



- “” INTELLIGIBILITY
- [] CONFIDENTIALITY
- () CONCENTRATION



Acoustical Guide

General Definitions



Typical criteria for acoustic regulations

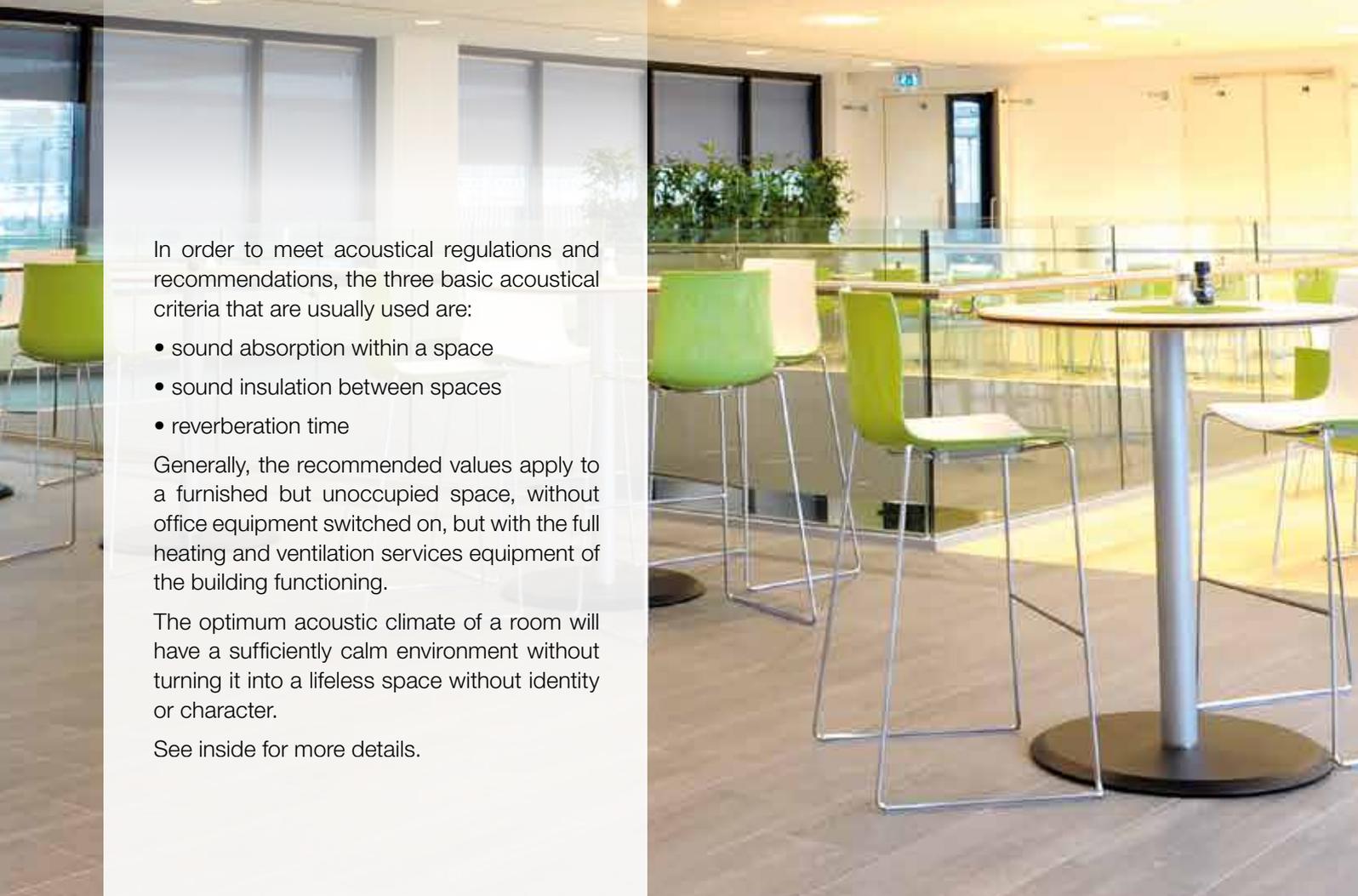
In order to meet acoustical regulations and recommendations, the three basic acoustical criteria that are usually used are:

- sound absorption within a space
- sound insulation between spaces
- reverberation time

Generally, the recommended values apply to a furnished but unoccupied space, without office equipment switched on, but with the full heating and ventilation services equipment of the building functioning.

The optimum acoustic climate of a room will have a sufficiently calm environment without turning it into a lifeless space without identity or character.

See inside for more details.





Understanding and overcoming acoustic challenges

(**I**ntelligibility, **C**onfidentiality and **C**oncentration

Acoustical standards cannot predict either practical results or subjective perceptions, which are linked to working conditions and the way a space is used.

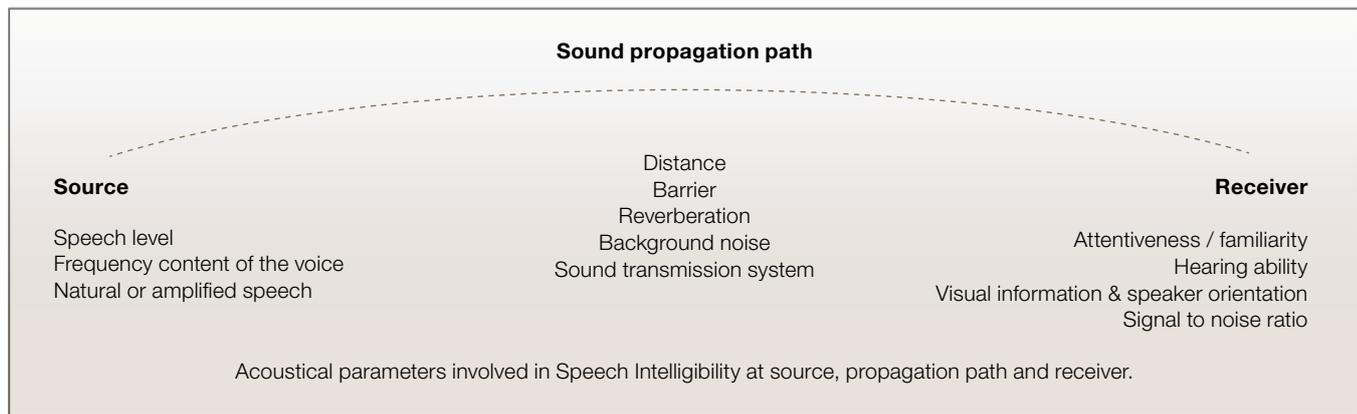
Occupants of any space, be it an office, a classroom, a shop, a hospital or any similar environment, need:

 **I**ntelligibility

 **C**onfidentiality

 **C**oncentration

In any functioning space, the sound transmission varies according to the following, source, path and receiver related parameters.



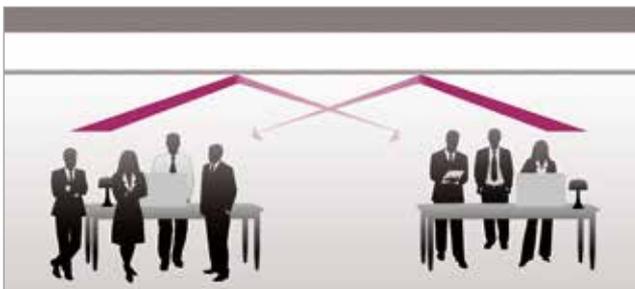
(See glossary on the backcover for further explanation)

Acoustical

(Sound absorption within a space

Any conversation that takes place in a space produces sound waves of a certain energy. These sound waves spread out from the source towards the ceiling, walls, floor and any objects within the space. Part of this energy is absorbed by these elements, while the remainder is reflected.

If a room is small and a lot of sound is absorbed at each reflection, then the resulting environment will tend to be quiet and have a short reverberation time. Conversely if the room has a larger volume and little sound is absorbed at each surface reflection, then the room will sound 'noisier' and have a longer reverberation time.



Sound absorption for better concentration

(Reverberation Time

This is a measure of how decaying sound persists in a room and it tells us something about how 'lively' or 'lifeless' a room's acoustics will be and how loud or quiet noise levels will sound. For any room, depending upon its size and whether it is primarily for speech or music, there will be an optimum reverberation time range.

For example, the reverberation time for speech must not be too long (0.8 seconds is a good upper limit) otherwise successive speech sounds will overlap with a consequential loss of intelligibility. However if it is too short (< 0.4 secs) then the space could seem 'lifeless', with no obvious reinforcement from the room, and this will make for extreme difficulty in conversation particularly when addressing a group of people over distance such as occurs in teaching spaces or in meeting rooms.

For teachers who take classes for perhaps 5 or 6 hours per day in 'lifeless' environments, the consequence can be fatigue, sore throats and lack of motivation.

Music activities however benefit from longer reverberation time with a consequential blending of successive notes and the resulting fullness of tone. However if the reverberation time is much too long then the received sound will lose clarity and appear 'muddy', and if it is too short, then the sound will be 'dry', the performers will seem distant and the sound will lack 'warmth' and 'envelopment'.

So, whatever the application, for any space the reverberation time should be optimised and be neither too long nor too short. Too much sound absorption, when it is not needed, is just as unacceptable as too little when it is!

performances...

(Sound Insulation between spaces

Sound insulation concerns the reduction of sound transmitted from one room to another.

When related to suspended ceilings, the plenum, which is the space between the structural soffit and the suspended ceiling, is an important path for sound transmission.

The reduction of this sound depends on the thickness and density of the elements which protect against the transmission of sound waves. The heavier (thicker) the element is, the lower will be the sound that is transmitted through it and hence the better will be its sound reduction ability.

The air tightness of the joints also influences considerably the quality of the insulation.

If there are significant gaps or cracks within or around the element then the sound transmission will be enhanced and the potential sound reduction severely reduced.

Think of an open window, and how a lot of sound easily transmits through it.

Suspended ceilings are unusual in that the sound reduction through them can be measured in two entirely different ways depending upon the location of the sound source.

Sound Reduction Index (R or SRI) is the measure when sound passes through the ceiling once. This may be when the source of sound is in the void above the ceiling, or the sound could be coming from the floor above.



Sound attenuation for better confidentiality

Sound Attenuation (Dnf) however, is the measure when the source of sound is in an adjacent area and the sound transmits through the ceiling twice via the common ceiling void. In most cases the quoted value (in dB) for a suspended ceiling is the sound attenuation performance.

In practice, sound attenuation is mainly used as continuous suspended ceilings are very common.

Whilst the Sound Intensity Level (LI) is not a direct measure of the performance of a ceiling tile, it is another measure that suspended ceilings can influence. This measures the intensity of sound radiating into a space due to rainfall onto a radiating surface, such as a lightweight roof construction. By using a suspended ceiling below, disturbance from rain noise impacting on a lightweight roof construction into a room below can be significantly reduced.



Sound attenuation and absorption for better intelligibility

The necessary level of sound attenuation depends on the user's need for speech privacy as well as the background noise in the receiving space. The best design approach is to create a good balance between the performances of the walls and the ceilings.

Light weight ceiling constructions only provide a low sound attenuation. Hence, it is important to pay attention to the Dnf value of a ceiling in order to reach the required room to room sound insulation.

... for acoustical

Intelligibility



“I want to be understood”

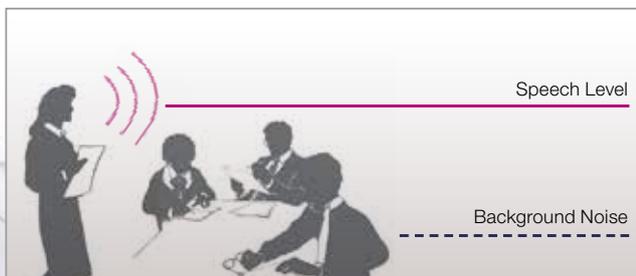
Speech intelligibility addresses the need for comprehension of verbal communication whether naturally spoken or broadcast by an amplified system, within a given space.

The measure of speech intelligibility is governed by country and segment specific norms and regulations, but the signal to noise ratio is commonly used to assess the level of intelligibility.

It expresses the difference in decibels between the level of speech and the background noise (heard at the listener’s position).

To ensure excellent intelligibility, this difference is recommended to be 10 - 15 dB minimum for people with good hearing and 20 - 30 dB for hearing impaired or users of head-sets (heard at the listener’s position).

Indicative levels of speech intelligibility related to signal-to-noise ratio		
People with good hearing	Signal-to-noise ratio	Hearing impaired or users of head-sets
-	30 dB	Excellent
-	20 dB	Good
Excellent	15 dB	Fair
Good	10 dB	Marginal
Fair	5 dB	Poor
Marginal	0 dB	No intelligibility
Poor	- 5 dB	-
No intelligibility	- 10 dB	-



Signal to noise ratio = speech level - background noise (see glossary)



comfort

(Confidentiality

“I don’t want to be overheard”

Speech privacy is a measure for defining the degree to which conversation cannot be overheard.

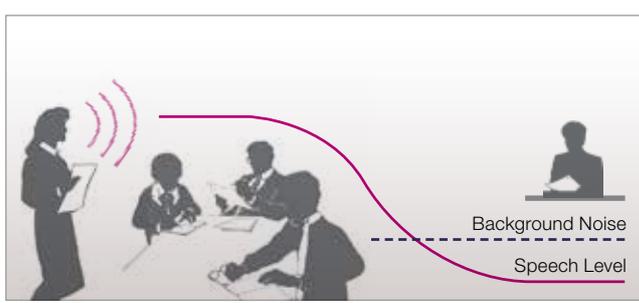
For good privacy between adjacent spaces, it’s necessary to focus on room-to-room sound attenuation and the background noise level.

In open plan spaces, the lack of physical barriers and the close proximity of work zones, results in reduced privacy, which can not be solved by traditional construction means only, and the focus needs to be on the background noise level.

To measure privacy, ASTM norms and regulations which exist in the USA, have started to be used as models for Europe.

Currently, the signal to noise ratio is also used in Europe.

The signal to noise for good privacy is recommended to be -5 dB or lower for people with normal hearing.



In an open space, a long distance would be necessary not to be overheard

Signal to noise ratio	Level of confidentiality	Result
At least - 10 dB	Confidential privacy	Detected but not understood
- 5 dB	Good	Effort required to understand
5 dB - 10 dB	Marginal / poor	Readily understood
More than 10 dB	No privacy	Fully intelligible

(Concentration

“I do not want to be disturbed”

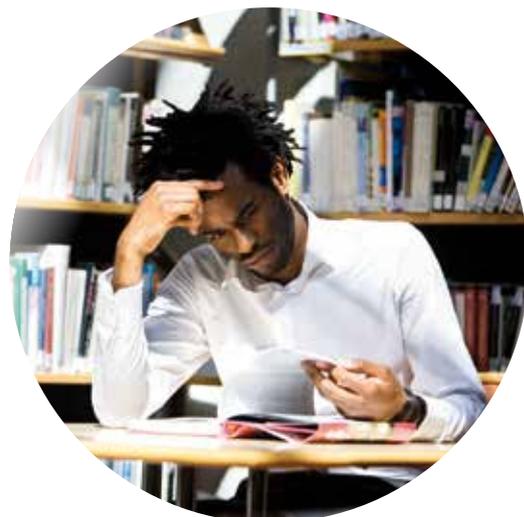
Concentration can be disturbed by different types of noise, such as other peoples’ voices, phones ringing, ventilation, keyboards, equipment, impacts, road and air traffic.

Continuous noise does not disturb as long as the level and the frequency range is broad enough, and passive acoustical treatment is sufficient.

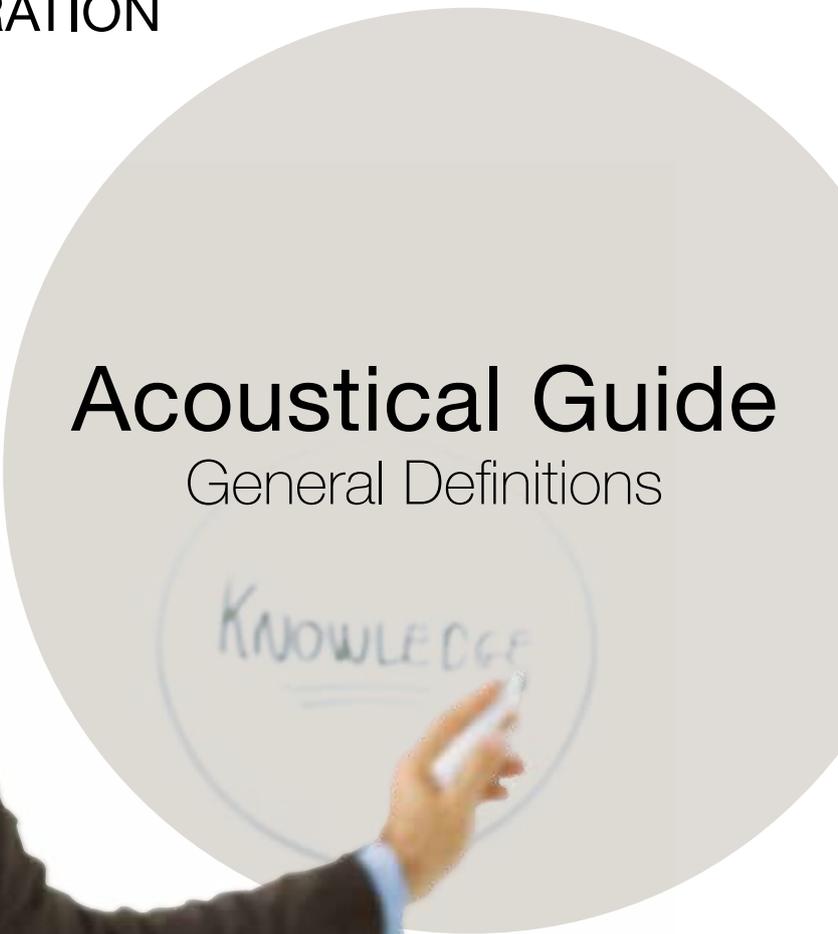
Intrusive noise will surely disturb concentration and therefore needs to be considered as another key factor in the design of the acoustical environment.



Physical barriers improve intelligibility, confidentiality and concentration



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