Open plan offices - classification scheme based on ISO 3382-3 parameters

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ABSTRACT

With the introduction of ISO 3382, part 3 for open plan offices in 2012 new room acoustic parameters have been introduced. For these parameters only little experience in real life projects is available. In contrast to the draft version of IOS 3382-3 in 2009 the final 2012 version of ISO 3382-3 does not suggest a classification scheme on open plan offices.
With the revision of German guideline VDI 2569 on "Sound insulation and room acoustic design in offices" a classification scheme based on the ISO 3382-3 parameters is discussed. The result is a classification into three quality levels for single and multi-person offices. The definitions on propagation paths (in ISO 3382-3) as well as other aspects of ISO 3382-3 will be discussed and additional recommendations and clarifications will be presented.

Keywords: Open plan offices, sound propagation, standardisation
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1. INTRODUCTION

At least in Germany there are presently no guidelines or suggestions for the new room acoustic parameters introduced by the ISO 3382, part 3 standard in 2012 (1). The present revision of the guideline VDI 2569 on "Sound insulation and room acoustic design in offices" (2) will close this gap. In contrast to other standards on room acoustics such as DIN 18041 "Acoustic quality in small and medium-sized rooms" (3) the VDI 2569 will focus on offices rooms. Single person offices as well as open-plan offices are object in this guideline.

A first task in the discussion about a classification scheme on offices was to find the right parameters for the description of the acoustic quality in an office room. A difference is made between offices for one or more than one person. For both cases a classification scheme based on a different set of room acoustic parameters is briefly described in the following under 2.

The classification on open plan offices or offices for more than one person is based on some of the ISO 3382-3 parameters. These parameters rely on propagation paths in the room between working places. The definitions and requirements for the choice of these paths is not clear in ISO 3382-3 and opens different choices. This can result in totally different results depending on the choice of the paths. Furthermore there are other concerns about ISO 3382-3 that are discussed under 3.

2. CLASSIFICATION SCHEME FOR OFFICE ROOMS

In the annex A to the draft version of ISO 3382-3 examples for four acoustical classes (A, B, C and D) have been given. These referred to the three room acoustic parameters spatial decay rate $DL_{2,S}$ (final version of ISO 3382-3: $D_{2,S}$), level at 4 m distance $L_{p,A,S,4m}$ and distraction distance r_D. For a class A rated office values of $DL_{2,S} \geq 11$ dB, $L_{p,A,S,4m} \leq 46$ dB and $r_D \leq 5$ m have been suggested. The values for the other classe can be found in Table 1. The final version of IDO 3382-3 published in 2012 did not give any classification scheme as in Table 1. Only target values for poor and goo acoustic conditions are quoted in the final document of ISO 3382-3.

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Table 1 – Table A.1 from draft ISO 3382-3: examples for acoustical classes A, B, C and D in open plan offices

Class	$DL_{2,S}$	$L_{p,A,S,4m}$	r_D
A	≥ 11 dB	≤ 46 dB	≤ 5 m
B	≥ 9 dB	≤ 49 dB	≤ 8 m
C	≥ 7 dB	≤ 52 dB	≤ 11 m
D	< 7 dB	> 52 dB	> 11 m

The final version of ISO 3382-3 states that most open plan office have poor or insufficient acoustic conditions and that these can be described with values such as $D_{2,S} < 5$ dB, $L_{p,A,S,4m} > 50$ dB and $r_D > 10$ m. Furthermore it is mentioned without any further reference that good acoustic conditions in open plan offices are hard to find. Values for this case would be $D_{2,S} \geq 7$ dB, $L_{p,A,S,4m} \leq 48$ dB and $r_D \leq 5$ m.

Based on these values the commission on the revision of German guideline VDI 2569 worked out suggestions for a classification on offices rooms. The present discussion will be briefly presented in this contribution and can also be found in (4).

The guideline VDI 2569 refers to building acoustics as well as room acoustics. Here only the room acoustic aspects will be discussed. The revision aims at a fully new version. One prerequisite is that noise is one of the annoyances in office with the highest ratings. It is a clear finding that not high levels cause annoyance and disturbance but low levels in combination for example with good speech intelligibility disturb people in offices. Furthermore it is a common finding that only 30% to 40% of the annoyances in offices can be solved by technical/acoustical measures. The other 60% to 70% need to be solved by other measures (6).

Presently it is discussed that the classification for offices for one person and more than one person should be included in a future version of the guideline.

2.1 Offices for one person

Most important in offices for one person is the amount of absorption in or reverberation time of the room. Accordingly suggestions for the maximum reverb time in octave bands have been used for the classification. Apart from the reverberation the back ground level should not be too high.

In Table 2 a summary of the required values for the maximum reverb time T_{max} in octave bands and the maximum background level $L_{NA,Bau}$ according to DIN 18041 (2) are given. To achieve the corresponding class A, B or C all requirements have to be reached. The proof can be done be calculation or measurement.

Table 2 – Suggestions for classification of single person offices, from (4).

Class	Reverberation time T_{max}[s]		$L_{NA,Bau}$ [dB]
	125 Hz	250 Hz – 4000 Hz	
A	≤ 0.8	≤ 0.6	≤ 30
B	≤ 1.0	≤ 0.8	≤ 35
C	≤ 1.2	≤ 1.0	≤ 40

2.2 Offices for more than person, open plan offices

It is discussed that the classification on open plan offices should be based on four parameters. These are again the maximum reverberation time T_{max} and the background level $L_{NA,Bau}$ according to DIN 18041 (2). Furthermore the spatial decay rate $D_{2,S}$ and the level at 4 m distance $L_{p,A,S,4m}$ according to ISO 3382-3 will be used. Comments on the distraction distance r_D that is not used will be given in the following.

In Table 3 the suggested values of the maximum reverberation time T_{max} and the background level $L_{NA,Bau}$ for the room acoustic classes in open plan offices are presented.

Table 3 – Suggestions for classification of open plan offices, from (4).

Room Acoustic Class	Reverberation time T_{max}[s] 125 Hz	Reverberation time T_{max}[s] 250 Hz – 4000 Hz	Level $L_{NA,Bau}$ [dB]
A	≤ 0.8	≤ 0.6	≤ 35
B	≤ 0.9	≤ 0.7	≤ 40
C	≤ 1.1	≤ 0.9	≤ 40

The room acoustic classes refer to the global parameters reverb time and background noise level. For the parameters $D_{2,S}$ and $L_{p,A,S,4m}$ a classification into three steps of propagation S1, S2 and S3 according to Table 4 are presently discussed.

Table 4 – Suggestions for classification sound propagation in open plan offices, from (4).

Step of propagation	Spatial decay rate $D_{2,S}$ [dB]	Level $L_{p,A,S,4m}$ [dB]
S1	≥ 8	≤ 47
S2	≥ 6	≤ 49
S3	≥ 4	≤ 51

The overall classification of an open plan office can the based on the room acoustic class in combination with the step of propagation in the room. Table 5 gives the overall classification of an open plan office depending on the step of propagation from Table 4 and the room acoustic class according to Table 3. To achieve a class A open plan office at least 2/3 of the propagation lines should reach step S1 and the rest need to be in S2. Apart from this the room acoustic class A is required. Both criteria (step of propagation and room acoustic class) have to be fulfilled.

Table 5 – Suggestions for classification of open plan offices, from (4).

Class	Requirement on step of propagation	Requirement room acoustics
A	2/3 of propagation lines in S1 rest in S2	room acoustic class A
B	2/3 of propagation lines in S2 rest in S3	room acoustic class B
C	1/3 of propagation lines in S2 rest in S3	room acoustic class C

This classification into class A, B or C relies or depends very much on the choice of propagation lines in the room. The definition of the propagation lines influences the single number ratings $D_{2,S}$, $L_{p,A,S,4m}$ but also r_D. So, there is an urgent need to clarify how lines should be chosen as well as how many lines are needed. Theses definitions must also be part of the new guideline and will briefly be discussed in the following under 3.

The idea of this classification scheme is to achieve a reliable comparison of the room acoustical quality in open plan offices. This scheme will make it easier to specify conditions for users, builders and designers of such room. For the acoustic designer or consultant the rating scheme allows the optimisation of the acoustic conditions. For this kind of planning the use of 3D computer models is required. The prediction of the new ISO 3382-3 parameters is still very much under development (5) as some aspects of sound propagation in rooms need further investigation (e.g. diffraction on multiple screens). The final proof of a room should be based in measurements.

3. COMMENTS ON ISO 3382-3

For practical applications and as described above ISO 3382-3 shows some ambiguities that need to be clarified it a reliable and transparent classification scheme is introduced one the basis of the standard. Two of these gaps in ISO 3382-3 will be discussed in the following. Other aspects such as the directivity and spectrum of the sound source applied

3.1 Choice of propagation lines

The choice of propagation lines is not very clear in ISO 3382-3. The user has a rather wide choice on how to define the propagation path for the deduction of the single number ratings. Figure 1 shows three possible paths in a room.

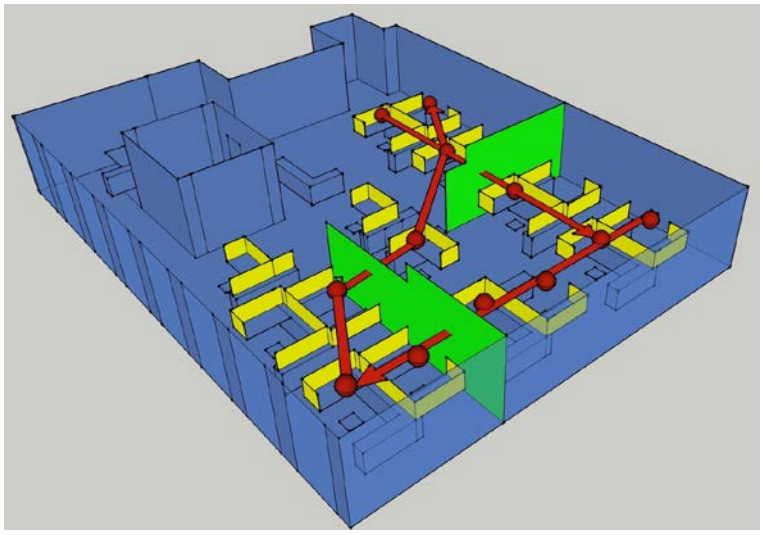

Figure 1 – Possible propagation paths in an open plan office and different screens (yellow and green).

For non-straight paths ISO 3382-3 does not give a value on the maximum deviation from a straight line. It is suggested that for example the angle between two consecutive working places/positions on the path should not exceed 30°. It would also be useful to use paths as long as possible although that ISO 3382-3 describes path lengths between 2 m and 16 m. For rooms smaller than this size in one direction ISO 3382-3 does not state anything. It is stated that a minimum of four and preferably six to ten positions on a path or line of propagation should be used. But ISO 3382-3 does not say anything about how many of the possible propagation lines should be used. It might be an idea to set-up a minimum number of lines depending on the number of people working in the room.

Another influence on the rating values along the propagation lines is the position and geometry of screens. Measuring only along lines without any sreens gives totally different results then measuring on propagation paths with screens or other obstacles. So it is suggested that it should be clarified that in rooms with screens some of the measuring paths have to be chosen along screens. If a propagation line with screens is used the first measuring point needs to be in front of the screen.

3.2 Background noise / distraction distance

The distraction distance r_D ist based on STI measurements along a propagation path in the room. The definition of the background noise $L_{p,B}$ refers to noise immissions in the room from technical equipment such as ventilation systems, also masking noise systems as well as traffic noise. The traffic noise from outside might differ during a working day and can have different values depending on the position in the room. Measuring STI is influenced by the background level.

Especially the time-dependence makes it difficult to set-up suggestions for the distraction distance that is based on STI measurements. Whenever traffic noise rises, STI decreases and r_D becomes smaller. It would be a suggestion to take the time and spatial average background noise level in the room as the reference for STI or r_D respectively. This background noise level needs to be clearly specified.

4. CONCLUSIONS

In this contribution a presently discussed classification scheme for the description of the acoustic quality in office rooms has been presented. For open plan office or offices with more than one working place this scheme is based on parameters of ISO 3382-3, namely the spatial decay rate $D_{2,S}$ and the level at 4 m $L_{p,A,S,4m}$. Incomplete descriptions of ISO 3382-3 on the line of propagation require further definitions for a classification scheme. Some suggestions on more detailed definitions for ISO 3383-3 are presented for further discussion. These suggestions might become part on a future version of the Geman guideline VDI 2569 that might introduce a classification scheme as presented.

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