Finnish Institute of Occupational Health

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MEASUREMENT OF SOUND REDUCTION OF A PHONE BOOTH

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MEASUREMENT OF SOUND REDUCTION OF A PHONE BOOTH

1 Background

Speech level reduction was measured for a phone booth. The measurement was made in a reverberation room. The result represents the worst case scenario in a very reverberant sound field. In situ, the sound field is usually less reverberant, e.g. in open-plan offices. In this case, the achieved speech level reduction can be higher, depending on the sound absorbing properties of the space, where the phone booth is placed.

The principle of the measurement method is to determine the sound power levels, in octave bands 125-4000 Hz, for a standardized speech sound source with and without the furniture, and thus to calculate the sound power attenuation produced by the furniture. The assumed octave-band sound power levels of speech are average values for male and female speakers using normal voice effort. The result is given as speech reduction index, D_S, which is the attenuation of A-weighted sound power level of speech produced by the furniture.

2 Description of the specimen

Name:	Martela Hush phone booth
Type:	
Manufacturer:	Martela Oy, Ojakkalantie 10, 03100, Nummela
Other features:	Dimensions LWH: 2200 x 1350 x 880 mm

3 Results

The speech reduction index was **D_S = 22.4 dB** for the phone booth. The results are presented in detail in Annex 1.
The reverberation time inside the phone booth was less than 0.20 s in the octave bands 125-4000 Hz.

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Annexes

Annex 1: Test results (2 pages)
Annex 2: Structure drawings (1 page)
Annex 3: Mounting of specimen (1 page)
Annex 4: Measurement arrangements (1 page)

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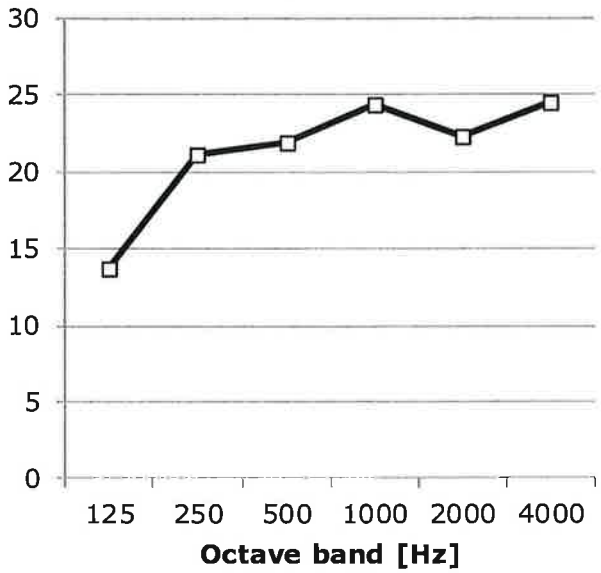
Measurement of sound reduction of a furniture ensemble

Product: Phone booth
Manufacturer: Martela
Test: Finnish Institute of Occupational Health, Turku
5th November, 2013 by Jukka Keränen
Test standards: Sound power level measurements $L_{W,P,1}$ and $L_{W,P,2}$ by ISO 3741:2010
Normalized speech spectrum $L_{W,S,1}$ is based on ISO 3382-3

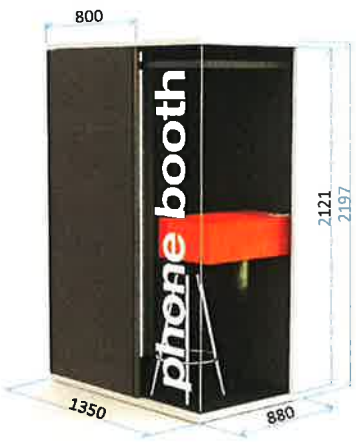
Test results:

	$L_{W,P,1}$ [dB]	$L_{W,P,2}$ [dB]	DL_W [dB]	$L_{W,S,1}$ [dB]	$L_{W,S,2}$ [dB]	A-weighting [dB]	$L_{W,A,S,1}$ [dB]	$L_{W,A,S,2}$ [dB]
125	87.5	73.8	13.7	60.9	47.2	-16.1	44.8	31.1
250	88.4	67.3	21.1	65.3	44.2	-8.6	56.7	35.6
500	87.7	65.8	21.9	69.0	47.1	-3.2	65.8	43.9
1000	88.4	64.0	24.4	63.0	38.6	0.0	63.0	38.6
2000	89.1	66.8	22.3	55.8	33.5	1.2	57.0	34.7
4000	86.7	62.2	24.5	49.8	25.3	1.0	50.8	26.3
A							68.4	46.0

Sound reduction DL_W [dB]



Speech Reduction Index
D_S 22.4



Abbreviations:
$L_{W,P,1}$=Sound power level of pink noise, without furniture
$L_{W,P,2}$= Sound power level of pink noise, with furniture
DL_W= Sound reduction of the furniture
$L_{W,S,1}$= Sound power level of standardized speech, without furniture
$L_{W,S,2}$= Sound power level of standardized speech, with furniture

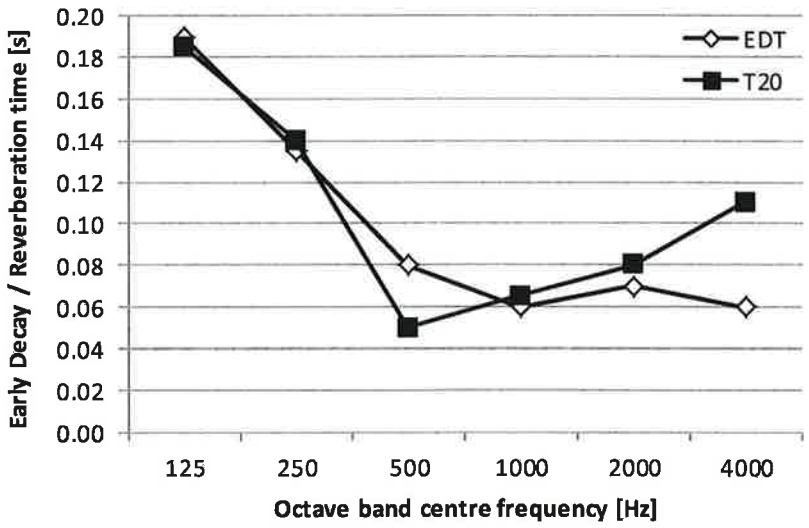
Reverberation time inside the phone booth

Specimen: Phone booth
Manufacturer: Martela
Client: Martela Oy, Kimmo Sundström
Laboratory: Finnish Institute of Occupational Health, Turku

Test date: 5.11.2013
Temperature of test room: 22 °C
Relative humidity: 56 - 60 %
Atmospheric pressure: 971 mbar

Test room volume: 2.1 m^3
Room boundary area: 7.0 m^2

	EDT [s]	T20 [s]
125	0.19	0.19
250	0.14	0.14
500	0.08	0.05
1000	0.06	0.07
2000	0.07	0.08
4000	0.06	0.11



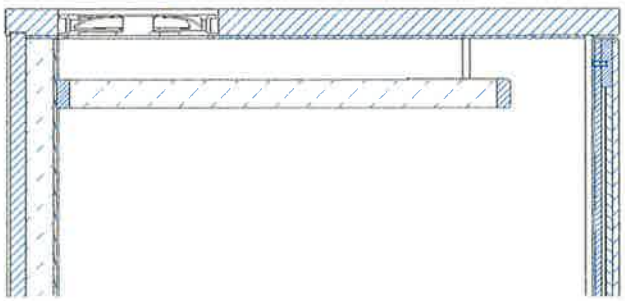
Materials

Ceiling and Floor:
38 mm MDF-board, 4 mm felt

Back wall:
22 mm chip board, 40 mm evona (42 kg/m^3), 4 mm felt

Door:
9 mm MDF-board, 16 mm MDF-frame + 10 mm evona (42 kg/m^3), 9 mm perforated MDF-board (96 holes, d 64 mm), 4 mm felt

Glass:
laminated glass 5+5 mm



Suspended ceiling:
650x1200x40 mm, chip board frame, 40 mm evona (42 kg/m^3), felt

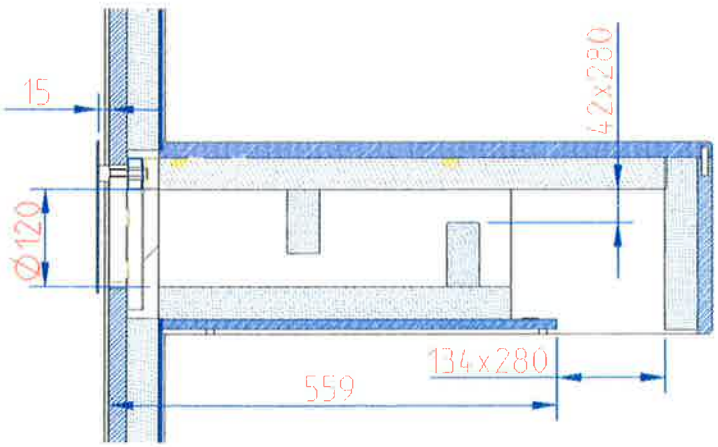


Table (ventilation intake):
MDF-board, 40 mm evona (42 kg/m^3)

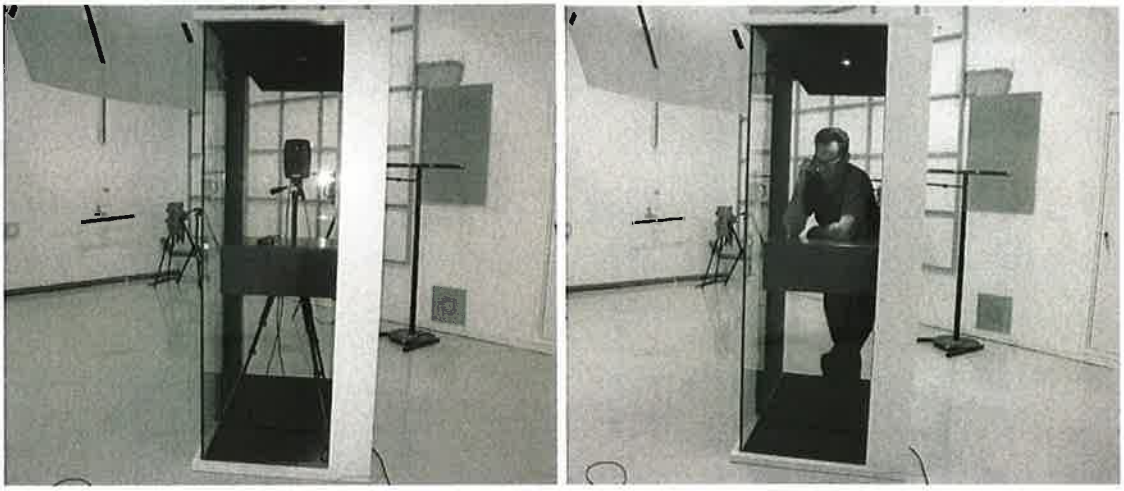


Figure 1. The loudspeaker (Genelec 8020A) at the height of 1.55 m inside the phone booth was used to represent a standing person speaking to a phone. The booth was unoccupied during the sound reduction measurement.

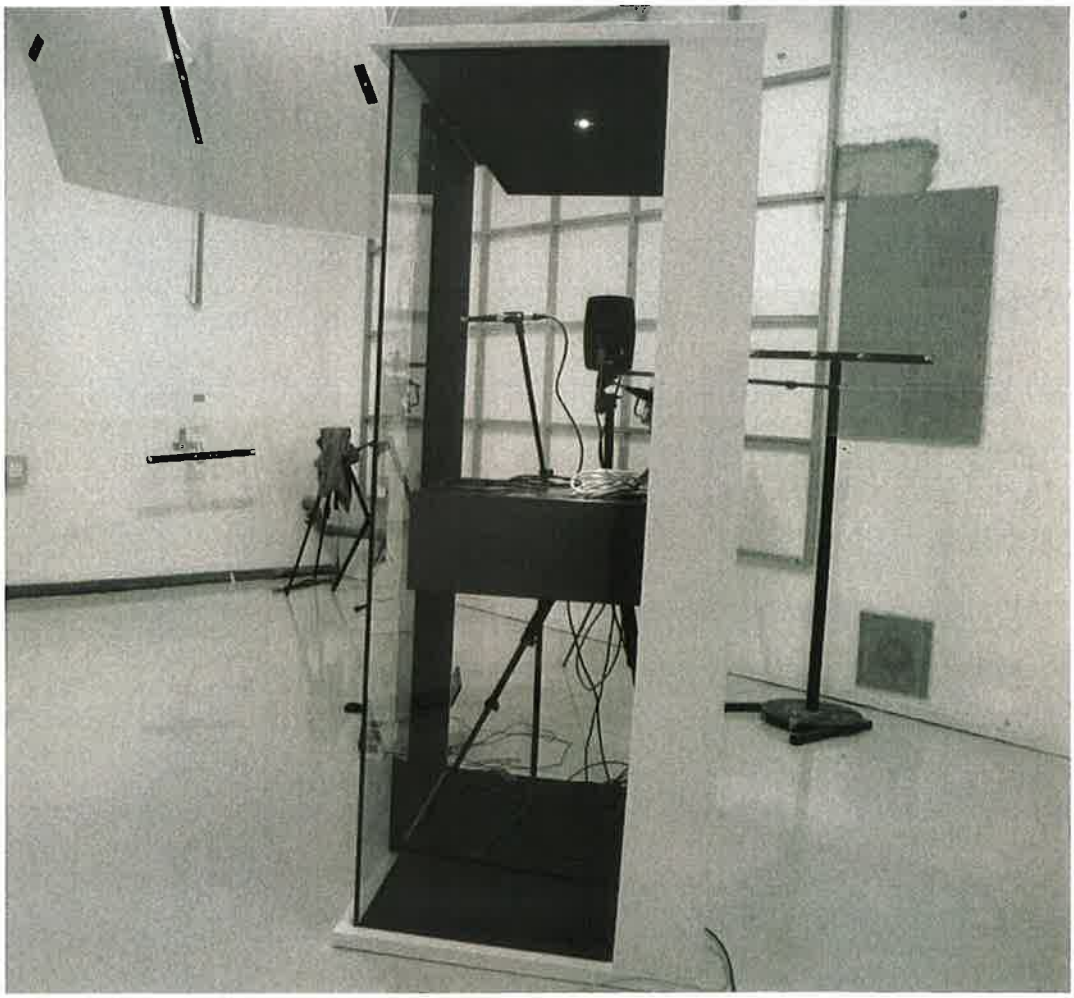


Figure 2. Measurement setup for the early decay and reverberation time measurements inside the phone booth. The booth was not occupied during the reverberation time measurement.

1 Acoustical measurements

The pink noise test signal was produced with a signal generator (Neutrik MR1) and amplified using an active loudspeaker (Genelec 8020A). The loudspeaker was located inside the phone booth at the height of 1.55 m so that it represented a standing person speaking to a phone (Annex 3, Figure 1). The sound pressure level in the reverberation room (outside the phone booth) was measured with a real time analyser (Norsonic 121) using a condenser microphone (Brüel&Kjær 4165 and preamplifier Brüel&Kjær 2669) in four fixed positions. The averaging time was 30 seconds. The measurement system was calibrated before the measurements with a sound level calibrator (Brüel&Kjær 4231). The measurements were repeated in an empty reverberation room, i.e., without the specimen using exactly the same loudspeaker and microphone positions.

For the reverberation time measurement in the reverberation room, the pink noise test signal was produced with the real time analyser (Norsonic 121) and amplified with a terminal amplifier (QSC 1300 W USA). Three fixed loudspeaker positions were used and the microphone was placed in four positions. The reverberation time was determined in conformance with ISO 354:2003 using 2 averaged decay signals from the decay range of –5 to -25 dB in each measurement. The sound analysis was made with the real time analyser (Norsonic 121).

For the reverberation time measurement inside the phone booth, a sine sweep test signal was produced with a measurement software (WinMLS 2003) and an external sound card (D-Audio) and amplified with the active loudspeaker (Genelec 8020A). The signal was recorded using a condenser microphone (BSWA SM4201) and post-analysed using the measurement software (WinMLS 2003). The measurement setup is presented in Annex 3 Figure 2.

The acoustical measurement equipment fulfilled the following IEC standards and grades of accuracy:

IEC 60651	Sound level meters (replaced by IEC 61672)	**type 1**
IEC 60804	Integrating sound level meters (replaced by IEC 61672)	**type 1**
IEC 61260	Octave-band and fractional-octave-band filters	**class 1**
IEC 60942	Sound level calibrators	**class 1**

2 Other measurements

The temperature and the relative humidity of the reverberation room were measured using an environmental measurement device (Thermo Recorder TR-73U). The dimensions of the specimen were measured with a roll meter (K-Prof).

3 The test room

The reverberation room was equipped with six fixed diffuser panels. The positions were selected randomly in respect with altitude, angle and position. The amount of diffusers and their arrangement fulfils the requirements of Annex A in ISO 354. The reverberation time of the reverberation room fulfils the requirements of ISO 354 for 155 m^3 test room except for the third octave bands 160 and 200 Hz, where the reverberation time was at most 17 % below the minimum required reverberation time.

4 References to the ISO standards

ISO 354:2003 (E) Acoustics - Measurement of sound absorption in a reverberation room, International Organization for Standardization, 2003, Genève, Switzerland.

ISO 3741:2010 (E) Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for reverberation test rooms

ISO 3382-3:2012 (E) Acoustics – Measurement of room acoustic parameters – Part 3: Open plan offices