GARCIA-BBM, S.L.

Consultants in Acoustics, Noise and Vibration Control

P-7545/3-v01 SEPTEMBER 2009

THE ACOUSTIC ASSESSMENT OF THE AUDITORIUM OF TROYES (FRANCE)

INTERIOR FINISHES

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1. INTRODUCTION

GARCIA-BBM was asked by the Architect D. José Ignacio Linazasoro Rodríguez to provide the Acoustic Assessment of the Auditorium of Troyes. This report presents general recommendations for the interior finishes of the different rooms in order to achieve the acoustic conditions necessary to meet the criteria for optimum reverberation times (Points 4.1.1 and 4.1.2 of our report P-7545/1) (see Appendix A)

The interior finishes proposed by GARCIA-BBM may coincide with those of the architectural team responsible for the project. However, it is important to point out that other proposals not mentioned in this report may be equally valid.

The reverberation time requirements (some related to the acoustic insulation between rooms) are regulated by legislation and must, therefore, be complied with.

2. RECOMMENDATIONS FOR INTERIOR FINISHES

2.1 Administration Building

Polyvalent Hall

Floor: Stone or gres or terrazzo or linoleum - type floor covering.

Walls: Plastered and painted or with vinyl finish or wood panels.

Ceiling: False ceiling composed of pressed rockwool absorbent panels with exterior face protected by a film of fibreglass white or coloured (at the discretion of the Board of Directors) 40 mm thick or by pressed wood chipboard 25 mm thick.

The weighted sound absorption coefficient (α_w, according to ISO 11654:1997) must be greater or equal to 0,8.

Note The absorbent panels must be suspended at least 200 mm from the structural slab

A blanket of fibreglass or rockwool 40 mm thick with a density ≥20 kg/m^3 must be placed above the pressed wood chipboard panels.

On walls and trusses a system for hanging curtains should be designed. Whether or not the curtains are hung will depend on the type of event programmed to take place in the Hall.

The rockwool panels with the mentioned characteristics are manufactured by the following commercial companies: Rockfon, Eurocoustic and Ecophon, The pressed wood chipboard is manufactured by the commercial firm: Heraklith.

Dining room/Restaurant

The same recommendation as for the Polyvalent Hall but without any system for hanging curtains and concrete on floor.

Foyers

The same recommendation as for the Polyvalent Hall. It is also possible to use systems to conceal the false ceiling with metal latticework or perforated wood with perforation ≥30%.

Offices, Meeting Rooms and similar rooms

Floor: Linoleum-type floor covering (able to reduce impact noise levels).

Walls: Plastered and Painted or vinyl finish or wood or prefabricated finish.

Ceiling: False ceiling of absorbent panels offering a weighted sound absorbent coefficient (α_w, ISO 11654:1997) greater or equal to 0,7.

Note: The absorbent panels with the aforementioned characteristics are:

- Pressed rockwool panels faced with a film 25 mm thick (commercial firms: Rockfon, Eurocoustic or Ecophon) with a density ≥40 kg/m^3.

- Perforated metal frames (perforation ≥30%) on which is placed a rockwool panel 20 mm thick faced with a black film and a density ≥40 kg/m^3.

The absorbent panels should be suspended at least 150 mm from the structural slab.

Passages or similar areas

The same recommendation as for Offices, etc.

Board Room

Floor : Wood flooring on anti impact sheet or parquet or similar flooring

Walls 50% of the surface plastered and painted or covered with DM type wood to be painted or veneered (at the discretion of the Board of Directors) 15 mm thick placed over thin joists .

50% of the surface treated with concealed absorbent material composed of rockwool panels 40 mm thick, its face protected with a black film and hidden by wood lathing with a perforation ≥30%.

Ceiling: Treated with concealed absorbent material composed of rockwool panels 25 mm thick, its face protected with a black film and hidden by a wood lattice with a perforation ≥25%.

Note: The seats should offer a weighted sound absorption coefficient (α_w, ISO 11654:1997) greater or equal to 0,4.

Storage Rooms, Kitchens and similar rooms

Floor: Terrazzo or gres.

Walls: Plastered and painted.

Ceiling: Plastered and painted and steel sheets.

Technical Areas

Floor: Construction finish.

Walls: Construction finish.

Ceiling: Construction finish.

Toilets

Floor: Gres or terrazzo or similar.

Walls: Plastered and painted or tiled.

Ceiling: Plaster or plaster board 10 mm thick with a perforation ≥20%.

2.2 Auditorium Building

Halls ,Foyer

Floor: Stone or gres or terrazzo or linoleum-type floor covering or wood flooring.

Walls: Plastered and painted or vinyl finish.

Ceiling: False ceiling composed of pressed rockwool absorbent panels with its face protected by a film of fibreglass white or coloured (at the discretion of the Board of Directors) 40 mm thick and with a density $\geq$40 kg/m^3 or by pressed wood chipboard 25 mm thick.

The weighted sound absorption coefficient (α_w, according to ISO 11654:1997) must be greater or equal to 0,8.

Note: The absorbent panels must be suspended at least 200 mm from the structural slab.

In the case of the pressed wood chipboard panels, a blanket of fibreglass or rockwool 40 mm thick with a density $\geq$20 kg/m^3 must be placed on top.

The rockwool panels with these characteristics are manufactured by the firms: Rockfon, Eurocoustic y Ecophon, and the pressed wood chipboard by the firm: Heraklith.

The absorbent panels can be hidden by wood or plasterboard or metal latticework with a perforation $\geq$30%.

Rehearsal Rooms

Floor: Wood flooring 19 mm thick on an anti-impact sheet.

Walls: Plastered and painted or painted or with vinyl finish or direct wood finish. There must be some system for hanging cotton fire-resistant cloth curtains (250 – 300 gr/m^2), on at least one wall.

Ceiling: False ceiling composed of absorbent panels with a weighted sound absorption coefficient (α_w, ISO 11654:1997) greater or equal to 0,7.

The absorbent panels can be made of pressed rockwool 25 mm thick with a film of fibreglass white or coloured (at the discretion of the Board of Directors) with a density $\geq$40 kg/m^3.

Note: The absorbent panels must be suspended at least 200 mm from the structural slab.

The absorbent panels with these characteristics are manufactured by the firms: Rockfon, Eurocoustic and Ecophon.

Passages, small Hallways

Floor: Linoleum-type floor (capable of reducing impact noise levels).

Walls: Painted or vinyl finish or prefabricated or wood finish.

Ceiling: False ceiling composed of absorbent panels offering a weighted sound absorption coefficient (α_w, ISO 11654:1997) greater or equal to 0,7.

Note: The absorbent panels with these characteristics are:

- Pressed rockwool panels faced with a film 25 mm thick (commercial firms: Rockfon, Eurocoustic or Ecophon) with a density $\geq$40 Kg/m^3.
- Perforated metal frames (perforation $\geq$30%) on which is placed a rockwool panel 20 mm thick faced with a black film and a density $\geq$40 kg/m^3.

The absorbent panels must be suspended at least 150 mm from the structural slab.

Individual Offices, Dressing Rooms

Floor: Linoleum-type floor cover (capable of reducing impact noise levels).

Walls: Painted or vinyl finish or wood or prefabricated finish.

Ceiling: False ceiling composed of absorbent panels offering weighted sound absorption coefficient (α_w, ISO 11654:1997) greater or equal to 0,7.

Note: The absorbent panels with these characteristics are:

- Pressed rockwool panels faced with a film 25 mm thick (the commercial firms are: Rockfon, Eurocoustic or Ecophon) with a density $\geq$40 kg/m^3.

- Perforated metal frames (perforation $\geq$30%) on which is placed a rockwool panel 20 mm thick faced with a black film and a density $\geq$40 kg/m^3.

The absorbent panels must be suspended at least 150 mm from the structural slab.

Café

Floor: Stone or gres or terrazzo or linoleum-type floor cover.

Walls: Plastered and painted or vinyl finish. A system for hanging curtains from the façades.

Ceiling: False ceiling composed of absorbent pressed rockwool panels, with its exterior face protected by a film of fibreglass white or coloured (at the discretion of the Board of Directors) 40 mm thick with a density o $\geq$40 kg/m^3 or pressed chipwood board 25 mm thick.

The weighted sound absorption coefficient (α_w, according to ISO 11654:1997) must be greater or equal to 0,8.

Notes: The absorbent panels must be suspended at least 200 mm from the structural slab.

In the case of the pressed wood chipboard panels a blanket of fibreglass or rockwool 40 mm thick with a density $\geq$20 kg/m^3 must be placed on top.

The panels of Rockwool with these characteristics are sold by the following firms: Rockfon, Eurocoustic y Ecophon, and the pressed chipwood by: Heraklith.

Booths

Floor: Carpet 8 – 10 mm thick.

Walls: Plastered and painted or painted or vinyl finish or similar.

Ceiling: False ceiling composed of absorbent panels offering a weighted sound absorption coefficient (α_w, ISO 11654:1997) greater or equal to 0,7.

The absorbent panels can be made of pressed rockwool 25 mm thick with a density $\geq$40 kg/m^3 with a film of fibreglass white or coloured (at the discretion of the Board of Directors).

Notes: The absorbent panels must be suspended at least 200 mm from the structural slab

The absorbent panels with these characteristics are sold by the following firms: Rockfon, Eurocoustic and Ecophon.

Installation Areas

Floor Construction finish.

Walls: Covered with rockwool panels 40 mm thick faced with a black film with a density $\geq$40 kg/m^3, protected by a perforated or stretched metal plate with a perforation $\geq$30%.

Ceiling: Covered with rockwool panels 40 mm thick faced with a black film with a density $\geq$40 kg/m^3, protected by a perforated or stretched metal plate with a perforation $\geq$30%.

This recommendation is mandatory in installation areas of level R+3 y R+4.

Storage Rooms

Floor: Terrazzo or gres.

Walls: Plastered and painted.

Ceiling: Plastered and painted.

Toilets

Floor: Gres or terrazzo or similar.

Walls: Plastered and painted or tiled.

Ceiling: Plaster or plasterboard 10 mm thick with a perforation ≥20%.

3. AUDITORIUM

3.1 Hall

Floor: Wood floor 20 – 22 mm thick on slab or thin wood joists.

Walls: Plastered and painted. Wood panels (oak, walnut or beech, etc. at the discretion of the Board of Directors) 19 mm thick. Plasterboard 20 mm thick is also valid.

In order to prevent unwanted reflections towards the stage (echoes), the wall at the back of the Hall will be covered with a rockwool panel 40 mm thick faced with a black film and concealed with wood latticework (lathing) with a perforation ≥30%

Ceiling: DM type board to be veneered or painted (at the discretion of the Board of Directors) 19 mm thick. Plasterboard 12,5+12,5 mm thick is also valid. .Allowance for mobility of some parts of the ceiling.

3.2 Stage

Floor: Wood flooring 35 – 40 mm thick (Consult the Stage Systems).

Walls: Plastered and painted. Wood panels (oak, walnut or beech, etc. at the discretion of the Board of Directors) 19 mm thick. Plasterboard 20 mm thick is also valid.

Ceiling: DM type board to be veneered or painted (at the discretion of the Board of Directors) 19 mm thick. Plasterboard 12,5+12,5 mm thick is also valid. .Allowance for mobility of some parts of the ceiling.

Notes: The walls above the level of the first line of lights (lateral and/or back) will be covered with pressed rockwool panels 40 mm thick and with a density $\geq$70 kg/m^3, its external face protected by a film of black fibreglass. 400 m^2 of this absorbent treatment is necessary.

3.3 Doors with Sound lock

Floor: Wood floor 20 – 22 mm thick on slab or thin wood joists.

Walls: Covered with rockwool panel 20 – 25 mm thick faced with a black film and density $\geq$40 kg/m^3, concealed by a wood or metal latticework with a perforation $\geq$30%.

Ceiling: Covered with rockwool panel 20 – 25 mm thick faced with a black film and density $\geq$40 kg/m^3, concealed by a wood or metal latticework with a perforation $\geq$30%.

4. SEATS

Seats play an important part in the acoustic response of the Hall. It is, therefore, essential that the acoustic absorption of the seats be compatible with the optimum reverberation time established for the Hall.

This means that the seats be installed, irrespective of their design, quality, comfort etc., must offer the required absorption coefficients.

Moreover, the absorption offered by the seats must show a frequency variation similar to that shown in Figure 1. (it must be noted that these absorption coefficients are expressed in Sabine meters (m^2)). Figure 2 shows the same absorption criteria per seat.

To this absorption must be added the absorption offered by the audience. With an audience the coefficient increase is considered to be 0,2 for middle and high frequencies and 0,1 for low frequencies.

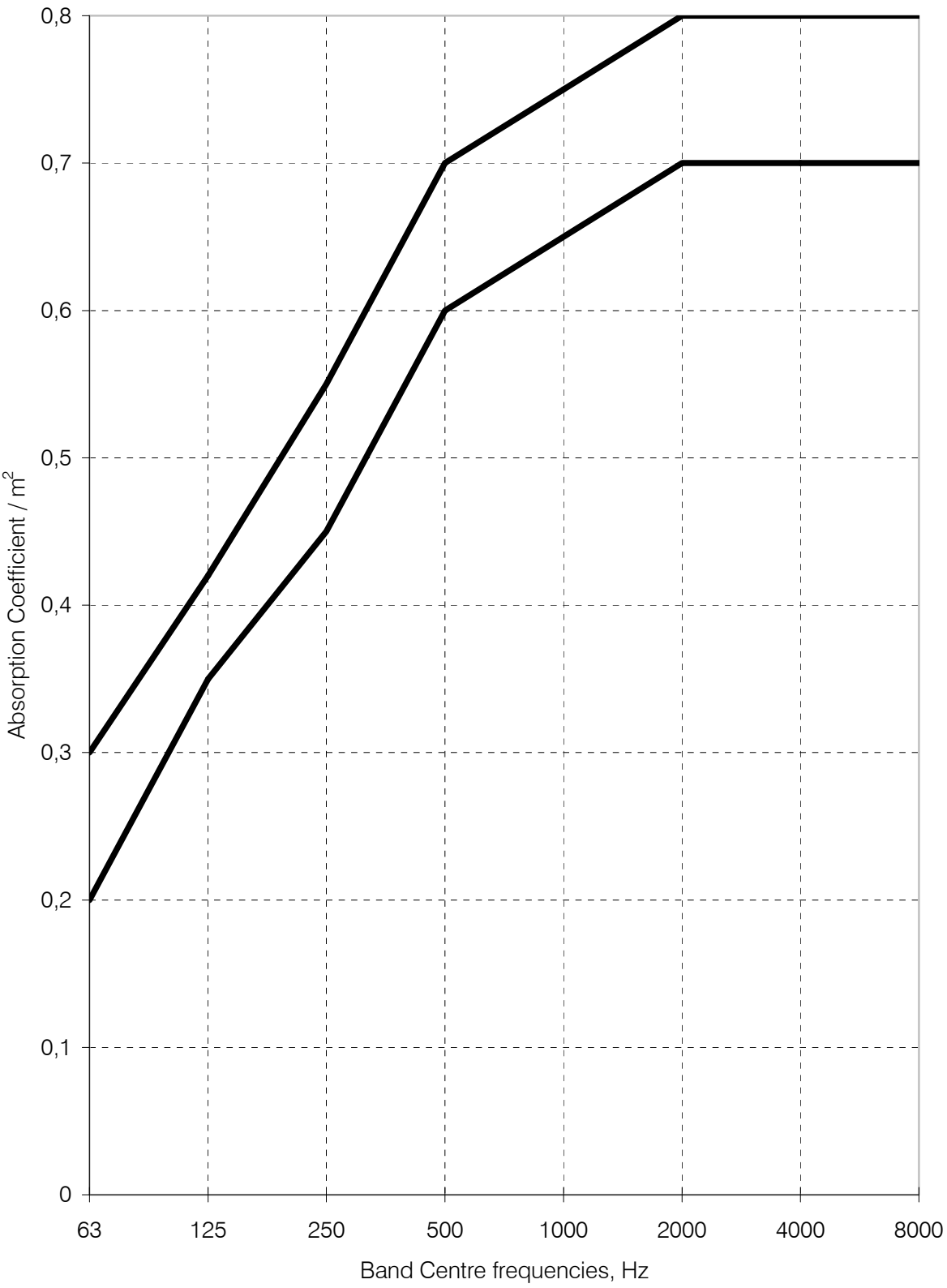

Figure 1.- Range of permitted absorption for seats. Unoccupied.

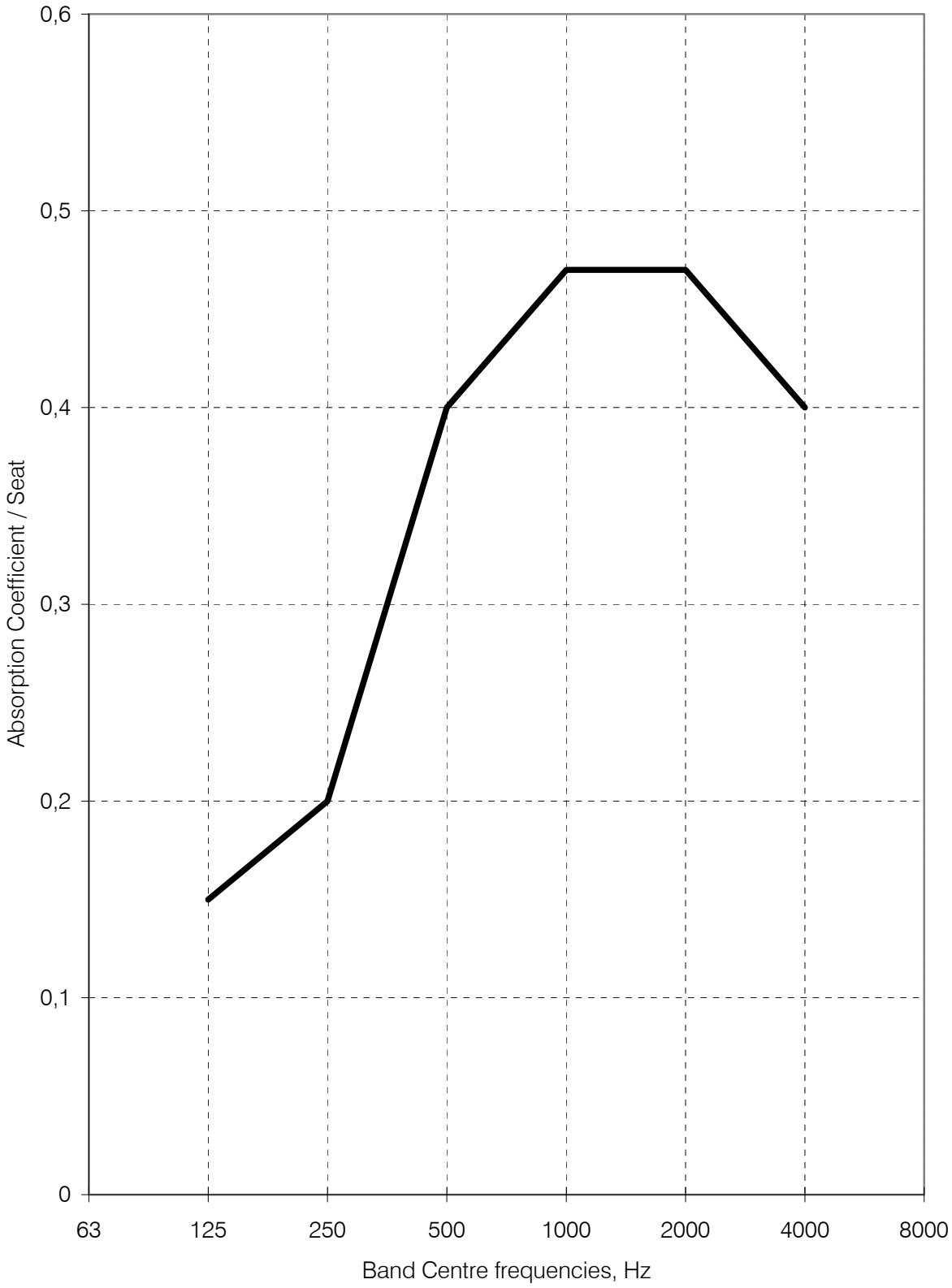

Figure 2.- Absorption coefficient required for seats. Unoccupied.

APPENDIX A

CONTENT

This Appendix contains the criteria for reverberation times.

A. CRITERIA FOR REVEBERATION TIMES

A.1 Administration Building

LEVEL R-1	T_{60}, secs.
– Technical areas	Unspecified

LEVEL RDC	T_{60}, secs.
– Multi-purpose room	≤1.4
– Foyer	≤1.4
– Dining room	1.0
– Administration kitchens	0.8
– Kitchens	≤1.0
– Storage Rooms	Unspecified
– Reception	1.0
– Passages	≤1.0
– Toilets	≤1.0
– Technical Area	Unspecified
– Personnel changing rooms	0.8
– Office for Chef	0.7

LEVEL R+1	T_{60}, secs.
– Offices	0.8
– Passages	1.0
– Meeting rooms	0.9
– Documentary centre	0.9
– Multipurpose rooms	0.9
– Storage rooms	Unspecified

LEVEL R+2	T_{60}, secs.
– Offices	0.8
– Meeting Room	0.9
– Committee Room	0.9

LEVEL R+2	T_{60}, secs.
– Reception	0.9
– Passages	1.0
– Storage Rooms	Unspecified
– Technical Areas	Unspecified

LEVEL R+3	T_{60}, secs.
– Reception	0.9
– Meeting Rooms	0.9
– Passages	1.0
– Board Room	0.9
– Technical Areas	Unspecified
– Storage rooms	Unspecified

A.2 Auditorium Building

LEVEL RDC	T_{60}, secs.
– Auditorium	
• For music	1.7
• For speech	1.2
– Foyer	$\leq$1.4
– Rehearsal Rooms	0.7
– Passage	1.0
– Toilets	1.0
– Storage rooms	Unspecified
– Sound lock	0.6

LEVEL R+1	T_{60}, seg.
– Café	≤1,4
– Dressing Rooms	0,8
– Rehearsal rooms	0,7
– Sound locks	0,6
– Passage	1,0
– Toilets	1,0

LEVEL R+2	T_{60}, seg.
– Foyer	≤1,2
– Offices	0,7
– Sound locks	0,6
– Passage	1,0
– Toilets	1,0

LEVEL R+3	T_{60}, seg.
– Booths	0,5
– Technical Areas and Storage Rooms	Unspecified
– Passage	1,0

LEVEL R+4	T_{60}, seg.
– Storage Rooms	Unspecified