

NOISE CONTROL IN PUBLIC PLACES. ACTIVE SOUNDPROOFING. INSPECTION AS A METHOD OF DATA MANAGEMENT.

Jose Elias Arias Puga.

Proceso Digital de Audio

Within a room sound pressure levels are produced due to various sound sources inside the room. These levels are often desirable but at other times may be the cause of annoyance within the building itself. This means that it needs to be limited. Depending on the conditions of the walls adjoining the premises, these sound pressure levels may produce noise in neighbouring buildings as well as the outside, noise which may be considered a disturbance. These noise levels are regulated by Local Authorities by means of bylaws which control noise levels both in the street and adjoining premises.

Within public places, the sources of noise can be classified in two groups: those with permanent emission levels, such as air conditioning, ventilators, etc. and those where noise emission levels can be varied by the user. This is the typical case of music emissions from P.A. systems and the noise generated by large numbers of people. The overall result of these noise sources is the existence inside the premises of a sound pressure level which, as we know, tends to extend in all directions. The noise is transmitted outside through the walls facing the street, provoking environmental noise pollution which causes annoyance to the public. This problem forces Local Authorities to control emissions through the previously mentioned bylaws whose objective is:

- to ensure the quality of the urban environment as regards noise pollution.
- to insist upon the necessary controls in buildings so that emissions do not occur.
- the regulation of the sound levels attributable to various causes.
- the creation of a legal system with respect to general procedures and fines.

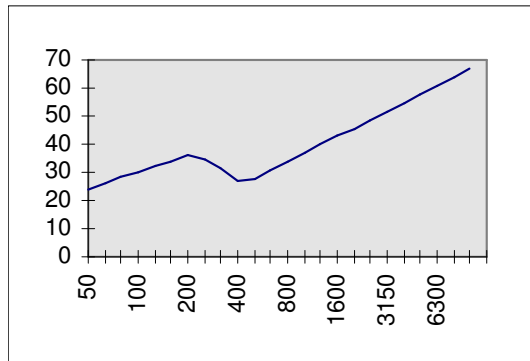
Therefore, it is necessary to tackle the problem of noise control so that levels transmitted remain within the established limits. This control can be achieved by restricting the source which would involve treating the physical limits of the premises where the noise occurs. In this way the transmission characteristics of the walls offer the necessary reduction so that the sound transmitted is within the permitted levels (**passive soundproofing**). Alternatively, the noise produced can also be controlled at source using active methods which restrict source emission to within pre-established limits so that, with the reduction of the premises, noise levels remain within local authority regulations (**active soundproofing**).

Both methods are complementary rather than exclusive. This means that we can not resolve a noise problem in a building by simply treating the wall-facing of the premises since the soundproofing we obtain is not always as effective as we would like. This is due to difficulties brought about by the loss of space and the fact that costs increase with the value of soundproofing materials. Therefore, the passive method has to be complemented with an active control of the noise source.

SOUNDPROOF QUALITIES OF THE WALL-FACINGS.

As we know, the values of the acoustic soundproofing of a wall-facing are proportional to its mass and grow proportionally with the frequency.

As can be seen in Figure 1, soundproofing increases with frequency, showing a dip at the critical frequency. Wall-facing soundproofing then recovers.



Given this behaviour, if we want to increase the soundproofing of a wall we will have to double the mass in order to obtain an increase of 6 dB which is not only expensive but also, building-wise, impossible.

In order to achieve this goal it would be necessary to build double walls with a mixture of different materials so as to obtain soundproofing improvements greater than those achieved by improving the wall mass.

In Figure 2 we can see the increase obtained in the soundproofing of a brick wall adjoining another wall of the same material with a 10 cm. separation and also the result of one wall adjoining another made of plaster or "pladur" separated by 5 cm.

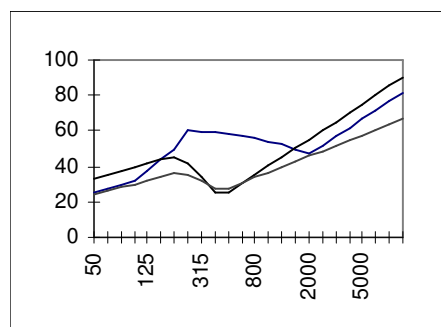


Figure 2

We can see that the increases obtained are greater than by increasing the mass. However, the disadvantage is greater irregularity of the soundproofing curve creating certain holes in which - at best - we will have the soundproofing of the wall-facing of greater mass. The design conditions will lead us to design the wall-facing so that, with the loss of space and the availability of materials, we can move these holes to areas which do not affect the desired soundproofing.

In conclusion:

In each wall-facing we have an area located below the resonance frequency of the chamber in which the partition walls are joined. For this reason the reduction introduced is that corresponding to the sum of the masses.

In any compound wall-facing there is a frequency for which the soundproofing falls below the soundproofing corresponding to the sum of the masses for that frequency.

It is for this reason that we can not design soundproofing as complete as we would like at reasonable prices and have to adapt it, not only to the source levels we want to control, but also to the noise spectrum emitted by the sources.

We have previously observed that sources within the premises fall into two groups:

1. Those which emit a constant noise, (when they are in operation) allowing us to know their emission levels and spectrum. Thus, when we are planning soundproofing for a room we use the spectrum of all the possible sources existing on the premises as a design model.
2. Those whose level and spectrum can be freely varied or those which depend considerably on the operating conditions. With this type of source, the design of the wall-facing is complicated and the only way it can be done at a reasonable price is to assume certain operating conditions and then regulate them so that they exceed the design conditions.

On premises used by the public - for example, those used as pubs, bars and discotheques - we have two noise sources which conform to the second of the above groups: on the one hand, the noise of the people on the premises, and on the other, the noise created by the P.A. system. The first, although contributing considerably to the total noise on the premises given that when the place is most crowded it will easily exceed the permanent noise emissions, registers quite reasonable higher levels. These will hardly exceed 90 dB. Thus, in our design we can successfully tackle the problem of transmitted noise if we assume soundproofing for that maximum level.

As regards the second source, due to the characteristics of the sounds emitted - which have a very wide dynamic margin - and also the high output capacity of the P.A. systems, we can not design our soundproofing using the maximum spectrum emitted by the P.A. system as a design characteristic unless we accept high costs. Even in that case we could find that in any future structural reform a sound system might be installed which would exceed our soundproofing. Therefore, the solution to the problem is to control the music system so that the emission levels are in line not only with the planned but also actually installed soundproofing.

In this example, we can control the source not only by means of the soundproofing of the passive factors which make up the parameters but also, moreover, we can introduce an active control factor which restricts the source to certain maximum emission limits.

ESTABLISHING MAXIMUM EMISSION LEVELS.

Once soundproofing has been carried out, the next step is to measure it and then to proceed to its certification. This measurement is taken using the established method: UNE 74-040-84, Part 4: "Measurement of the soundproofing of buildings and building materials" or "Measurement -in situ- of the soundproofing of the air

noise between premises", regulation ISO 140 (VI) 1978. In both cases, the capacity of the soundproofing of the partition walls is defined in terms of octave thirds. Once this soundproofing is known, we can determine the maximum noise spectrum the premises can tolerate.

In those premises used by the public in which the dominant sound source is the P.A. system we can, in general, attribute all the permitted spectrum to this source. The remaining sources can be taken into account - principally the number of people on the premises - and retain two or three additional decibels.

Two spectra which generate a pressure level of 30 dB(A) can produce different degrees of annoyance.

In Figure 3 we can see two distinct spectra which have the same A-weighting value while both represent a noise level of 30 dB(A). One corresponds to a defined ISO spectrum corresponding to an NC-15 noise correction curve whose origin is the evaluation of the degrees of silence in recording studios used to measure the degree of humming of air conditioning appliances. This spectrum has certain values which, if we were to filter them through a weighting net, would give us values in each octave third of approximately 15 A-weighted dB. This noise would represent the same degree of annoyance in all the bands.

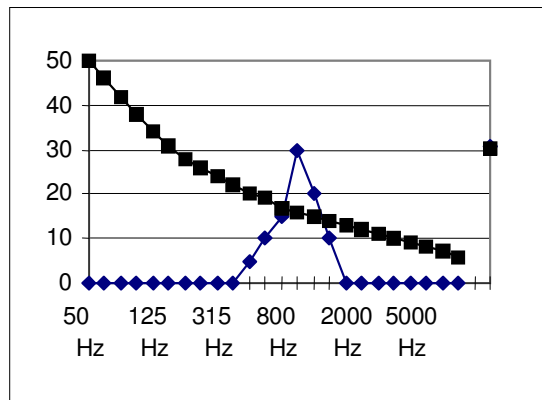


Figure 3

The second spectrum corresponds to a narrow band noise in the 1 KHz. area, which has the same value of 30 dB(A) but whose energy is centred on the most sensitive part of the ear. For this reason the sound is much higher and, therefore, the annoyance level is also much greater.

As a result, when we want to determine what the maximum noise the premises can tolerate we must define it by means of a spectrum. To do this we will use the soundproofing measured in octave thirds and the maximum contaminating noise spectrum which, as we saw before, can be correlated with a spectrum defined by an NC. The value of the latter in most cases is the NC-15 which corresponds to a transmitted value of 30 dB(A). This maximum noise spectrum will, therefore, be the:

Noise level on the premises < Soundproofing + Maximum legal value permitted (NC-15)

This spectrum is the maximum allowed on the premises so that in the building affected by noise pollution we do not exceed the NC-15 spectrum - or in other words - the 30 dB of transmitted noise level. Therefore, none of the noise sources can exceed that spectrum. In a public place the dominant source is the P.A. system and, generally speaking, all the permitted spectrum can be assigned to it or we can hold back two or three dBs for the rest of the sources. Thus, once our soundproofing is installed we have to maintain the spectrum emitted by the equipment below the permitted limit.

ACTIVE SOUNDPROOFING ELEMENTS.

There are various methods for maintaining the PA systems below certain emission limits. The most well-known are limiters whose operation consists of analyzing the pressure level existing in the room and of reducing the equipment in relation to it. This operation has three disadvantages:

1) They work on a feedback loop which, to avoid oscillations, must have a highly damped loop, in turn making them very slow.

2) They take the sample of all the noise existing on the premises. Thus, in order to avoid shouts and sporadic noise which might cause alterations of the levels, they work on very strong integrations, again meaning they are slow.

3) Limiters operate on the entire spectrum. This is clearly a misuse of the spectrum and consequently leads to a loss of sound level in the room.

Predictive algorithm systems work quite differently, taking advantage of each of the above mentioned characteristics for active soundproofing elements, leading to better use of the maximum spectrum within the premises and ensuring that the emitted spectrum at no time exceeds the maximum permitted.

Their fundamental characteristics are:

1) They work on the line levels and thus avoid the entire feedback process.

2) They use the characteristics of the premises as calculation elements.

3) They perform spectrally.

CONCLUSIONS.

Any room can tolerate a sound pressure level without emissions through the wall-facings necessarily being above the legally permitted levels. This level, which is the maximum that the premises can bear, is related to its acoustic soundproofing.

Since acoustic soundproofing measurement is one-off and univocally defines the behaviour of the room in question, the maximum noise spectrum will also be one-off. This, therefore, defines the premises - acoustically speaking. Thus, maintaining the levels below the spectrum defined as a maximum on the premises, guarantees that the levels transmitted to the adjoining buildings are within those permitted by law.

INSPECTION SYSTEM

We have previously observed that any premises can be acoustically classified by means of its soundproofing measured according to the ISO 140-4 and that, depending on this soundproofing, the premises will be able to tolerate internally a noise which can be defined by

"the soundproofing value + the inmission level permitted by law".

This inmission value permitted by law is generally expressed as a value in dB(A), as we have seen, can be adapted to a maximum pollutant spectrum which we can correlate to the NC curve. This curve - added and integrated - gives us the legal limit. Given that soundproofing measured according to the ISO-140-4 is a function of the frequency, the above equation defines the **maximum noise spectrum** which the room in

question can tolerate internally: the emissions produced in the adjoining premises thus being below the values permitted by law.

What is really important is that with this noise spectrum the sound which a room can internally tolerate is univocally defined.

Thus a way of resolving one of the biggest problems facing environmental authorities, namely the inspection and control of activities on the premises in question, may be found.

If the licence to open a business is depends on certain conditions, including the maximum noise permitted on the premises, inspection can then be reduced to a simple visit to the site to see whether the conditions of the licence are being adhered to.

To do this, environmental authorities have to take on two fundamental jobs:

- **Acoustic cataloguing of premises** in order to determine the maximum noise spectrum.
- An **inspection** of the premises by previously installing a device which registers and stores sufficient data to ensure that the maximum levels within the premises are always below the level stipulated in the licence.

In order to perform the first task, only personnel and equipment are necessary. The success of the second part depends on the apparatus from which all the information is obtained. This device or "black box" would, when correctly installed on the premises, give us the information regarding when it was operating, what levels were generated inside the room and finally, could record that data so that the inspection authorities could collect the information and check that the activities occur within the established limits.

This inspection and control system should be able to carry out the following functions:

- Record and store the periods of sound production on the premises, recording the starting and finishing times and dates, the level equivalent to a maximum 1 minute period and the time at which this is produced and, finally, the average equivalent levels of the session.
- Record and store the operating periods of the sound sources, registering the time and date of switching on, time and date of switching off, as well as the energy performance of the sound reproduction system so as to ensure its adequate functioning.
- Store the above information for a certain period in order to facilitate inspection at a later date.
- Incorporate a system which allows the Local Authority Engineering Department to collect the data which may be downloaded to the inspection service computers for analysis, evaluation and printing. This data collection should be neither destructive nor permit any untoward tampering.
- Finally, the system should incorporate the necessary protective devices in order to avoid manipulation of the set-up. This should be carried out by means of electronic keys or access codes.

ADVANTAGES OF THE SYSTEM

The implementation of an inspection and control system based on the previous observations has the advantage of being founded on the objective data of the acoustic conditions existing on each premises. This means that, at all times, the extracted data is also objective and thus eliminates the hit-or-miss factor of each particular situation.

Being able to obtain data of what has happened not only on the day in question but also during longer periods of up to 100 days, means that the activity on a premises can be based on a statistical analysis of the noise levels emitted. Likewise, knowledge of the changes in these levels over a period of time eliminates uncertainties regarding measurements taken after a complaint, with all the legal problems this would involve. Finally, the greatest advantage of a system of this type is that it permits the planning and control of all possible noise sources, providing information on how much each contributes to the noise pollution of the environment, regardless of the problems posed by neighbouring buildings. In the great majority of the cases presently dealt with by environmental authorities noise control is not implemented *ex officio* but is rather the consequence of a complaint by a citizen. This means that often more conflictive situations remain outside the control of the authorities because neighbours may be more tolerant.