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Regulatory sound insulation requirements in South America – Status for housing, schools, hospitals and office buildings

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ABSTRACT

In a pilot study in 2016 about acoustic requirements for housing and schools in Europe and South America with comparisons between the two regions, significant differences in acoustic descriptors and limit values were found, both internally in the regions and between them. The countries considered in South America were Argentina, Brazil and Chile. Now, a wider study has been made about sound insulation regulations for housing, schools, hospitals and office buildings, extended to more countries in South America and focusing on studying, evaluating and summarizing the status of such regulations. The paper includes examples of specific acoustic requirements on airborne and impact sound insulation between rooms in the before-mentioned buildings and indications of traffic noise limits. It is found that many countries in South America have weak or no acoustic regulations. Thus, the paper provides a basis for future cooperation on developing and optimizing acoustic regulations.

Keywords: Building Acoustics, Regulations, South America, sound insulation, housing, schools, hospitals, offices.
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1. INTRODUCTION

The fact that noise affects our health has been recognized since long ago by many authors and by the World Health Organisation in different publications; see e.g. [1–4]. In order to ensure that the citizenship is properly protected against noise, the corresponding authorities may develop different regulations depending on the specific noise problem: environmental noise, noise in working environment, noise in buildings etc.

Building acoustic regulations in most cases include requirements to airborne, impact and façade sound insulation. In some cases the regulations include as well maximum sound pressure levels indoors and other acoustic requirements related to noise from service equipment/installations and/or reverberation time in common areas.

In Europe several comparative studies of sound insulation requirements and descriptors have been carried out over the last decade [5–8]. Additionally some considerations on the evolution of the international regulatory framework within building acoustics can be found in [9].

More recently, in 2016 a pilot study was performed [10] comparing the acoustic regulations for housing and schools in selected countries in Europe and South America. This study included five European countries (Austria, Belgium, Czech Republic, Denmark and Spain) and three South American countries (Argentina, Brazil and Chile) which were selected according to two main principles: a) existence of some regulations in building acoustics; b) interest and motivation to discuss such regulations and apply ISO standards. Besides, these three selected countries represented a high percentage of the population in South America. In that study it was found that there are significant differences concerning acoustic regulations between the selected European and South American countries and even within each of these regions.

In spite of the pilot study, the situation concerning building acoustic regulations in South America is still quite unknown. This fact has motivated to widen the previous study to the 10 largest South American countries, and also to consider other types of buildings such as hospitals and offices.

The main purpose of this paper is to gather updated information on the status of building acoustic regulations for housing, schools, hospitals and office buildings in South America. From the research done, some relevant conclusions related to the "state-of-the-art concerning building acoustics" in South America can be obtained. Notice that all the objective information presented in this paper has been extracted from the corresponding documents, whereas the subjective considerations presented in the conclusions section are partly obtained from conversations with experts in the field in the corresponding countries.

It is the hope of the authors that this input might foster the cooperation between countries in this region when developing their respective building acoustic regulations.

In order to have a rough idea of the potential impact of developing building acoustic regulations in South America, some relevant demographic and geographic data are summarized in Table 1 for the 10 selected countries. When available, additional data such as number of dwellings and percentage of people living in urban spaces (urban population density) is shown, since it is mainly in urban environment where noise in housing is a major problem.

Table 1. Geographical data and population distribution in 10 South American countries

Country	Population (%)	Population (millions)	Area [11] (10^3 km^2)	Population density (inhab./km^2)	No. of dwellings (millions)	Urban population (millions)	Urban population density (%)
	Total (100%)	**409,3**	**16.218**			**199,0**	
Brazil [1]	51%	209	8.515	25	44.7	176	85
Argentina [3]	11%	44	2.780	16	13.8	39.4	92
Colombia [2]	11%	43	1,142	38	12.0	33.4	78
Peru [4]	7%	29	1.285	23	10.1	23	79
Venezuela [5]	8%	31	916	34	---	27.5	89
Chile [6]	4%	18	756	24	5.5	15.8	89
Ecuador [7]	3%	14	283	59	2.7	8.8	63
Bolivia [8]	3%	11	1.099	10	3.3	7.8	69
Paraguay [9]	2%	7	407	16	1.2	4.3	62
Uruguay [10]	1%	3,3	176	20	1.4	3.1	95

1- Instituto Brasileiro de Geografia e Estatística (IBGE) - https://www.ibge.gov.br/

2- Departamento Administrativo Nacional de Estadística (DANE) - https://sitios.dane.gov.co/cnpv-presentacion/src/

3 - Instituto Nacional de Estadística y Censos (INDEC) - https://www.indec.gob.ar/nivel2_default.asp?seccion=P&id_tema=2

4- El Instituto Nacional de Estadística e Informática-INEI - https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1539/libro.pdf

5- Instituto Nacional de Estadísticas (INE) - https://www.ineinfo.ine.gob.ve

6- Instituto Nacional de Estadísticas (INE) - http://www.censo2017.cl/

7- Instituto Nacional de Estadísticas y Censos (INEC)- http://www.ecuadorencifras.gob.ec/base-de-datos-censo-de-poblacion-y-vivienda/

8- Instituto Nacional de Estadística (INE) - http://censosbolivia.ine.gob.bo/webine/index.php

9- Dirección General de Estadística encuestas y censos (DGEEC) - http://www.dgeec.gov.py/Publicaciones/Biblioteca/proyeccion%20nacional/Estimacion%20y%20proyeccion%20Nacional.pdf

10- Instituto Nacional de Estadística (INE) - http://www.ine.gub.uy/

11- "World Population Prospects: The 2017 Revision". ESA.UN.org (custom data acquired via website). United Nations Department of Economic and Social Affairs, Population Division. Retrieved 10 September 2017

2. EXISTING BUILDING ACOUSTIC RELATED REGULATIONS

Table 2 summarizes, for the 10 selected countries, what has been identified as "protection against noise inside buildings" regulations. In some cases the regulations are related to building codes and include requirements for airborne and impact sound insulation whereas in other cases the regulations are related to environmental or health issues and include limits to maximum indoor SPL.

As it can be seen from Table 2, there are only three countries out of ten having specific building acoustic regulations (Argentina, Brazil and Chile), and only in two of them (Brazil and Chile) these regulations are normative. Two other countries (Colombia and Ecuador) have limits to SPL_{max} indoors and these limits have been stablished either by the Health Ministry or by the Environmental Ministry.

Hereinafter the status of the building acoustic regulations in the different countries is described and the most relevant issues are summarized.

Table 2: Acoustic regulations and corresponding valid sound insulation measurement methods

Country	**(1) BUILDING ACOUSTIC REGULATIONS**	**MEASUREMENT METHODS(4)**
Brazil	NBR 15575 (-1, -3, -4, -5, -6) (**N**)	ISO 16283-1, -2, -3 (Engineering) ISO 10052 (Survey)
Argentina	IRAM 4044:2015 (**R**)	ISO 140 series both for laboratory and situ
Colombia	(2) RESOLUCION 8321 de 1983	None
Peru	None	None
Venezuela	No information found	No information found
Chile	(3) OGUC: Título 4 - Capítulo 1, Artículos 4.1.5 y 4.1.6 (**N**)	ISO 140 series both for lab and situ.
Ecuador	(2) NEC 11- Chapter 13; 2011	None
Bolivia	None	None
Paraguay	None	None
Uruguay	None.	None

(1) **R** = Recommended; **N** = Normative
(2) Regulation for maximum indoors SPL_{max} or $L_{Aeq,T}$
(3) An acoustic classification proposal under consultation (prNCh352/1) − will refer both to in-situ measurements (ISO 16283) and estimated sound insulation values.
(4) The field standards ISO 140-4, -5, -7 have now been replaced by the ISO 16283 series, published 2014-2016 and part 2 updated in 2018.

2.1 Brazil

In Brazil, the ABNT NBR 15575 [11] was approved in 2013 and includes acoustic performance criteria for residential buildings in five of its six parts: -1,-3,-4,-5,and -6. The enforcement of technical standards in Brazil is not mandatory. However, Brazilian consumer law [12] establishes that all technical standards must be followed in every sales purchase. As a consequence, the requirements of ABNT NBR 15575 have become mandatory for all residential buildings designed after July 19th, 2013.

The standard defines three levels of compliance for airborne, impact and façade sound insulation between different types of spaces inside the building: Minimum (M), Intermediate (I) and Superior (S). The Minimum corresponds to the mandatory level whereas Intermediate and Superior levels are voluntary and are expected to be reached when the promotor's objective is to deliver higher levels of sound insulation. The descriptors used are $D_{nT,w}$; $L'_{nT,w}$ and $D_{2m,nT,w.}$ ABNT NBR 15575-6 incorporates recommendations for sound pressure level from service equipment in residential buildings, only for bedrooms.

When other types of buildings are considered (not residential), there are no sound insulation regulations but instead there are national limits to immission SPL included in ABNT NBR 10152 [13]. This standard, which is also mandatory for those buildings where sales purchases are stablished (i.e., a new dwelling is bought) presents measurement procedures for determining indoor SPL as well as maximum values, independent of the contributing noise sources, according to the different types of spaces: i.e. hospitals, schools, offices, worship spaces etc. Requirements are set for $L_{Aeq,T}$; $L_{ASmáx}$, and NC curves and are independent of the time of day or of the noise source. For each space, all three requirements should be met simultaneously for reaching accomplishment, as shown in Table 3.

Table 3: Extract from ABNT NBR 10152: Requirements for indoor SPL - independent of the contributing noise sources

Type of space	Requirements		
	$L_{Aeq,T}$ (dB)	$L_{ASmáx}$ (dB)	NC
Hospitals and clinics			
Nursery	≤ 35	≤ 40	≤ 30
Shared rooms	≤ 40	≤ 45	≤ 35
Individual rooms	≤ 35	≤ 40	≤ 30
Educational			
Classrooms	≤ 35	≤ 40	≤ 30
Music Classrooms	≤ 35	≤ 40	≤ 30
Offices			
Open plan Offices	≤ 45	≤ 50	≤ 40
Meeting rooms	≤ 35	≤ 40	≤ 30
Call centers	≤ 50	≤ 55	≤ 45

2.2 Argentina

In Argentina the IRAM 4044 was updated and approved Nov 2015. This is a recommendation document, thus not mandatory, and applies to:

a) Apartment buildings for homes or offices;
b) Single family homes;
c) Accommodation facilities such as hotels and similar
d) Buildings intended for health (such as hospitals, clinics, nursing homes)
e) Educational buildings
f) Public and private non-industrial premises;

The IRAM 4044 [14] defines two levels for compliance or classes: basic and higher (Escala I and II).

The descriptors used are R'_w; $L'_{n,w}$ and $D_{2m,nT,w}$. The limits depend on the class, the type of building and the type of spaces. There are different requirements for different scenarios such as hospital bedroom and corridors, classrooms and corridors, classrooms and noisy spaces (gym, music spaces…) etc.

As an example, for the Class I, the required minimum airborne sound insulation between adjoining dwellings (i.e. two bedrooms) is $R'_w \geq 50$ dB whereas the required minimum airborne sound insulation between two hotel rooms is $R'_w \geq 47$ dB. A similar pattern is observed for impact sound and Class II where the limits are $L'_{n,w} \leq 39$ dB between adjoining dwellings and $L'_{n,w} \leq 46$ dB between two hotel rooms.

In Argentina, besides the most common limits, there are also requirements for airborne and impact sound insulation between spaces within the same dwelling. For example for class I, the limits between spaces within the same dwelling that does not share a door in the separating wall are $R'_w \geq 42$ dB and $L'_{n,w} \leq 53$ dB.

2.3 Colombia

Regulations to protect the citizens against noise have existed in Colombia since 1983 and have been produced by the Ministry of Health, so they do not regulate sound insulation, but maximum SPL indoors instead.

The Resolución 8321 de 1983 (agosto 4), Ministerio de Salud [15] por la cual se dictan normas sobre Protección y Conservación de la Audición de la Salud y el bienestar de las personas, por causa de la producción y emisión de ruidos (which rules are issued on Protection and Conservation of the Hearing of Health and the well-being

of people, due to the production and emission of noise) sets maximum indoors SPL limits. For residential areas the limits were 65 dBA during day time (7 am to 9 pm) and 45 dBA during night time (9 am to 7 pm). In 2010 an additional regulation came into force, Resolución-6918-de-2010 [16] por la cual se establece la metodología de medición y se fijan los niveles de ruido al interior de las edificaciones (inmisión) generados por la incidencia de fuentes fijas de ruido (where the measurement methodology is established and the SPL_{max} inside the buildings generated by the incidence of fixed sources of noise is fixed). The maximum day time limit was modified and was reduced to 55 dBA for residential, institutions and service/community buildings[4]. In the first document from 1983, there is no reference as whether the immission limit is set to any specific source of noise, but in the second one from 2010, it is stated that it refers both to outdoor noise as well as noise produced inside the building (neighbours and or service equipment /installations).

2.4 Perú

In Peru the National Building Code (Reglamento Nacional de Edificaciones – RNE [17]) was originally published in 2006. In the section related to "General issues" Section G.010-article 10 says that "*To ensure the safety of people, the quality of life and the protection of the environment, urban permits and buildings must be designed and built so to provide such thermal and* ***sound protection*** *so that the interior temperature and the noise perceived in them does not threaten the comfort or health of people, allowing them to satisfactorily perform their activities".* Besides, in section GE.040-articles 8 and 9, say (in summary) that *the building service equipment should be isolated from the structure of the building, so that there are no vibrations transmitted to it and so that the* ***noise or vibration*** *produced by the use of equipment or machinery does not, in any case, disturb the occupants of the building itself or those of neighbouring buildings, and must comply with the provisions established by the municipalities on the matter* and that *the use of the building must avoid the production of smoke, humidity, salinity,* ***noise****, vibration, corrosion, temperature changes or bad odours, which may cause damage to people, to the building itself or to third parties*.

Unfortunately, in spite of the declaration of intentions shown in the "General Issues" section, there is no section where the acoustic performance of the building is further developed. In 2014 a section considering thermal efficiency of the building has been developed (Title III.4: Electrical and mechanical installations- EM 110: Thermal and Light Comfort - Energy Efficiency) where again the need for adequate protection against noise and mounting of service equipment is mentioned, but without any specification.

2.5 Venezuela

It has not been possible to obtain reliable information, but according to what is publicly available, there are no national building acoustic regulations.

2.6 Chile

In Chile, as of March 2019, the regulation in force is the *OGUC: Title 4 - Chapter 1, Articles 4.1.5 and 4.1.6,* revised in 2006 [19]. The requirements apply to so called "isolated spaces" such as hospital rooms, class rooms, libraries and to "partly isolated spaces" such as hotels, dwellings, religious spaces and offices if located in a "noisy" neighbourhood according to the classification made by the Municipality (article

[4] According to the text, the limit was lowered following the WHO recommendations

4.1.5). This document is a first approach to regulating sound insulation in buildings and is nowadays under revision. The document needs clarification since is not very clear defining the corresponding sound insulation descriptors and allows three alternative methods to verify compliance with requirements, which are not compatible: Method A: All the constructive solutions used must be registered in the Official List of Building Solutions for sound insulation of the Ministry of Housing and Urban Planning. Method B: Laboratory testing of all the vertical and horizontal elements according to the laboratory measurement standards, NCh 2786 = ISO 140-3 and ISO 140-6, or in situ measurements according to NCh 2785 = ISO 140-4 ad ISO 140-7. In both cases the assessment procedure shall be according to ISO 717-1 and 2. Due to the ambiguity of the OGUC, there was an initiative for developing another standard (draft NTM 011-1:2014) aiming at developing and clarifying the existing regulation but this initiative has been paralyzed and the draft NTM 011 has been archived.

When writing this paper a new normative document is being drafted and is under public consultation until March 30th 2019. It is a draft Chilean Standard prNCh352/1 - Acústica y vibraciones – Aislación acústica – Parte 1: Clasificación acústica de la edificación residencial (Sound and Vibration: Sound Insulation - part 1: Acoustic classification for residential buildings). In this proposal the sound insulation descriptors are $D_{nT,A} = D_{nT,w} + C$; $L_{nT,w}$ and $D_{nT,A,tr}$ for airborne, impact and façade sound insulation respectively and the corresponding measurement and assessment procedures are the ISO 16283 series + ISO 717 series.

2.7 Ecuador

In Ecuador the only regulations concerning acoustic characteristics inside a building is included in the Ecuador Building Standard: *Norma Ecuatoriana de la Construcción -NEC 11- Eficiencia Energética en la construcción en Ecuador-2011* [20]–(Building energy efficiency). In this standard Chapter 13, section 13.3.5.1.2 is dedicated to Acoustic Confort and includes limits to maximum indoor SPL in different types of spaces. No specific noise source, descriptor or measurement procedure is included. As an example, the maximum SPL in a bedroom is set to 50 dB independently of the time of the day. The requirements shall be progressively be adopted over a 10 year period since the publication of the NEC 11 (that is, no later than April 2021) and apply only to main refurbishment or new building constructions.

2.8 Bolivia

In Bolivia there is no regulation related to building acoustics, although there are environmental noise regulations aiming at preserving and maintaining the health of the citizens. The 1333 Environmental Law establishes that the State, through its competent bodies, will establish, regulate and control noise levels originated in commercial, industrial, domestic, transport or other activities in order to preserve and maintain health, safety and welfare of the population. Annex 6 of the 1333 Law sets the limits for emitted SPL of different types of sound sources depending on the area where they are placed and the time of the day. In general each municipality may regulate noise pollution. The only existing national technical standards related to noise abatement are NB 62005-05: *Air quality - Environmental noise - Vocabulary* and NB 62006: 05: *Air quality - Fixed source emissions - Determination of sound pressure levels - Measuring equipment.*

2.9 Paraguay

In Paraguay there are no national building acoustic requirements. The Paraguayan standards on sustainable construction (NP 55 001 14 and NP 55 002 15) do not include any issue related to acoustics, although they consider other sustainable aspects of the building such as thermal performance/ green areas protection/pollution during building process.

2.10 Uruguay

In Uruguay there are no national regulations concerning building acoustics, but there are some municipality limits to noise immission. The state-of-the-art concerning acoustic pollution regulations in Uruguay as of 2008 is shown in [21] . Concerning building acoustics, there has been no change since then. As an example, it can be mentioned that in the Municipality of Montevideo (Artículo D3366, Sección IX del capítulo I del Digesto Departamental de Montevideo) there is a requirement for walls and floors which shall provide at least a "sound insulation" of 45 dB (no descriptor mentioned nor measurement procedure).

In the next sections, a summary of existing requirements for housing, schools, sanitary buildings and offices will be presented for the five countries where regulations on building acoustics or SPL_{max}/ maximum value of $L_{Aeq,T}$ indoors have been found. All the Tables in section 3 provide just an overview of the main requirements in standard situations and for the lower class for Argentina. Typically, there are stricter requirements towards e.g. noisy premises and looser or non-existing towards spaces such as commercial or public concurrence spaces. All the detailed requirements and conditions can be found in the corresponding building codes or corresponding regulations.

3. SOUND INSULATION REQUIREMENTS FOR HOUSING

Table 4 shows a sample of the existing requirements for housing. As already observed in [10], there is a significant wide spread considering both sound insulation requirements and descriptors. For airborne, three different descriptors are used (R'_w, R_A/R'_A, $D_{nT,w}$) and requirements for similar spaces vary from 50 to 45 dB. For impact sound insulation, there are only two different descriptors ($L'_{n,w}$, $L'_{nT,w}$) and the requirements range from 53 to 80 dB. The regulations for sound insulation in housing in Argentina, Brazil and Chile are so different between them that it is difficult to make a comparison. For example in Argentina there are two performance levels (Escala I and Escala II) for airborne, impact and façade requirements and the limit values vary depending on the use of the building and type of separating spaces; in Brazil there are three levels of compliance for airborne, impact and façade insulation: Minimum (M), Intermediate (I) and Superior (S), and the limit values vary depending on the type of separating spaces, and in Chile, as of February 2019, there are just minimum requirements for airborne and impact sound insulation and not for façade.

Besides, in some cases the limit is set to SPL_{max} or $L_{Aeq,T}$ indoors, which makes the comparison between the existing regulations even more difficult.

Table 4: Sound insulation requirements for multi-family housing

Sound insulation between dwellings in multi-family housing – Requirements			
Country	**Airborne [dB]**	**Impact [dB]**	**Comments /Other**
Brazil	$D_{nT,w} \geq 45$	$L'_{nT,w} \leq 80$	Between adjoining dwellings where at least one room is a bedroom
Argentina	$R'_w \geq 50$	$L'_{n,w} \leq 53$	Between adjoining dwellings.
Colombia	None	None	$SPL_{max} \leq 55$ dB(A) during day time in housing
Chile	$R_A / R'_A \geq 45$	$L_{n,w} \leq 75$	Dwellings considered "partly isolated space"
Ecuador	None	None	For bedrooms $SPL_{max} \leq 50$ dB

4. SOUND INSULATION REQUIREMENTS FOR SCHOOLS

Just as for housing, the wide spread of sound insulation requirements and descriptors makes impossible to make a rigorous comparison of the results.

Nevertheless, the situation for educational building seems slightly worse than for housing since, in this case, there are only two countries (Argentina and Chile) with sound insulation requirements. Surprisingly, when considering airborne sound insulation, the level of requirement found in Argentina is lower for educational spaces than for residential spaces, whereas for Chile the limits remain unchanged. Brazil does not have requirements for sound insulation in educational buildings but has a strict maximum value of $L_{Aeq,T}$, which somehow shows that there is a concern towards the acoustic quality of docent spaces. On the other hand, for countries considering SPL_{max} indoors as a limiting descriptor, the variations compared to housing limits do not have any trend: Colombia keeps the same limit, and Ecuador a looser limit. A summary can be found in Table 5.

Table 5: Sound insulation requirements for educational buildings

Sound insulation requirements for schools – Between normal classrooms			
Country	**Airborne [dB]**	**Impact [dB]**	**Comments /Other**
Brazil	None	None	$L_{Aeq,T} \leq 35$ dB and $L_{AS,max} \leq 40$ dB and NC≤ 30
Argentina	$R'_w \geq 47$	$L'_{n,w} \leq 53$	Between adjoining classrooms.
Colombia	None	None	$SPL_{max} \leq 55$ dBA during day time in educational areas
Chile	$R_A / R'_A \geq 45$	$L_{n,w} \leq 75$	Schools considered "isolated space"
Ecuador	None	None	Studying spaces $SPL_{max} \leq 55$ dB

5. SOUND INSULATION REQUIREMENTS FOR HOSPITALS

In this case, the wide spread of sound insulation requirements and descriptors is the same as for housing and schools. It is observed that considering the limits between adjacent rooms, the requirements for Argentina and Chile are the same as for housing. For Brazil, the limit for $L_{Aeq,T}$ is the same as for schools between classrooms and for Colombia the limit is the same as for schools and housing. Lastly, for Ecuador, the SPL_{max} is lower than for housing and lower than for schools. In fact in Ecuador the requirement for hospitals is 10 dB lower than for residential areas, which seems to point out at the different weight that silence has in these two different contexts. Table 6 summarizes the findings.

Table 6: Sound insulation requirements for sanitary buildings

Sound insulation requirements for hospitals – Between normal hospital bedrooms			
Country	**Airborne [dB]**	**Impact [dB]**	**Comments /Other**
Brazil	None	None	$L_{Aeq,T} \leq 35$ and $L_{AS,max} \leq 40$ and NC$\leq$ 30
Argentina	$R'_w \geq 50$	$L'_{n,w} \leq 53$	Between adjoining rooms.
Colombia	None	None	$SPL_{max} \leq$ 55 dBA during day time in sanitary areas
Chile	$R_A / R'_A \geq 45$	$L_{n,w} \leq 75$	Hospitals considered "isolated space"
Ecuador	None	None	Sanitary spaces $SPL_{max} \leq$ 45 dB

6. SOUND INSULATION REQUIREMENTS FOR OFFICES

Another space where citizens spend an important part of their life is in offices. The situation found for this type of spaces is summarized in Table 7.

As it can be seen, Argentina, Colombia and Chile keep the same requirements as for housings. On the other hand Brazil allows for higher $L_{Aeq,T}$ limit in offices if compared to schools or hospitals (10 dB more) and a similar pattern is observed for Ecuador where the limit is also 10 dB higher than for housing. It seems that when the office working environment is differentiated from the residential space, it is admitted that higher noise levels are acceptable.

Table 7: Sound insulation requirements for offices

Sound insulation requirements for offices(1)			
Country	**Airborne [dB]**	**Impact [dB]**	**Comments /Other**
Brazil	None	None	$L_{Aeq,T} \leq 45$ and $L_{AS,max} \leq 50$ and NC$\leq$ 40
Argentina(1)	$R'_w \geq 50$	$L'_{n,w} \leq 53$	
Colombia	None	None	$SPL_{max} \leq$ 55 dBA during day time in public or private institutions
Chile	$R_A / R'_A \geq 45$	$L_{n,w} \leq 75$	Hospitals considered "isolated space"
Ecuador	None	None	Offices spaces $SPL_{max} \leq$ 60 dB
(1) Offices are included in the scope of the IRAM 4044 but not shown in the corresponding tables. It is the author's interpretation that they shall be considered as residential spaces.			

7. CONCLUSIONS AND SUGGESTIONS

Based on the research done concerning building acoustic regulations in South America and on conversations with different acousticians in all the considered countries (except Venezuela), hereinafter follows a list of some relevant conclusions which, considered properly, could be of use for acousticians working in this field in South America.

- In most countries there is not only a lack of building acoustics regulations, but also a lack of knowledge among legislators concerning social impact of noise within buildings.
- There are only three countries (Argentina, Brazil and Chile) having developed building acoustic regulations and these are not comparable because they are based on different sound insulation descriptors and have different requirement levels. Besides, the regulations are not always normative.
- The impact of environmental noise on the society is better known and thus more countries have developed environmental noise regulations. When no building acoustics exist, often the environmental noise regulation includes limits for

maximum sound pressure levels inside the buildings, as a function of the use of the building. Again, neither the descriptors used nor the requirement levels are the same so cannot properly be compared.

- In most cases, the absence of building acoustic regulations is directly related to the lack of awareness and initiatives from the public administration, as well as from acoustic consultants, experienced building acoustic laboratories and the population in general.
- Based on the requirement levels (both for sound insulation and for maximum SPL indoors) there are evidences about the general understanding that docent and sanitary buildings require higher protection against noise. Similarly, there are evidences that working offices are considered less sensible spaces compared to housing, schools or sanitary spaces.

Based on their own experience in the field of building acoustic regulations and standardisation, the authors have the following suggestions for building acousticians and building acoustic legislators in South America:

For countries not having yet developed their own building acoustics regulations:

- To consider and inform about the impact on the society of developing building acoustic regulations: benefits for end users (health, privacy…) and for the building sector.
- To stablish building acoustic expert groups to assess the corresponding legislation and to study existing building acoustic regulations in South America and the corresponding ISO documents, aiming at producing regulations compatible and comparable to existing ones. This will, in the long run, foster cooperation and understanding between manufacturers, promotors, legislators and end users.
- Postpone the development of an acoustic classification scheme until sufficient experience and data have been collected in this field in their country. Having a national data base gathering the results of all the in situ sound insulation measurements can be a useful tool for the future.

For countries already having developed their own building acoustic regulations:

- Encourage the use of the regulations even if not normative.
- Revise and update the regulations every five year period based on the feedback obtained from their own and from other countries' experience.
- Aim at harmonizing sound insulation descriptors used within South America
- Take the lead in South America and promote the development of building acoustic regulations by addressing the adequate public: conferences in University, health units, administrative sector and general public.

All the information and suggestions included in this paper have the intention to promote the understanding and collaboration between experts in the building acoustics field and does in no way aim at criticizing the existing regulation or situation. The development of new regulations is already a big challenge, but if one adds the intention to develop something compatible and comparable to high-end regulations, then the task is twice as challenging. This in any case should not prevent acousticians or legislators to try to do the effort and provide the citizens with the best possible regulations.

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