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A Survey Method for Determining Sound Power Levels under Reverberant Conditions in Situ - A Pilot Study

Nordtest Project 1064 - 92

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Abstract

A survey method for determining sound power levels under reverberant conditions in situ. A pilot study.

In a pilot study ISO 3746, which is a survey method for determining sound power levels employing an enveloping measurement surface over a reflecting plane, is modified to include measurements in the far field of a machine for different values of the environmental correction factor K_{2A}. The equivalent sound absorption area is estimated from the guidelines given in ISO 3746.

The results indicate that it is probably not necessary to have any upper limit of the allowable environmental correction and that it is often more convenient to measure in the reverberant field than it is to measure in the direct field on a measurement surface.

The equivalent sound absorption area has been determined by using a reference sound source in a number of rooms. The results have been compared with those obtained by following ISO 3746. There seems to be a systematic overestimate of the sound absorption. Expressed in dB this overestimate is about 1 dB. The standard deviation is also about 1 dB.

The main conclusion of this pilot project is that it should be possible to make a survey method using measurements in the far field and estimating the equivalent sound absorption area. Such a method should have a standard deviation of the reproducibility of about 3 dB.

Key words: sound power, in situ, measurement, reverberant, determination

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Preface

This project has been financed by Nordtest, project 1064-92. The project has been carried through by a project group consisting of

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The project group has had one meeting.

Thank you for all your help!

Hans Jonasson

1 Introduction

1.1 Background

The most widely used international standard for determining sound power levels in the field is ISO 3746. The principle of this standard is to measure the sound pressure level on a measurement surface enveloping the machine to be tested. Ideally these values are free field values over a reflecting plane. In practice, however, these values are affected by reflections from nearby reflecting surfaces. In order to allow for these reflections the standard permits a correction of the measurement values by subtracting an environmental correction, K_{2A}. The maximum correction allowed for in the standard is 7 dB.

A correction larger than 3 dB means that the more or less reverberant sound field due to reflections dominates on the measurement surface. It is then no longer logical to measure on a measurement surface as this normally requires a considerably larger measurement effort, that is more microphone positions, than it does to measure at longer distances from the machine in a more or less reverberant field. As some machines are expensive to operate, for example wood working machines, it is desirable to cut down the number of microphone positions. When K_{2A} is large it is much easier to take one step backwards and decrease the number of microphone positions than it is to take one step forwards and increase the number of positions!

Logically the standard should require measurements on a measurement surface when the direct field dominates and in the more or less reverberant field when the reverberant field dominates unless there are nearby noisy machines in operation which create high background noise.

The present ISO 3746 states that the standard deviation of the reproducibility is less than 4 dB. It has been proposed, in the 2nd revised DIS, to lower this value to 3 dB when the environmental correction K_{2A} is less than 5 dB and to keep it for 5 dB$\leq K_{2A} \leq$7dB.

1.2 Aim

The aim of this project, which is a pilot project, is to investigate the possibilities to simplify ISO 3746 by introducing fewer microphone positions located in the far field of the machine in those cases where the environmental correction is large. In case the answer is positive a final project is to be proposed to Nordtest.

1.3 Carrying out

The project group had one meeting. Before this meeting the project leader carried out the investigations and wrote a preliminary report. The report was discussed during the meeting and the project group reached consensus as to conclusions and proposal.

2 Theoretical considerations

In a free field over a reflecting plane the sound power level is given by(see ISO 3744)

$$L_W = L_{pd} + 10\lg(S) \qquad (2.1)$$

where L_{pd} = the sound pressure level averaged over the measurement surface S. In a perfectly diffuse sound field the sound power level is given by

$$L_W = L_{pr} - 10\lg(\frac{4}{A}) \qquad (2.2)$$

where A = the equivalent sound absorption area of the room. The difference between the sound pressure level of the direct field, L_{pd} and that of the reverberant field, L_{pr} then becomes

$$L_{pd} - L_{pr} = 10\lg(\frac{A}{4S}) \qquad (2.3)$$

In most practical cases we have neither perfectly hemi-anechoic nor perfectly diffuse conditions. The total sound pressure level, L_p, will then receive contributions from both sound fields as given by

$$L_p = 10 * \lg(10^{(L_W - 10\lg(S))/10} + 10^{(L_W + 10\lg(4/A))/10}) =$$

$$L_W + 10\lg(\frac{1}{S} + \frac{4}{A}) = L_W - 10\lg(S) + 10\lg(1 + \frac{4S}{A}) \qquad (2.4)$$

which in the familiar form of ISO 3746 can be written as

$$L_W = L_p + 10\lg(S) - K_{2A}. \qquad (2.5)$$

where the environmental correction

$$K_{2A} = 10\lg(1 + \frac{4S}{A}) \qquad (2.6)$$

Eq. (2.4) is valid for all sound fields. For reverberant measurements it is more convenient to write it in the form

$$L_W = L_p - 10\lg(1 + \frac{A}{4S}) - 10\lg(\frac{4}{A}) \qquad (2.7)$$

In the more or less reverberant field the "true" reverberant sound pressure level is given by

$$L_{pr} = L_p - 10\lg(1 + \frac{A}{4S}) \qquad (2.8)$$

As (2.7) is to be used in rather reverberant fields the second term can be neglected and a y% error in the estimate of the sound absorption area will yield an error of

$$10\lg(1+y) \quad \text{dB} \qquad (2.9)$$

As eq. (2.7) and eq. (2.5) are identical the error due to the estimate of the sound absorption area will be the same in ISO 3746 as long as $\frac{A}{4S} \ll 1$. In the case of max allowable correction, K_{2A}= 7 dB, this condition is approximately fulfilled, see figure 2.1.

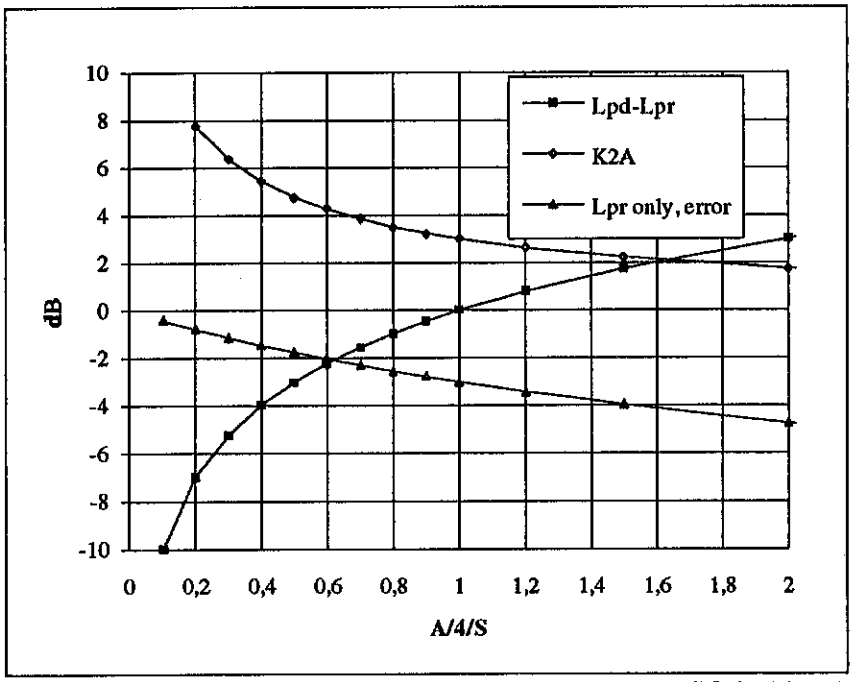

Figure 2.1 Environmental correction K_{2A} according to ISO 3746 and the difference between the hemi-free field sound pressure level L_{pd} and the reverberant sound pressure level L_{pr}.

In figure 2.1 we can also see that the reverberant field is larger than the direct field as long as K_{2A}> 3 dB. For K_{2A}= 5 dB the reverberant field contributes 3 dB more than the direct field. Principally it would be more logical to work with the microphones in the reverberant field in this case. In the figure it is also shown what will happen if we ignore the direct field. For K_{2A}< 7 dB the error will be less than 1 dB.

The calculation of K is based on the assumption that all room absorption is distributed evenly on the boundaries. It has been shown, see [1] for a summary, that K is always underestimated but never more than 3 dB. This leads to an overestimate of the sound power level.

In both methods we we also have errors other than those coupled to the estimate of the equivalent sound absorption:

ISO 3746:

- Near-field error. The sound emitted by the sound source will not pass a box-shaped measurement surface along the normal only and the sound pressure and particle velocity will not be in phase, as required by the theory behind the standard, close to the source. Because of this error the sound power level will be overestimated. This error is up to 3 dB, see [1].

- Finity error. Because of the limited number of microphones on the measurement surface errors are introduced. The magnitude will depend on the directional characteristics of the sound source.

Modified ISO 3746:

- The sound field will never be perfectly diffuse. A perfectly diffuse field will yield a constant sound pressure level in the whole room as soon as the reverberant field dominates. However, in practice, especially in large rooms we will have a certain amount of decay as a function of the distance from the source even in the reverberant field.

It is difficult to put a number on the different errors above. However, it is obvious that the two methods essentially coincide when K_{2A}= 7 dB and if ISO 3746 works then it will also work when K_{2A} > 7 dB. Because of the systematic errors in the measurement surface method it cannot be taken for granted that we get more accurate results when K_{2A}=is small than we do when K_{2A}=is large.

In principle it would also be possible to keep ISO 3746 as it is and just reduce the number of microphone positions when the reverberant field dominates.

3 Determination of the sound power level

3.1 Estimation of the sound absorption

In ISO 3746 guidelines are given on how to estimate the average sound absorption coefficient in a room. Only A-weighted values are considered. In table 3.1 the A-weighted values and room descriptions of ISO 3746 are given together with an additional estimate in octave bands in the range 125 - 8000 Hz. For categories 2-7 it has been assumed that the rooms have light weight walls. If not, the 125 Hz values should have been lower.

Frequency	1	2	3	4	5	6	7
125	0,05	0,2	0,2	0,25	0,3	0,4	0,4
250	0,05	0,1	0,15	0,2	0,25	0,35	0,4
500	0,05	0,1	0,15	0,2	0,25	0,35	0,5
1000	0,05	0,1	0,15	0,2	0,25	0,35	0,5
2000	0,05	0,1	0,15	0,2	0,25	0,35	0,5
4000	0,05	0,1	0,15	0,2	0,25	0,35	0,5
8000	0,05	0,1	0,15	0,2	0,25	0,35	0,5
A-weighted	0,05	0,1	0,15	0,2	0,25	0,35	0,5

1. Nearly empty room with smooth hard walls made of concrete, brick, plaster or tile.
2. Partly empty room, room with smooth walls.
3. Room with furniture, rectangular machinery room, rectangular industrial room.
4. Irregularly shaped room with furniture, irregularly shaped machinery room or industrial room.
5. Room with upholstered furniture, machinery or industrial room with a small amount of sound absorbing material(for example partially absorptive ceiling) on ceiling or walls
6. Room with sound absorbing materials on both ceiling and walls.
7. Room with large amounts of sound absorbing materials on ceiling and walls.

Table 3.1 Average sound absorption coefficient in 7 different types of rooms, from ISO 3746(the A-weighted values).

Table 3.1 has been applied to 12 different rooms and used to determine the equivalent sound absorption area. In each room the sound absorption was also determined with a reference sound source. The mean value and the standard deviation are given in figure 3.1 and figure 3.2. Complete information about the rooms is given in Annex A. One room has been included with 4 different source-microphone combinations.

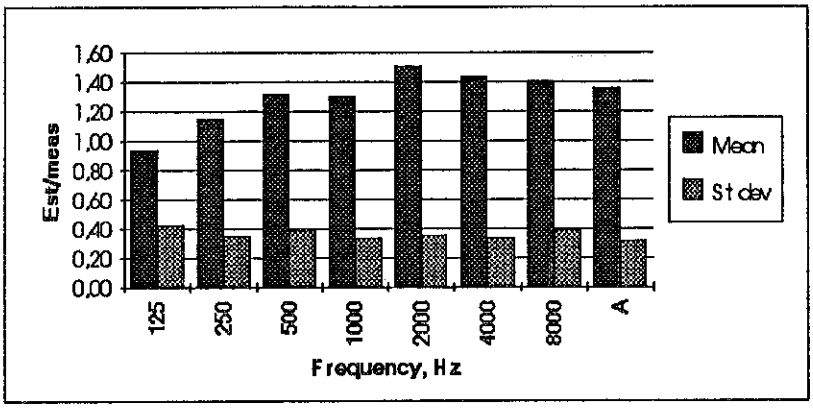

Figure 3.1 12 Different rooms. Estimated over measured equivalent sound absorption area(m^2).

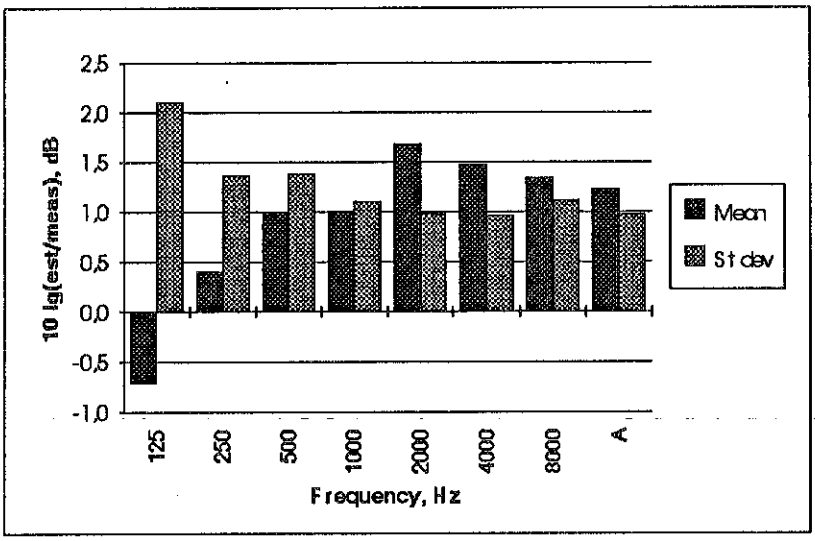

Figure 3.2 12 different rooms. 10 lg(Estimated over measured equivalent sound absorption area)(dB).

Figure 3.1 and 3.2 indicate a small systematic overestimate of A. This is probably intentional in ISO 3746. By overestimating A we overestimate the sound power level. It has been considered to be important not to underestimate the sound power level. An underestimate would encourage manufacturers to use a less accurate survey method in stead of an engineering method.

However, from one point of view it is not satisfactory to make a systematic overestimate.If the sound power level is to be declared in accordance with ISO 4871 the declared level

$$L_d = L_m + K \qquad (3.1)$$

where L_m is the estimate of the average noise emission value and K a constant to be determined.

For an engineering method K=3(approx) and for a survey method K = 7(approx) dB. It is, of course, not satisfactory to have a systematic error overestimating the sound power level if, in addition to that, you have to add another 7 dB because of the uncertainty of the method used.

By working a little more with table 3.1 it will probably be possible to decrease the systematic overestimate. The variation in sound absorption with frequency seems to be so small that it is probably not worthwhile to include anything else than A-weighted values. One exception might, however, be very low frequency sources in nearly empty rooms with light weight walls.

3.2 Estimation of room type

In connection with the meeting of the project group all participants visited the different rooms and classified them in accordance with the list in figure 3.1. The result is given in table 3.2. A description of the rooms 1-9 is given in annex A. The rooms 10 and 11 are described in clause 4.

Room no	HN	HO	AU	HJ	Measured type	Measured α	Max error in L_{WA}
1	3	3	1	2	2	0,09	3 dB
2	5	5	5	6	2	0,21	5,5 dB
3	2	2	5	4	3	0,15	2,2 dB
4	3	3	3	3	4	0,2	3 dB
5	5	5	5	5	3-4	0,13-0,21	2,2 dB
6	5	5	5	5	3-4	0,17	2,2 dB
7	2	1	2	4	2	0,08	3 dB
8	1	4	1	4	2	0,11	3 dB
9	5	3	3	3	3	0,14	2,2 dB
10	2	1	1	1	1-2	0,07	3 dB
11	5	6	5	6	5	0,27	1,5 dB

Table 3.2 Subjective classification of room types.

In table 3.2 the unsigned maximum error in $10 \lg(\frac{A_{meas}}{A_{est}})$ has been calculated.

The large error in room 2 depends on the ceiling. It looks like a sound absorbing ceiling but it is not. Anyhow the results indicate that it is possible to keep the maximum error below 3 dB, that is the standard deviation due to this uncertainty will be below 2 dB. The different measurement results given for room 5 are for different source and microphone positions. This room was very long.

The members of the project group were all of the opinion that the room descriptions given in ISO 3746 could be improved. Especially it was pointed out that it was desirable to separate the contents of the room from the room itself. The number of categories was probably satisfactory but more examples should be given in each category.

3.3 Calculation of the sound power level

The conclusion from 3.1 and 3.2 is that it should be possible to estimate the sound absorption with an uncertainty, expressed as standard deviation, of about 2 dB. We now want to transform this uncertainty to the sound power level.

In principle the method proposed corresponds to measurements with a reference sound source but replacing the reference sound source by an estimate of the sound absorption.

For more or less in situ measurements we have, for the time being, four different methods: ISO 3743-1:1993, ISO 3747:1987, NT ACOU 060:1986 and NT ACOU 070:1988. ISO 3743-1 is based on NT ACOU 060 and ISO 3747 is now under revision taken the contents of NT ACOU 070 into consideration. One of these methods, ISO 3747, is a survey method, while the others are engineering methods with a stated standard deviation of the reproducibility of 2 dB in A-weighted sound power level.

If we make a conservative estimate of the standard deviation of the 10 lg(A) term and put it to 2 dB we should get an overall uncertainty of about

$$\sqrt{2^2+2^2} = \sqrt{8} < 3 \text{ dB}$$

4 Some measurements

Some measurements have been carried out on a B&K 4204 reference sound source with different methods and in two different rooms, one with an average sound absorption coefficient of 0,27 and one with 0,06. ISO 3746 has been applied on three different measurement surfaces with different room corrections. The modified 3746 is eq. (2.2) with equivalent sound absorption area determined according to table 2.1 and with 5 microphone positions selected in accordance with ISO 3743-1. Complete results are given in annex B.

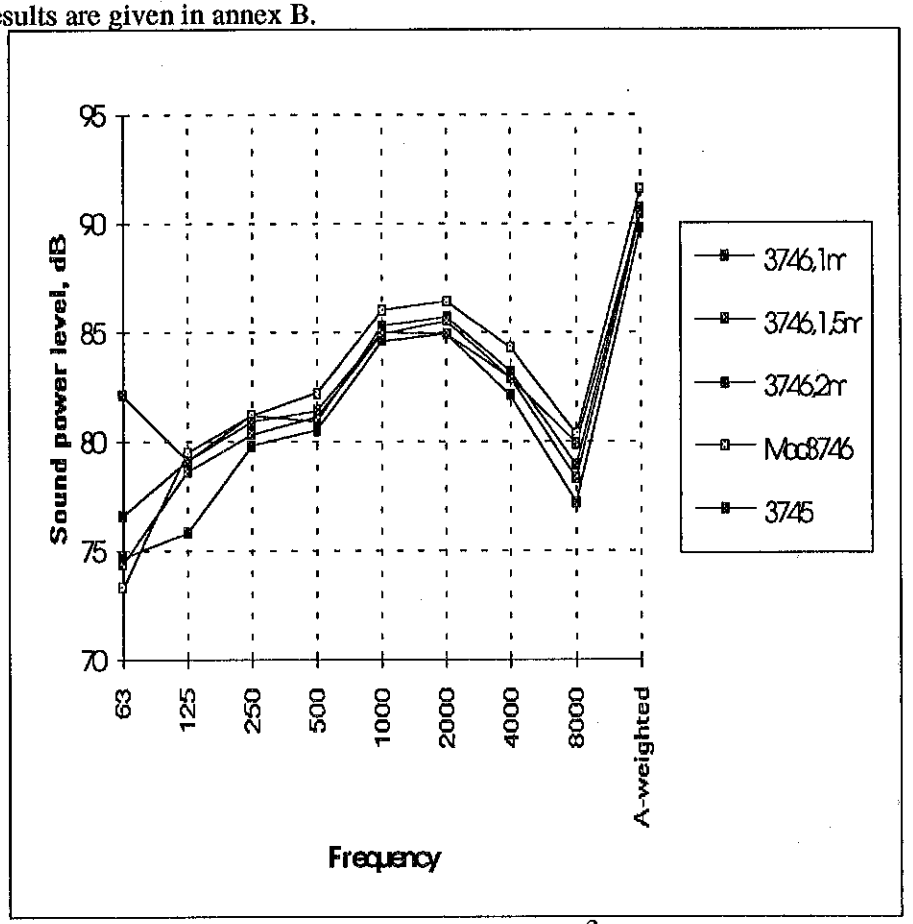

Figure 4.1 Some different 3746 measurements in a 134,1 m^3 room with boundary surface area 160 m^2. Estimated absorption area: 56 m^2, measured equivalent sound absorption area 42,9 m^2. Room no 10.

Method	L_{pA}, dB	L_{WA}, dB
1. 3746, d= 1 m, S= 17,4 m^2, K_{2A}= 3,5 dB	81,8	90,7
2. 3746, d= 1,5 m, S= 34,9 m^2, K_{2A}= 5,4 dB	80,4	90,4
3. 3746, d= 2 m, S= 58,4 m^2, K_{2A}= 7,1 dB	79,8	90,4
4. Mod. 3746, A= 56 m^2	80,2	91,6
5. ISO 3745, calibration		90,5

Table 4.1 Measurement results in the room of figure 4.1. Measured average sound pressure level and sound power level determined in accordance with the prescribed methods.

The results given in figure 4.1 and table 4.2 indicate an almost too good agreement between ISO 3746 and ISO 3745. The modified method is not as good, although it is still very good. As can be seen from the values of the measured sound pressure levels the microphone positions, when applying the modified procedure, have been closer to the source than 2 m.

In table 4.2 and figure 4.2 the corresponding results for a very reverberant room is given. In this room it was not possible to measure according to ISO 3746 at 1 m from the reference box. After having added about 9 m^2 mineral wool K_{2A} dropped to 6,9 dB. Both methods agree remarkably well with the ISO 3745 result. In this case it should be noted that ISO 3746 did not allow measurements without adding sound absorption while the modified method yielded an accurate results without any changes of the room.

Method	L_{pA}, dB	L_{WA}, dB
1. 3746, d= 1 m, S= 17,4 m^2, K_{2A}= 6,9 dB A= 18 m^2(9 m^2 added), 5 mic. positions	85	90,5
2. Mod. 3746, A= 9 m^2, 3 mic. positions	87,2	90,7
3. Mod. 3746, A= 18 m^2(9 m^2 added), 4 mic. positions	84,5	91
4. ISO 3745, calibration		90,5

Table 4.2 Measurement results in the room of figure 4.2.

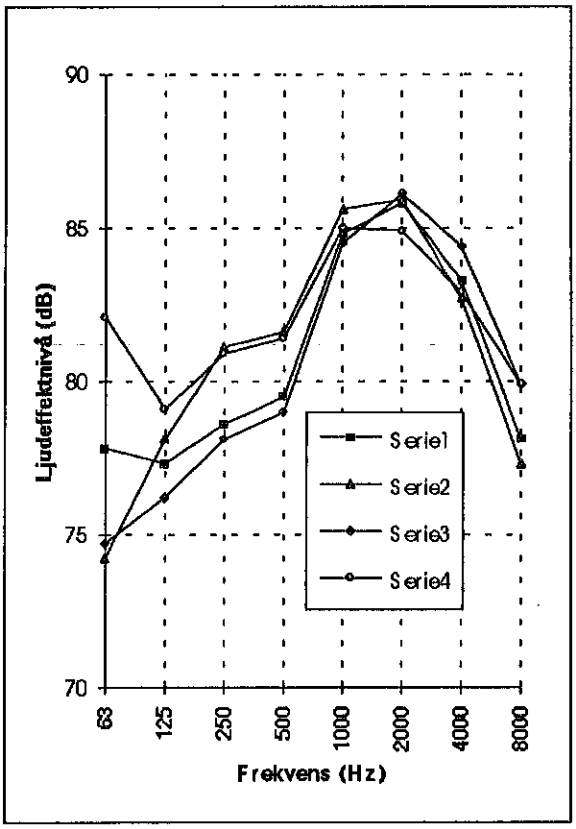

Figure 4.2 Some different 3746 measurements in a 107,3 m^3 room with boundary surface area 140,9 m^2. Estimated sound absorption area: 9 m^2, measured sound absorption area 8,6 m^2. The room was also reequipped with another 9 m^2 sound absorbers. Room no 11.

It is, of course, not possible to draw any firm conclusions from these two measurements. The reference source is a very nice, omnidirectional source and because of its small dimensions K_{2A} becomes rather small. In the reverberant room above only a very small increase in source dimensions would have required additional amounts of sound absorbers with ISO 3746.

5 Conclusions and proposal

By carrying out measurements in the far field of a machine in situ and by estimating the sound absorption from a table it is possible to determine the A-weighted sound power level with a standard deviation of reproducibility of about 3 dB. The measurement effort will be considerably less than that of ISO 3746.

The proposal is to modify ISO 3746 in such a way that it includes measurements in the far field. Whenever possible the preferred method should be the far field method as it requires less effort, that is a smaller number of microphones. The measurement surface method should not be used for $K_{2A} > 5$ dB and the revised standard should be extended to values of $K_{2A} > 7$ dB.

Nordtest should launch a project with the purpose of making such a method a Nordtest method and then to propose it to ISO/CEN. The project should include a Nordic Round-Robin and some additional work with the table to be used for determining the average sound absorption coefficients in rooms. In particular it should be studied whether more room types are required. It should also be considered to include a simple measurement method for determining the reverberation time.

The round robin should be arranged in connection with a project group meeting. The project leader selects about 10 machines in the neighboorhood of the meeting place. The sound power levels of these machines are determined with the most accurate method available, that is ISO 3743-1, ISO 3744 or ISO 9614. Then all the participating laboratories measure on the same machines using the new method.

6 References

[1] Noise and vibration, Ellis Horwod Ltd, 1982

[2] ISO 3743:93 Determination of sound power levels of noise sources - Engineering methods for small, movable sources in reverberant fields
Part 1: Comparison method in hard-walled test rooms

[3] ISO/DIS 3744:91 Engineering method employing an enveloping measurement surface in an essentially free field over a reflecting plane

[4] ISO 3745:1977 Precision methods for anechoic and semi-anechoic rooms

[5] ISO/DIS 3746:92 Survey method employing an enveloping measurement surface over a reflecting plane

[6] ISO 3747-1987 Survey method using a reference sound source

[7] NT ACOU 060:86 Noise sources: Sound power level - Engineering method using a reference sound source

[8] NT ACOU 070:88 Noise sources: Sound power level: Engineering method - Reference sound source, in situ

Annex A Room no 1

Source: B&K 4204, Reference sound source.
Test room: SP Acoustics, compressor room.
Estimated room category: Room type 2.
Room data: Retangular machinery room without absorbers. Ceiling, floor and one wall made of concrete and the other walls are made of double gypsum. The room has three windows, one door and one overhead door. The source was placed on the top of the compressor. The microphones were placed in the reverberant field.

L= 6,1 m
W= 3,8 m
H= 4,1
V= 93,9 m³
S= 126,6 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	L_{We} (dB)	A (m²)	α	L_{Wm} (dB)	A (m²)	α	L_{We}-L_{Wm}
100	59,4	61,9	63,3	61,8								
125	60,8	62,9	63,4	62,5	68,1	76,1	25,3	0,2	79,1	50,6	0,40	3,0
160	62,8	65,9	65,7	65,0								
200	67,0	68,4	68,4	68,0								
250	70,3	70,0	68,0	69,5	74,5	79,5	12,7	0,1	80,9	17,7	0,14	1,4
315	71,1	70,5	71,8	71,2								
400	71,6	72,5	73,3	72,5								
500	71,5	72,1	71,7	71,8	77,2	82,2	12,7	0,1	81,4	10,1	0,08	-0,8
630	72,5	72,7	73,4	72,9								
800	73,7	74,6	74,6	74,3								
1000	75,3	75,3	75,9	75,5	80,7	85,7	12,7	0,1	85,0	11,4	0,09	-0,7
1250	77,0	77,3	77,7	77,4								
1600	76,9	77,6	77,7	77,4								
2000	76,0	76,8	77,0	76,6	81,2	86,2	12,7	0,1	84,9	8,9	0,07	-1,3
2500	74,4	74,8	75,2	74,8								
3150	74,1	74,8	74,6	74,5								
4000	73,7	74,5	74,3	74,1	78,7	83,7	12,7	0,1	82,9	10,1	0,08	-0,8
5000	72,8	73,3	73,4	73,2								
6300	71,4	72,1	72,2	71,9								
8000	69,4	70,3	70,1	69,9	75,0	80,0	12,7	0,1	79,9	12,7	0,10	-0,1
10000	67,1	68,4	67,9	67,8								
A	85,8	86,4	86,6	86,2	86,2	91,2	12,7	0,1	90,5	11,4	0,09	-0,7

Annex A Room no 2

Source: B&K 4204, Reference sound source.
Test room: SP acoustics conference room
Estimated room category: Room type 5.
Room data: Conference room with a absorbing[1] ceiling and furniture. The floor and one wall are made of concrete and the other walls are made of double gypsum. The room has a book case from the floor to the ceiling on one short side wall. The source was placed on top of the table in the middle of the room and the microphone positions were in the reverberation field.

1) The ceiling was of perforated sheet metal, but without sound absorbing material on top of it

L= 6,8 m
W= 3,8 m
H= 3,0 m
V= 77,9 m^3
S= 115,7 m^2

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m^2)	α	LWm (dB)	A (m^2)	α	LWe-LWm
100	54,6	58,5	61,7	59,2								
125	60,3	62,5	61,1	61,4	65,8	75,2	34,7	0,3	79,1	85,6	0,74	3,9
160	62,1	63,1	60,6	62,0								
200	64,9	66,2	65,0	65,4								
250	67,1	69,4	67,5	68,2	71,9	80,5	28,9	0,25	80,9	31,2	0,27	0,4
315	65,7	67,8	67,8	67,2								
400	65,8	69,8	67,7	68,0								
500	66,9	67,9	66,2	67,1	72,5	81,1	28,9	0,25	81,4	31,2	0,27	0,3
630	66,8	69,0	68,3	68,1								
800	69,3	70,4	69,5	69,8								
1000	70,6	71,3	70,7	70,9	76,3	84,9	28,9	0,25	85,0	30,1	0,26	0,1
1250	72,4	74,3	72,9	73,2								
1600	72,6	74,0	73,0	73,2								
2000	71,6	72,9	72,4	72,3	77,1	85,7	28,9	0,25	84,9	24,3	0,21	-0,8
2500	70,2	72,4	71,4	71,4								
3150	70,5	72,9	71,6	71,8								
4000	71,0	72,6	71,6	71,8	76,4	85,0	28,9	0,25	82,9	17,4	0,15	-2,1
5000	70,6	71,9	71,3	71,3								
6300	69,8	71,1	70,1	70,4								
8000	68,2	69,6	68,8	68,9	73,8	82,4	28,9	0,25	79,9	16,2	0,14	-2,5
10000	67,0	67,8	67,0	67,3								
A	81,9	83,5	82,6	82,7	82,7	91,3	28,9	0,25	90,5	24,3	0,21	-0,8

Annex A Room no 3

Source: B&K 4204, Reference sound source.
Test room: SP Acoustics, outside the water appliance laboratory.
Estimated room category: Room type 5.
Room data: Laboratory hall without absorbers. The floor and the ceiling are made of concrete, three walls are made of double gypsum and one wall "is missing". The room has some machinery placed on the floor. The source was placed in the corner on the opposite side of the missing wall >1,5 m from the walls and the distance between the microphones and the source was about 3 m.

L= 6,6 m
W= 3,4 m
H= 4,1 m
V= 89,7 m^3
S= 124,7 m^2

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	L_{We} (dB)	A (m^2)	α	L_{Wm} (dB)	A (m^2)	α	LWe-LWm
100	66,0	64,7	68,2	66,6								
125	64,5	60,9	63,5	63,2	69,7	79,4	37,4	0,3	79,1	34,9	0,28	-0,3
160	65,9	63,9	62,0	64,2								
200	70,5	66,1	69,0	68,9								
250	70,6	67,4	70,1	69,6	73,5	82,4	31,2	0,25	80,9	22,4	0,18	-1,5
315	68,5	65,3	68,3	67,6								
400	69,3	67,7	68,3	68,5								
500	68,2	67,7	69,0	68,3	73,6	82,5	31,2	0,25	81,4	23,7	0,19	-1,1
630	68,7	68,8	70,6	69,5								
800	71,3	71,0	72,9	71,8								
1000	72,9	72,2	73,6	72,9	78,2	87,1	31,2	0,25	85,0	18,7	0,15	-2,1
1250	75,0	74,2	75,4	74,9								
1600	74,5	74,7	74,9	74,7								
2000	73,3	73,4	74,3	73,7	78,4	87,3	31,2	0,25	84,9	17,5	0,14	-2,4
2500	71,9	71,8	72,8	72,2								
3150	72,0	71,8	72,5	72,1								
4000	71,6	71,6	72,4	71,9	76,5	85,4	31,2	0,25	82,9	17,5	0,14	-2,5
5000	70,8	70,8	71,5	71,0								
6300	69,7	69,7	70,2	69,9								
8000	68,3	68,1	68,6	68,3	73,2	82,1	31,2	0,25	79,9	18,7	0,15	-2,2
10000	66,7	66,4	66,8	66,6								
A	83,5	83,3	84,2	83,7	83,7	92,6	31,2	0,25	90,5	18,7	0,15	-2,1

Annex A Room no 4

Source: B&K 4204, Reference sound source.
Test room: SP Acoustics, computer room.
Estimated room category: Room type 4.
Room data: Room without absorbers. The floor, ceiling and one wall are made of concrete and three walls are made of double gypsum. The room has some furniture and book cases on two walls. The source was placed on the floor >1,5 m from the walls and the microphone positions was placed in the reverberation field.

L= 3,8 m
W= 3,8 m
H= 4,1 m
V= 58,8 m³
S= 90,8 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	59,7	62,5	64,9	62,9								
125	63,1	59,6	64,8	63,0	67,8	75,3	22,7	0,25	79,1	53,6	0,59	3,8
160	65,6	63,6	57,3	63,3								
200	68,2	64,8	62,5	65,8								
250	71,1	67,7	66,5	68,9	72,4	79,0	18,2	0,2	80,9	28,1	0,31	1,9
315	66,7	68,5	67,3	67,6								
400	69,0	67,6	67,1	68,0								
500	68,1	67,7	67,4	67,8	73,0	79,6	18,2	0,2	81,4	27,2	0,30	1,8
630	69,7	68,4	68,6	68,9								
800	71,8	71,8	71,6	71,8								
1000	73,1	72,2	72,5	72,6	77,8	84,4	18,2	0,2	85,0	20,9	0,23	0,6
1250	75,0	73,4	74,4	74,3								
1600	75,7	74,7	74,6	75,0								
2000	74,6	74,2	74,0	74,3	78,9	85,5	18,2	0,2	84,9	16,3	0,18	-0,6
2500	73,4	72,6	72,5	72,9								
3150	73,4	72,1	72,5	72,7								
4000	73,3	72,0	72,1	72,5	77,1	83,7	18,2	0,2	82,9	15,4	0,17	-0,8
5000	72,5	71,2	71,2	71,7								
6300	71,5	70,2	70,2	70,7								
8000	70,0	68,7	68,6	69,2	74,1	80,7	18,2	0,2	79,9	15,4	0,17	-0,8
10000	68,5	66,9	66,7	67,4								
A	84,6	83,6	83,7	84,0	84,0	90,6	18,2	0,2	90,5	18,2	0,20	-0,1

Annex A Room no 5a

Source: B&K 4204, Reference sound source.
Test room: The entrance hall of SP Acoustics on basement level.
Estimated room category: Room type 5.
Room data: Long narrow room with absorbing ceiling. The floor and three walls are made of concrete, one wall is made of bricks and the short sides of the room has glass doors. The room has an opening with stairs in one end of the room. There were two machines placed on the floor in middle of the room. The source was placed at the end of the room on the opposite side of the stairs >1,5 m from the walls and the distance between the source and themicrophones was about 3 m.

L= 14,2 m
W= 3,0 m
H= 2,8 m
V= 121,9 m³
S= 183,8 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	65,0	66,3	68,2	66,7								
125	64,2	63,7	64,1	64,0	70,0	81,4	55,1	0,3	79,1	33,1	0,18	-2,3
160	65,7	63,5	64,0	64,5								
200	66,4	69,0	66,4	67,5								
250	67,8	69,1	68,1	68,4	72,7	83,3	46,0	0,25	80,9	25,7	0,14	-2,4
315	68,1	66,9	68,4	67,9								
400	68,5	67,5	68,1	68,1								
500	69,7	68,5	68,7	69,0	73,8	84,4	46,0	0,25	81,4	23,9	0,13	-3,0
630	70,5	69,7	69,2	69,8								
800	71,1	70,9	72,5	71,6								
1000	72,2	71,7	72,2	72,0	77,1	87,7	46,0	0,25	85,0	23,9	0,13	-2,7
1250	73,3	73,3	73,4	73,3								
1600	73,9	73,3	74,3	73,8								
2000	72,6	72,3	73,7	72,9	77,6	88,2	46,0	0,25	84,9	22,1	0,12	-3,3
2500	71,1	71,1	72,0	71,4								
3150	70,6	71,2	71,3	71,0								
4000	70,7	70,6	70,9	70,7	75,4	86,0	46,0	0,25	82,9	22,1	0,12	-3,1
5000	70,0	69,9	70,3	70,1								
6300	69,1	69,0	69,4	69,2								
8000	67,8	67,9	67,8	67,9	72,8	83,4	46,0	0,25	79,9	20,2	0,11	-3,5
10000	66,4	66,7	66,4	66,5								
A	82,8	82,5	83,2	82,8	82,8	93,4	46,0	0,25	90,5	23,9	0,13	-2,9

Annex A Room no 5b

Source: B&K 4204, Reference sound source.
Test room: The entrance hall of SP Acoustics on basement level.
Estimated room category: Room type 5.
Room data: Long narrow room with absorbing ceiling. The floor and three walls are made of concrete, one wall is made of bricks and the short sides of the room has glass doors. The room has an opening with stairs in one end of the room. There were two machines placed on the floor in middle of the room. The source was placed at the end of the room on the opposite side of the stairs >1,5 m from the walls and the distance between the source and themicrophones was about 6 m.

L= 14,2 m
W= 3,0 m
H= 2,8 m
V= 121,9 m³
S= 183,8 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	61,8	60,6	61,7	61,4								
125	62,1	64,3	63,4	63,4	67,6	79,0	55,1	0,3	79,1	57,0	0,31	0,1
160	63,9	63,0	63,0	63,3								
200	65,7	65,9	64,6	65,4								
250	66,6	66,1	66,2	66,3	71,3	81,9	46,0	0,25	80,9	36,8	0,20	-1,0
315	66,7	67,8	68,4	67,7								
400	67,0	67,0	67,6	67,2								
500	66,6	68,2	67,3	67,4	72,2	82,8	46,0	0,25	81,4	33,1	0,18	-1,4
630	67,1	68,1	68,2	67,8								
800	69,0	69,8	69,3	69,4								
1000	70,0	71,0	69,2	70,1	75,2	85,8	46,0	0,25	85,0	38,6	0,21	-0,8
1250	71,7	71,9	71,1	71,6								
1600	71,4	71,6	70,8	71,3								
2000	70,3	70,0	70,6	70,3	75,0	85,6	46,0	0,25	84,9	38,6	0,21	-0,7
2500	69,0	68,2	68,5	68,6								
3150	67,9	68,2	68,3	68,2								
4000	67,5	68,0	68,0	67,9	72,5	83,1	46,0	0,25	82,9	44,1	0,24	-0,2
5000	67,0	67,4	66,9	67,1								
6300	66,2	66,4	66,3	66,3								
8000	64,7	64,8	64,8	64,8	69,7	80,3	46,0	0,25	79,9	42,3	0,23	-0,4
10000	62,8	63,1	63,3	63,1								
A	80,3	80,6	80,2	80,4	80,4	91,0	46,0	0,25	90,5	40,4	0,22	-0,5

Annex A Room no 5c

Source: B&K 4204, Reference sound source.
Test room: The entrance hall of SP Acoustics on basement level.
Estimated room category: Room type 5.
Room data: Long narrow room with absorbing ceiling. The floor and three walls are made of concrete, one wall is made of bricks and the short sides of the room has glass doors. The room has an opening with stairs in one end of the room. There were two machines placed on the floor in middle of the room.
The source was placed in the middle of the room >1,5 m from the walls and the distance between the source and the microphones was about 3 m.

L= 14,2 m
W= 3,0 m
H= 2,8 m
V= 121,9 m³
S= 183,8 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	L_{We} (dB)	A (m^2)	α	L_{Wm} (dB)	A (m^2)	α	L_{We}-L_{Wm}
100	66,8	64,4	63,6	65,2								
125	65,2	62,4	62,9	63,7	69,7	81,1	55,1	0,3	79,1	34,9	0,19	-2,0
160	67,6	63,7	64,6	65,6								
200	66,6	66,4	67,8	67,0								
250	66,6	66,6	65,9	66,4	71,5	82,1	46,0	0,25	80,9	34,9	0,19	-1,2
315	67,4	67,5	65,6	66,9								
400	68,2	67,5	68,0	67,9								
500	68,2	66,3	67,3	67,3	72,5	83,1	46,0	0,25	81,4	31,2	0,17	-1,7
630	68,6	67,4	67,7	67,9								
800	70,8	69,6	69,5	70,0								
1000	70,4	70,2	70,5	70,4	75,7	86,3	46,0	0,25	85,0	34,9	0,19	-1,3
1250	71,7	71,8	72,8	72,1								
1600	72,3	71,9	73,1	72,5								
2000	72,4	71,1	71,1	71,6	76,2	86,8	46,0	0,25	84,9	29,4	0,16	-1,9
2500	69,8	69,4	70,1	69,8								
3150	68,9	69,2	69,6	69,2								
4000	68,9	68,5	69,3	68,9	73,5	84,1	46,0	0,25	82,9	34,9	0,19	-1,2
5000	68,1	67,6	68,6	68,1								
6300	67,4	66,8	68,2	67,5								
8000	65,9	65,2	66,7	66,0	70,9	81,5	46,0	0,25	79,9	31,2	0,17	-1,6
10000	64,5	63,8	65,0	64,5								
A	81,4	80,9	81,6	81,3	81,3	91,9	46,0	0,25	90,5	33,1	0,18	-1,4

Annex A Room no 5d

Source: B&K 4204, Reference sound source.
Test room: The entrance hall of SP Acoustics on basement level.
Estimated room category: Room type 5.
Room data: Long narrow room with absorbing ceiling. The floor and three walls are made of concrete, one wall is made of bricks and the short sides of the room has glass doors. The room has an opening with stairs in one end of the room. There were two machines placed on the floor in middle of the room.
The source was placed in the middle of the room >1,5 m from the walls and the distance between the source and the microphones was about 6 m.

L= 14,2 m
W= 3,0 m
H= 2,8 m
V= 121,9 m³
S= 183,8 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	62,2	64,2	63,0	63,2								
125	60,4	64,4	64,5	63,5	68,1	79,5	55,1	0,3	79,1	49,6	0,27	-0,4
160	60,0	64,9	63,9	63,4								
200	65,5	64,6	66,7	65,7								
250	66,5	64,9	67,2	66,3	71,0	81,6	46,0	0,25	80,9	38,6	0,21	-0,7
315	66,9	66,6	66,2	66,6								
400	68,2	67,1	67,1	67,5								
500	67,1	67,3	67,7	67,4	72,3	82,9	46,0	0,25	81,4	33,1	0,18	-1,5
630	68,1	67,2	67,8	67,7								
800	69,7	68,4	70,6	69,7								
1000	69,0	69,4	69,5	69,3	74,8	85,4	46,0	0,25	85,0	42,3	0,23	-0,4
1250	70,9	71,4	70,7	71,0								
1600	71,3	70,8	71,1	71,1								
2000	70,5	70,2	69,8	70,2	75,0	85,6	46,0	0,25	84,9	38,6	0,21	-0,7
2500	69,2	69,2	68,9	69,1								
3150	69,1	68,2	68,5	68,6								
4000	68,4	68,0	68,3	68,2	72,8	83,4	46,0	0,25	82,9	40,4	0,22	-0,5
5000	67,4	67,0	67,0	67,1								
6300	66,4	65,9	66,3	66,2								
8000	64,4	64,4	64,9	64,6	69,6	80,2	46,0	0,25	79,9	42,3	0,23	-0,3
10000	62,7	63,2	63,3	63,1								
A	80,5	80,2	80,3	80,3	80,3	90,9	46,0	0,25	90,5	42,3	0,23	-0,4

Annex A Room no 6

Source: B&K 4204, Reference sound source.
Test room: The passage between the entrance hall and the corridor of house 7 on ground level
Estimated room category: Room type 5.
Room data: A small room with absorbing ceiling. The floor and one wall is made of concrete and one wall is made of bricks. On two walls the main parts are made of glass. There were two small machines placed on the floor. The source was placed in middle of the room >1,5 m from the walls and the microphone positions were in the reverberant field.

L= 3,3 m
W= 3,0 m
H= 3,0 m
V= 29,8 m³
S= 57,8 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	70,0	65,4	69,5	68,7								
125	63,2	64,8	61,3	63,3	71,8	78,2	17,3	0,3	79,1	21,4	0,37	0,9
160	65,8	68,3	68,0	67,5								
200	72,0	70,4	71,8	71,5								
250	72,7	72,3	73,5	72,9	77,2	82,8	14,5	0,25	80,9	9,2	0,16	-1,9
315	71,7	74,0	72,4	72,8								
400	72,6	73,8	73,4	73,3								
500	73,1	74,4	74,0	73,8	78,6	84,2	14,5	0,25	81,4	7,5	0,13	-2,8
630	73,8	74,1	74,6	74,2								
800	75,5	75,1	75,2	75,3								
1000	75,5	75,6	76,4	75,9	81,2	86,8	14,5	0,25	85,0	9,8	0,17	-1,8
1250	77,5	77,7	77,6	77,6								
1600	77,6	76,8	77,3	77,3								
2000	76,6	76,0	76,5	76,4	81,1	86,7	14,5	0,25	84,9	9,8	0,17	-1,8
2500	75,3	74,8	75,4	75,1								
3150	74,7	74,5	74,6	74,6								
4000	74,4	73,8	74,1	74,1	78,8	84,4	14,5	0,25	82,9	10,4	0,18	-1,5
5000	73,5	73,0	73,3	73,3								
6300	72,5	72,2	72,4	72,4								
8000	70,8	70,7	71,1	70,9	75,8	81,4	14,5	0,25	79,9	10,4	0,18	-1,5
10000	68,9	69,1	69,6	69,2								
A	86,6	86,3	86,6	86,5	86,5	92,1	14,5	0,25	90,5	9,8	0,17	-1,6

Annex A Room no 7

Source: B&K 4204, Reference sound source.
Test room: The entrance hall of SP Acoustics on floor level two.
Estimated room category: Room type 3.
Room data: A long narrow room without absorbents. The floor and the ceiling are made of concrete and the main part of the long side wall is made of glass construction. Along the other long side wall there was a book case. The short sides of the room have glass doors. The room has an opening with stairs in one end of the room. The source was placed at the end of the room opposite the stairs >1,0 m from the walls. The distance between the source and the microphones was about 3 m.

L= 17,4 m
W= 3,4 m
H= 3,0 m
V= 176,4 m³
S= 242,1 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	57,9	57,4	62,1	59,7								
125	63,9	61,4	59,7	62,0	66,8	77,6	48,4	0,2	79,1	67,8	0,28	1,5
160	63,2	64,3	63,3	63,6								
200	66,5	66,9	66,9	66,8								
250	67,9	68,8	67,5	68,1	71,9	81,5	36,3	0,15	80,9	31,5	0,13	-0,6
315	66,7	66,5	65,8	66,4								
400	69,4	68,3	69,0	68,9								
500	68,6	69,7	68,7	69,0	73,8	83,4	36,3	0,15	81,4	24,2	0,10	-2,0
630	69,2	69,3	69,3	69,3								
800	71,3	71,9	71,2	71,5								
1000	72,2	72,3	72,2	72,2	77,6	87,2	36,3	0,15	85,0	21,8	0,09	-2,2
1250	74,5	74,0	74,1	74,2								
1600	74,5	74,8	74,8	74,7								
2000	73,6	74,1	73,7	73,8	78,5	88,1	36,3	0,15	84,9	16,9	0,07	-3,2
2500	72,1	72,9	72,4	72,5								
3150	71,4	72,2	72,0	71,9								
4000	71,2	71,8	71,1	71,3	76,0	85,6	36,3	0,15	82,9	19,4	0,08	-2,7
5000	70,2	71,1	70,3	70,5								
6300	68,8	69,8	69,1	69,2								
8000	67,0	68,3	67,5	67,6	72,5	82,1	36,3	0,15	79,9	21,8	0,09	-2,2
10000	65,3	66,7	65,5	65,9								
A	83,3	83,7	83,3	83,4	83,4	93,0	36,3	0,15	90,5	19,4	0,08	-2,5

Annex A Room no 8

Source: B&K 4204, Reference sound source.
Test room: The staircase in the entrance hall of SP acoustics between the 2nd and the 3rd floor.
Estimated room category: Room type 3.
Room data: Stairs without absorbers. The stairs, walls and ceilings are made of concrete. The source was placed on the landing between the 2nd and 3rd floor. The microphone positions were in the reverberant field.

L= 4,0 m
W= 2,9 m
H= 3,6 m
V= 42,2 m³
S= 73,3 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	67,7	65,9	73,0	70,0								
125	68,6	71,7	69,5	70,1	74,8	80,5	14,7	0,2	79,1	11,0	0,15	-1,4
160	66,7	73,1	66,8	70,0								
200	69,0	70,6	69,0	69,6								
250	72,2	73,6	70,5	72,3	76,5	80,9	11,0	0,15	80,9	11,0	0,15	0,0
315	72,4	74,4	70,0	72,6								
400	72,5	72,4	69,3	71,6								
500	72,9	73,3	71,9	72,7	77,5	81,9	11,0	0,15	81,4	9,5	0,13	-0,5
630	73,6	74,4	72,9	73,7								
800	75,7	76,4	75,3	75,8								
1000	77,5	77,5	76,1	77,1	82,0	86,4	11,0	0,15	85,0	8,1	0,11	-1,4
1250	79,0	79,2	77,2	78,5								
1600	79,0	79,7	77,7	78,9								
2000	78,3	78,0	76,8	77,7	82,5	86,9	11,0	0,15	84,9	6,6	0,09	-2,0
2500	76,5	76,9	75,1	76,2								
3150	76,0	76,7	74,4	75,8								
4000	75,5	76,2	73,9	75,3	79,9	84,3	11,0	0,15	82,9	8,1	0,11	-1,4
5000	74,6	74,9	73,2	74,3								
6300	73,2	73,5	71,6	72,9								
8000	71,5	71,8	69,9	71,1	76,1	80,5	11,0	0,15	79,9	9,5	0,13	-0,6
10000	69,6	69,7	68,0	69,2								
A	87,8	88,2	86,4	87,5	87,5	91,9	11,0	0,15	90,5	8,1	0,11	-1,4

Annex A Room no 9

Source: B&K 4204, Reference sound source.
Test room: SP Acoustics, carpenter's workshop.
Estimated room category: Room type 3.
Room data: Carpenter's workshop without absorbers. The floor, and ceiling are made of concrete and the walls are made of double gypsum. The source was placed in the middle of the room >1,5 m from the walls and microphone positions were in the reverberant field..

L= 8,3 m
W= 6,1 m
H= 2,5 m
V= 122,6 m³
S= 170,2 m²

Freq (Hz)	Measured values					Estimated values			Measured values			Diff
	Mic 1 (dB)	Mic 2 (dB)	Mic 3 (dB)	Average (dB)	Average (dB)	LWe (dB)	A (m²)	α	LWm (dB)	A (m²)	α	LWe-LWm
100	59,9	61,4	64,4	62,3								
125	60,9	63,0	65,2	63,4	68,2	77,5	34,0	0,2	79,1	49,4	0,29	1,6
160	66,7	63,6	61,3	64,4								
200	67,1	67,7	66,7	67,2								
250	66,2	67,3	68,3	67,3	71,8	79,8	25,5	0,15	80,9	32,3	0,19	1,1
315	64,7	66,4	68,2	66,7								
400	65,6	67,2	68,1	67,1								
500	65,4	67,9	68,5	67,5	72,5	80,5	25,5	0,15	81,4	30,6	0,18	0,9
630	67,5	69,2	68,7	68,5								
800	69,4	70,6	71,7	70,7								
1000	70,1	72,1	71,7	71,4	76,8	84,8	25,5	0,15	85,0	27,2	0,16	0,2
1250	72,3	73,5	74,4	73,5								
1600	72,5	74,2	74,7	73,9								
2000	71,6	73,3	74,0	73,0	77,7	85,7	25,5	0,15	84,9	20,4	0,12	-0,8
2500	70,1	72,3	72,1	71,6								
3150	69,7	71,6	71,9	71,2								
4000	69,2	71,0	71,6	70,7	75,4	83,4	25,5	0,15	82,9	22,1	0,13	-0,5
5000	68,0	70,4	70,5	69,8								
6300	66,6	69,4	69,5	68,7								
8000	64,6	68,0	67,8	67,1	72,0	80,0	25,5	0,15	79,9	23,8	0,14	-0,1
10000	62,3	66,4	66,0	65,3								
A	81,2	83,0	83,4	82,7	82,7	90,7	25,5	0,15	90,5	23,8	0,14	-0,2

Annex B Room no 10

Source: B&K 4204 reference sound source
Room volume: 134,1m³, boundary surface area: 160 m²
Sound absorption coefficient according to ISO 3746: 0,35
Equivalent sound absorption area according to ISO 3746 A=56m²

	1 (dB) 3746,1m	2 (dB) 3746,1,5m	3 (dB) 3746,2m	4 (dB) Mod3746	5 (dB) 3745	6 (m²)
63	76,6	74,4	74,7	73,3	82,1	41,9
125	79,1	78,6	75,8	79,5	79,1	50,4
250	81,2	80,3	79,8	81,2	80,9	51,,5
500	80,9	81,1	80,5	82,2	81,4	45,9
1000	85,3	84,9	84,6	86	85	43,8
2000	85,7	85,5	84,9	86,4	84,9	39,1
4000	83,2	82,9	82,1	84,3	82,9	40
8000	78,9	78,3	77,2	80,3	79,9	50,4
A-weight	90,7	90,4	89,8	91,6	90,5	42,9

1= ISO 3746, d=1 m. Measurement surface=17,4m². K2A=3,5 dB
2= ISO 3746,d= 1,5 m. Measurement surface=34,9m². K2A=5,4 dB
3=ISO 3746, d=2,0 m. Measurement surface=58,4m². K2A=7,1 dB
4= Mic.pos according to ISO 3743 Sound absorption area =56m²
5= Calibration according to ISO 3745, CTH 9305
6= Measured equivalent sound absorption area

Annex B Room no 11

Source: B&K 4204 reference sound source
Room volume = 107,3 m³, boundary surface area :140,9 m²
Estimated sound absorption coefficient according to ISO 3746 = 0,05 - 0,1
Estimated equivalent sound absorption area according to ISO 3746 A=9m²

	1	2	3	4	5	6
63	(dB)	(dB)	(dB)	(dB)	(m²)	(m²)
125	77,8	74,2	74,7	82,1	55,2	98
250	77,3	78,1	76,2	79,1	11,3	35
500	78,6	81,1	78,1	80,9	8,6	34
1000	79,5	81,6	79	81,4	8,6	31
2000	84,8	85,6	84,5	85	7,8	20
4000	85,8	85,9	86,1	84,9	7,1	14
8000	83,3	82,7	84,4	82,9	9,4	13
A-weight	78,1	77,3	79,9	79,9	16,3	18
	90,5	90,7	91	90,5	8,6	16

1= ISO 3746, 1 m. S=17,4m². K2A=6,9 dB (9 m² absorption added)
2= 3 reverberant mic pos. A =9 m² according to ISO 3746
3= 4 reverberant mic pos. A =18 m² according to ISO 3746 (9 m² absorption added)
4= Reference sound source, calibration values
5= Calculated A from 4 och Lp of 2 above.
6= Calculated A from 4 and Lp of 3 above.