Syndicat National de l'Isolation

FESI Document A1

Acoustic Warranty Code

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FESI Document A1: „Acoustic Warranty Code“

Intention

This warranty code has been developed by the Acoustic Committee of the French “Syndicat National de l’Isolation”, SNI. The use of this code without any copyright dues was granted by SNI to FESI.

The intention of this revised “Acoustic Warranty Code” is to allow acoustic contractors working in residential and other occupied buildings, in industrial production facilities, and in the environment as far as it is frequented by humans, to benefit from the rules for acoustical contracting laid down to form a basis of common understanding between contractor and client.

Contractors engage themselves to solve acoustic problems with expertly executed assignments on the basis of contracts that specify acoustic improvements in the form of a measurable change of original conditions to the better. The degree of an improvement can only be proven, and thus only be warranted, if it can be expressed and **measured** in terms both contracting parties have agreed to prior to the commencement of work.

Clients benefit from the fact that they receive a confirmation by contract of a certain result to be achieved. As soon as they have defined the level of change they desire, a contract following the rules of this code is insurance for them that the desired level will be warranted by the contractor.

Introduction

The markets for acoustic insulation works in residential buildings, in the industry, and in the environment are frequently an occasion to enter obligations to achieve certain results. These are offered to the customer by the contracting company for the work it performs, that such results meet existing regulatory criteria or that they improve an existing situation which has been the cause for an acoustic irritation. **The results to be achieved shall be expressed in measurable terms.**

The Acoustic Warranty Code regulates with the aid of purpose tailored “Warranty Sheets” the practical conditions of the acoustical obligations of a contractor opposite his client regarding the insulation work to be performed or the acoustical corrections to be achieved in buildings, in industrial or in any other environments.

This Warranty Code is mainly applicable to the improvement or modification of an existing acoustical situation. Addressing and dealing with the problem at hand must follow the sequence given below:

- identification of the acoustical problems to be dealt with
- determination of the acoustical properties that characterize the acoustical problem
- **measurement of the initial conditions and recording them in the Warranty Sheet**
- determination of the “target values”, the **measurable acoustic performance values to be achieved and fixing them in the Warranty Sheet**
- evaluation of possible actions to obtain the “target values”, decision, which approach to follow
- implementation of acoustical improvement efforts
- **measurement** of the final condition and **comparison of the values achieved with those laid down in the Warranty Sheet**

In other words: once the acoustical problem that needs attending to is well defined, the logical sequence of operations is as follows: initial measurements, evaluation of the problem, implementation

of acoustical improvement works, final inspection and measurement to demonstrate that the contactor's obligations have been met, and that the customer's expectations have been satisfied.

The measurements for the final inspection may be executed by the contractor, the customer or any qualified third party.

If the final measurement shows that the values guaranteed and laid down in the Warranty Sheet and signed by customer and contractor, have been obtained, the contract between the parties is considered completed.

If guaranteed values have not been obtained, the contractor is obliged to take remedial action at his own expense until the contract is fulfilled by attaining the target values.

The Warranty Sheets have been adjusted to the French regulatory situation. The most obvious example is the reverberation time Warranty Sheet. This sheet shows that depending upon the location of the building to be treated, the pertinent regulatory requirements are very different.

It must be noted that the problem to be solved does not necessarily have regulatory aspects. The quality/value to be considered and to be laid down in the Warranty Sheet should, therefore, result from a discussion between customer and contractor. Preferably, this discussion should be based on a proposal by the contactor.

The Warranty Sheets specify the measurement methods to be used on the site and the performance of products to be used.

It is important to remember that only measurable values can be warranted!

A reduction of a noise level, an improvement of sound insulation can be warranted.

A minimization or even only a lowering of a person's subjective impression of noise irritation after the acoustic improvement measures have been implemented cannot be warranted.

The noise irritation is a subjective phenomenon, for which a number of influencing objective factors can be defined, the change of which may allow for a decrease of the irritation.

The Warranty Sheets of this Acoustic Warranty Code advice on the effectiveness of certain measures to be taken for the solution of certain problems.

One example for the limitations of these measures that could possibly be taken is the acoustic treatment of walls to reduce the noise level in a workshop. It will not be effective near a machine which is the principal source of noise in that workshop.

The complete FESI "Code de Garantie" consists of 8 "Warranty Sheets:

WARRANTY SHEET 1	**SOUND POWER LEVEL OF A NOISE SOURCE**
WARRANTY SHEET 2	**SOUND PRESSURE LEVEL OR SOUND PRESSURE LEVEL DIFFERENCE IN A SPECIFIED POSITION**
WARRANTY SHEET 3	**DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A NOISE SOURCE**
WARRANTY SHEET 4	**REVERBERATION TIME IN A ROOM**
WARRANTY SHEET 5	**ACOUSTIC LEVEL INSULATION BETWEEN TWO ROOMS**

WARRANTY SHEET 6	**STANDARDISED OR NORMALISED SOUND PRESSURE LEVEL DIFFERENCE BETWEEN TWO ROOMS**
WARRANTY SHEET 7	**SOUND PRESSURE LEVEL DIFFERENCE FROM EXTERNAL NOISE**
WARRANTY SHEET 8	**IMPACT SOUND PRESSURE LEVEL (or attenuation of impact sound pressure level)**

In case an acoustic assignment is to be executed in a new building, the initial state obviously cannot be measured. In this case, a number of sections of this code are not applicable, including those aimed at decreasing noise levels or sound pressure levels of a source. The company will study the services to be implemented based on planning studies such as those described in the series of European standards EN 12354 or in the FESI Acoustic Documents A 2 to A 6.

Most types of work related to various forms of acoustic warranties are given in the table below:

TYPES OF WORKS	SHEETS TO CONSULT
Noise source enclosure	Sheets 1, 2
Implementation of a silencer	Sheets 1,2
Implementation of a screen	Sheets 2, 3
Construction of an acoustic cabin	Sheets 2, 4, 5, 6
Soundproofing of a reception room	Sheets 2, 3, 4, 5, 7, 8
Complete or partial partitioning of a local	Sheets 4, 5, 6
Doublings acoustic of walls	Sheets 5, 6, 7, 8
Implementation of acoustical barriers between roofs and suspended ceilings	Sheets 5, 6
Tightness of windows	Sheet 7
Treatment of inlets	Sheet 7
Replacement of glazings or windows	Sheet 7
Treatments of coffers/ shutters	Sheet 7
Application of double glazing	Sheet 7
Window installation dubbing	Sheet 7
Treatment of roofs and attics	Sheet 7
Floor covering to damp impact noise	Sheet 8
Floating floor to interrupt the transmission of impact noise	Sheet 8
Uncoupling of the walls at the reception	Sheet 8

Disclaimer

The information contained in this document is considered by us to be good practice and industry guidance (**Guidance**). The Guidance is provided by a commission of FESI (www.fesi.eu), and is considered to be correct at the date of publication. Whilst we are confident the information contained within it is up to date and accurate, it is a reference document only. It is your responsibility to ensure your knowledge of the matters discussed in the Guidance is kept up to date.

The Guidance is intended to be used for general purposes only and is not intended to take precedence over appropriate national and international standards, guidelines or laws (where applicable). The Guidance is not intended to replace detailed calculations and assessments of prevailing physical conditions in complicated building assignments.

The Guidance does not constitute professional advice and specific queries should be referred to qualified professionals. Any reliance placed on the Guidance without seeking such advice is strictly at your own risk. We make no representations or warranties of any kind, express or implied, about the completeness, accuracy, reliability or suitability of the Guidance.

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WARRANTY SHEET 1

SOUND POWER LEVEL OF A NOISE SOURCE

(or lowering the level of sound power of a noise source)

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
e-mail		**e-mail**	
Construction site address		**Building / Installation to be treated**	

The acoustic power level (or the lowering of that level) emitted by a noise source allows for controlling the efficiency of the implementation:

- of an enclosure around the source
- of a silencer

The acoustic power level emitted by a source of noise does not allow for controlling the efficiency of other acoustic improvement techniques that might be used. In particular, any interventions at the source itself in order to change parts of it or its operating mode are not a part of their domain.

Note:

The acoustic power level of a noise source is equal to 10 times the logarithm to the base 10 of the ratio of the acoustic power of the source considered to the reference acoustic power (10^{-12} Watts). It is expressed in dB ref. 10^{-12} W. In all tables, the octave band value is given in dB, and the global value is given in dBA.

The acoustic power level of a source of noise depends on its operating condition and on the labour it performs. It is essential that its operating conditions are the same when measuring before and after the acoustic improvement action. Therefore, it is important to complete Annex 1 of this Warranty Sheet.

Date		**Done in 2 copies, at**	
Number of annexes attached		**The Client**	**The Company**
Price of the intervention (EUROS excl. VAT)			
Starting date			
Intervention ending date			

WARRANTY SHEET 1

SOUND POWER LEVEL OF A NOISE SOURCE

(or lowering the level of sound power of a noise source)

WARRANTY OF THE ACOUSTIC PERFORMANCE OF THE PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which is based its obligation to achieve defined results.

In the sense of the present FESI Acoustic Warranty Code, based on a code of the "Syndicat National de l'Isolation" of France, the preconditions of a warranty of acoustic performance are the following:

- For an enclosure:

  - A complete measurement report of the sound reduction index according to the measuring protocol defined in the standards EN ISO 140-3 and EN ISO 717-1, for products or constructive systems clearly identified in brand, type, nature, dimensions, tested in assembling conditions clearly and detailed enough described.
  - A complete inspection report of the acoustic absorption coefficient in a reverberation room according to the measuring protocol defined in the standards EN ISO 354 and EN 11654, for products or constructive systems clearly identified in brand, type, nature, dimensions, tested in assembling conditions clearly and detailed enough described.

- For a silencer:

  - A complete inspection report of the insertion loss of the silencer and of the flow generated noise, according to the measuring protocol defined in the standard EN ISO 7235, or, in case the dimensions of the silencer to be installed don't correspond to those for which measurement results are available, a simulation report, clearly demonstrating, for the calculation of the insertion loss, the influence of the air resistance of the filling and its surface and also the speed of the air flow, also mentioning an estimation of the silencer's self-generated noise.

INITIAL SOUND POWER, L_{Wi}, if necessary, AND MEASUREMENT PROTOCOL

Preliminary note: The values of the sound power levels result from measurements at measurement points chosen according to the measurement protocol and are rounded to 0.1 dB, for operating conditions of the source described in detail.

☐ **Enclosure of a source other than a ventilator, a combustion engine or a gas turbine, according to the standard:**

☐ ISO 3744 ☐ ISO 3747 ☐ ISO 3746

☐ **Enclosure of a ventilator:** Standard ISO 13347

☐ **Enclosure of a internal combustion engine:** Standard ISO 6798

☐ **Enclosure of a gas turbine:** Standard ISO 10494

☐ **Silencers:** Standard EN ISO 11820

Initial sound power level L_{Wi} in octave bands of the centre frequency:

f (Hz)	31,5	63	125	250	500	1000	2000	4 000	8 000	dBA
Lwi (dB ref 10^{-12}W)										

WARRANTY SHEET 1

SOUND POWER LEVEL OF A NOISE SOURCE

(or lowering the level of sound power of a noise source)

WARRANTED SOUND POWER, L_W OR WARRANTED SOUND POWER LEVEL DECREASE , ΔL_W AND ASSOCIATED MEASUREMENT PROTOCOL

Preliminary note: The measurement procedure to be followed must be identical to the one used for the initial measurement.

Warranted and measured sound power levels L_W and L'_w and warranted and measured sound power level decrease ΔL_W, and $\Delta L'_w$ in octave bands of the centre frequency f:

f (Hz)	31,5	63	125	250	500	1000	2000	4 000	8 000	dBA
L_w (dB ref10^{-12}W)										
$\Delta L_W = L_{Wi} - L_W$										
L'_w										
$\Delta L'_w = L_{Wi} - L'_w$										

CRITERIA ALLOWING TO JUDGE THE OBTAINED PERFORMANCE AFTER INTERVENTION REGARDING THE COMPANY'S ENGAGEMENTS

Note: The prediction of a sound power level emitted by a source is burdened with a fundamental uncertainty, caused by numerous factors including the uncertainty regarding the performance of construction products and systems used, the uncertainty of the mathematical models used for the prediction, and the uncertainty of measurements and rounding. In order to examine the conformity of the values obtained after the treatment to the warranted values, the difference between the value warranted and the sound power level measured after the intervention (L_W') rounded to 1 dB shall be considered.

The performance obligation of the company towards its client is deemed satisfied if the value (or values) of the sound power level measured after the intervention is (or are) such as: $L_W' - L_W \leq 1$ dB.
In case of a power level decrease: $\Delta L'_W - \Delta L_W >= -1$ dB

In case the conformity to a reference value with an unknown uncertainty is checked which demands a maximum sound power level $L_{W,lim}$, or a minimum decrease of the sound power level $\Delta L_{W,lim}$,it is strongly recommended to adjust the value warranted to the uncertainty. The warranted value L_W should be taken equal to $L_{W,lim}$ -1 (dB).The level difference warranted, $\Delta L_{W,lim}$, must be + 1 (dB)

Examples of conformity examinations, with 1 dB uncertainty:

Lw' (dB ref 10^{-12}W)	97	99	101	102
Lw (dB ref 10^{-12}W)	100	100	100	100
Lw' - Lw (dB)	-3	-1	+1	+2
Is the obligation satisfied?	Yes	Yes	Yes	No

ΔLw' (dB ref 10^{-12}W)	13	11	9	8
ΔLw (dB ref 10^{-12}W)	10	10	10	10
ΔLw' -Δ Lw (dB)	+3	+1	-1	-2
Is the obligation satisfied?	Yes	Yes	Yes	No

WARRANTY SHEET 1

SOUND POWER LEVEL OF A NOISE SOURCE

(or lowering the level of sound power of a noise source)

Annex 1

Nature of the noise source and operating conditions being the conditions of this warranty

(If this annex is not completed, the warranty is not valid)

Noise source:

Location of the source and measuring points:

Operating conditions (operating point or work accomplished):

Important notice regarding the encapsulation of a sound source:

When executing the encapsulation of a sound source, sufficient ventilation must be taken care of to ensure the functioning of the source under good conditions. A special attention is required to limit the infringement of the performance of the encapsulation as a result of the openings for air intake and outlet.

WARRANTY SHEET 2

Sound pressure level or the sound pressure level difference in a specified position

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
e-mail		**e-mail**	
Construction site address		**Building / Installation to be treated**	

The sound pressure level or the sound pressure level difference in a specified position allows for controlling the efficiency of the installation:

- of an enclosure
- of an acoustic screen
- of an acoustic cabin
- of a silencer
- of a local sound absorption treatment, when the noise source is far enough away from the position.

The sound pressure level in a specified position doesn't allow for controlling the efficiency of any other acoustic improvement measures that might be contemplated.

Note:

The sound pressure level warranty in a specified position is possible only if there is only one source of unwanted noise which generates a noise clearly above the noise level of other noise sources, eventually active in that location. **If the other noise sources cannot be stopped, the warranted value can only be measured, if the noise level of all the other sources is at least 6 to 10 dB below that warranted value.** In all tables, the octave band value is given in dB, and the global value is given in dBA.

Date		**Done in 2 copies, at**	
Number of annexes attached		**The Client**	**The Company**
Price of the intervention (EUROS excl. TVA)			
Starting date			
Intervention ending date			

WARRANTY SHEET 2

Sound pressure level or the sound pressure level difference in a specified position

18.07.2013

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which is based its obligation to achieve defined results.

In the sense of the present FESI Acoustic Warranty Code, based on a code of the "Syndicat National de l'Isolation" of France, the preconditions of a warranty of acoustic performance are the following:

- For an enclosure, acoustic screen or acoustic cabin:

  - A complete measurement report of the sound reduction index according to the measuring protocol defined in the standards EN ISO 140-3 and EN ISO 717-1, for products or constructive systems clearly identified in brand, type, nature, dimensions, tested in assembling conditions clearly and detailed enough described.
  - A complete inspection report of the acoustic absorption coefficient in a reverberating room according to the measuring protocol defined in the standards EN ISO 354 and EN 11654, for products or constructive systems clearly identified in brand, type, nature, dimensions, tested in assembling conditions clearly and detailed enough described.

- For a silencer:

  - A complete inspection report of the insertion loss of the silencer and of the flow generated noise, according to the measuring protocol defined in the standard EN ISO 11820, or, in case the dimensions of the silencer to be installed don't correspond to those for which measurement results are available, a simulation report, clearly demonstrating, for the calculation of the insertion loss, the influence of the air resistance of the filling and its surface and also the speed of the air flow, also mentioning an estimation of the silencer's self-generated noise.

INITIAL SOUND PRESSURE LEVEL L_{Pi}, if necessary, AND RELATED MEASUREMENT PROTOCOL

Preliminary note: The measured values of the sound pressure levels are rounded to 0.1 dB. They are taken for precisely defined operating conditions.

☐ **Acoustic insulation work, for which exists an own standard**

- ☐ EN ISO 11201, 11202, 11204 — L_{Pi} is noted $L_{P,\,eq,\,T}$
- ☐ EN ISO 11546-2 — L_{Pi} is noted $L_{P,\,eq,}$
- ☐ EN ISO 11957 — L_{Pi} is noted $(L_P)_{\,cabin,}$
- ☐ EN ISO 11820 — L_{Pi} is noted $(L_P)_{\,cabin,}$

☐ **Environmental protection acoustic insulation treatments**

- ☐ NF S 31-010 — L_{Pi} is noted $L_{A,\,eq,\,T}$
- ☐ NF S 31-110 — L_{Pi} is noted $L_{A,\,eq,\,T}$

☐ **Workers protection acoustic insulation treatments**

- ☐ EN ISO 9612 — L_{Pi} is noted L_{PAT}

Initial sound pressure level L_{pi} and initial reverberation time T_{ri} by octave bands of middle frequency **f**:

f (Hz)	31,5	63	125	250	500	1000	2000	4 000	8 000	dB(A)
Lp_i (dB ref $2{\cdot}10^{-5}$ Pa)										
Tr_i (s)										

WARRANTY SHEET 2

Sound pressure level or the sound pressure level difference in a specified position

18.07.2013

WARRANTED SOUND PRESSURE LEVEL, L_P OR WARRANTED SOUND PRESSURE LEVEL DIFFERENCE, ΔL_P

It's necessary to use the same standard for the initial and the final measurements.

Standard used for the measurement protocol	

Warranted sound pressure level L_p or warranted sound pressure level difference, by octave bands of middle frequency:

f (Hz)	31,5	63	125	250	500	1000	2000	4 000	8 000	dBA
L_p (dB)										
$\Delta L_{p=} L_{pi} - L_p$										

The warranted value is valid, if both measurements are made with identical reverberation times and source operating conditions.

CRITERIA ALLOWING FOR AN ASSESSMENT OF THE OBTAINED PERFORMANCE AFTER INTERVENTION REGARDING THE CONTRACTOR'S WARRANTED RESULT OBLIGATIONS

1- During sound pressure measurements after an acoustic treatment, the operating conditions of the noise source must be the same as during the initial measurements (annex 1).

2- It can be necessary to correct the sound pressure level measurement results L_{p2} after the treatment. This is possible in two ways:

- A reverberation time correction after treatment: In case the reverberation time changed after the initial measurements: if in an octave interval, the reverberation time is T'_r , the sound pressure level value to compare to the warranted value is:

$$L_{P3} = L_{P2} - 10 \log_{10}(T'_r / T_{ri})$$

- A correction necessitated by the ambient sound pressure level in a room: If the noise source to be treated is stopped: If L_{P2} is the value of the sound pressure level in an octave interval measured while the treated source is working; and if L_{amb} is the sound pressure level when the source is stopped, then the sound pressure level values for be warranted are $L_{P4} = L_{P2} + C$. With a correction C :

$L_{P2} - L_{amb}$	3	4	5	6	7	8	9	10
C	-3	-2	-2	-1	-1	-1	-1	0

The sounds pressure level L'_P , to compare to the warranted value is $\mathbf{L'_P = L_{P2} - 10 \log_{10}(T'_r / T_{ri}) + C}$

3- The prediction of the sound pressure level of a source in an itemized location has a fundamental uncertainty that is caused by numerous factors including the uncertainty regarding the construction products' and systems' performance, the uncertainty in the mathematical models used, and the uncertainties in measurement and rounding. In order to examine the conformity of an installation, the difference, between the sound pressure level measured after the intervention (values with ') and the warranted value is calculated and rounded to 1 dB.

The performance obligation of the company towards its client is deemed satisfied, if the value of the sound pressure level measured after the intervention L_p' is such as: $L_p' - L_p \leq 1$ dB.

In case of a sound pressure level attenuation, the obligation is satisfied if: $\Delta L'_p - \Delta L_p >= -1$ dB

Note: In the case that the conformity being checked contains a reference with an unknown uncertainty and is imposing a maximum sound pressure level $L_{p,lim}$,or $\Delta L_{p,lim}$, it is strongly recommended to adjust the warranted value to the uncertainty. The warranted value L_p should be taken $L_p \leq L_{p,lim} - 1$ dB or dBA.The attenuation value guarantee must be $\Delta L_p >= \Delta L_{p,lim} + 1$dB or dBA

WARRANTY SHEET 2

Sound pressure level or the sound pressure level difference in a specified position

18.07.2013

Measured values after the improvement assignment (Example for a record of results)

f (Hz)	31,5	63	125	250	500	1000	2000	4000	8000	dBA
L_{p2} (dB)										
T'_r (s)										
10 log (T'_r/T_{ri})										
L_{res} (dB)										
L_{p2} - **L_{res}**										
C										
L'_p (dB)										
$\Delta L'_p = L_{pi} - L'_p$ (dB)										

Examples of conformity checks, with 1 dB uncertainty:

Reminder: the measurement values are rounded to 1 dB, for example if the sound level pressure is 63.6 dB the value will be 64 dB and if it was 63.5db will be 64 dB.

Measurements after intervention, (including correction if necessary)	L'_p (dB)	59	60	61	62
Guarantee	L_p (dB)	60			
difference	$L'_p - L_p$	-1	0	+1	+2
Is the engagement accomplished?		Yes	Yes	Yes	No

Measurements after intervention, (including correction if necessary)	$\Delta L'_p$ (dB)	13	14	15	16
Guarantee	ΔL_p (dB)	15			
difference	$\Delta L'_p - \Delta L_p$	-2	-1	0	+1
Is the engagement accomplished?	$\Delta L'_p$ (dB)	No	Yes	Yes	yes

Annex 1: Nature of the noise source and operating conditions which are the subject of this warranty. (If this annex is not filled, the warranty is not valid)

Noise source:

Location of the source and measure points:

Operating conditions (operating point or work accomplished):

WARRANTY SHEET 3

DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A SOURCE OF NOISE

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
e-mail		**e-mail**	
Construction Site Address		**Building / Installation to be treated**	

The decay of a sound pressure level by doubling the distance from a noise source allows for controlling the efficiency of the implementation:

- of an acoustic improvement by applying sound absorbing materials in a room
- of a positioning of screens

The **decay of a sound pressure level by doubling the distance from a noise source** does not allow for controlling the efficiency of any other acoustic improvement techniques that might be used. In particular, any interventions at the source itself in order to change parts of it or its operating mode are not a part of their domain.

Note:

The decay of a sound pressure level by doubling the distance from a noise source in a room is not obtained as a result of a direct sound pressure measurement.
Sound pressure level measurements are made in **one direction** at different distances from the noise source. For every direction, the measurement results are put on a graph and the regression line is calculated. It corresponds to the sum total of the measured values.
In free field conditions, i.e. without obstructions, without walls in a room, the decay of a sound pressure level by doubling the distance from a noise source is between 5 and 6 dB, according to the type of ground where the measurement is made. **In a room after an acoustic improvement intervention, one cannot warrant a decay of sound pressure level above 6 dB by doubling the distance from the most effective source.**

Date		**Done in 2 copies, at**	
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Price of the intervention (EUROS excl. VAT)			
Starting date			
Intervention ending date			

WARRANTY SHEET 3

DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A SOURCE OF NOISE

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which is based its obligation to achieve defined results.

In the sense of the present FESI Acoustic Warranty Code, based on a code of the "Syndicat National de l'Isolation" of France, the warranties of acoustic performance are the following:

- In case of an acoustical absorption material implementation

For each absorbing material, a complete measurement report of the acoustic absorption coefficient in a reverberation room according to the measuring protocol defined in the standards EN ISO 354 and EN 11654, for products or constructive systems clearly identified in brand, type, nature, dimensions, tested in assembling conditions clearly and detailed enough described and compatible with the planned implementation on the building site.

- For a positioning of screens

A complete inspection report of measured sound reduction indices according to the measuring protocol defined in the standards EN ISO 140-3 and ISO 717-1 for products or constructive systems clearly identified in brand, type, nature, and dimensions, tested in assembling conditions clearly and detailed enough described.

INITIAL DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A NOISE SOURCE DL_i (if necessary)
WARRANTED DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A NOISE SOURCE DL AND THE RELATED MEASUREMENT PROTOCOL

Preliminary note: The values of the decay of sound pressure level by doubling the distance from a noise source are the average values of the measurement results obtained at the points chosen according to the measurement protocol and are rounded to 0.1 dB.

- ☐ **The place considered is in the open:** The measurement protocol applicable is defined in the standard EN ISO 3382
- ☐ **The room is NOT an open plane space:** The measurement protocol applicable is defined in the standard EN ISO 14257.

Range of distances of considered: (from the acoustic center of the source used for the test).

Lower limit (m): Upper limit (m):

Initial acoustic attenuation by doubling the distance from a noise source DL_i

DL_i (dB(A))= ☐ **an empty space** ☐ **a cluttered space**

Guarantee acoustic attenuation by doubling of distance from a noise source DL

DL (dB(A))= ☐ **an empty space** ☐ **a cluttered space**

Note: If the measuring conditions before and after the intervention are not identical (obstacles in an open space, positioning of equipment, measuring points) the guarantee will be not valid.

WARRANTY SHEET 3

DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A SOURCE OF NOISE

CRITERIA ALLOWING FOR A JUDGEMENT OF THE CONFORMITY OF THE PERFORMANCE OBTAINED AFTER THE INTERVENTION WITH THE COMPANY'S WARRANTED OBLIGATIONS

Note: The prediction of an acoustic attenuation by doubling the distance from a noise source is burdened with a fundamental uncertainty, caused by numerous factors including the uncertainty regarding the performance of construction products and systems used the uncertainty of the mathematical models used for the prediction, and the uncertainty of measurements and rounding. In order to examine the conformity of the values obtained after the treatment to the values guaranteed, the relative difference, rounded to 1dB, between the guaranteed attenuation by doubling the distance to the source, measured before (DL) and after (DL') the intervention is compared.

The performance obligation of the company towards its client is deemed satisfied if the value of the acoustic attenuation by doubling the distance to the source DL' meets the condition DL' -D L>= -0.1 dBA.

Note: In case of the conformity being examined in the context of an unknown uncertainty and where a maximum acoustic level DL_{lim}, is imposed, it is strongly recommended to adjust the guaranteed value to the uncertainty. The guaranteed value for the acoustic attenuation by doubling the distance to the source should in such cases be $DL=DL_{lim}$ +0.1 dBA.

Examples of conformity exams:

Reminder: The measurement values are rounded to the nearest 0.1 dB. So if the attenuation rate is 3.11 dBA the rounded value will be 3.1 dBA and a measurement result of 3.15 dBA then will be rounded to 3.2 dBA.

Measurement	DL' (dB(A))	2.7	2.9	3.1	3.3
Guarantee	DL (dB(A))	3.0			
	DL' –DL (dB(A))	-0.3	-0.1	0.1	0.3
	Uncertainty	-0.1			
	conformity	no	yes	yes	yes

WARRANTY SHEET 3

DECAY OF SOUND PRESSURE LEVEL BY DOUBLING THE DISTANCE FROM A SOURCE OF NOISE

Annex 1

Nature of the noise source and operating conditions being the subject of this warranty

(If this annex is not filled, the warranty is not valid)

Noise source:

Location of the source and measuring points:

Operating conditions (operating point or work accomplished):

Example: A drilling machine is tested initially perforating 5/10 steel plates, with a 50mm punch. At the time of the final measurements, the work was a perforation of inox 10/10 steel plates with the same punch. The work accomplished is not the same, so the warranty does not apply.

WARRANTY SHEET 4
REVERBERATION TIME IN A ROOM

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
e-mail		**e-mail**	
Construction site address		**Building / Installation to be treated**	

The reverberation time allows for controlling the main efficiency of an acoustic improvement measure (application of acoustic absorbers, or, les often, acoustic reflectors in a room)
The reverberation time allows for controlling the secondary efficiency:

- of a complete room partitioning, even when the main efficiency is connected to the acoustic insulation as such
- of a cabin for personnel, even when the main efficiency is connected to the acoustic insulation as such

The reverberation time does not allow for controlling the efficiency of any other soundproofing techniques: the use of this warranty sheet is limited to the insulation techniques mentioned above.

Note:

For ordinary rooms like offices; classrooms, gymnasiums…, the reverberation time measurement for a final control, does only make sense for a diffuse acoustic field. Sufficient diffusion can be obtained with absorption materials on, at least, two adjacent walls, or with relatively much furniture in the room.

In the case of an insufficiently diffused acoustic field, the final control cannot be done.

Date		**Done in 2 copies, at**	
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Starting date			
Intervention ending date			

WARRANTY SHEET 4
REVERBERATION TIME IN A ROOM

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which its obligation to achieve defined results is based.

In this FESI Acoustic Warranty Code based on the "Code de Garantie" of the "Syndicat National de l'Isolation" of France, the warranties of acoustic performance for a product demand, a complete measurement report of the acoustic absorption in a reverberation room according to the measuring protocol defined in the standards EN ISO 354 and EN 11654, for every product or constructive system clearly identified in brand, type, nature, and dimensions, tested in a laboratory under assembling conditions similar to those planned for the implementation on the building site.

INITIAL REVERBERATION TIME (if necessary), WARRANTED REVERBERATION TIME AND RELATED MEASUREMENT PROTOCOL

Preliminary note: The values of the reverberation time are the average from the measurement results at the measurement points chosen according to the measurement protocol (the precision decided by the contracting entities and specified in Annex 2) and are rounded to 0.05 s,

- **The room is neither a gymnasium nor a classroom:** the measurement protocol is defined in the standard EN ISO 3382, Parts 1 and 2.

Initial reverberation time in octave bands

F (Hz)	125	250	500	1000	2000	4000
T_i (s)						

Warranted reverberation times T_w(s) and measured reverberation times T_m(s) after the implementation of the acoustical improvement in octave bands

F (Hz)	125	250	500	1000	2000	4000
T_w(s)						
T' (s)						

□ max values □ target values

- **The location is a classroom or an office, or a meeting room of a sports building**: a specimen measurement protocol is available in the French standard NF 90-207.

The initial reverberation time T_{mi} , the warranted reverberation time T_{mw}, the measured reverberation time T'_m (average of the values measured in the octave bands centered on 500, 1000 and 2000 Hz)

T_{mi} (s) =

T_{mw} (s) =

T'_m (s) =

WARRANTY SHEET 4
REVERBERATION TIME IN A ROOM

- **<u>The local is a gymnasium, an meeting room or a restaurant in a sports building:</u>**

The initial reverberation time T_{mi} , the warranted reverberation time T_{mw} , the measured reverberation time T'_m (average of the values measured in the octave bands centered on 500, 1000 and 2000 Hz)

T_{mi} (s) =

T_{mw} (s) =

T'_m (s) =

CRITERIA ALLOWING FOR AN ASSESSMENT OF THE OBTAINED PERFORMANCE AFTER INTERVENTION REGARDING THE CONTRACTOR'S WARRANTED RESULT OBLIGATIONS.

Note: The prediction of an acoustic reverberation time has a fundamental uncertainty that is caused by numerous factors including the uncertainty regarding the construction products' and systems' performance, the uncertainty in the mathematical models used, and the uncertainties in measurement and rounding. In order to examine the conformity of an installation with the warranted obligations of the contractor, one must compare the relative difference between the measured reverberation time after the intervention (T') and the warranted value, rounded to 0.05 s.

Dependent upon whether the warranty either covers a reverberation time T in one or multiple octave bands, or an average reverberation time T_m, two cases are to be considered:

- <u>Guaranteed values are maximum limits</u> (thus, all lower values are in conformity)

The performance obligation of the contractor towards his client is deemed satisfied if, in any frequency interval, the value of the reverberation time T', after intervention, is such that $(T'-T_w) / T_w <= 0.2$ s.

Also, if the warranted value is an average T_{mw}, the performance obligation is deemed satisfied if T'_m, after intervention, is such as $(T'_m-T_{mw})/T_{mw} <= 0.2$ s

Note: In case the conformity is being examined in the context of a regulatory text, which doesn't mention implicit uncertainties and which imposes a maximum reverberation time T_{max}, it is strongly recommended to include the uncertainty when determining the result that can be warranted. The warranted value T_w should be taken equal to 0.8 T_{max}

- <u>Warranted values are targets values</u> (usually for musical rooms or theaters)

The performance obligation of the contractor towards his client is deemed satisfied, if, in any frequency interval, the value of the acoustic reverberation T', after intervention, is such that $[T'-T_w] / T_w <= 0.2$ s. or if $[T'-T_w]$ is the absolute value, (always positive) of the difference $T'-T_w$

Remember:

The reverberation time is the period required for a 60 dB decrease of the sound pressure level after the termination of the noise emitted by the source.

The locations of the source and the measuring points are to be specified in an annex

WARRANTY SHEET 4
REVERBERATION TIME IN A ROOM

Examples of conformity examinations: Are the reverberation times measured after intervention (T') in conformity with the guaranteed values?

	T'(s)	0,70	0,95	0,70	1,25
	T_w(s)	1	1,10	0,9	1,00
Warranted values are max.limits: $(T'-T_w) / T_w <= 0.2$.	$(T'-T_w) / T_w$	-0,30	0,15	-0,20	0,25
Conformity		Yes	Yes	Yes	no
Warranted values are target values $[T'-T_w] / T_w <= 0.2$	$[T'-T_w] / T_w$	0,30	0,15	0,20	0,25
Conformity		no	Yes	Yes	no

Annex 1: Positions of measuring points (sketch, not compulsory)

WARRANTY SHEET 5

Acoustic insulation between two rooms

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
e-mail		**e-mail**	
Construction site address		**Building to be treated**	

The sound pressure level difference between two rooms allows for controlling the main efficiency of the implementation of a full or partial partitioning of a room, of a doubling the wall lining of the separating or of lateral walls, of a treatment of weak points (canalisations, chutes, tightness of junctions), by installing an acoustic barrier.

The sound pressure level difference between two rooms allows for controlling the secondary efficiency of:

- the reception room soundproofing improvement
- a personnel sound protection cabin, if the principal efficiency expected is related to an sound pressure level

The sound pressure level difference measurement does neither allow for controlling the efficiency of an absorption treatment in the emission room, nor the efficiency of any treatment of the noise source. (anti vibration treatment, silencers, baffles)

Note:

The sound pressure level difference D is the difference between the pressure levels in the reception and the emission rooms. The sound pressure level difference depends on the reception room's properties (reverberation time, equivalent absorption area).

One cannot warrant an acoustic insulation without determining the initial reverberation time in the reception room. (see Annex 1) It depends on uncontrollable factors like the reception room's furniture and the materials of walls and ceiling.

In all tables, the octave band value is given in dB, and the global value is given in dBA.

Date		**Done in 2 copies, at**	
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Intervention ending date			

WARRANTY SHEET 5

Acoustic insulation between two rooms

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which its obligation to achieve defined results is based.

In this FESI Acoustic Warranty Code based on the "Code de Garantie" of the "Syndicat National de l'Isolation" of France, the warranties of acoustic performance for a product demand, a complete measurement report of the acoustic sound reduction index according to the measuring protocol defined in the standards EN ISO 140, of the sound reduction index variation in case of lining, of the normalised sound level difference of little parts, for every product or constructive system clearly identified in brand, type, nature, and dimensions, tested in a laboratory under assembling conditions similar to those planned for the implementation on the building site..

INITIAL ACOUSTIC LEVEL DIFFERENCE BETWEEN TWO ROOMS (if necessary) WARRANTED SOUND PRESSURE LEVEL DIFFERENCE AND RELATED MEASUREMENT PROTOCOL

Preliminary note: The sound pressure level differences may either be values by octave bands, or unique values like in EN ISO 717 part 1, or global values in dBA for a special emission spectrum.

Type of local

Emission room	
Reception room	

Type of emission noise ☐ pink noise ☐ road noise

☐ Noise described in the table below in octave bands at the central frequency f.

f (Hz)	63	125	250	500	1000	2000	4000	8000
Lp (dB ref $2 \cdot 10^{-5}$ Pa)								

- **Initial sound pressure level difference D_i between two rooms and initial reverberation time T_i by octave bands**, the measurement protocol is defined in the standards EN ISO 10052

f (Hz)	63	125	250	500	1000	2000	4000	8000
Di (dB)								
Ti (s)								

Unique measured values D_{iw} = dB $D_{iw} + C$ = dB $D_{iw} + C_{tr}$ = dB

The initial sound pressure level difference in dBA for the spectrum : Di = dBA

WARRANTY SHEET 5

Acoustic insulation between two rooms

- **Warranted sound pressure level difference D_w , and measured difference D' ,between two rooms** by middle octave bands,

f (Hz)	63	125	250	500	1000	2000	4000	8000
D_w (dB)								
D' (dB)								
T'r (s)								

Unique measured values

D_{iw} = dB $D_{iw} + C$ = dB $D_{iw} + C_{tr}$ = dB

D' = dB D' + C = dB D' + C_{tr} = dB

For details of this calculation see EN ISO 140-3

The sound pressure level differences after intervention will be corrected with a calculation of the values with the same reverberation in the reception room before & after the interventions.

The guarantee level difference in dBA for the spectrum : D_w = dBA

CRITERIA ALLOWING FOR AN ASSESSMENT OF THE PERFORMANCE OBTAINED AFTER INTERVENTION, REGARDING THE CONTRACTOR'S WARRANTED RESULT OBLIGATIONS.

Note: The prediction of an acoustic sound pressure level difference has a fundamental uncertainty that is caused by numerous factors including the uncertainty regarding the construction products' and systems' performance, the uncertainty in the mathematical models used, and the uncertainties in measurement and rounding.

The sound pressure level differences measured in definite frequency intervals, before and after the intervention, are given in tenth of decibel. The sound pressure level differences warranted by frequency intervals and the differences given in global values in dBA, are rounded to the nearest decibel. Where the calculation of tenth of decibel terminates at 0,5 dB, the rounding is to the upper dB.

The generally accepted uncertainty, to be taken into consideration when interpreting the results of the measurements taken prior to the commencement of work, to be able to assess the conformity or the non-conformity of the improvement achieved to the warranted values, is 3 dB. It should be included in the contract about the warranted values.

Note: Where the uncertainty is included in the contract, it is strongly recommended to take them into account in the target values of the investigation. If the uncertainty is included, the value D_w, "target value of the project" is then the warranted value augmented by 3 dB or dBA.

WARRANTY SHEET 5

Acoustic insulation between two rooms

Examples: the sound pressure level difference values measured after intervention (function of initial reverberation time (D')), is it conform to the warranted target value difference (D_w)?

C: conforming, NC: not conforming

	Frequency's uncertainty	125	250	500	1000	2000	4000
D_w		40	44	48	52	56	60
D' ,measurement with correction	3dB	37.6	40.2	46.0	50.1	56.1	58.0
		C	NC	C	C	C	C

In the following table, there is an example for conclusion without uncertainties.

Generally in this case, for sound pressure level differences, we establish + 3 dB as target value.

	D + C (dB)		D + C_{tr} (dB)		D (dBA)	
Warranted value	>= 50		>= 47		>= 42	
Target value (D_w +3dB)	53		50		45	
Measured value	49	51	47	49	41	46
conclusion	NC	C	C	C	NC	C

The target value is the value taken into account when investigating possible solutions. It contains an uncertainty of 3dB or dBA, average deviation, which is most frequently used between the forecast and the measurement.

Annex 1: The importance of reverberation time in a room

In case of standardized DnT acoustic insulation, sound insulation is calculated, as if one had measured insulation, with reverberation time in the receiving room equal to a reference reverberation time T0.

DnT = D + 10 log10 (T/T0) where D is the raw sound insulation

D = L2-L1, which is the sound pressure level in the source room minus the sound pressure level in the receiving room. In fact, it is the sound pressure level at the reception which is corrected:

$$L_{2nT} = L_2 - 10 \log_{10} (T/T_0)$$

In case of acoustic insulation being measured at different periods (the delay between the initial measurements and the final measurements may be more or less important), the reverberation time of the receiving room can be very different. If the receiving room is more reverberant during the final measurement than during the initial measurement, the sound pressure level at the reception, for the same level of emission, will be higher than it would have been with the same condition of reverberation, and sound insulation will be less than it would have been if the reverberation time had not changed. It is necessary, therefore, to control the reverberation time. In this case, one does not calculate the sound insulation which would have been reached, if the reverberation time had been a reference period, but instead one calculates the sound insulation that would have been achieved, if the reverberation time had been the same as in the initial measurements.

D' corrected= D' (measured) + 10 log10 (T'r / Ti)

Where T'r is the reverberation time during the final measurements and Ti the reverberation time during the initial measurements in the receiving room.

WARRANTY SHEET 5

Acoustic insulation between two rooms

Note:

In all problems of acoustic insulation of air-borne noise between rooms, one must examine the direct transmission through the wall of separation between the rooms, but also lateral transmissions through walls, linked to the wall of separation, and as well parasite transmissions: holes, passages pipes or ducts, intakes of power components ..In case of an existing situation, it is necessary to make a diagnosis to identify the predominant paths of acoustic transmission, in order to give them priority treatment .

During the measurements, one must be sure to characterize the sound insulation between rooms. For this, the sound pressure level in the source room, must be high enough, so that the sound pressure level in the receiving room is not influenced by the background noise in that room. A measurement of the background noise in the receiving room, whilst the noise source in the emission room is silenced, must at least be made at the beginning and at the end of the measuring process, if the background noise is fluctuating. A correction of the background noise in the reception room must be affected, if the pressure level of the emission source, measured in the reception room, is between 3 and 10 dB above the background noise. If one measures more than 10 dB difference, a correction of the background noise is not required, if one measures less than 3 dB difference, the result of an insulation treatment can be given only as an indication and cannot be compared with warranted values.

WARRANTY SHEET 6

STANDARDIZED OR NORMALIZED SOUND PRESSURE LEVEL DIFFERENCE BETWEEN TWO ROOMS

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
E-mail		**E-mail**	
Construction site address		**Building / Installation to be treated**	

The standardised or normalized sound pressure level difference between two rooms allows for controlling the efficiency of the implementation:

- of a total or partial partitioning of a room,
- of an acoustic lining of a separation screen or of lateral screens,
- of a treatment of weak points (canalization, ducts, tightness of joints)
- of placing an acoustic barrier between roof and suspended ceiling**.**

The sound pressure level difference measurement does not allow for controlling the efficiency of absorption treatment neither in the emission nor in the reception room, or of acoustic treatment of the noise source (anti vibration, silencers, Damping…)

Note: The level difference D is the difference between the sound pressure levels in the reception and the emission room. It depends on the reception room's acoustical characteristics.

To achieve a normalized level difference between two rooms D_n , one must correct the level difference by calculating the level difference one would obtain if the reception room had an equivalent absorption reference area A_0 : D_n **= D - 10 log (A/A₀),** where A is the actual equivalent absorption area in the reception room.

To achieve a standardised level difference between two rooms D_{nT} , one must correct the level difference by calculating the level difference one would obtain if the reception room had a reference reverberation time T_0 : $D_{nT} = D + 10 \log (T/T_0)$ where T is the actual reverberation time of the reception room.

In all tables, the octave band value is given in dB, and the global value is given in dBA.

Date		**Done in 2 copies, at**	
Number of annexes		**The Client**	**The Company**
Price of the intervention (EUROS excl. VAT)			
Starting date			
Intervention ending date			

WARRANTY SHEET 6

STANDARDIZED OR NORMALIZED SOUND PRESSURE LEVEL DIFFERENCE BETWEEN TWO ROOMS

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which its obligation to achieve defined results is based.

In this FESI Acoustic Warranty Code based on the "Code de Garantie" of the "Syndicat National de l'Isolation" of France, the warranties of acoustic performance for a product demand, a complete measurement report of the acoustic sound reduction index and the normalised sound level difference of little parts, according to the measuring protocol defined in the standards EN ISO 140, for every product or constructive system clearly identified in brand, type, nature, and dimensions, tested in a laboratory under assembling conditions similar to those planned for the implementation on the building site..

INITIAL LEVEL DIFFERENCE BETWEEN TWO ROOMS (if necessary), WARRANTED LEVEL DIFFERENCE AND MEASUREMENT PROTOCOL

Preliminary note: The level differences can either be values by octave bands, or unique values as defined in EN ISO 717 - 1, or global values in dBA for a special emission spectrum.

Type of room

emission room	
reception room	

Type of emission noise ☐ pink noise ☐ traffic noise

☐ noise with the following spectrum

F (Hz)	63	125	250	500	1000	2000	4000	8000
L_p (dB ref $2 \cdot 10^{-5}$ Pa)								

- **Initial level difference, normalized D_{ni} or standardised D_{nTi}, based on measurements of A and T: the measurement protocol is defined in the standard EN ISO 10052**

F (Hz)	63	125	250	500	1000	2000	4000	8000
D_{ni} (dB)								
D_{nTi} (dB)								
T_i (s)								

T_0 = sec A_0 = m²

Normally, in rooms in residential buildings, A_0 = 10 m² and T_0 = 0.5 s are the values used for all frequencies.

Unique initial values	D_{niw}=	dB	D_{niw} + C =	dB	D_{niw} + C_{tr}=	dB
	D_{nTiw}=	dB	D_{nTiw} + C=	dB	D_{nTiw}+ C_{tr} =	dB

Acoustic initial level difference in dBA for the spectrum :

D_{ni} = dBA D_{nTi} = dBA

WARRANTY SHEET 6

STANDARDIZED OR NORMALIZED SOUND PRESSURE LEVEL DIFFERENCE BETWEEN TWO ROOMS

Standardized D_{nT}, or normalized D_n, level differences between two rooms; acoustic warranty

f (Hz)	63	125	250	500	1000	2000	4000	8000
D_n (dB)								
D_{nT}(dB)								

Unique warranted values

D_{nw}= dB $D_{nw} + C$ = dB $D_{nw} + C_{tr}$= dB

D_{nTw}= dB $D_{nTw} + C$= dB $D_{nTw} + C_{tr}$ = dB

Warranted level differences in dBA for the spectrum **:**

D_n = dBA D_{nT} = dBA

Standardized D'_{nT}, or normalized D'_n, level differences between two rooms, based on measurements of A and T; measured values after intervention

f (Hz)	63	125	250	500	1000	2000	4000	8000
D'_n (dB)								
T_r (s)								
D'_{nT}(dB)								

Unique measured values

D'_{nw}= dB $D'_{nw} + C$ = dB $D'_{nw} + C_{tr}$= dB

D'_{nTw}= dB $D'_{nTw} + C$= dB $D'_{nTw} + C_{tr}$ = dB

Warranted level differences in dBA for the spectrum :

D'n = dBA D'nT = dBA

CRITERIA ALLOWING TO JUDGE THE PERFORMANCE OBTAINED AFTER INTERVENTION REGARDING THE COMPANY'S COMMITMENTS

Note: The prevision of the acoustic level difference has a global uncertainty that is connected to numerous factors including the uncertainty regarding the construction products' and systems' performance, the uncertainty regarding the used mathematical models, and the uncertainty due to measurement and rounding.

The level differences measured at frequency intervals are given in 0.1 dB. The warranted level difference in a definite frequency interval, the unique values and global values in dB A will be rounded to the nearest dB. Where the calculation in tenth of decibels leads to 0.5 dB it will be rounded to the upper dB.

In order to examine the conformity of an installation, generally one accepts a tolerance of 3 dB in the warranted level difference; but this can be lowered, even a 0-tolerance can be contracted.

Note: If the tolerance is lowered or put to 0, it is strongly recommended, to take the uncertainty into account. If the tolerance is put to 0, the values D_n or D_{nT} , the "objectives of the assignment" must be set to the warranted values plus/minus 3dB.

Examples: the level difference values measured after intervention, D'_{nT} , are they conform to the warranted target differences D_{nT} ?

C: conforming, NC: not conforming

	Frequencies 's uncertainty	125	250	500	1000	2000	4000
D nT warranted		40	44	48	52	56	60
D' nT measurement		37.6	40.2	46.0	50.1	56.1	58.0
	3 dB	C	NC	C	C	C	C

WARRANTY SHEET 6

STANDARDIZED OR NORMALIZED SOUND PRESSURE LEVEL DIFFERENCE BETWEEN TWO ROOMS

In the following table, there is an example for conclusion without uncertainties.

	D_{nTw} + C (dB)		D_{nTw} + C_{tr} (dB)		D_{nT} in dB(A)	
Guarantee value	>= 50		>= 47		>= 42	
Guarantee target	53		50		45	
Measured value	49	51	47	49	41	46
conclusion	NC	C	C	C	NC	C

Some advice how to use this sheet:

- The Table ' Type of room': the information about the volume of the reception room is useful for the calculation of the areas of equivalent absorption from the reverberation times (formula Sabine)

- Type of emission noise: the pink noise or traffic noise, are conventional sounds, the octave-band spectrum of which is well defined in the standards EN ISO 717 – 1 and EN ISO 140. On the other hand, one could be obliged not to exceed a noise level in the reception area, expressed in dBA, when a well identified noise source works in an adjacent room (e.g. a building equipment room with ventilation machinery). Knowing the noise that is generated there, and the level that must not be exceeded in the reception room, one can deduce the sound insulation in dBA that must be achieved. For an insulation in dBA, dependent on the emission spectrum of the noise, the knowledge of that spectrum is required.

- The tables of the initial and the warranted level differences: not all the boxes need to be completed. Only the boxes for the desired type of sound insulation (determined by the research or demanded by the customer) are required. It is indispensable to have the same information in the two tables, “initial” and "warranted” level difference. As the unique values are determined from values by frequency ranges, it is useful to complete the appropriate boxes in the table “initial level difference”.

Reminder:

- The unique values to be used for the level differences between rooms are specified in EN ISO 717 - 1. They are determined from the spectrum of the level differences by frequency bands. In France, the octave bands are being used for measurements in situ. The comparison of this spectrum, with a reference spectrum, allows for obtaining weighted level differences, D_{nW} or D_{nTw}, dependent upon whether a normalized or a standardized level difference is sought. An overall calculation of the level difference in dB (A) for pink noise or for traffic noise to the level of the original emission, yields two adaptation terms C and C_{tr}. In French regulations for determining the acoustic requirements of buildings, the acoustic level difference between rooms is a standardized level difference, for a pink noise in the source room, $D_{nTA,}$ which is equal to D_{nTw} +C. For the sound pressure level differences from outside noise, the standardized level difference $D_{nTA,tr}$, which is equal D_{nTw} + C_{tr} is being used. These level differences D_{nTA} or $D_{nTA.tr}$, despite their resulting from a global calculation in dB (A), are given in dB.

- The notion of standardized level differences is not used very commonly in France. But , it is very much used in other countries, so it needed to be included into this “Code de Guarantee”

WARRANTY SHEET 6

STANDARDIZED OR NORMALIZED SOUND PRESSURE LEVEL DIFFERENCE BETWEEN TWO ROOMS

Annex 1: The importance of reverberation time in a room

- In case of standardized DnT acoustic insulation, sound insulation is calculated, as if one had measured insulation, with reverberation time in the receiving room equal to a reference reverberation time T0.
  - **DnT = D + 10 log10 (T/T0) where D is the raw sound insulation**
- D = L2-L1, which is the sound pressure level in the source room minus the sound pressure level in the receiving room. In fact, it is the sound pressure level at the reception which is corrected:
  - $L_{2nT} = L_2 - 10 \log_{10} (T/T_0)$
- In case of acoustic insulation being measured at different periods (the delay between the initial measurements and the final measurements may be more or less important), the reverberation time of the receiving room can be very different. If the receiving room is more reverberant during the final measurement than during the initial measurement, the sound pressure level at the reception, for the same level of emission, will be higher than it would have been with the same condition of reverberation, and sound insulation will be less than it would have been if the reverberation time had not changed. It is necessary, therefore, to control the reverberation time. In this case, one does not calculate the sound insulation which would have been reached, if the reverberation time had been a reference period, but instead one calculates the sound insulation that would have been achieved, if the reverberation time had been the same as in the initial measurements.

D' corrected= D' (measured) + 10 log10 (T'r / Ti)

Where T'r is the reverberation time during the final measurements and Ti the reverberation time during the initial measurements in the receiving room.

Note:

In all problems of acoustic insulation of air-borne noise between rooms, one must examine the direct transmission through the wall of separation between the rooms, but also lateral transmissions through walls, linked to the wall of separation, and as well parasite transmissions: holes, passages pipes or ducts, intakes of power components ..In case of an existing situation, it is necessary to make a diagnosis to identify the predominant paths of acoustic transmission, in order to give them priority treatment .

During the measurements, one must be sure to characterize the sound insulation between rooms. For this, the sound pressure level in the source room, must be high enough, so that the sound pressure level in the receiving room is not influenced by the background noise in that room. A measurement of the background noise in the receiving room, whilst the noise source in the emission room is silenced, must at least be made at the beginning and at the end of the measuring process, if the background noise is fluctuating. A correction of the background noise in the reception room must be affected, if the pressure level of the emission source, measured in the reception room, is between 3 and 10 dB above the background noise. If one measures more than 10 dB difference, a correction of the background noise is not required, if one measures less than 3 dB difference, the result of an insulation treatment can be given only as an indication and cannot be compared with warranted values.

WARRANTY SHEET 7
SOUND PRESSURE LEVEL DIFFERENCE FROM EXTERNAL NOISE

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
E-mail		**E-mail**	
Construction site address		**Subject of the intervention**	

Note: In all tables, the octave band value is given in dB, and the global value is given in dBA.

The sound pressure level difference from outside noise allows for controlling the effectiveness of the possible corrective actions listed below: (put a cross in the box or boxes used)

	Tightness of windows		Treatment of air inlets
	Replacing of windows		Treatment of roller shutter boxes
	Double-glazed window		Doublings of the opaque parts of the facade
	Installation of a window dubbing		Treatment of roofs or attics
	Replacement of a window		sound absorption at the reception *

* Only in case of sound level difference

Reminder:

The sound level difference, can be considered as normalized or as standardized sound level difference, in one or more frequency bands, or expressed as unique values as defined in standard EN ISO 717 - 1

In case of sound level difference, it is useful to control the reverberation time before and after the acoustical improvement work, it can be modified by the client (modification of the clutter, of wall coverings ...).

To protect oneself against a particular external noise, it may be necessary to consider an overall sound insulation in dBA calculated for the spectrum of the noise.

Date		**Done in 2 copies, at**	
Number of annexes		**The Client**	**The Company**
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Starting date			
Intervention ending date			

WARRANTY SHEET 7
SOUND PRESSURE LEVEL DIFFERENCE FROM EXTERNAL NOISE

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions, on which its obligation to achieve defined results is based.

In this FESI Acoustic Warranty Code based on the "Code de Garantie" of the "Syndicat National de l'Isolation" of France, the warranties of acoustic performance for a product demand, a complete measurement report of the acoustic sound reduction index according to the measuring protocol defined in the standards EN ISO 140, of the sound reduction index variation in case of lining, of the normalised sound level difference of little parts, for every product or constructive system clearly identified in brand, type, nature, and dimensions, tested in a laboratory under assembling conditions similar to those planned for the implementation on the building site..

INITIAL ACOUSTIC LEVEL DIFFERENCE (if necessary), WARRANTED ACOUSTIC LEVEL DIFFERENCE AND MEASUREMENT PROTOCOL

Preliminary note: The acoustic level differences can be values by octave bands or unique values as defined in EN ISO 717 - 1, or global values in dBA for a special emission spectrum.

Type of local

emission room		
reception room		Volume= m^3

Type of emission noise ☐ pink noise ☐ traffic noise

☐ noise described in the table below in octave bands at the central frequency f.

f (Hz)	63	125	250	500	1000	2000	4000	8000
Lp (dB ref $2 \cdot 10^{-5}$ Pa)								

- **Initial acoustic level difference D_i normalised D_{ni}, or standardised D_{nTi} :** the measurement method is defined in the standard EN ISO 10052

f (Hz)	63	125	250	500	1000	2000	4000	8000
D_i (dB)								
T_i (s)								
D_{ni} (dB)								
D_{nTi} (dB)								

T_0 = sec A_0 = m^2

Normally, in rooms in residential buildings, A_0 = 10 m^2 and T_0 = 0.5 s are the values used for all frequencies.

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Unique measured values	D_{iw}=	dB	$D_{iw} + C$ =	dB	$D_{iw} + C_{tr}$=	dB
	D_{niw}=	dB	$D_{niw} + C$=	dB	$D_{niw} + C_{tr}$ =	dB
	D_{nTiw}=	dB	$D_{nTiw} + C$=	dB	$D_{nTiw} + C_{tr}$ =	dB

WARRANTY SHEET 7
SOUND PRESSURE LEVEL DIFFERENCE FROM EXTERNAL NOISE

Acoustic initial level difference in dBA for the spectrum :

D_{Ai} = dBA D_{nAi} = dBA D_{nTAi} = dBA

Warranted level difference D , standardized D_{nT}, or normalized D_n, ;

f (Hz)	63	125	250	500	1000	2000	4000	8000
D (dB)*								
D_n (dB)								
D_{nT} (dB)								

Unique	D_{iw}=	dB	D_{iw} + C =	dB	D_{iw} + C_{tr}=	dB
measured	D_{niw}=	dB	D_{niw} + C=	dB	D_{niw}+ C_{tr} =	dB
values	D_{nTiw}=	dB	D_{nTiw} + C=	dB	D_{nTiw}+ C_{tr} =	dB

The level difference has to be corrected by the initial reverberation time of the reception room,
Acoustic initial level difference in dBA for the spectrum :

D = dBA D_n = dBA D_{nT} = dBA

CRITERIA ALLOWING FOR AN ASSESSMENT OF THE OBTAINED PERFORMANCE AFTER INTERVENTION REGARDING THE CONTRACTOR'S WARRANTED RESULT OBLIGATIONS.

Note: The prediction of an acoustic sound pressure level difference has a fundamental uncertainty that is caused by numerous factors including the uncertainty regarding the construction products' and systems' performance, the uncertainty in the mathematical models used, and the uncertainties in measurement and rounding.
The sound pressure level differences measured in definite frequency intervals, before and after the intervention, are given in tenth of 1 decibel. The sound pressure level differences warranted by frequency intervals and the differences given in global values in dBA, are rounded to the nearest decibel. Where the calculation of tenth of decibel terminates at 0,5 dB, the rounding is to the upper dB.
The generally accepted uncertainty, to be taken into consideration when interpreting the results of the measurements taken prior to the commencement of work to be able to assess the conformity or the non-conformity of the improvement achieved to the warranted values, is 3 dB. It should be included in the contract about the warranted values.
Note: Where the uncertainty is not included in the contract, it is strongly recommended to take it into account in the target values of the investigation. If the uncertainty is included, the value D_w, "target value of the project" is then the warranted value augmented by 3 dB or dBA.

WARRANTY SHEET 7
SOUND PRESSURE LEVEL DIFFERENCE FROM EXTERNAL NOISE

Examples: the level difference values measured after intervention, D'_{nT} , are they conform to the warranted target differences D_{nT} ?

C: conforming, NC: not conforming

	Frequency	125	250	500	1000	2000	4000
D' nT guarantee		25	29	33	37	41	45
D' nT measurement		22.6	25.2	31	35.1	41.1	43
Uncertainty	3 dB	C	NC	C	C	C	C

In the following table, there is example for conclusion without uncertainties. The target is the study target

	D_{nTA} (dB)		$D_{nTA,tr}$ (dB)		D_{nT} (dBA)	
Guarantee value	>= 35		>= 32		>= 27	
Guarantee target	38		35		30	
Measured value	34	36	32	34	26	31
conclusion	NC	C	C	C	NC	C

* The target value is objective for the study of solutions. It reflects an uncertainty of 3 dB, the average gap often found between prediction and measurement.

Some help to use this form:

- Table 'nature of the rooms' means that the indication of the volume of the receiving room is useful to calculate the areas of equivalent absorption from reverberation times (formula Sabine)

- Nature of the noise emission: the pink noise or traffic noise, are conventional sounds, whose spectra are well defined in the standard EN ISO 717 -1. On the other hand, one could be obliged not to exceed a sound level at the reception area expressed in dBA, when a well identified noise source works in adjoining premises (for example a plant room with plants of air). Knowing the noise at the outside in front of the façade of the reception area, and the level one must not exceed in the receiving room, one can deduce the sound insulation value in dBA that must be achieved. For an insulation value in dBA, dependent on the emission spectrum of the noise, the knowledge of that spectrum is required.

WARRANTY SHEET 7
SOUND PRESSURE LEVEL DIFFERENCE FROM EXTERNAL NOISE

- Tables of the warranted initial acoustic insulation: not all boxes are required. Only the boxes need to be ticked off, that hold the intended type of sound insulation, (determined by the study or requested by the customer).
  One must have the same information in the two tables, “initial insulation” and "warranted insulation". As the unique values are determined from values by frequency ranges, it is not useless to complete the appropriate boxes in the table “initial acoustic level difference”.
  But, in the table of warranted values, it is not useful to fill the boxes by frequency ranges, where a unique value is sought.

Annex 1: The importance of reverberation time in a room

In case of standardized DnT acoustic insulation, sound insulation is calculated, as if one had measured insulation, with reverberation time in the receiving room equal to a reference reverberation time T0.

DnT = D + 10 log10 (T/T0) where D is the raw sound insulation

D = L2-L1, which is the sound pressure level in the source room minus the sound pressure level in the receiving room. In fact, it is the sound pressure level at the reception which is corrected:

$$L_{2nT} = L_2 - 10 \log_{10} (T/T_0)$$

In case of acoustic insulation being measured at different periods (the delay between the initial measurements and the final measurements may be more or less important), the reverberation time of the receiving room can be very different. If the receiving room is more reverberant during the final measurement than during the initial measurement, the sound pressure level at the reception, for the same level of emission, will be higher than it would have been with the same condition of reverberation, and sound insulation will be less than it would have been if the reverberation time had not changed. It is necessary, therefore, to control the reverberation time. In this case, one does not calculate the sound insulation which would have been reached, if the reverberation time had been a reference period, but instead one calculates the sound insulation that would have been achieved, if the reverberation time had been the same as in the initial measurements.

D' corrected= D' (measured) + 10 log10 (T'r / Ti)

Where T’r is the reverberation time during the final measurements and Ti the reverberation time during the initial measurements in the receiving room.

Caution!:

It is not prudent to measure the acoustic insulation for the outside noise using the real source. If the level difference is the right one, we may measure, in the receiving room, the residual noise level, and not the noise level of the source, which sometimes leads to findings of non-compliance. It is more effective for measuring the acoustic insulation, to use an external artificial source, capable of producing a high enough emission level, so that the sound pressure level in the reception room will be well above the residual noise.

WARRANTY SHEET 8

SOUND PRESSURE LEVEL OF IMPACT SOUND
(or attenuation of impact sound pressure level)

18.07.2013

Client (name and address)		**Company** (name and address)	
Contact		**Contact**	
Telephone		**Telephone**	
Fax		**Fax**	
E-mail		**E-mail**	
Construction site address		**Subject of the intervention**	

The warranty for impact sound, or for an impact sound attenuation, is available for,

- implementation of a floor covering in the emission room
- implementation of a floating floor in the emission room
- decoupling of walls in the reception room
- dubbing walls in the reception room
- absorbent treatment in the reception room (limited effectiveness of the raw values)

Note:

The impact sound treatment effectiveness is controlled by a normalized tapping machine in situ, the levels of impact sound are registered as L' and they are :

- "normalized": for acoustic equivalent absorption area A_0 : $L'_n = L' + 10\text{Log}_{10}(A/A_0)$, where A is the acoustic equivalent absorption area of the reception room.
- "standardized" for an reverberation time of reference T_0 : $L'_{nT} = L' - 10\text{Log}_{10}(T/T_0)$, where T is the reverberation time of the reception room.

The unique values L'_{nw} ou L'_{nTw} are obtained by the comparison of measured sound pressure level curve, dependent upon the frequency, with the reference curve.

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WARRANTY SHEET 8

SOUND PRESSURE LEVEL OF IMPACT SOUND (or attenuation of impact sound pressure level)

18.07.2013

WARRANTY OF THE ACOUSTIC PERFORMANCE OF PRODUCTS AND CONSTRUCTIVE SYSTEMS, the implementation of which is proposed by the company in the context of improvement actions on which its obligation to achieve defined results is based.

In the present Acoustic Warranty Code of the "Syndicat National de l'Isolation" (Isolation Syndicate of France), the certificates of acoustic performance for a product demand a report of measurements conducted in an acoustic laboratory as defined in the standard EN ISO 140, for perfectly identified products, in brand, type, nature, and dimensions, tested in a laboratory under assembling conditions similar to those planned for the implementation on the building site.

INITIAL IMPACT SOUND LEVEL (IF NECESSARY), WARRANTED IMPACT SOUND LEVEL AND RELATED MEASUREMENT PROCEDURE:

Preliminary note: The impact sound pressure levels considered, can either be values by octave bands, or unique values as defined in EN ISO 717 - 2, or global values in dBA.

Type of local

emission room		
reception room		Volume= m^3

- **Initial impact sound pressure level , normalized (L_{ni}), or standardized (L_{nTi}): the measurement procedure is defined in the standards EN ISO 10052 and EN ISO 140-7.**

f (Hz)	125	250	500	1000	2000	(4000)
L'_{ni} (dB ref $2 \cdot 10^{-5}$ Pa)						
T_{ri} (s)						
L'_{nTi} (dB ref $2 \cdot 10^{-5}$ Pa)						

T_0 = sec A_0 = m^2

Normally, in rooms in residential buildings, A_0 = 10 m^2 and T_0 = 0.5 s are the values used for all frequencies.

Unique initial values

L'_{niw} = dB

L'_{nTi} = dB

L'_{niw} = dBA

WARRANTY SHEET 8

SOUND PRESSURE LEVEL OF IMPACT SOUND (or attenuation of impact sound pressure level)

18.07.2013

Warranted impact sound pressure level, normalized (L_n), or standardized (L_{nT}).

F (Hz)	125	250	500	1000	2000	(4000)
L'_n (dB ref $2 \cdot 10^{-5}$ Pa)						
T'_r (s)						
L'_{nT} (dB ref $2 \cdot 10^{-5}$ Pa)						

Unique measured values

L'_{nw} = dB

L'_{nT} = dB

L'_{nw} = dBA

CRITERIA ALLOWING TO JUDGE THE PERFORMANCE OBTAINED AFTER INTERVENTION REGARDING THE COMPANY'S COMMITMENTS

Note: The prevision of the acoustic impact sound level has a global uncertainty that is connected to numerous factors including the uncertainty regarding the construction products' and systems' performance, the uncertainty regarding the mathematical models used, and the uncertainty due to measurement and rounding.

The impact sound pressure levels measured in frequencies , before and after the intervention, are given in 0.1 dB. The warranted values in frequencies, the unique values and global values in dBA, will be rounded to the nearest decibel. If the calculation in 0.1 dB comes to a 0.5 dB value, it will be rounded to the lower dB value.

The generally accepted uncertainty, which one has to take into account when interpreting the measurement results after the improvement measures, to establish the conformity or non-conformity to the warranted values, is 3 dB or dBA. It may be included in the written contract.

Note: If the uncertainty is not included in the contract, it is strongly advised, to take them into account in the target values of the improvement assignment. If the uncertainty is included in the contract, the values L'n or L'nT will be the warranted target values minus 3 dB or dBA

WARRANTY SHEET 8

SOUND PRESSURE LEVEL OF IMPACT SOUND
(or attenuation of impact sound pressure level)

18.07.2013

Examples: the impact sound pressure level after intervention (L'_{nTw}) is it conform to the guaranteed target difference (L'_{nTw}). In this example, the 3 dB – uncertainty was included in the contract.

C: conforming, NC: not conforming

guaranteed value L'_{nTw}	50					
measured value L'_{nTw}	48	50	51	53	54	56
conclusion	C	C	C	C	NC	NC

Important notes :

1. For a sound produced by a normalized tapping machine on a heavy floor, type concrete slab, gas concrete, a reliable methodology of forecast exists (standard EN 12354-2). Also, the performance of ΔL_w of a floor covering is measured in a laboratory with a floor made of concrete slab. However, where the floors are light, such as floor assemblies in wood or metal, a reliable methodology of forecast doesn't exist. The performance of the flooring on such supports is often less than 10 dB over that measured on solid slab. **With such light floors it's very difficult to warrant a result.** In case there are many locations to be treated, it is advisable to test a location before committing to warranting results.

2. In a laboratory, one measures a normalized impact sound pressure level diminution of a floor covering. On the building site, in France, most often, one aims at achieving a standardized impact sound pressure level. The transformation of the one to the other is achieved with the equation below:
One can use the formula:

$$L_{nT} = L_n - 10 \log_{10}(0{,}16\ V/(A_0\ T_0)) \text{ or } L_{nT} = L_n - 10 \log_{10}(0{,}032\ V)$$

With $A_0 = 10\ m^2$ and $T_0 = 0{,}5\ s$

Where V is the reception room's volume (in m^3)

3. – In a laboratory, the impact sound pressure level transmission only passes through the floor between the reception and emission room. In a building, one has also lateral transmissions through the walls which are vertically joined to the separating floor. Generally, these lateral transmissions are less important than the direct transmission via the floor but if one wants to treat the problem only by putting an effective acoustic coverage on the ceiling in the reception room, the lateral transmission via the walls become preponderant, and the result will not be good. In that case one has also to treat the lateral transmissions.

Annex 1: The importance of reverberation time in a room
In case of standardized LnT acoustic insulation, sound insulation is calculated, as if one had measured insulation, with reverberation time in the receiving room equal to a reference reverberation time T_0.

$L_{nT} = L_n - 10 \log_{10}(0{,}16\ V/(A_0\ T_0))$ or $L_{nT} = L_n - 10 \log_{10}(0{,}032\ V)$

WARRANTY SHEET 8

SOUND PRESSURE LEVEL OF IMPACT SOUND (or attenuation of impact sound pressure level)

18.07.2013

In case of acoustic insulation being measured at different periods (the delay between the initial measurements and the final measurements may be more or less important), the reverberation time of the receiving room can be very different. If the receiving room is more reverberant during the final measurement than during the initial measurement, the sound pressure level at the reception, for the same level of emission, will be higher than it would have been with the same condition of reverberation, and sound insulation will be less than it would have been if the reverberation time had not changed. It is necessary, therefore, to control the reverberation time. In this case, one does not calculate the sound insulation which would have been reached, if the reverberation time had been a reference period, but instead one calculates the sound insulation that would have been achieved, if the reverberation time had been the same as in the initial measurements.

$$\mathbf{L'_n\ corrected = L'\ (measured) + 10\ log10\ (T'r\ /\ Ti)}$$

Where T'r is the reverberation time during the final measurements and Ti the reverberation time during the initial measurements in the receiving room.