

New French acoustic regulation for buildings undergoing thermal renovation

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Summary

Since July 2017 a new acoustic regulation is applicable for some buildings undergoing a thermal renovation. The concerned buildings are lodging buildings, educational buildings, healthcare facilities and hotels; more specifically only some room types are covered with acoustic requirements. These acoustic requirements only concern façade sound insulation. Furthermore, the targeted building have to be located in specific noisy environment. This paper describes which thermal renovation implies the respect of this new regulation. The acoustic requirements are then presented for the different situations of the building with respect to outdoor noise condition. In order to select the acoustic performance of some building façade components such as windows, air-inlet, etc..., either a specific acoustic analysis or predefined performance depending on different configurations is required. These predefined performances are presented. Differences with the current regulation for new buildings of the same type concerning sound insulation with respect to outdoor noise is also discussed. Finally, the application guide developed in order to support the implementation of this new acoustic regulation is introduced.

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1. Introduction

The law n°2015-992 from August 17th, 2015 relative to the energy transition to support green growth, makes mandatory the respect of minimum acoustic performances in the context of major energy related renovation, of façade renovation, of re-roofing, and of refurbishment work of rooms or parts building to make them habitable, when the concerned existing buildings are located in areas of high outdoor noise level and in noise pollution plans.

This measure allows to seize the opportunities of major rehabilitation work chosen by a project manager to integrate the sound insulation issues regarding outdoor transportation noise.

Following this law, a decree was published in June 2016, and an order in April 2017.

Therefore, since July 2017 a new acoustic regulation is applicable for some buildings undergoing a thermal renovation. The concerned buildings are lodging buildings, educational buildings, healthcare facilities and hotels; more specifically only some room types are covered with acoustic requirements. These acoustic requirements only concern façade sound insulation. Furthermore, the targeted building have to be located in specific noisy environment. This paper describes which thermal renovation implies the respect of this new regulation. The acoustic requirements are then presented for the different situations of the building with respect to outdoor noise condition. In order to select the acoustic performance of some building façade components such as windows, air-inlet, etc..., either a specific acoustic analysis or predefined performance depending on different

configurations is required. These predefined performances are presented. Differences with the current regulation for new buildings of the same type concerning sound insulation with respect to outdoor noise is also discussed. Finally, the application guide developed in order to support the implementation of this new acoustic regulation is introduced.

2. Decree no 2016-798 of June 2016

The decree published in June 2016 [1] defines the buildings, the building rooms and the building elements concerned by the acoustic performance, the noise affected zones. It leaves to an upcoming order the task of defining the acoustic performance levels to be respected. This upcoming order was published in April 2017 and is detailed in the next section.

The considered major energy related renovations correspond to rehabilitation works in application of the existing building energy regulation or of articles R 131-28-7 to R 131-28-11 of the French building code. These impose thermal insulation works in case of façade renovation, of re-roofing, and of refurbishment work of rooms or parts building to make them habitable.

The rooms and buildings aimed by the decree are

- main rooms of lodgings, i.e. living rooms, bedrooms as well as premises for professional use located in a lodging ;
- teaching rooms (excepted those dedicated exclusively to sports practices), nursery school resting rooms, offices and meeting rooms in educational buildings,
- accommodation and nursing rooms in healthcare facilities;
- bedrooms in hotels.

The building has to be located in a zone affected by transportation noise, i.e. land and air transport infrastructures (road, rail and air traffic).

3. Order of April 2017

The order published in April 2017 [2] relative to the acoustic characteristics of existing buildings undergoing major energy related renovations defines the implementation rules following the June 2016 decree. It offers two possibilities to verify the minimum acoustic performance requirements:

- An acoustic investigation prior to the rehabilitation work
- The respect of acoustic performance demands on components

It explains the requirement levels targeted depending on the location the considered building with respect to the outdoor noise exposure zoning. The concerned outdoor noise exposure zoning correspond to the 3 zone types associated to the noise disturbance plan (PGS in French standing for plan de gêne sonore) related to a dozen of French airports (see [3]), and the strategic noise maps of type « c » (referred in the following as C-maps) for road and rail traffic.

It should be mentioned that the PGS consists of a report and a map (scale: 1/25000) showing the 3 zones:

- zone 1, denoting a very high level of noise pollution within the L_{den} 70 index curve;
- zone 2, denoting a high level of noise pollution between the L_{den} 70 and L_{den} 65 or 62 curves;
- zone 3, denoting a moderate level of noise pollution between the L_{den} 65 or 62 and L_{den} 55 index curves.

The C-maps represent the zones above the following limits :

- $L_{den} \geq 68$ dB(A) et $L_n \geq 62$ dB(A), for roads and high speed rail lines ;
- $L_{den} \geq 73$ dB(A) et $L_n \geq 65$ dB(A), for standard rail lines.

Table I presents the defined three levels (basic level, improved level and reinforced level) and their corresponding façade sound insulation. When the building is located at the same time in a C-map and a PGS zone, then the highest sound insulation level given in Table I should be targeted.

Furthermore the targeted façade sound insulation can be modified subject to a justification and calculation note following a specific acoustic investigation. This calculation note has to present the different elements having allowed to determine a different façade sound insulation target (with respect to the existing regulation, noise exposure, diagnostic of the existing situation, etc...).

The acoustic performance requirements on components concern the façade or roofing elements and are provided in 2 annexes of the April 2017 order. An example is given in Table II for the improved level case (concerning Zone 2 PGS and C-maps). It can be seen that the components performance depends on different ratios (openings total surface to room floor surface, and roof surface to room floor surface); as would be expected, the larger the opening the higher the required acoustic performance.

Table I. Acoustic performance levels and their corresponding façade sound insulation.

<i>Building location</i>	<i>Acoustic performance level</i>	<i>Targeted façade sound insulation $D_{nT,A,tr}$</i>	<i>Acoustic solutions</i>
PGS zone 1	Reinforced	38 dB	Determined by an acoustic investigation
PGS zone 2	Improved	35 dB	Respect of acoustic performance demands on components or
C-map		35 dB	
PGS zone 3	Basic	32 dB	Determined by an acoustic investigation

4. Application guide

The goal of the application guide [4] is to facilitate the application of this new regulation concerning the acoustic requirements in case of major energy related renovations.

The application guide provide information on the buildings and rooms concerned, the types of renovation aimed, the noise exposure zoning and details on the acoustic performance by providing examples. The different regulations applicable through time as well as certifications and other programs related to noise limitation are also listed; this information can help evaluating the initial acoustic situation. Another section provides general material on building acoustics and elements acoustic performance. The guide also includes a final section regarding compatibility between energy renovation and ventilation.

It is clearly stated that the energy renovation should not deteriorate the initial acoustic situation, since the risk is that the occupants will hear more the interior noise (from service equipments, neighbors, etc...) once façade sound insulation is improved. Therefore, throughout the guide, a specific acoustic study is always recommended (when not mandatory) in order to define the most appropriate solution regarding the occupants comfort.

One major issue explained in the guide is where and how the information about noise zone mappings (PGS and C-maps) can be found and used. Indeed, the PGS maps can be accessed on the IGN (national institute for geographic and forest information) web site www.geoportail.gouv.fr. An example of the map available is shown in Figure 1; in that case the building with the entered address is out of the PGS zone and therefore is not concerned by the new regulation. The C-maps are little trickier to obtain since there is not a single place to find them; indeed they can be edited by agglomerations of more than

100000 habitants (this list is updated at least every 5 years, last update was December 2017, see Article L 572-2 of Code de l'Environnement [5]) or for important land infrastructures (roads and rail lines) with respect to their circulation traffic. It is recommended to use C-maps edited by agglomerations since they combine noise sources of the same types. From the C-maps (see example in Figure 2), the noise exposed façades are those intersecting or tangent to the zones where limit values are exceeded.



Figure 1. Example of building with respect to PGS zones.



Figure 2. Example of buildings with respect to C-map associated to road traffic.

It should be noted that the current acoustic regulation with respect the outdoor noise for new buildings (if applicable) is not based on the same

principle; indeed it refers for land transportation infrastructure to classification of road and rail line (classes 1 to 5 depending on levels during the 2 periods 6-22h and 22-6h). This classification is supposedly based on a 20-year projection horizon of the road/rail traffic. For this new regulation, C-maps were chosen since they are mandatory (European noise mapping directive) and should be regularly updated (every 5 years). Therefore C-maps should represent more appropriately the current actual outdoor noise environment. As a consequence, the targeted façade sound insulation could be different for 2 buildings closely located (with the same outdoor noise pollution) one in construction and one much older under renovation. Obviously, it would be quite hazardous to enforce the same level of façade sound insulation on a new building and an old building solely undergoing façade renovation (due to interior noise and exterior noise balance). Thus, C-maps appeared to be a satisfactory compromise.

As mentioned previously, a specific acoustic investigation is mandatory

- when the building is located in PGS zone 1 (very high level of noise pollution),
- or when out of the cases considered in the order annexes providing the acoustic performance requirements for the façade components.

These out of cases correspond to

- the presence of a lightweight façade (mass per unit area $\leq 200 \text{ kg/m}^2$),
- the ratio (rE or rT) are out of the range of those indicated in the annexes table.

However, the application guide highly recommends an acoustic investigation:

- if the building is exposed to different noise sources, in order to better evaluate noise exposure and façade sound insulation target
- if a chimney is present on the roof to be renovated.

It is indicated that the acoustic investigation also allows a constructive discussion on the building specificities, on its situation, on the use of the rooms to be considered, and permits to define an optimal solution on the basis of a diagnostic and the non-degradation principle of the initial acoustic performance (before thermal retrofitting). Moreover, it is mentioned that it could be accompanied by a surveillance in the components implementation and the acoustic performance validation once the renovation is completed.

The importance of balancing sound insulation with respect to noise within the building and with respect

to outdoor noise is stated; indeed, it is well known that increasing the façade sound insulation too much might allowed emergence of interior noise (from other apartments, other rooms, etc...) that can be quite problematic for the occupants acoustic comfort.

The guide proposes the content of such an acoustic investigation

- a diagnostic of the acoustic situation for the considered building and rooms, i.e. date of construction, composition of the building, interior acoustic quality evaluation, outdoor noise environment ;
- the targeted façade sound insulation and the necessary components acoustic performance levels, justified by a calculation note if they are different from those stated in the new regulation, based on the diagnostic;
- the description of the necessary tasks in order to achieve the objectives;
- an estimation of the cost

Indeed this content should be defined before consulting acoustic professionals which include engineering offices or consulting engineers in acoustics having a professional civil liability insurance and decennial liability insurance.

Obviously, this acoustic investigation has to be coordinated with other aspects such as thermal, ventilation, etc...

Finally examples in the application of this new regulation are given. The following paragraph presents how to use Table II.

The first step is to define the target level as a function of the building noise environment. Let's consider that the building is located in the C-map zone and that the improved target level has to be respected.

The second step is to verify that the simple method following the components acoustic performance requirements given in Table II can be applied. Let's consider that it is the case (façade mass per unit area larger than 200 kg/m^2 , ratio rE or rT within the ranges of Table II).

The third step is to determine the components acoustic performance in Table II. To this end, let's consider a living room of 22 m^2 (floor area) with a 3 m^2 window, leading to a ratio rE of 0.14. Since there is a single air inlet and that this air inlet is incorporated into the window, the acoustic performance of the window including the air inlet has to be $R_w + C_{tr} \geq 34 \text{ dB}$. If the air inlet was not incorporated into the window, then it would be necessary to choose a window with an acoustic

performance of $R_w + C_{tr} \geq 34$ dB and an air inlet with an acoustic performance of $D_{n,e,w} + C_{tr} \geq 39$ dB. If the air inlet was incorporated into a roller shutter, then it would be necessary to choose a window with an acoustic performance of $R_w + C_{tr} \geq 34$ dB and a roller shutter including an air inlet with an acoustic performance of $D_{n,e,w} + C_{tr} \geq 45$ dB.

Therefore, the use of Table II for improved target level is rather simple, but all the possible cases cannot be covered and the components acoustic performance might not be optimal for the room considered. This is why an acoustic investigation is rather recommended.

5. Conclusions

Since July 2017 a new acoustic regulation is applicable for some buildings undergoing a thermal renovation. The concerned buildings are lodging buildings, educational buildings, healthcare facilities and hotels; more specifically only some room types are covered with acoustic requirements. These acoustic requirements only concern façade sound insulation. Furthermore, the targeted building have to be located in specific noisy environment.

This paper described the different acoustic requirements and the application guide associated to this new regulation applicable since the beginning of July 2017. Differences with the current regulation for new buildings of the same type concerning sound insulation with respect to outdoor noise was also introduced.

It should be noted that a specific acoustic study is always recommended (when not mandatory) in order to define the most appropriate solution regarding the occupants comfort.

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References

- [1] Décret no 2016-798 du 14 juin 2016 relatif aux travaux d'isolation acoustique en cas de travaux de rénovation importants, Journal officiel du 16 juin 2016, NOR : LHAL1526866D
- [2] Arrêté du 13 avril 2017 relatif aux caractéristiques acoustiques des bâtiments existants lors de travaux de rénovation importants, Journal officiel du 20 avril 2016, NOR : LHAL1617568A
- [3] Autorité de controle des nuisances aéroportuaires (ACNUSA), <http://www.acnusa.fr/en/>
- [4] Guide d'accompagnement de l'arrêté du 13 avril 2017 relatif aux caractéristiques acoustiques des bâtiments existants lors de travaux de rénovation importants, To be published, 2018.
- [5] [Code de l'environnement, Article L572-2.](#)

Table II. Acoustic performance requirements on components for the improved level.

Renovation work location	Changed elements	Ratio rS or rT*	Weighted sound reduction index or weighted element-normalized level difference		
			No air-inlet	1 air-inlet in room	2 air-inlets in room
Façade	Window, glazed door, exterior door, combined aperture frame	$rE \leq 0.3$	$R_w+C_{tr} \geq 31\text{dB}$	$R_w+C_{tr} \geq 34\text{dB}$	$R_w+C_{tr} \geq 34\text{dB}$
		$0.3 < rE \leq 0.5$	$R_w+C_{tr} \geq 33\text{dB}$	$R_w+C_{tr} \geq 36\text{dB}$	$R_w+C_{tr} \geq 36\text{dB}$
		$0.5 < rE \leq 0.7$	$R_w+C_{tr} \geq 34\text{dB}$	$R_w+C_{tr} \geq 37\text{dB}$	$R_w+C_{tr} \geq 37\text{dB}$
		$0.7 < rE \leq 0.8$	$R_w+C_{tr} \geq 36\text{dB}$	$R_w+C_{tr} \geq 41\text{dB}$	$R_w+C_{tr} \geq 41\text{dB}$
	Air-inlet	Not applicable		$D_{n,e,w}+C_{tr} \geq 39\text{dB}$	$D_{n,e,w}+C_{tr} \geq 41\text{dB}$
Roof of converted attic space *** or roof terrace	Window, glazed door, exterior door, combined aperture frame	$rE \leq 0.2$	$R_w+C_{tr} \geq 31\text{dB}$	$R_w+C_{tr} \geq 31\text{dB}$	$R_w+C_{tr} \geq 31\text{dB}$
		$0.2 < rE \leq 0.3$	$R_w+C_{tr} \geq 33\text{dB}$	$R_w+C_{tr} \geq 33\text{dB}$	$R_w+C_{tr} \geq 33\text{dB}$
		$0.3 < rE \leq 0.5$	$R_w+C_{tr} \geq 34\text{dB}$	$R_w+C_{tr} \geq 34\text{dB}$	$R_w+C_{tr} \geq 34\text{dB}$
		$0.5 < rE \leq 0.7$	$R_w+C_{tr} \geq 36\text{dB}$	$R_w+C_{tr} \geq 36\text{dB}$	$R_w+C_{tr} \geq 36\text{dB}$
	Air-inlet	Not applicable		$D_{n,e,w}+C_{tr} \geq 39\text{dB}$	$D_{n,e,w}+C_{tr} \geq 41\text{dB}^{**}$
	Roof system	$rT \leq 1.5$	$R_w+C_{tr} \geq 41\text{dB}$		
Undeveloped attic above concerned room	Roof system	$rT \leq 1.5$	$R_w+C_{tr} \geq 34\text{dB}$		
	OR				
	Ceiling separating attic and concerned room	300 mm thermal insulation placed in attic with sound absorption rating $\alpha_w \geq 0.95$ or airflow resistivity $4 \leq A_{Fr} \leq 70 \text{ kPa s/m}^2$ ****			
Technical equipment	Roller shutter box with or without air inlet	Not applicable	$D_{n,e,w}+C_{tr} \geq 45\text{dB}$		
The opaque part of the façade corresponds to a mass per unit area larger than 200 kg/m². Out of this range, a specific acoustic investigation is mandatory. This acoustic investigation should target a sound insulation with respect to outdoor noise such that: $D_{nT,A,tr} \geq 35\text{dB}$.					
* Ratio rE = elements surface / room floor surface and Ratio rT = roof surface / room floor surface The elements surface is the total surface of all the windows, glazed doors, exterior doors, rood windows, combined aperture frame in the considered room, using the opening reveal dimensions. For converted attic space, the roof surface correspond to the limited roof surface associated to the room considered. Example for a window : <ul style="list-style-type: none">The element surface corresponds to the surface of the glazing plus the surface of the frame, (opening reveal dimensions are those of the hole in the façade)The floor surface corresponds to the floor area of the room considered.					
** In case of 2 air inlets, if it is necessary to have air inlets with performance $D_{n,e,w}+C_{tr} \geq 39\text{dB}$ then increase the performance indicated for the openings (window, door, etc..) by 1 extra dB.					
*** When the concerned room is a converted attic, the openings can be placed on the roof and/or the façade.					
****Ceiling supporting thermal insulation (suspended ceiling or floor) of mass per unit area $\geq 18 \text{ kg/m}^2$ – Thermal insulation presenting a minimum thermal resistance as fixed by elements by elements thermal regulation (following Order of May 3 rd 2007)					
Airborne sound insulation performance of an element: it can be identified on the basis of a certification, a test report from an accredited laboratory or a calculation note.					