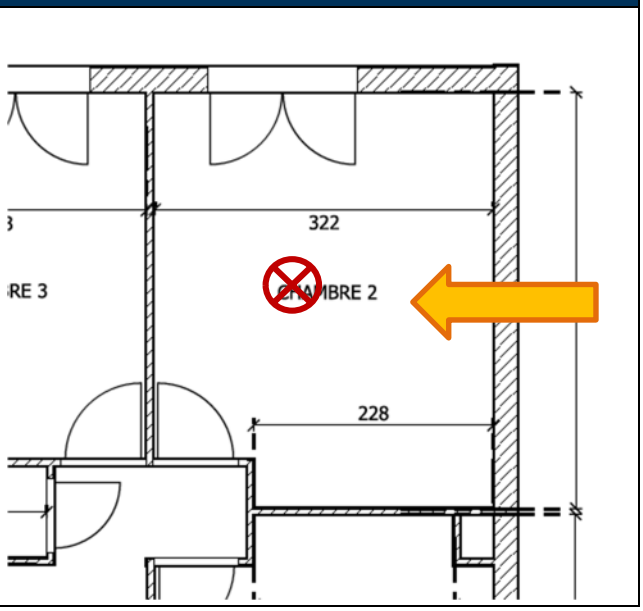
Location of measurement points	
	

Table12 : Location of impact noise measurements

Impact sound transmission measurements were carried out, and the results are shown in the table below:

Local emission	Reception area	Type of floor and floor covering	Isolation $L'_{nT,w}$		Observations regarding regulations	Rating according to guide
			Measurement results	Regulatory objectives		
Living room n°16	Living room n°18	Concrete slab	**64 dB**	**≤ 58 dB**	**Excessive**	**Out of category**
Bedroom 2 n°16	Bedroom 2 n°18	Wooden floor on joists	**52 dB**		**Compliant**	**3 points**

Table13 : Impact noise insulation measurement results

- Analysis of existing construction principles:

The nature of the floors provides acoustic qualities:

- **insufficient** with regard to acoustic regulations in terms of impact noise reduction for the ground floor rooms, which are on a concrete slab. With a minimum score of 4 points according to the guide.
- **sufficient** to comply with acoustic regulations in terms of impact noise reduction for the rooms on the ground floor (R+1), as the floor is made of wood and interrupted by the masonry partition wall. With a score of 3 points according to the guide.

❖ *Insulation from land infrastructure noise*

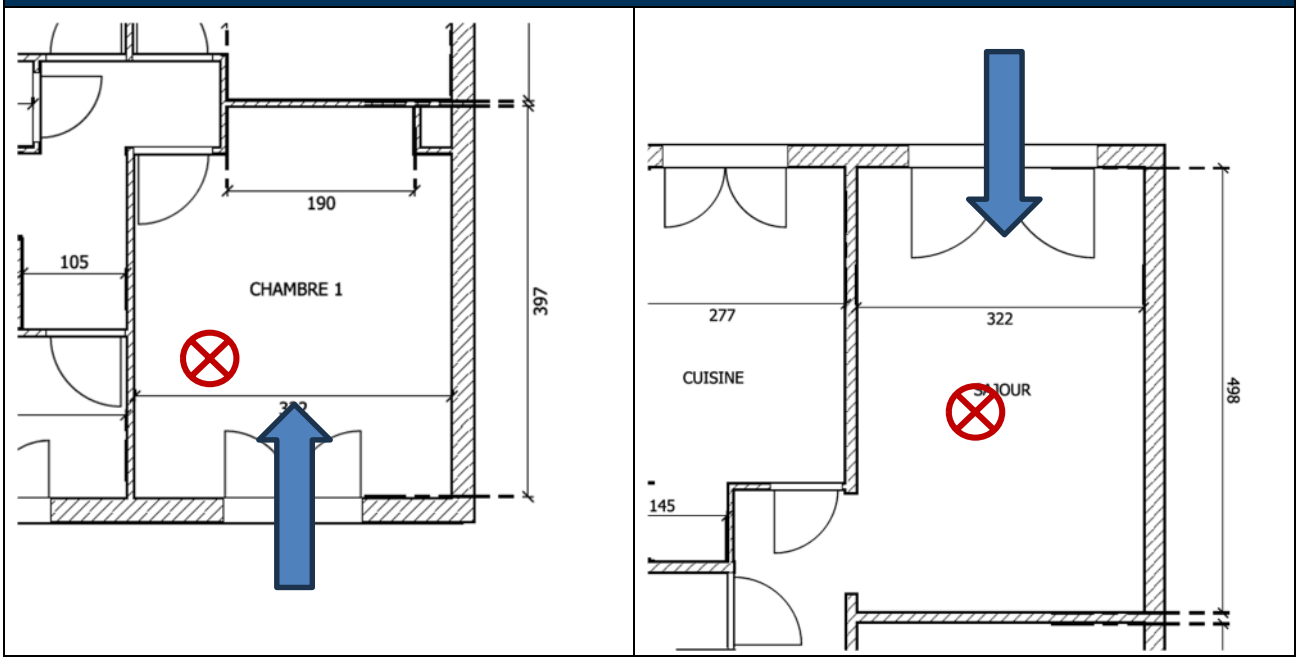
Location of measurement points


Table14 : Location of insulation measures against external noise

Measurements of insulation against external noise were carried out; the results are presented in the table below:

Local emission	Reception area	Type of separator	Insulation DnT,w + C_{Tr}		Observations regarding regulations	Rating according to guide
			Measurement results	Regulatory objectives		
Rue	Room 1 n°18	Single masonry wall, hollow breezeblock, rendered on both sides, PVC double-glazed window frames	**31 dB**	**≥ 30 dB**	**Sufficient**	**Not applicable**
Garden	Living room n°18	Single masonry wall, hollow breezeblock, rendered on both sides, PVC double-glazed window frames	**30 dB**			

Table15 : Results of measurements of insulation against external noise

- Analysis of existing construction principles:

The construction principles for the façades are:

- **satisfactory** regarding the structure of the buildings and external joinery,
- The active house guide does not take this parameter directly into account; only the indoor noise level is sought (directly linked to the noise from neighbouring transport infrastructures and activities outside the dwellings). This point is addressed in paragraph 4.6

4.4. Internal correction

Not applicable.

4.5. Noise level of technical equipment

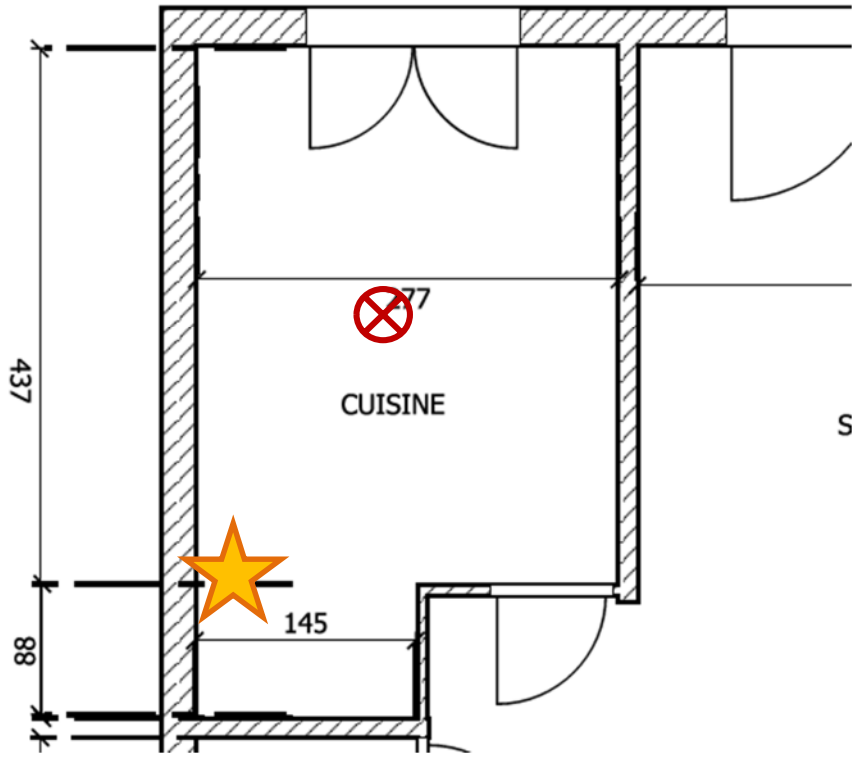
Location of measurement point


Table16 : Location of equipment noise measurements

Equipment noise measurements were carried out; the results are presented in the table below:

Local emission	Reception area	Equipment	Equipment noise $L_{n,A,T}$		Observations regarding regulations	Rating according to guide
			Measurement results	Regulatory objectives		
Kitchen	Closed kitchen	Single masonry wall, hollow breezeblock, rendered on both sides, PVC double-glazed window frames	**40 dB**	**≤ 50 dB**	**Compliant**	**4 points**

Table17 : Results of equipment noise measurements

- Analysis of existing equipment:

The current technical equipment is:

- the boiler and water heater in the kitchen **were satisfactory in** terms of regulations,
- and the least **satisfactory** rating for the Active House Guide,
- The ventilation system is not in working order but opens into the bathrooms on the ground floor (R+1).

4.6. Internal noise

Map showing location of measurement points

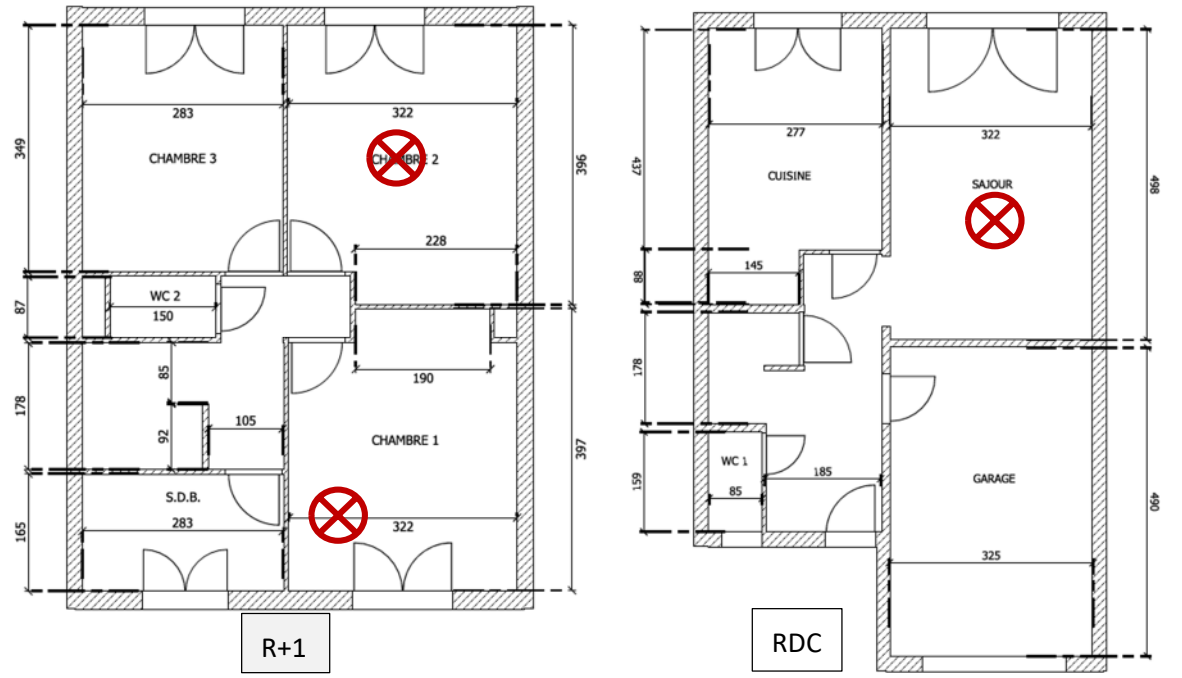


Table18 : Location of internal noise measurements

Ambient noise measurements were carried out inside the rooms; the results are presented in the table below:

Reception area	Measurement times	Measurement results	Rating according to guide
Bedroom 2	5.30 pm - 6.15 pm	**Lp = 26 dB(A)**	**2 points**
Bedroom 1		**Lp = 25 dB(A)**	**1 point**
Living room		**Lp = 24 dB(A)**	**1 point**

Table19 : Results of indoor noise measurements

- Analysis of indoor ambient noise levels:

The pressure level measurements were carried out with the windows and doors closed, and were:

- **the most satisfactory score** on average according to the Active House Guide,
- the measurements were taken during a busy period for road traffic, and in the presence of children in the dwelling.

5. MODELLING TOOL

Acoubat Sound V8 was used to carry out the acoustic calculations for the project.

This calculates insulation levels between rooms according to the geometric characteristics and nature of the separating walls, using the ISO 717 standard.

The measurements presented in paragraph**Erreur ! Source du renvoi introuvable.** provide information on the acoustic performance of existing systems, enabling the modelling to be refined as much as possible.

6. AIRBORNE NOISE CONTROL BETWEEN HOUSES

6.1. Principles for renovation work

- The renovation work will not have any impact on the transmission of airborne noise between dwellings.

6.2. Proposals for additional acoustic treatments

❖ *Installing a lining on the walls*

- Thermo-acoustic lining of the masonry wall:
  - consisting of BA13 plasterboard cladding on metal framing independent of the wall,
  - 80 mm thick mineral or bio-sourced wool insulation between uprights,
  - for an improvement in the standardised weighted sound reduction **$\Delta R_w + C \geq 8$ dB**.
  - ***Location:*** *Masonry walls on ground and first floors.*

6.3. Calculation results with additional treatment

The calculations were carried out in the living room of the house studied.

The calculation results are compared with the objectives set out in paragraph 3.

❖ *Airborne sound insulation*

The isolation levels calculated with treatments are shown below:

Local emission	Reception area	Type of separator	Regulatory objectives	Calculation results	Comments	According to guide
Adjoining living room (n°16)	Living room on the river (n°18)	***Rendered hollow concrete block wall +***	$D_{nT,w} + C \geq 53$ dB	$D_{nT,w} + C = 55$ dB	**Satisfactory**	**3 points**
Chambre voisin (n°16)	Riparian room (n°18)			$D_{nT,w} + C = 53$ dB		

Table20 : Airborne sound insulation modelling results

The performance of the lining is capped by the noise transmission path passing through the floor, which becomes predominant once the direct path is treated (via the lining). As the slab is continuous with the terraced house on the ground floor and the living room of the dwelling studied already has an underlay, the improvement in this indicator is limited. The treatment also makes it possible to gain one point on the guide's rating.
The calculation sheets are presented in APPENDIX 1.

6.4. Analysis

With the treatments proposed in paragraph6 , the airborne sound insulation in the living room of the dwelling **is satisfactory** regarding the regulatory objectives and gains one point in the guide's rating. The effectiveness of the lining is capped by the acoustic weakness of the concrete slab between the two dwellings.

7. INSTALLATION FOR THE TRANSMISSION OF IMPACT NOISE BETWEEN HOUSES

None of the improvements planned as part of the renovation work will have an impact on the transmission of impact noise between dwellings.

In the living room, the only possible way of improving the existing situation would be to **work on the flooring of the neighbouring house, which is not feasible within the scope of the renovation programme.** Impact noise performance has not changed and remains the lowest rating in the guide.

However, the project includes the creation of a floor covering for the converted attic space. In order not to disturb the neighbouring house, this will be made up of at least the following elements:

- 25 mm thick Fermacell hard floor covering on thin levelling course,
- existing flexible flooring on the ground floor removed and reinstalled with a new acoustic underlay to reduce impact noise **$\Delta_{L(w)} \geq 18$ dB**.

Finally, following the removal of the floor covering in the living room on the ground floor, this area will be fitted with parquet flooring on an acoustic underlay to reduce impact noise **$\Delta_{L(w)} \geq 18$ dB**.

8. AIRBORNE SOUND INSULATION ON FACADES

8.1. Principles for renovation work

The following work is planned as part of the project:

❖ *Thermal insulation of facades*

- External thermal insulation:
  - thermal insulation from the outside, pegged or glued with a finishing coat,
  - for an improvement in the standardised weighted sound reduction **$\Delta R_w + C \geq -2$ dB**.
  - ***Location:*** *Exterior masonry walls.*

❖ *Cover*

- **Tiled** roof over wooden framework and plasterboard ceiling:
  - **Tiled** roof over timber frame using the sarking method with polyurethane insulation,
  - minimum 80 mm thick wood wool insulation between rafters and BA 13 plasterboard,
  - for a sound reduction index **$R_w + C_{tr} \geq 35$ dB.**
  - ***Location****: All new roofs.*

❖ *External joinery*

- Glazed frames and glazed doors with thermal double glazing*:
  - with thermal break and minimum type **4(16)4** standard thermal double glazing from K-LINE,
  - Installation ensuring perfect airtightness by laying a Compriband-type resilient,
  - for a sound reduction index of the joinery (frame + glazing) in accordance with PV testing**,**
  - air inlets in any joinery with an attenuation of $\mathbf{D_{n,e,w}+ C_{tr}\geq 37\ dB,}$
  - roller shutter box with attenuation $\mathbf{D_{n,e,w}+ C_{tr}\geq 43\ dB.}$
  - ***Location:*** *All new joinery*

***NOTA:** In the absence of acoustic performance presented on the technical data sheets, it is advisable to provide for compliance with the performance presented above.*

- Roof window with asymmetrical double glazing:
  - Vitrage 76 roof window from Velux, with single-sided laminated acoustic glass of type 33.1(16Ar)4 or equivalent,
  - for a sound reduction index of the joinery (frame + glazing) $\mathbf{R_w+ C_{tr}\geq 30\ dB}$ according to PV tests.
  - ***Location****: All roof windows.*

8.2. Analysis

Façade performance is already **satisfactory in** its current state, according to the regulations, and is not taken into account in the guide. In the context of renovation work and house improvements, the planned principles will not degrade the performance of the building and will even have a positive effect.

9. EQUIPMENT NOISE MANAGEMENT

9.1. Principles for renovation work

❖ *Utility room on ground floor*

It is planned to create a technical room in place of the old garage, with the creation of a new separator made up of:

- a breeze-block wall at least 20 cm thick, rendered on at least one side, with a mass per unit area of 235 kg/m², with a thermal insulation lining based on mineral or bio-sourced wool (on the living room side), with a sound reduction index of $\mathbf{R_w+ C\geq 54\ dB,}$
- an insulated access door with a 4-sided seal for a sound reduction index of $\mathbf{R_w+ C\geq 27\ dB.}$

The new technical equipment installed in this room is:

- an Aeromax 200 thermodynamic tank from Thermor with a sound power level $\mathbf{L_w}$**of 50 dB(A),**
- an interior module for the Daikin Altherma 3 heat pump with a sound power level $\mathbf{L_w}$**of 44 dB(A).**

❖ *Attic ventilation box*

A ventilation box is to be installed in the converted attic of the project. The equipment selected is a Purevent supply air unit from VMI, which generates a sound pressure level Lp of **29 dB(A)** at 1 m from the supply air outlet for a flow rate of 200 m³/h.

9.2. Proposals for additional acoustic treatments

❖ *Utility room on ground floor*

To guarantee a level of performance that meets the requirements of current acoustic regulations, we recommend installing an insulated door block from the living room with a 4-sided seal to achieve a sound reduction index of **R_w+ C≥ 35 dB.**

❖ *Attic ventilation box*

As a minimum, the plenum will be encased in a soffit consisting of two BA13 plasterboard panels and a mineral wool mat at least 40 mm thick. An insulating inspection hatch will be installed with a sound reduction index **Rw + C ≥ 30 dB**.

To guarantee a level of performance that complies with level 1 of **The Active House** Specifications guide**,** we recommend installing an insulating and absorbent duct at least 1 m long (Smo Phon or Phoniflex type or equivalent) or a rigid insulating and absorbent duct (CF type from Trox) with a sound attenuation of at least **10 dB(A)**.

❖ *Outdoor heat pump unit*

In addition to complying with the requirements of **The Active House** Specifications guide**,** it will also be necessary to ensure compliance with regulatory constraints on neighbourhood protection:

- emergence below **3 dB(A)** at night [10pm; 7am],
- emergence below **5 dB(A)** during the day [7am; 10pm].

9.3. Analysis

With the acoustic treatment proposals presented above, a score of level 1 of the guide "**The Active House Specifications"** will be achieved. On the other hand, if only the basic work is carried out, scores of level 2 or 3 will be obtained.

10. SUMMARY TABLE OF RESULTS

The following table summarises the differences in scores according to the guide between the work planned as part of the contract and the improvement brought about by the additional treatment proposals:

Quantitative criteria	Grading according to guide	
	With the work planned as part of the	With proposals for additional treatments
Equipment noise	2 to 3pt	1pt
Indoor airborne sound insulation between houses	4pt	3pt
Impact sound insulation between houses	4pt	-
Insulation against external airborne noise	1pt	1pt

Table 22: Summary of scores according to the active house guide

APPENDIX 1 - Airborne sound insulation calculation notes

Airborne sound insulation calculations

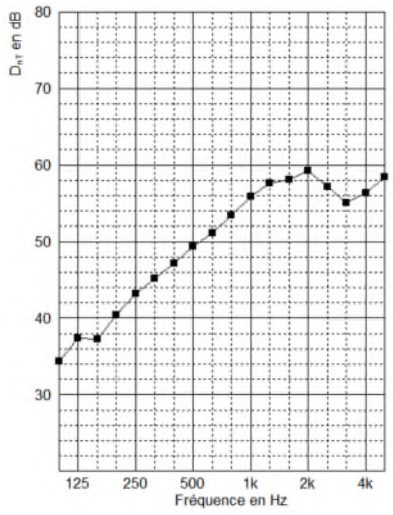
Before treatment

Description of construction principles

- Hollow concrete block dividing wall with single-sided rendering
- Concrete floor,
- Floating parquet and tiled floors.

Between riverside living room (n°18) and neighbouring living room (n°16)

Standardised weighted sound insulation $D_{nT,A}$	Acoubat model



Fréq.	D_{nT}
100	34.4
125	37.4
160	37.3
200	40.4
250	43.2
315	45.1
400	47.1
500	49.3
630	51.1
800	53.4
1000	55.8
1250	57.6
1600	58.1
2000	59.3
2500	57.1
3150	55.0
4000	56.3
5000	58.4
Hz	dB

$D_{nT,A}$ = 51 dB

Indice global calculé selon l'arrêté (30/06/1999)

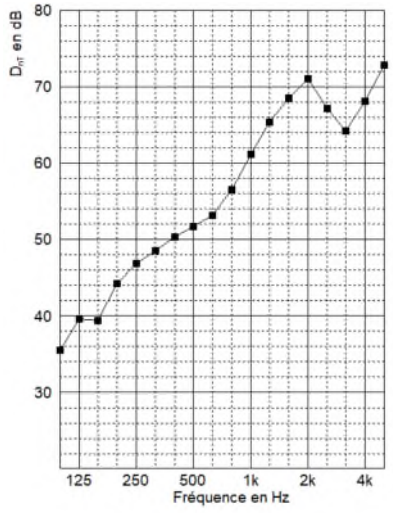
After treatment

Description of construction principles

- Hollow concrete block dividing wall, rendered on one side
- Bonded mineral wool lining 80 mm + 1 BA13 plate
- Concrete floor,
- Floating parquet and tiled floors.

Between riverside living room (n°18) and neighbouring living room (n°16)

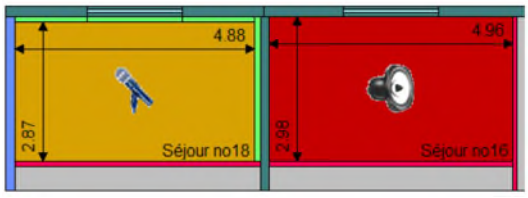
Standardised weighted sound insulation $D_{nT,A}$	Acoubat model



Fréq.	D_{nT}
100	35.5
125	39.6
160	39.4
200	44.2
250	46.9
315	48.5
400	50.3
500	51.7
630	53.2
800	56.6
1000	61.2
1250	65.3
1600	68.5
2000	71.0
2500	67.2
3150	64.3
4000	68.1
5000	72.9
Hz	dB

$D_{nT,A}$ = 55 dB

Indice global calculé selon l'arrêté (30/06/1999)



Airborne sound insulation calculations

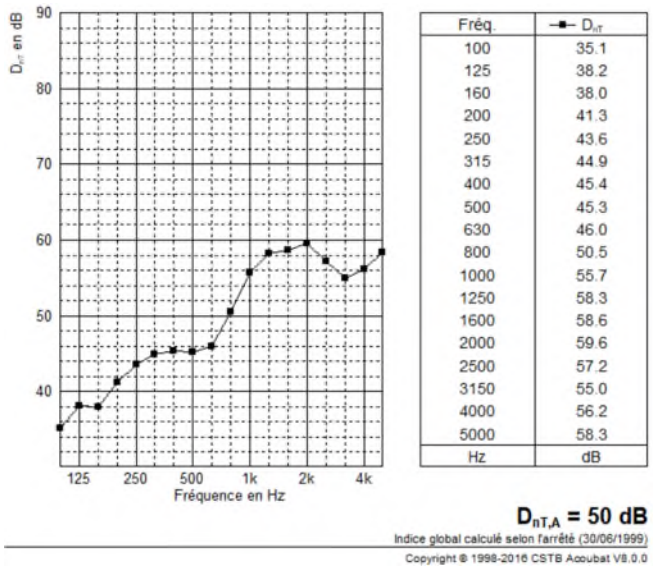
Before treatment

Description of construction principles

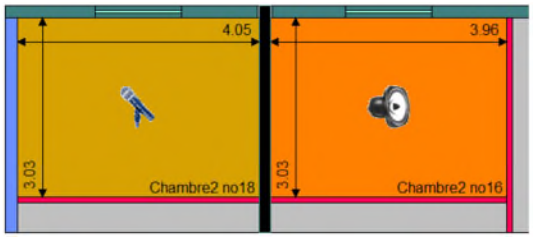
- Hollow concrete block dividing wall, rendered on one side
- Concrete floor,
- Floating parquet and solid parquet flooring.

Between neighbouring bedroom (n°18) and bedroom next door (n°16)

Standardised weighted sound insulation $D_{nT,A}$	Acoubat model



Fréq.	D_{nT}
100	35.1
125	38.2
160	38.0
200	41.3
250	43.6
315	44.9
400	45.4
500	45.3
630	46.0
800	50.5
1000	55.7
1250	58.3
1600	58.6
2000	59.6
2500	57.2
3150	55.0
4000	56.2
5000	58.3
Hz	dB



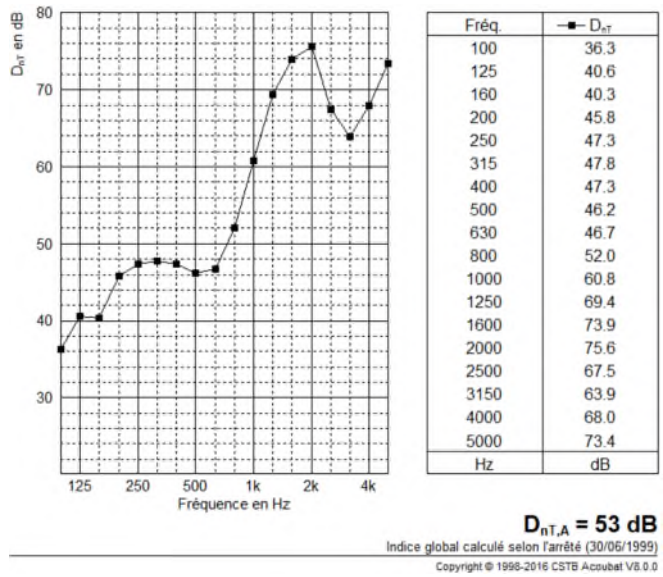
After treatment

Description of construction principles

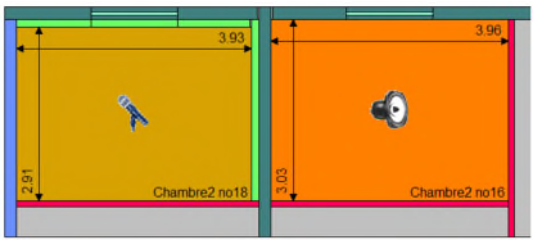
- Hollow concrete block dividing wall, rendered on one side
- Bonded mineral wool lining 80 mm + 1 BA13 plate
- Concrete floor,
- Floating parquet and solid parquet flooring.

Between neighbouring bedroom (n°18) and bedroom next door (n°16)

Standardised weighted sound insulation $D_{nT,A}$	Acoubat model



Fréq.	D_{nT}
100	36.3
125	40.6
160	40.3
200	45.8
250	47.3
315	47.8
400	47.3
500	46.2
630	46.7
800	52.0
1000	60.8
1250	69.4
1600	73.9
2000	75.6
2500	67.5
3150	63.9
4000	68.0
5000	73.4
Hz	dB



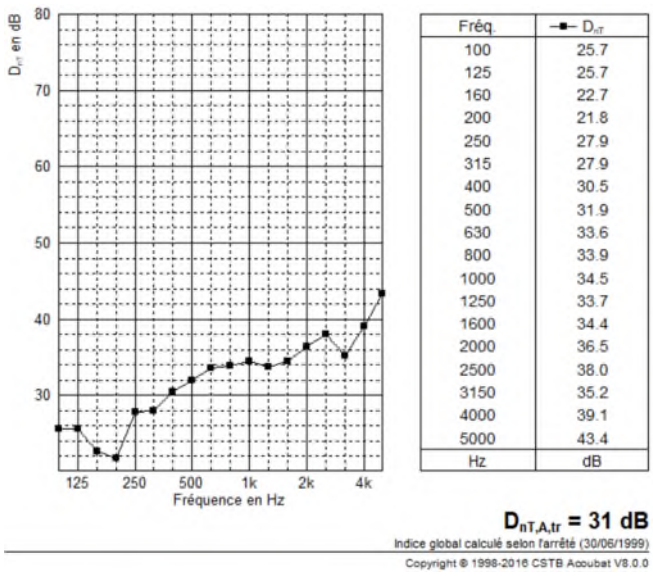
Predictive calculations for insulation against external airborne noise

Description of construction principles

- Hollow concrete block dividing wall, rendered on one side
- Concrete floor,
- Floating parquet flooring.

Between street and bedroom 1 on ground floor

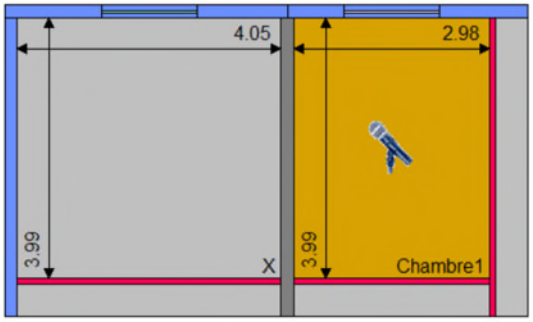
Standardised weighted sound insulation $D_{(nT,A)(,tr)}$	Acoubat model



Fréq.	D_{nT}
100	25.7
125	25.7
160	22.7
200	21.8
250	27.9
315	27.9
400	30.5
500	31.9
630	33.6
800	33.9
1000	34.5
1250	33.7
1600	34.4
2000	36.5
2500	38.0
3150	35.2
4000	39.1
5000	43.4
Hz	dB

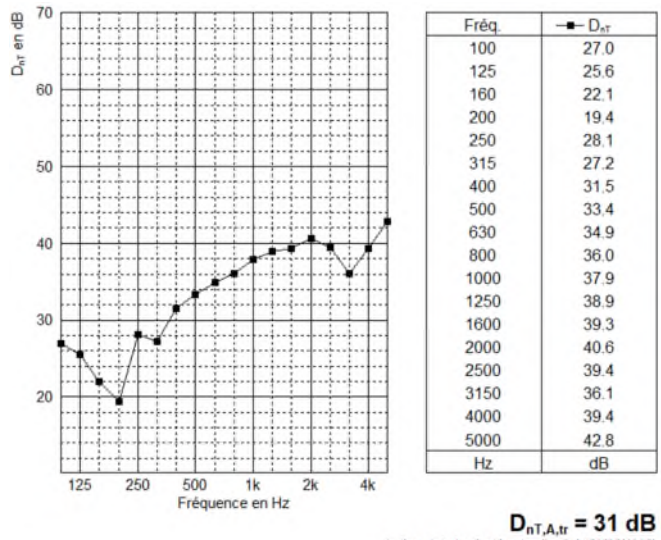
$D_{nT,A,tr}$ = 31 dB

Indice global calculé selon l'arrêté (30/06/1999)



Between garden and living room on ground floor

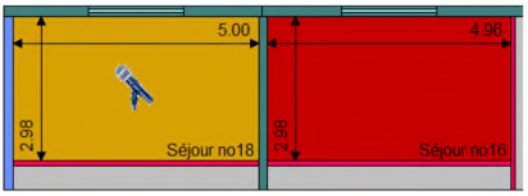
Standardised weighted sound insulation $D_{(nT,A)(,tr)}$	Acoubat model



Fréq.	D_{nT}
100	27.0
125	25.6
160	22.1
200	19.4
250	28.1
315	27.2
400	31.5
500	33.4
630	34.9
800	36.0
1000	37.9
1250	38.9
1600	39.3
2000	40.6
2500	39.4
3150	36.1
4000	39.4
5000	42.8
Hz	dB

$D_{nT,A,tr}$ = 31 dB

Indice global calculé selon l'arrêté (30/06/1999)



APPENDIX 2 - Terminology and definition of acoustic terms

❖ *Equivalent pressure level L_{Aeq}*

The concept of noise is expressed in "A-weighted decibels" (dB(A)), the choice of weighting is linked to the response of the ear; A-weighting is intended to reproduce the noise perceived by the human ear (more sensitive to medium and high frequencies).

$L_{Aeq}$is the equivalent continuous pressure level weighted by the A filter and obtained over an acquisition period.

The most frequently cited physical meaning of the term $L_{(eq)\ (t1}$, t_2) is that of a fictitious sound level which is constant over the entire duration (t_1, t_2) and contains the same acoustic energy as the fluctuating level actually observed.

Data integration was carried out in short L_{Aeq}. The integration time chosen for the measurements was 1 second.

❖ *Sound spectrum by frequency band*

The power levels of the sources in question were determined by octave band over the interval [63 Hz; 4000 Hz].

❖ *Reverberation time (R.T.)*

The sound quality of a room is characterised by its **reverberation time TR**, i.e. the decay of sound energy over time. The reverberation time is the time it takes for the sound energy of a noise to decrease by **60 decibels** after it has been turned off.

In practice, to avoid any dynamic problems, reverberation time is generally measured by extrapolating the decay between -5 dB and -35 dB (equivalent to T-30).

❖ *Absorption coefficient α*

The absorption of sound energy by a material is characterised by its absorption factor "α ", also known as the absorption coefficient, which corresponds to the ratio between the acoustic energy absorbed by a plane and the incident acoustic energy; its value is between 0 and 1.

❖ *Weighted standardised isolation*

In situ" sound insulation represents the value of the insulation measured on site. It depends on the attenuation index $R_w$of the construction element studied, the geometric characteristics of the partition, the premises studied, and the lateral transmissions - implementation.

Airborne sound insulation objectives between premises are expressed in terms of standardised weighted acoustic insulation $D_{nT,A}$in decibels.

❖ *Environmental noise*

Expressed in terms of the emergence of the "ambient" noise level containing the noise in question, in relation to the "residual" noise level made up of all the usual exterior and interior noise in the property concerned.

$$e = L_{Aeq,T}(amb) - L_{Aeq,T}(res)$$

❖ *Definition of regulatory terms*

Ambient noise is made up of all the noise emitted by all the sources near and far from the site under study.

Specific noise is the component of ambient noise that we wish to distinguish. In the context of this study, this refers to noise emissions generated by technical equipment.

Residual noise is the noise without the specific noise.

Emergence is the difference between the ambient noise level and the residual noise level. It measures the contribution of the object under study to the ambient noise.

Emergence is calculated in accordance with standard NFS 31-010.

❖ *Acoustic indices and their affiliations*

- Unique weighted absorption index$\alpha_{(w)}$)

  The single weighted absorption index tests are carried out by specialist acoustic laboratories in accordance with standard NF EN ISO 11654. They concern the following elements:
  - false ceilings,
  - wall coverings.

- $R_{(w)}$ (C ; C_{tr})" weighted attenuation index

  The weighted loss index tests are carried out by specialist acoustic laboratories in accordance with standard NF EN ISO 140-3. They concern the following elements:
  - partitions,
  - lining complexes,
  - glazed frames,
  - door units.

- Noise levels of technical equipment

  Acoustic characterisation tests on technical equipment are carried out by an approved laboratory. They will be provided in terms of sound pressure level at a given distance or sound power level, in octave bands between 63 Hz and 4 kHz. They concern the following elements
  - Ventilation and air handling equipment (AHUs), extractor fans, kitchen equipment, etc.

- Insertion loss and noise regenerated by the passage of air

  The acoustic characterisation tests for silencers are carried out in accordance with standard EN ISO 7235. They concern the following elements:

  silent.