ODEON APPLICATION NOTE – ISO 3382-3 Open plan offices

JHR, December 2012

Scope

This is a guide how to calculate the room acoustical parameters specially developed for open plan offices according to the international standard ISO 3382-3:2012 Acoustics – Measurement of room acoustic parameters – Part 3: Open plan offices [1].

The method is intended for furnished rooms, i.e. the room model must include tables, bookshelves, screening elements etc., but with no people present. The results can be used to evaluate room acoustical properties in open plan offices and it may be used for comparison of alternative solutions in design or acoustical treatment.

This application note refers to ODEON version 12, all editions.

Method

Although ISO 3302-3 is a measurement method, the measurement procedure can be simulated in ODEON, thus providing a tool for the acoustical design of open plan offices.

The principle is to calculate the sound propagation from a sound source to a number of receivers that are located in different distances from the source, which must be omnidirectional, and a standardised sound power spectrum of normal speech is used. Both the A-weighted sound pressure level (SPL) and the speech transmission index (STI) are calculated, and a number of acoustical parameters are derived from the results. The positions of sources and receivers must correspond to actual work stations in the furnishing plan.

The results using this method are influenced by the amount of sound absorption, the use of screens and level of background noise. Examples of variation of these parameters are found in ref. [2].

Terms and definitions

Background noise level
sound pressure level in octave bands during working hours, but not including noise caused by people, spatially averaged over the work stations.

Sound power spectrum of normal speech
sound power level in octave bands emitted by a human speaker at normal vocal effort, as defined in ANSI 3.5 [3] and assuming a directivity as in [4].

Spatial decay rate of speech
$D_{2,S}$
rate of spatial decay of A-weighted sound pressure level of speech per distance doubling.

A-weighted sound pressure level of speech at a distance of 4 m

$L_{p,A,S,4\ m}$

nominal A-weighted sound pressure level in a distance of 4 m, when an omnidirectional sound source emits a sound power spectrum of normal speech, obtained using a linear regression line through a series of measurement positions.

Distraction distance

r_D

distance from speaker where the STI falls below 0,50.

Privacy distance

r_P

distance from speaker where the STI falls below 0,20.

Room conditions

The room model should include the absorption and the rough geometry of tables and other furniture. An example is shown in Fig. 1.

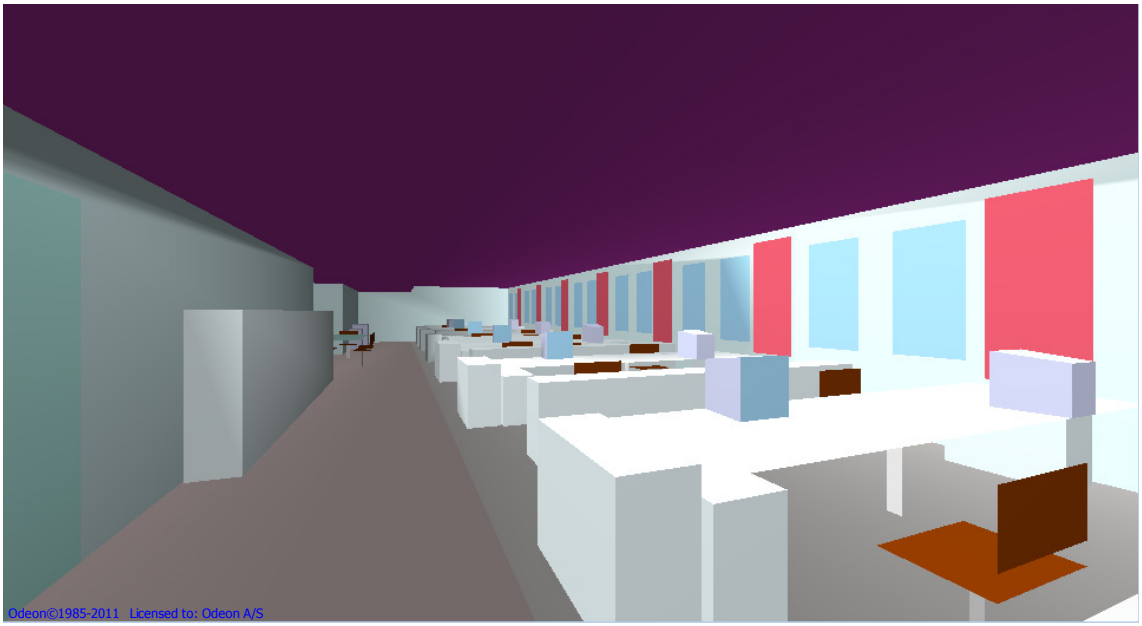

Figure 1. Example of room model including furniture and sound absorbing materials.

The background noise level is one of the important parameters in this simulation. It is applied for the STI calculations, and thus the background noise level has a direct influence on the distraction distance and the privacy distance. According to ISO 3382-3 the background noise shall represent the HVAC devices and other noise sources operating as during typical working hours. If the office is equipped with a sound-masking

system, this shall be applied for the background noise in the calculations. If the background noise varies with position, the average over all receiver positions shall be applied for the simulations.

Background noise from people talking and other activities (the dynamic background noise) shall not be applied for the general simulations in accordance with the standard, but it may be used for a supplementary simulation.

The background noise level in octave bands is entered in the Room Setup, see the example in Fig. 2. It is not necessary to give data for the 63 Hz octave band, as this frequency band is not used for the simulations.

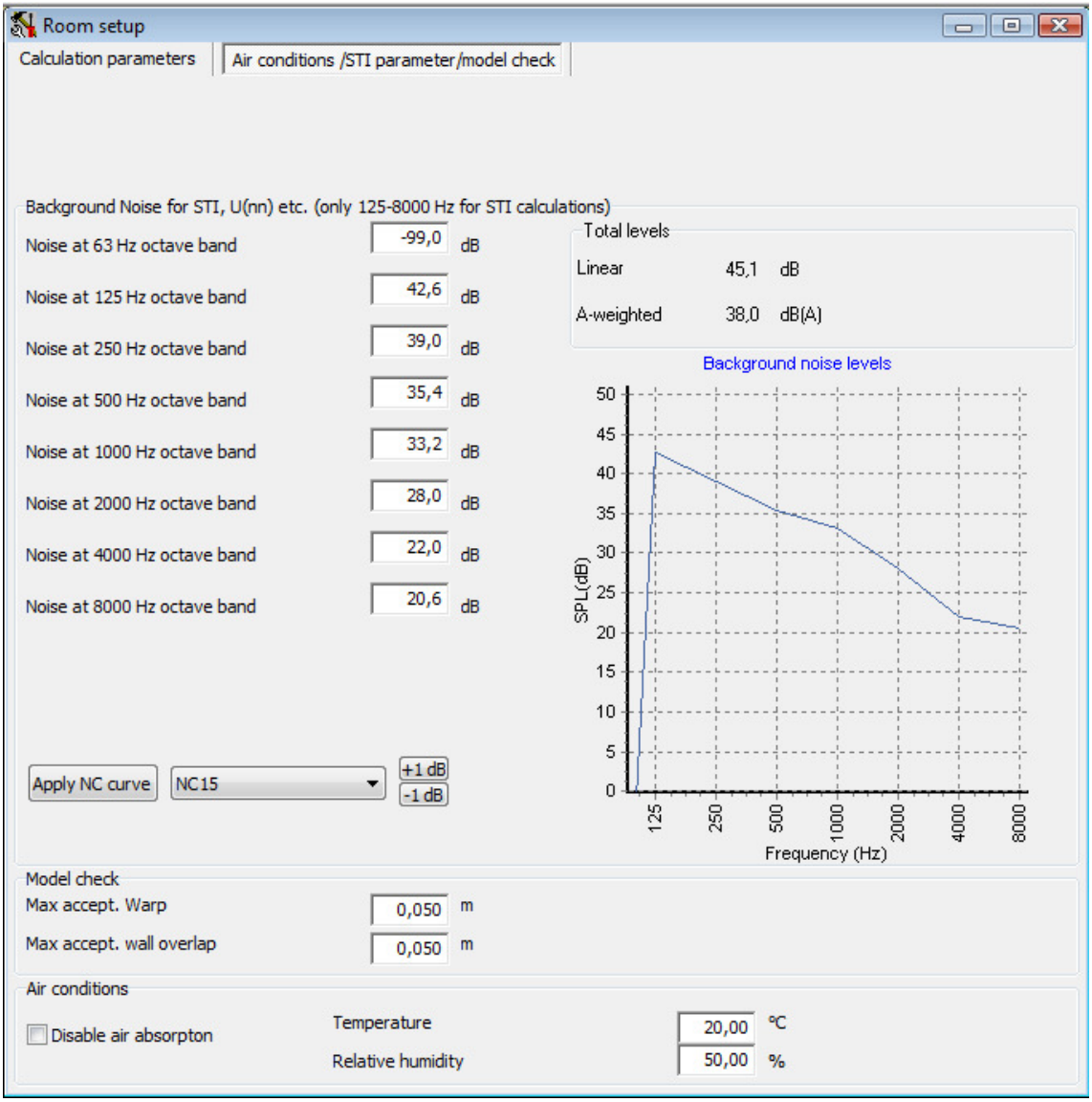

Figure 2. Example of background noise entered in octave bands, and with the A-weighted sound pressure level of 38 dB(A).

Sound sources

An omnidirectional sound source is used, and the spectrum and sound power is defined in order to represent speech at normal vocal effort. The spectrum is based on ANSI 3.5 [3].

Since the directivity of a talking person is not applied, there is no need to consider the sound pressure level in the frontal direction; the sound power level in octave bands is sufficient. The source data are included in the predefined sound source ISO3382-3_OMNI.SO8, see Fig. 3.

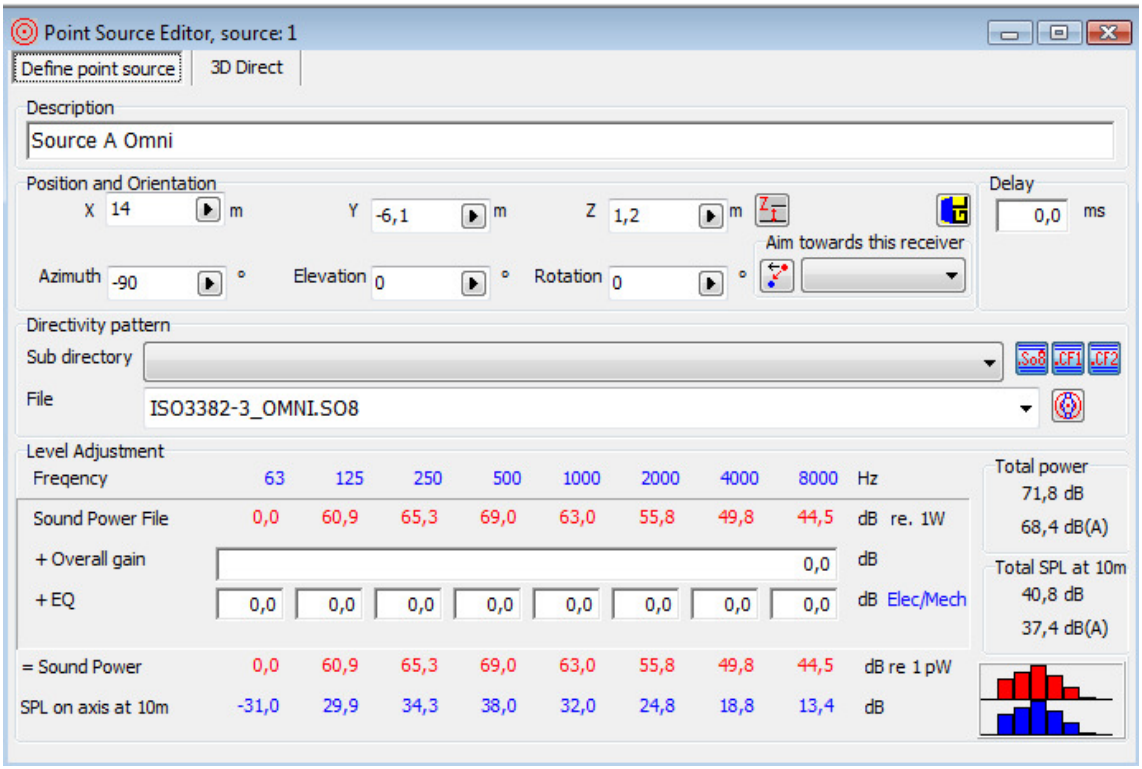

Figure 3. The source definition menu; the source with the name ISO3382-3_OMNI.SO8 has the spectrum and sound power of normal speech as specified in the standard. The A-weighted sound power level is 68,4 dB(A).

At least two sound source positions shall be used. Each sound source shall be at the end of a line of receivers (see next section). The same line of receivers may be used twice with a sound source in each end of the line.

Sound sources and receivers are placed in typical workstations, and the height shall be 1.20 m above the floor, representing seated persons.

Receivers

The receivers are located in workstations at a height of 1.20 m above the floor. The receivers shall be arranged in such a way that each group of receivers are related to one source position. Each group must consist of minimum 4 receivers, and preferably between 6 and 10 receivers approximately on a line. The

distance to the most remote receiver position depends of the size of the room; however, only positions within the range 2 m to 16 m are used for the determination of the spatial decay rate of speech. This is automatically managed by ODEON.

The calculations are set up in the Job list with one job for each sound source, and the Multi Point Response is calculated. When looking at the results in Multi Point Response, the first window is used to select the appropriate group of receivers related to the active sound source, see the example in Fig. 4.

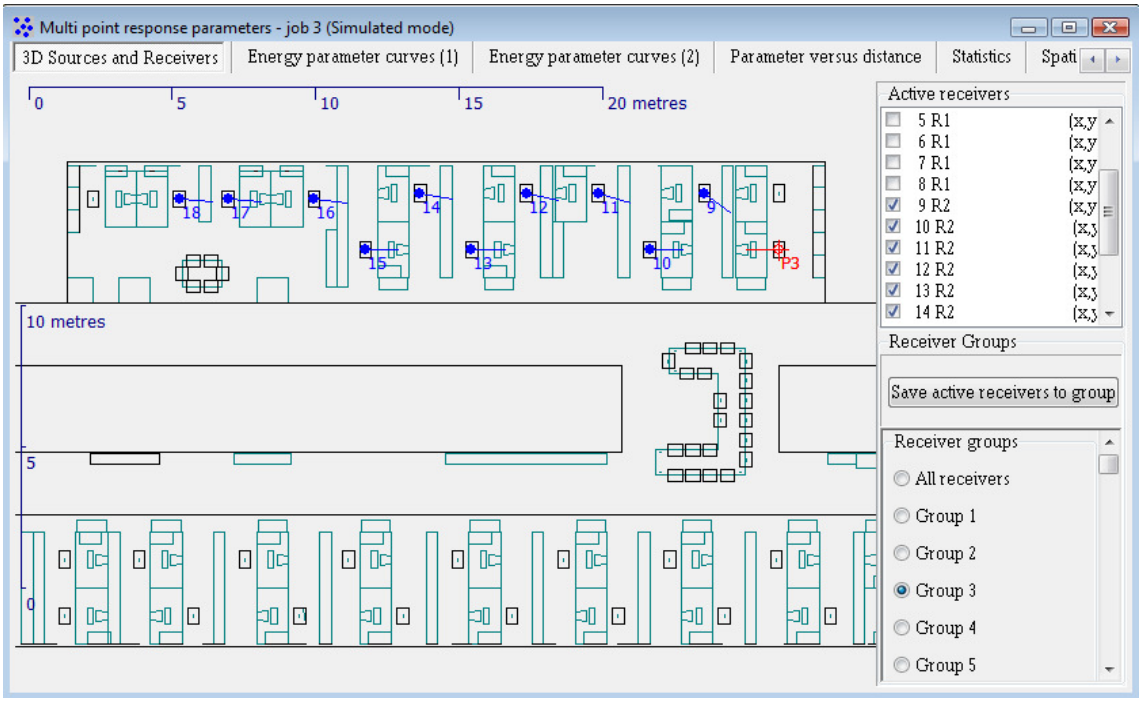

Figure 4. A group of ten receivers (no. 9 to 18) have been associated to sound source P3.

Results

In the Multi Point Response there are three windows with results that are relevant for the open plan office.

Having selected the appropriate group of receivers (see above), the page with Spatial decay curves displays the spatial decay rate of speech and the two parameters derived from that curve, $D_{2,S}$ and $L_{p,A,S,4m}$. NB: There are several spatial decay graphs on this page; use the up/down arrows to select the right graph. An example is shown in Fig. 5.

On the next page is a graph showing the spatial sound distribution of the STI parameter, and the regression line used to calculate the distraction distance and the privacy distance, see the example in Fig. 6. It is noted that the privacy distance can exceed the largest dimension of the room, typically in cases with no screens and low background noise. In other cases with efficient screens and high background noise it may occur that the distraction distance cannot be derived, simply because the STI values are below 0,5 in all distances from the source.

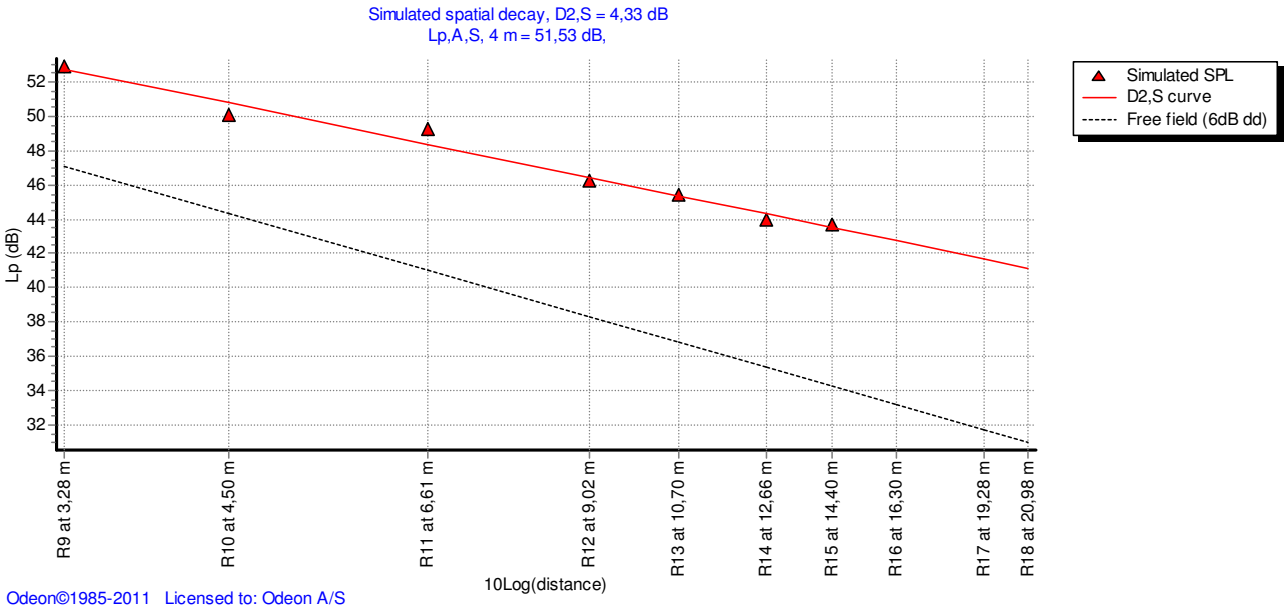

Figure 5. The spatial decay rate of speech: Note that only receivers within the range from 2 m to 16 m are used for the calculation of the regression line, i.e. receiver no. 9 to 15.

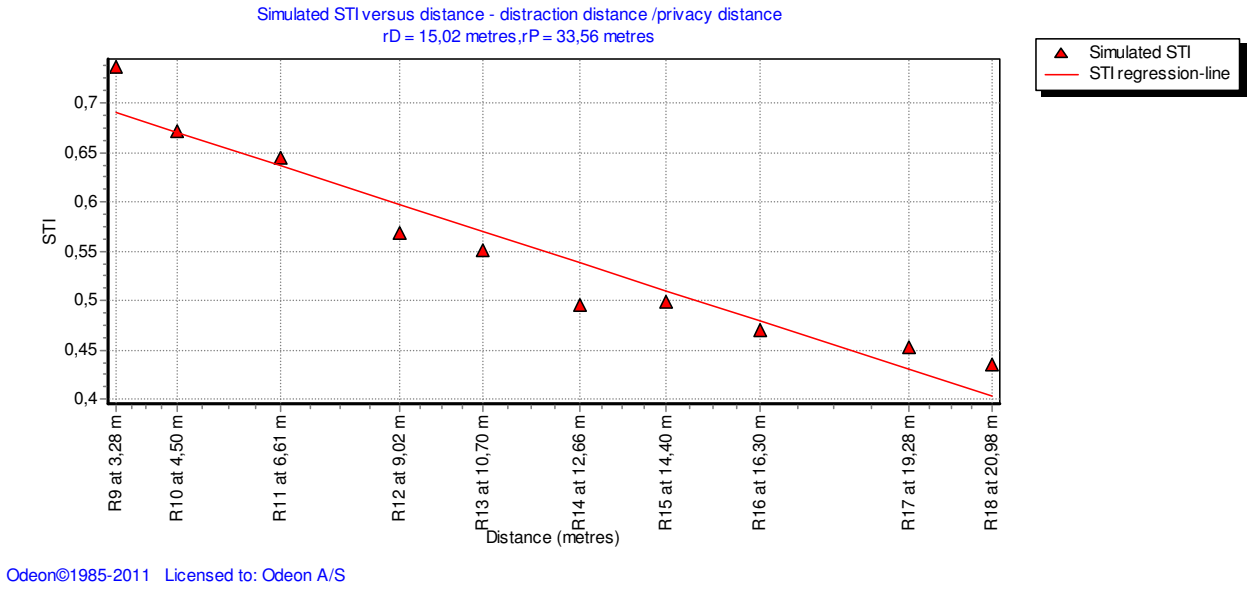

Figure 6. The spatial sound distribution of STI and the regression line used to calculate r_D and r_P.

The page with energy parameters displays the results in each position and the statistics from the selected group of receivers. At the bottom is found the ISO 3382-3 parameters, see the example in Fig. 7. Use Ctrl + A to export the results to a text file, which can be further copied into a spreadsheet or a table in a document, see Table 1.

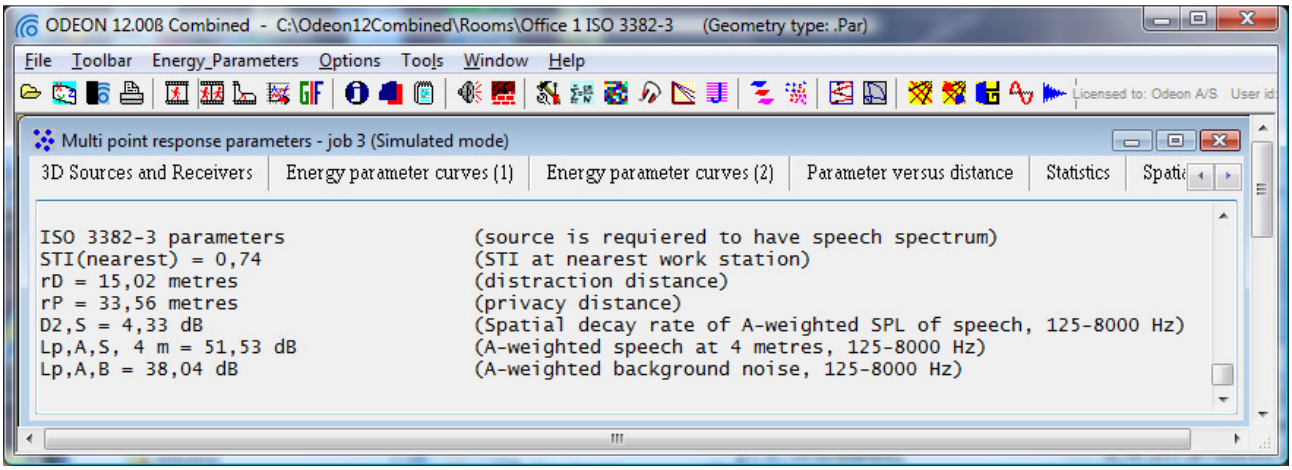

Figure 7. The results as they appear in the bottom of the page with energy parameters.

Table 1. Example of results with ISO 3382-3 parameters for one sound source position exported from ODEON to a document.

STI(nearest)	0,74	(STI at nearest work station)
rD	15,02	(distraction distance)
rP	33,56	(privacy distance)
D2,S	4,33	(Spatial decay rate of A-weighted SPL of speech, 125-8000 Hz)
Lp,A,S, 4 m	51,53	(A-weighted speech at 4 metres, 125-8000 Hz)
Lp,A,B	38,04	(A-weighted background noise, 125-8000 Hz)

For the evaluation of results, Annex A of ISO 3382-3 provides some examples of target values. Offices with poor acoustical conditions have typical values like $D_{2,S} < 5$ dB, $L_{p,A,S,4m} > 50$ dB, and $r_D > 10$ m. As examples of target values for good acoustical conditions are mentioned $D_{2,S} \geq 7$ dB, $L_{p,A,S,4m} \leq 48$ dB, and $r_D \leq 5$ m.

References

1. ISO 3382-3:2012 Acoustics – Measurement of room acoustic parameters – Part 3: Open plan offices. International Organization for Standardization, Geneva, Switzerland (2012).
2. J.H. Rindel and C.L. Christensen: “Acoustical simulation of open-plan offices according to ISO 3382-3”. Proceedings of Euronoise 2012, Prague, Czech Republic (2012).
3. ANSI 3.5-1997. *American National Standard – Methods for Calculation of the Speech Intelligibility Index*, (1997).