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Appendices

Appendix A

A.1 Thesis intellectual property restrictions as related to the relevant industrial partnership.

- The research material and data generated during the partnership to be used as basis of the thesis content, should be written as generically as possible without giving specific detailed data or identified business generating information.
- Throughout the thesis there should be no direct mention of the partner company or stations names.
- Generic names should be used throughout the thesis for stations and companies.
- The thesis will be privately examined under confidentiality agreement by two academics not involved in any project with LU and with no commercial interest in VA systems on underground stations.
- The thesis will be officially sealed for three years from the date of viva voce examination, thus preventing public access or disclosure of any information contained in it for that period of time.
- No electronic version of the dissertation will be made available prior to the seal expiration.
- Only the thesis title, abstract and table of contents will be submitted to the British Library during the valid period of the seal.

Appendix B

B.1 Impulse response theory

An Impulse response (IR) is defined as the response *y(t)* at the output of a system under test *h(t)* when an unit impulse or Dirac delta function *δ,* ideal infinitely short duration impulse of infinite high power and unit energy, is fed into the input *x(t)* (equation B:1 and figures B:1 and B:2). This response to the fundamental input signal, provides both a characterisation of the transmission system and the mathematical basis of how the system will create a response to more complex inputs.

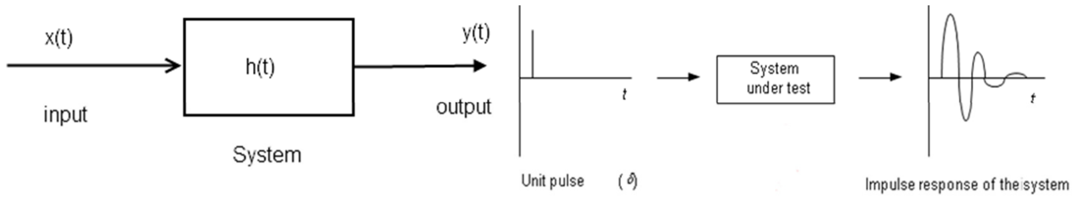
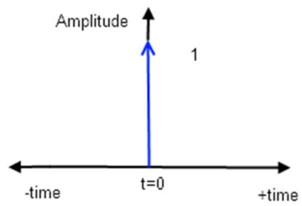


Figure B:1 Impulse response of a transmission system.

$$\int_{-\infty}^{+\infty} \delta(t)dt = 1$$



Equation B:1 Dirac delta function Figure B:2 Dirac delta function as an ideal system input signal in the time domain.

Where *δ(t)* = 0, when t≠0 and approximates to infinity when t=0

A more realistic continuous input signal *x(t)* can be considered as a infinite number of delta-function parts which enables the calculation of the system output.

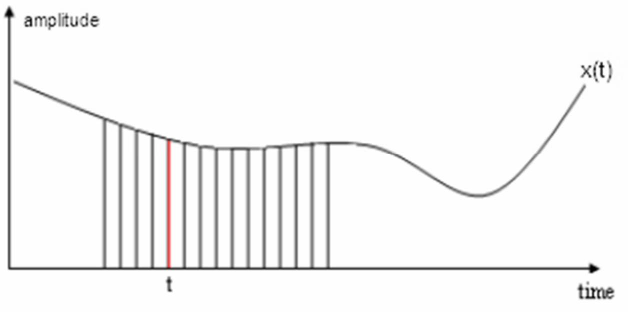


Figure B:3 A realistic continuous input signal x(t)

In the context of room acoustics, this excitation input signal x(t) can be analysed as a signal made up of an infinite number of delta pulses contributions (figure B:3). Each pulse creates its own impulse response at the receiver position (output of the system). If the transmission system is linear and time invariant (LTI), the sound field of the system at the receiver is the summation (integration) of all contributing impulse responses with their corresponding time delays (equation B:2).

$$y(t) = \int_{-\infty}^{t} h(t-\tau)x(\tau)d\tau = \int_{0}^{\infty} x(t-\tau)h(\tau)d\tau = h(t) * x(t)$$

Equation B:2 Receiver output of a continuous input signal

where the operator $*$ is referred to as convolution.

Equation B:2 entails that any other signal present at the input of a linear and time-invariant transmitter (LTI) can be convolved with the system's IR to obtain the new output signal.

An impulse response completely describes any linear time invariant system and therefore in the case of a room (as part of the system), the IR contains an abundance of individual room reflections, each being a function of time, level, direction and frequency. Hence a room impulse response (RIR) (figure B:4) can be shown to contain all information about the acoustics of a room between two specific source and receiver positions.

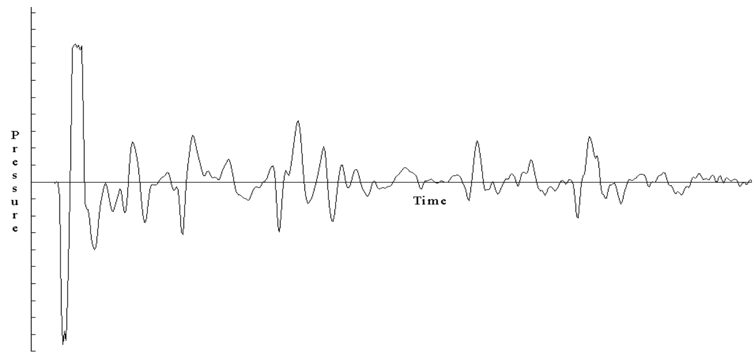


Figure B:4 Impulse response represented as the sound pressure registered by the receiver in a room as a function of time as a result of delta pulse excitation.

The transmission of sound within a room is in practice regarded as a close approximation to a LTI system.

Impulsive sources such as blank gun shots, balloon pops and electric sparks provide signals which closely approximate the theoretical delta function and can be used in practice to measure the response of the room. However, these signals can introduce a considerable grade of uncertainty due to their insufficient control of spectral content and directional characteristics. Nowadays to obtain the required control of the excitation signal, the room is excited by known digitally processed signal (deterministic signals) to ensure high reproducibility, repeatability, dynamic range and immunity to undesired noises through the method of deconvolution.

These signals, also provide the practical convenience of being able to be reproduced by loudspeakers (i.e. VA systems). Examples of suitable non-impulsive excitation signals are MLS (Maximum Length Sequence) signals, the swept sine (sine with frequency increasing linearly or exponentially with time), white noise and pink noise.

For a practical and perceptual interpretation of the development of sound in a room, an impulsive sound is taken as an example of signal input. This sound signal is received after being modified by the room. This modification process allows valuable information to be gained, through analysis of the signal, concerning the acoustics characteristics of the space (figure B:5). The first part arriving at the listener/receiver is the direct sound. This sound comes in a straight line (direct line of sight) and has not undergone any reflection. The time between the production of the impulse response (t=0) and the reception of the direct sound at the receiver is a function of the distance between the source and receiver (figure B:6). The next part is the early reflections bounced off from nearby objects and/or surfaces. They are considered early if arrive within the first 50ms and 80ms for speech and music purposes respectively. This early energy is considered useful as it can reinforce the direct sound and contribute significantly to subjective impressions of the overall room acoustics of a space. The late reflections that arrives at the receiver after the initial 80-150ms, contributes to the reverberation time impression and perception of the room volume. The later reflections are of a high density and form the reverberation portion or diffuse field. If this portion is of a relatively high level with respect the earlier parts, it will dramatically impede the perception of speech signal.

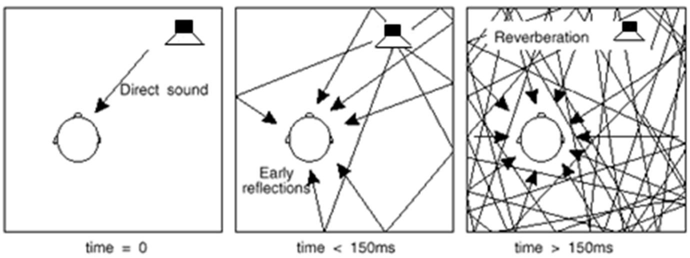


Figure B5 Representations of the different sound paths received by a listener (or microphone): direct, early and late reflections.

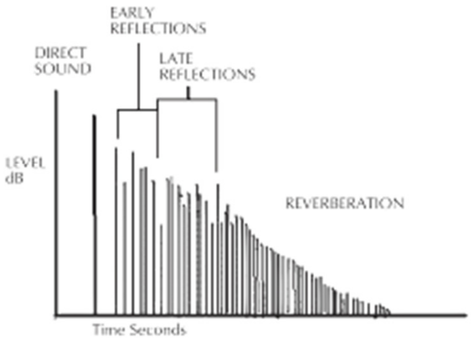


Figure B:6 Representation of the different parts in the perception and reception of an impulsive sound in a room (after Ballou, 2005).

The impulse response of an acoustic transmission system can be measured (in full size rooms and in scale models) or simulated (computer models) to fully characterise the sound field. The acoustic parameters derived from the impulse response can be used as a basis for acoustic design, remedial work and assessments.

Impulse response excitation signals

Several excitation signals have been created, these can be used to efficiently obtain a RIR. Below is a summary of each test signal together with a description of the advantages and disadvantages of their use in practical measurement situations.

In principle any kind of excitation signal may be used to determine the impulse response of a linear and time-invariant system provided that the test signal is well defined and has sufficient energy at each relevant frequency.

The classic and intuitive type of excitation signal involve creating approximations of the Dirac impulse, such as blank pistol shots, balloon bursts and electric sparks. These signals lack controllable directivity, repeatability and good reproducibility. They are often unsuitable for testing where people can be disturbed due to their highly intrusive nature. However they offer the advantage of requiring minimal equipment and therefore are inexpensive. These sources are often considered for survey or engineering measurements when high precision and noise disturbance are not of concern. Another advantage of this excitation signal compared with loudspeaker reproduced signals (white noise, MLS and swept sine see below) is that it does not require additional processing.

Another type of classic test signal is white noise which on average has a flat frequency spectrum. However due to it random nature, repeatability is poor and residual noise is obtained in the measured IR which limits the available SNR. This type of signal has the advantage of being perceived as non-intrusive in practical situations when measurements are taken with occupants.

Deterministic excitation such as MLS and swept sine test signals (see below) are preferred to classic excitation signals to obtain the impulse response in room (RIR) due to their higher reproduction consistency and reproducibility. The use of deterministic signals also offer the great advantage of being more efficient at suppressing extraneous noises and obtaining a higher effective signal to noise ratio than classic excitation signals. Effective signal-to-noise ratio expressed in dB can be thought as the usable IR decay range. It is formally defined as ten times the logarithm to the base 10 of the ratio of the mean-square value of the signal part caused by the excitation and obtained by the new method, to the mean-square value of the unwanted part of the signal obtained by the same method and caused by sources other than the excitation (BS 18233 :2006).

Loudspeakers inherently have severe limitations to reproduce Dirac impulse approximation signals however have good properties with regard to the reproducibility, spectrum and directivity of deterministic and random signals.

MLS

Maximum Length Sequence (MLS) (Rife & Vanderkooy,1989) is a pseudorandom binary sequence (periodic), having the property of its frequency spectrum over one period being as flat as the spectrum of an ideal impulse.

The MLS is characterized by an order, N, given by a whole number. The length of the sequence is $l_N = 2^N - 1$. The autocorrelation of the sequence will almost be a periodic delta-pulse when the sequence is replayed periodically. The signal will thus be an approximation to a record of white noise replayed with a repetition frequency $f_{rep} = 1/T_{rep} = f_c / (2^N-1)$ (BS 18233 :2006).

MLS signal have the convenience of being generated using a simple shift register and be deconvolved swiftly using a cross correlation based on the Hadamard Transform. MLS signals are particularly sensitive to system nonlinearities and time-variance. These effects can cause measurement errors or noise that is distributed over the full length of the response which reduce the effective SNR or the IR decay range. If more periods of the recorded response are synchronously averaged, the effective signal-to-noise ratio may be enhanced by 3dB per doubling of the number of averages taken (Vorländer & Kob, 1997). As a flat and broad frequency band noise (white noise, somewhat resembling natural background noise) its sound is perceived as non intrusive, a significant practical advantage. Another convenient aspect is that the signal’s absolute level can be easily determined using a sound level meter (SLM), thus allowing level calibration.

Swept sine excitation

This type of excitation also known as chirps and time stretched pulse, consists of a sine wave that changes over time from the lower to the upper edge of the frequency range required (figure B:7). There are two types of sweeps, the linear and the exponential sweep (e-sweep) where the frequency increases linearly and exponentially over time respectively. A linear sweep signal has a white spectrum, while the e-sweep has a pink spectrum where there is equal energy per octave band. This e-sweep spectrum characteristic is advantageous in situations where it is difficult to obtain a high a SNR at lower frequencies. Unlike random signals, in MLS and the swept sine signals the extracted impulse response is not contaminated by any noise due to the excitation signal. Swept sine signals permit a higher power output level from a reproducing system than an MLS signal, due to its lower crest factor through the system. Transmission systems using swept sines are markedly less sensitive to time variance than using MLS signals.

The e-sweep type has the important quality that noise caused by system non-linearities (e.g. loudspeaker harmonic distortion) or time-variance (persons or air movements, temperature changes) can easily be separated from the actual impulse response (Farina, 2000) preventing a potential reduction of the effective SNR. Since harmonic distortion can be eliminated from the measurements the signal can be supplied to the system with substantially more power than MLS signals. This in turn allows higher effective SNR to be obtained in situation where the background noise is high.

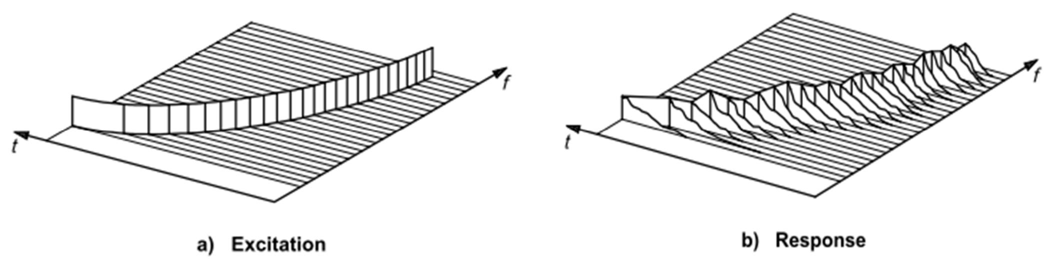


Figure B:7 Time frequency representation of the exponential swept sine signal (after BS 18233:2006)

Increasing the sweep duration increases the acoustic energy into the room and therefore increases the effective SNR. The obtained SNR depends on extraneous noise level, amplitude of excitation, the sweep rate and the algorithms for the signal processing. Doubling the duration of the sweep will normally lead to an increase in the effective SNR ratio by 3 dB. Another important practical advantage of swept sine signals is that they do not require a strict sampling clock synchronization between the signal generation and recording units (asynchronous). In this way measurements can be conveniently taken using external sources not linked to measurement processing unit (open loop) (Gomez et al, 2008). However swept sine signals are found more disrupting and alarming than the MLS and random test signals (Gomez et al, 2008). Another disadvantage of this test signal if not applied with caution is that it can strain the loudspeakers by temporarily concentrating a large amount of energy on each single frequency.

Considering the practical advantages and disadvantages of each excitation signal it becomes clear that e-sweep is the most appropriate test signal for conducting acoustic measurement on deep level platforms during engineering hours and under the practical conditions and limitations encountered. The e-sweep test signal was employed consistently for all the acoustic measurements undertaken during the field research of this project and reported in this thesis.

Integrated impulse response method in acoustic measurements

Schroeder (1965) demonstrated that the expected sound energy decay at one particular receiver position can be obtained without the need of averaging using the classic techniques involving impulse or random signals. This can be achieved by processing the impulse response between the excitation signal (i.e. loudspeaker and the receiver position (microphone) directly. This method is applicable to obtain the decay curve and the stationary levels provided the system is linear and time-invariant.

Schroeder showed that the reverberation curve can be measured with increased precision by backwards integration of the square impulse response, $h^2(t)$, as follows:

$$G(t) = \int_t^\infty h^2(t)dt = \int_0^\infty h^2(t)dt - \int_0^t h^2(t)dt$$

Equation B:3 Schroeder derivation of the energy of a decay curve in which *G(t)* is equivalent to the decay of the squared pressure decay ($p^2(t)$ represented here as $h^2(t)$). Hence, Schroeder integration is defined as a time-reversed integration of the instantaneous power of the signal. The method is called backwards integration because the integration starts at the end of the finite length impulse response and progress to the start of the square impulse response (equation B:3).

The sound pressure level (SPL) in dB at any location in a room can be calculated by integrating the square of the instantaneous sound pressure (p^2) of the impulse response h(t) at the receiver position over the time window of interest from t=0, this is expressed as:

$$SPL(t) = 10log\left(\int_0^\infty p^2(t)dt\right) \equiv 10log\left(\int_0^\infty h^2(t)dt\right) \qquad (dB)$$

Equation B:4 SPL calculation from the impulse response

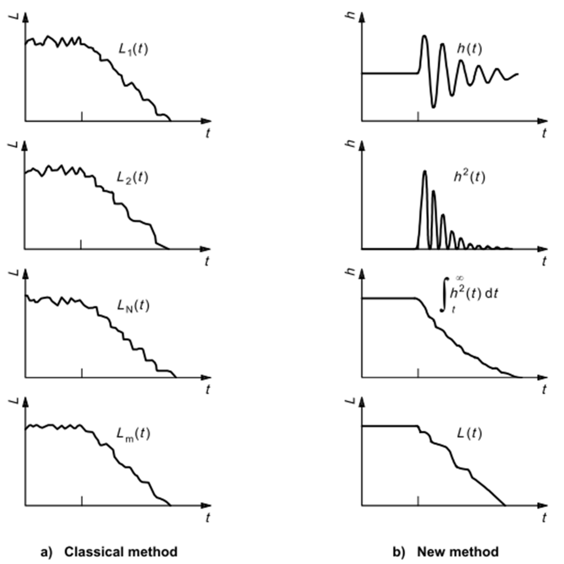


Figure B:7 Graphical comparison between classic method of obtaining the decay curve based on averaging decays (Lm(t)) and the newer Schroeder method (after BS18233:2006).

Unlike the classic methods of calculating RT (figure B:7) which assume a diffuse field, the new method permits the analysis of a variety of acoustic parameters including RT in non-diffuse spaces. International standard BS EN ISO 3382-1:2009 defines relevant acoustical parameters which can be derived from the RIR including RT,EDT,C50,D50.

The Energy Decay Curve (also known as EDC, Schroeder curve) is a curve obtained by backward integration of the energy of the room impulse response (RIR) (figure B:8). It is widely used in room acoustics to determine the reverberation time indices by analysing the energy decay rate. These indices include the RT20, RT30, RTxx (user defined measurement range) and EDT (see below). Unlike the classic acoustics theory measuring techniques to measure RT, the Schroeder method allows the accurate calculation of RT for non-diffuse spaces.

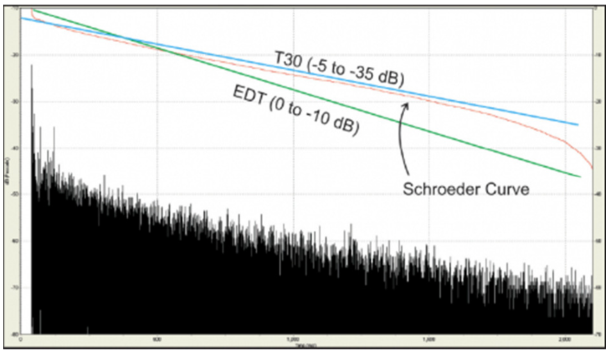


Figure B:8 Determination of RT indices derived from fitting lines on Schroeder decay curve

B.2 The Speech Transmission Index (STI)

The speech transmission index is based on the initial concept of the modulating transfer function (MTF).

MTF method description

In speech, the intensity of the signal varies with time producing a variation in the intensity envelope of the speech. Slow fluctuations of the intensity envelope correspond with word and sentence boundaries while fast fluctuations coincide with individual phonemes within words. Preservation of the intensity envelope is of the paramount importance. The MTF concept on which the STI method is based, quantifies how the channel affects the intensity envelope of the speech signal (Houtgast & Steeneken, 1973) ,(Steeneken&Houtgast,1980).

The STI concept is based on the empirical finding that the fluctuations in speech signals carry the most relevant information relating to speech intelligibility, (Houtgast & Steeneken, 1973), (Steeneken & Houtgast, 1980,1982).Fluctuations in speech result from the acoustic separation of sentences, words and phonemes, which are the fundamental elements of speech. The fluctuations, termed modulations, can be quantified as a function of modulation frequency *F* producing the modulation spectrum. For clear speech, the modulation frequencies typically extend from 0,5 Hz up to 16 Hz with maximum modulation at approximately 3 Hz. Deterioration of the modulation spectrum by the transmission channel is considered as a reduction of the speech intelligibility. This deterioration of the modulation spectrum corresponds to a reduction of the modulation depth (*m*) which can occur at one or more modulation frequencies (figure B:9).

The STI test signal of a known modulation index m_i is played into a room through a communication channel and received at the listener positions with a resulting modulation index m_o. The test signal consists of a carrier with a speech-shaped frequency spectrum and a sinusoidal intensity modulation with modulation frequency *F* (figure B:9 and B:11).

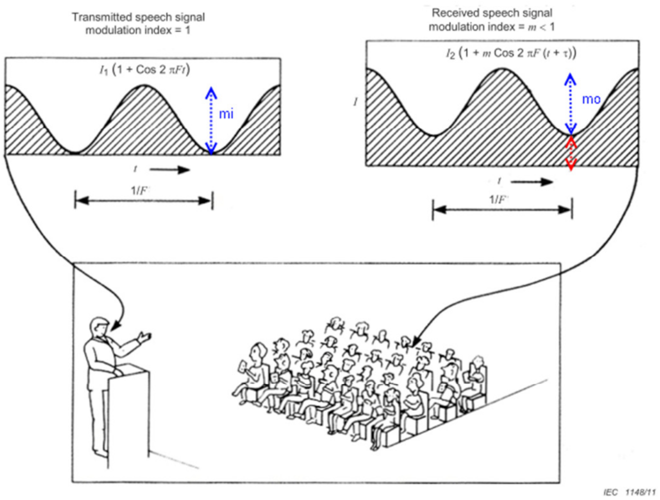
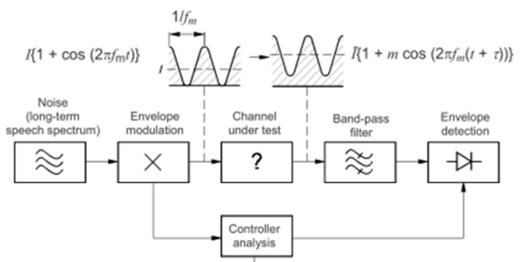


Figure B:9 Modulation reduction between talker (m_i) and listener (m_o) due to the transmission channel (after BS EN 60268-16:2011).

The modulation transmission value for each octave band can be calculated over the speech spectral range (125 Hz - 8 kHz, octave bands centre frequencies).

The STI test signal comprises seven octave band carriers which correspond to the octave bands from 125 Hz up to 8 kHz. Each noise carrier is modulated with 14 frequencies at one-third octave intervals ranging from 0.63 Hz up to 12.5 Hz. The combination of modulation frequencies and the seven octave carrier bands form a modulation matrix of 98 *m(F)* values. Figure B:10 illustrates a measuring arrangement in which the modulation transfer function, *m (F),* is determined separately for each modulation frequency in each octave band.



Octave-band Hz	125	250	500	1k	2k	4k	8 k
f_1 = 0,63 Hz	m						
f_2 = 0,8 Hz							
f_3 = 1,0 Hz							
f_4 = 1,25 Hz							
f_5 = 1,6 Hz							
f_6 = 2,0 Hz							
f_7 = 2,5 Hz							
f_8 = 3,15 Hz							
f_9 = 4,0 Hz							
f_{10} = 5,0 Hz							
f_{11} = 6,3 Hz							
f_{12} = 8,0 Hz							
f_{13} = 10 Hz							
f_{14} = 12,5 Hz							
I_k							

IEC 1152/11

Figure B:10 Measurement system structure diagram and modulation transfer matrix (after BS EN 60268-16:2011)

The reduction in the modulation index at each frequency *F* is quantified by the modulation transfer function *m(F)* which is determined by the expression:

$$m(F) = \frac{m_o(F)}{m_i(F)}$$

Equation B:5 modulation transfer function at frequency F

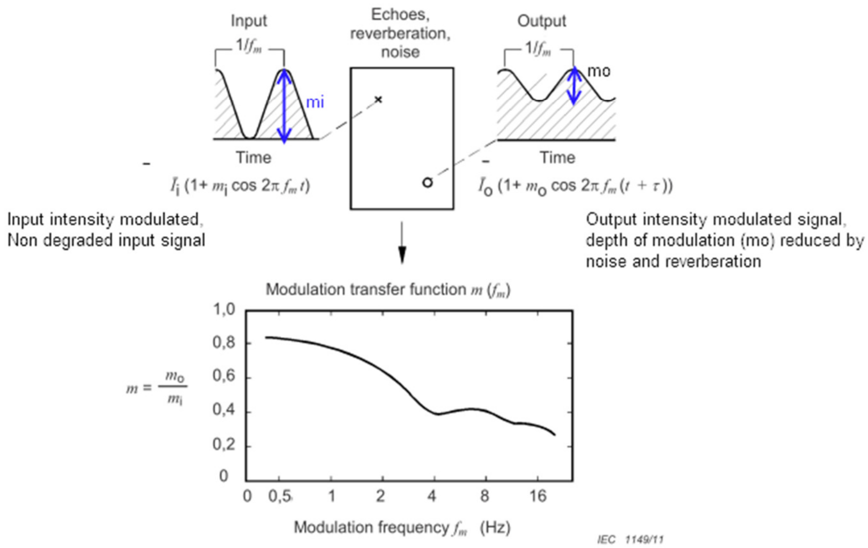


Figure B:11 Input – output comparison respect modulation depth and resulting MTF ($m(f_m)$) spectrum (after BS EN 60268-16:2011).

If the two envelope spectra are the same, then m(F) = 1, and no signal degradation has taken place. However the smaller the m(F) becomes, the more the signal has been distorted by effects such as echoes, reverberation and noise. Irrespective of the cause of the reduction in modulation (interfering noise, reverberation, echoes, or non-linear distortion) the reduction in modulation is interpreted as a reduction in the effective signal-to-noise ratio SNR_{eff}, (in dB) and it is calculated by the following equation:

$$SNR_{eff} = 10log\left(\frac{m(F)}{1-m(F)}\right)$$

Equation B:6 Reduction in modulation as effective SNR

The values of the effective signal-to-noise ratio are limited to the range of -15 dB to +15 dB. Values less than –15 dB are truncated to the value of –15 dB and values greater than 15 dB are truncated to a maximum value of 15dB.

Theoretical expression of the MTF

In the theoretical case of purely exponential decay of the sound field (diffuse field), the mathematical expression of the MTF due to reverberation is given by:

$$m(f_m) = \frac{1}{\sqrt{1 + \left(\frac{2\pi f_m T}{13.8}\right)^2}}$$

Equation B:7 Calculated reverberant contribution to the modulation transfer function

where f_m is the modulation frequency; T is the reverberation time in seconds. Interfering noise will increase the mean intensity reducing as a result the modulation index for all the modulation frequencies independent of the modulation frequency. In the presence of noise the MTF is defined by the signal-to-noise ratio (SNR) and the mathematical expression is:

$$m = \frac{1}{1 + 10^{(-SNR/10)}}$$

Equation B:8 Calculated noise contribution to the modulation transfer function

The speech transmission index is then determined by the weighted contribution of a number of frequency bands within the frequency range of the speech signals. Each octave band presents a different contribution to speech intelligibility. The overall STI for the transmission channel is determined by using the weighted sum of these transmission index values.

Calculation of the STI

Hearing related aspects such as auditory masking, the reduction in aural sensitivity by a stronger, lower frequency sound, as well as the absolute reception threshold are modelled in the STI calculation by applying appropriate noise terms. The auditory effects will reduce the effective signal-to-noise ratio in the various octave bands and can be expressed as a reduction of the modulation transfer function resulting in generally lower STI values. STI evaluates the modulation loss and calculates the effective signal-to-noise-ratio in each octave band independently of the other octave bands. The STI method in the 2003 revision (BS EN 60268-16 :2003) discriminates between male and female speech signals. Gender related factors are expressed in different test signal spectra and different weighting factors. The latest revision of the method (BS EN 60268-16 :2011) is standardised to the worst case, male speech.

The calculation of STI involves the determination of transmission indices (TI) from the apparent S/N ratio, specific for octave band k and frequency f as shown in equation B:9. As STI is linearly related to S/N ratios in a 30dB range from -15dB to 15dB , all related S/N ratios are adjusted (truncated) to fit within the that range and thus allow for STI values in the range of 0 to 1 (equation B:9)

$$TI_{k,f} = \frac{SNR_{k,f} + 15}{30}$$

Equation B:9 Calculation of the transmission index

The 14 transmission indices, obtained for each octave band, are then averaged to give the modulation transfer index (MTI_k), specific for octave band *k*, (Equation B:10)

$$MTI_k = \frac{1}{14}\sum_{f=1}^{14} TI_{k,f}$$

Equation B:10 Calculation of the Modulation transmission index

The revised form of the STI (BS EN 60268-16:2003) requires a number of corrections in the calculation process to account for auditory masking (level dependant masking) and reception threshold. Level dependant masking is particularly important for PA and VA systems broadcasting announcements at high SPL. The correction algorithm accounts for the subjective reduction in intelligibility at high levels.

Weighting and redundancy corrections are applied as follows:

Initially, the intensities of octave band specific audio masking effects ($I_{am,k}$) are determined using equation B:11 below:

$$I_{am,k} = I_{k-1} * amf$$

Equation B:11 Calculation of auditory masking effects

where I_{k-1} is the intensity of the masking signal in band k -1 (i.e. an octave lower than *k*) and *amf* is the auditory masking factor related to the absolute reception threshold by means of lower limit of the masking noise level within each octave band ($I_{rs,k}$) and dependent on masking signal level (as defined in BS EN ISO 60268-16 :2003).

Applying the corrections for auditory masking and reception threshold gives the corrected version of *m*, as defined by equation B:12

$$m'_{k,f} = m_{k,f} \frac{I_k}{I_k + I_{am,k} + I_{rs,k}}$$

Equation B:12 Calculation of modulation transfer function including auditory effects contributions

where $m_{k,f}$ is the modulation index for octave band *k* and frequency *f*, $m'_{k,f}$ is the corrected index and I_k is the signal's intensity in octave band k.

Subsequently, the effective S/N ratio (in dB) for octave band k and modulation frequency f takes a revised form to represent the corrections made, as shown in equation B:13.

$$SNR_{k,f} = 10log \frac{m'_{k,f}}{1 - m'_{k,f}}$$

Equation B:14 Effective SNR including auditory effects contributions

Using the corrected S/N ratios, updated $TI_{k,f}$ and subsequently updated MTI_k values can be derived. Ultimately, the revised speech transmission index, *STIr* , is obtained through a weighted summation of the modulation transfer indices for the seven octave bands and the corresponding redundancy corrections (see BS EN ISO 60268-16:2003), as shown below in equation B:14

$$STI_r = \sum_{k=1}^{7} \propto_k MTI_k - \sum_{k=1}^{7} \beta_k \sqrt{MTI_k * MTI_{k+1}}$$

Equation B:14 Calculation of STI accounting for auditory masking, frequency contribution weightings and redundancy effects

where α_k represents the octave weighting factor and β_k represents the redundancy correction factor related to the contribution of adjacent frequency bands. As the particular corrections are (speaker) gender depended, optimal gender related weighting and redundancy factors along with threshold corrections are given in BS EN ISO 60268-16:2003.

Indirect measuring method

The modulation transfer function MTF, in which the STI method is based, can also be calculated from the impulse response of a transmission channel, using a process known as the Schroeder method. The impulse response of the transmission channel is acquired and the MTF is derived from it. The STI is subsequently calculated from the computed MTF

Schroeder (1981) demonstrated that it is possible to compute the MTF from the impulse response of transmission channel. From the computed MTF, the STI can be calculated. This way to measure STI (and its derivatives, see below) based on the impulse response is normally referred as an indirect methods (BS EN 60268-16:2011). This indirect method is only applicable to linear, time-invariant systems.

The equation B:15 below shows in the first factor, the Schroeder formula which calculates the modulation transfer function $m_{f,k}$ at modulation frequency f_m in the octave band *k.* through the Fourier transform of the squared impulse response normalized by the total impulse response energy (equation B:15).

$$m_k(f_m) = \frac{\left|\int_0^{\infty} h_k(t)^2 e^{-j2\pi f_m t} dt\right|}{\int_0^{\infty} h_k(t)^2 dt} * \frac{1}{(1 + 10^{-SNR_k/10})}$$

Equation B:15 Modulated transfer function derived from the system's impulse response as shown by Schroeder

Where $h_k(t)$ is the impulse response of octave band k, f_m is the modulation frequency and SNR_k is the signal to noise ratio in dB.

This faster and generally more accurate way of deriving the MTF formed the basis which allowed computer acoustic simulation programs to derive the MTF from the predicted impulse response.

Limitations of STI method

The STI method exhibits some limitations related to the form of analysis (inherent limitations of the MTF theory) and test signals used. The method should not be used to assess transmission channels that introduce frequency shifts or frequency multiplication, or channels that include vocoders. Other factors can affect the accuracy of the STI including, transmission channel limited frequency response, presence of audible echoes, unrepresentative low background noise setting, high level of non linear distortions (particularly in the indirect methods), presence of significant impulsive or fluctuating noise.

The common intelligibility scale (CIS)

BS EN 60849:1998 incorporated a scale which determined relationships among results of the various methods of speech intelligibility measurements (figure B:12) for conversion purposes. Figure B:13 shows a look up table which interrelates CIS and STI scales with STI subjective speech intelligibility ratings.

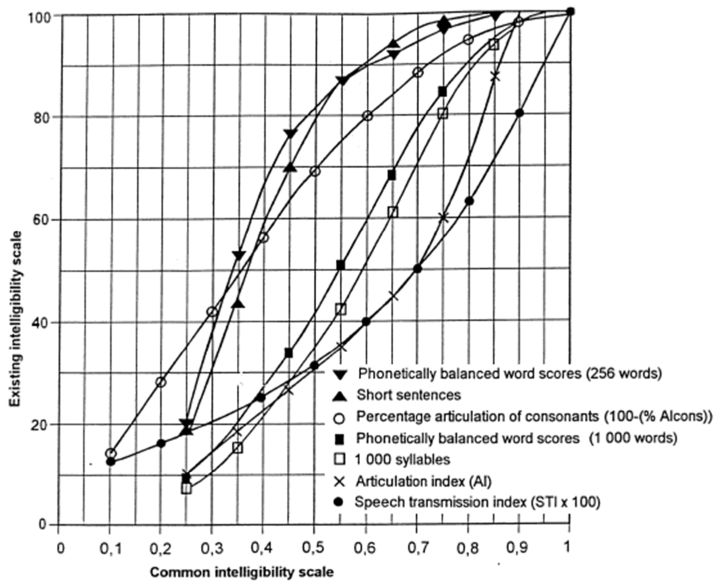


Figure B:12 Conversion of existing intelligibility scales to the CIS (after BS EN 60849:1998).

Figure B:13 Relationship between CIS, STI and STI subjective ratings

STI derivative methods

Since measuring the direct full STI measurement method is unpractical in many situations (one full direct measurement takes approximately 15min), faster derivatives methods (RASTI and STIPA, see below) were developed. The direct full STI method of measurement is generally now only used for background STI research (BS EN 60268-16:2011).

<u>Room Acoustic Speech Transmission Index (RASTI)</u>

This simplified method, it was originally developed for screening purposes only and focused on direct communication between persons without making use of an electro-acoustic communication system. The technique was created to provide a faster method of obtaining an STI measurement, there being an order of magnitude reduction in the data and corresponding computational effort. However the reliance of the technique operating on just two octave carriers was found to be a serious limitation of the method when testing electroa-coustic systems. RASTI has been shown to be unreliable and inaccurate predictor of sound system performance (Mapp, 2004,2002a,2002b). RASTI is now declared obsolete and "*shall not be used as an indication of the predicted" STI* (BS EN 60268-16:2011).

Speech transmission index for public address systems (STIPA)

This metric appeared in 2001 (Steeneken et al, 2001) as a STI condensed derivative specifically aimed for assessing speech intelligibility for transmission channels involving a sound system. It correctly accounts for the distortions that are related to public address systems although it does not account accurately for strong echoes. The specific test signal (pseudo-random noise spectrally shaped to approximate a generic speech spectrum) is provided on a CD and a specific hand-held analyser performs the analysis in approximately 15 seconds. Each of the seven octave band is modulated by only two modulation frequencies simultaneously, which increase its sensitivity to impulsive noises. The type of signal removes the requirement for 'source-receiver' synchronization in the time scale while enabling a significant simplification of the measurement procedure in practical applications

The method is only validated for the male speech spectrum and can be derived from impulse response measurements assuming LTI systems. It was first internationally standardised in 2003 (BS EN 60268-16:2003). The STIPA's superior accuracy and reliability respect the RASTI method as well as its practical qualities (instrumentation portability, calculation speed and simplicity), have established the STIPA method implemented on sound level meters as the de-facto industry standard for on-site direct indication of intelligibility performance measurements of PA/VA sound systems.

Relevant changes in latest international standard revision

The masking functions given in the latest revision (2011) are continuous which leads to continuous STI results as a function of the overall acoustic level. This correction is aimed to avoid some undesired effects that occurred with the 2003 version, where very small changes in level could result in significant different values. The main updates and differences of the 2011 version with respect to the previous version are as follows:

- In the 2011 revision the Room Acoustic Speech Transmission Index (RASTI) is declared obsolete and required not be used
- The new standard include expanded notes on limitations of the STI method and methods to predict the STI performance of transmission channels based on the predicted (as distinct from measured) performance of parts or all of the transmission channel.
- The 2011 standard suggests in its appendix F (figure), a new nominal qualification band system aiming to replace the often confusing five point rating scale laid on (table 2:1) (BS EN ISO 9921:2003). This qualification system attempts to provide both flexibility in measurements, different applications and tolerance for assessment and/or prediction.

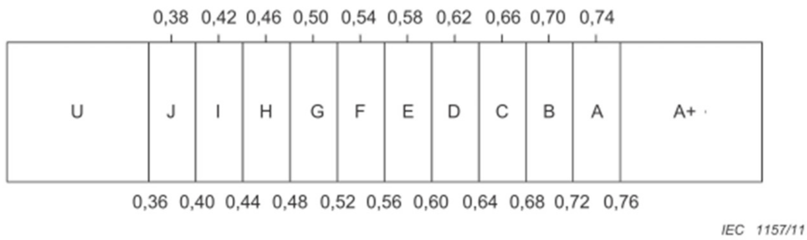


Figure B:14 New nominal qualification bands system for STI (after BS EN 60268-16:2011)

The upper row of number indicate centre band STI values, lower row of numbers indicate STI values at the borders of the bands and the letters are the bands designations. The standard provides an informative table showing examples between STI qualification bands and typical applications. This table is suggested as minimum target values. Also provided as an appendix is description methods for the calibration of STI test signal level

Appendix C

C.1 Summary review of the documents introduced in chapter 3

1- *London Underground 2004, SCS-ST-0008 Public Address systems on Sub-surface railway systems.*

This standard defines the minimum technical requirements for PA[1] systems to be provided on LUL sub-surface stations. Electro acoustical parameters specifications are provided, however there are not direct reference for compliance to any standards. At the time of field research work (2007-2009) compliance with specifications of this document constituted contractual guidelines for companies working on behalf or for LUL.

"The PA system shall be able to provide a SPL uniformly distributed at a level 1.5 metres above the floor. The PA system shall maintain SPL level of at least 10 dB(A) above normal ambient noise[2] level in all areas. The SPL measurement method shall involve a RASTI[3] input signal to the power amplifier, set to give an SPL figure measured midway between two loudspeakers of 10 dB(A) above background noise. Each amplifier shall have an output power capability that ensures SPL between 10 and 20dBA above the ambient noise levels as required by local conditions to maintain intelligibility". "The minimum acceptable index of speech intelligibility RASTI[4] measurement levels for any area of the station, and from any microphone point, shall be 0.5. RASTI values shall be calculated from the average of five samples taken at each of at least five positions along the platform. Each measurement shall be made mid-way between the rear platform wall and the platform edge. The positions chosen shall include the centre point of the platform, at a distance of five metres from each headwall, and midway between these positions".

[1] This document does not consider the differentiation between PA and VA. For consistency with terminology of this research, where it is mentioned PA should be considered VA.
[2] Ambient noise in these standards and in this research is the same as background noise (i.e noises present during broadcast different from the sound signal or announcement of interest).
[3] RASTI input signal has been superseded by a speech like signal called speech shape noise signal in the measurement of SPL levels (see 2 below).
[4] In a LUL written note (London Underground, 2007), it mentions the use of RASTI or "*equivalent if another recognised standard for measuring speech intelligibility is employed"*. RASTI has been gradually disused in the industry concerned and it has been superseded either by the full STI derived by means of RIR measurements or by direct STIPA measurements. For the purposes of this research where specifications indicate RASTI, full STI is considered instead. RASTI is now officially obsolete (BS EN 60268-16 2011).

In a written note (London Underground, 2007) aimed to clarify the interpretation of the above documents, it is recognised that "*the 0.5 RASTI[8] level (or equivalent if another recognized standard is employed) may be unachievable*".

"Unidirectional loudspeakers will be installed along platforms at intervals of 5 metres maximum. Each loudspeaker shall be mounted at a minimum height of 2.3 metres[5]".
"The overall frequency response shall be a minimum of ±2 dB between 120 Hz and 9.5 kHz, and there shall be a maximum of 5% second harmonic distortion within this frequency range".
"The PA system shall provide zone separation, and an automatic level volume adjustment (Automatic Noise Sensors, ANS) for individual zones shall be incorporated into the PA system design".
"Each PA loudspeaker shall require certification and approval from LUL, prior to being purchased".

2- *VA system specifications*, 2005 *(Undisclosed Installer and designer Contractor Company for London Underground).*

This document defines the minimum technical requirements for the design, procurement, installation and measurement of VA systems in sub surface stations as laid out by the contractor company responsible for upgrade and maintenance of VA systems of several lines of the LU network.

Systems provided by this *contractor company* conform to the requirements of parent document London Underground (2004) and therefore with BS 5839-8 and BS 60849 (editions a the time). At the time of field research work (2007-2009) compliance with specifications of this document constituted contractual guidelines for sub-contractor companies working on behalf or for the *Contractor Company*.

"The system shall provide a minimum SPL of at least 10 dBA above the average inherent background noise at the time of an announcement without audible distortion at a maximum SPL of 90dBA on platform and ticket hall areas measured with the speech shape[6] input signal (SSN)" (table C:1).

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[5] This minimum height mainly stipulated for vandal prevention has been revised and is currently a minimum height of 2.8m
[6] Speech Shaped Noise (SSN) is a test signal defined as a random noise that has the same long-term spectrum as a given speech signal. Used for assessing speech SPL.

Freq (Hz)	31.5	63	125	250	500	1k	2k	4k	5k	16k
dB	-6.2	-3.4	-1.1	0	-1	-4.4	-10.1	-17.7	-26.3	-35.1

*Table C:1 Speech Shape noise attenuation (*VA system specifications, 2005)

"Ambient noise sensors (ANS) are to be fitted by the contractor as part of the PA system, which continuously monitors the ambient noise level of the platforms and ticket hall areas. The contractor shall also ensure that the VA output level in the above areas shall be 10dBA above the ambient noise level in normal working conditions".
"The method of measuring speech intelligibility shall be common intelligibility scale (CIS) using the methods outlined in BS 60268-16: 2003".
"The VA design shall achieve a rating of 0.5 RASTI for subsurface stations in the presence of typical operational noise and with the acoustics of each space. Any deviations from the required RASTI shall be agreed on a site by site basis".
"If acoustic treatment is required to meet the RASTI , it shall be the responsibility of the contractor to advise the extent of the acoustic treatment required".
"Direct level coverage[7] of the proposed design shall not deviate by more than ±2dBA over 90% of the area to be covered. This shall be verified in squares of a maximum size 1m X 1m".
"With the system operating at 70% of maximum rated output voltage, each zone shall be measured with a 1 kHz sine wave and the distortion percentage recorded".
"The operational frequency response shall be ±2dBA over the range 250 Hz and 6kHz.
Over the range 100Hz to 10kHz the level difference between adjacent 1/3 octave bands shall be no more than 5dB". "All loudspeakers shall be approved and certified as fit for use". "Deviation from the required performance parameters may be permitted only at the discretion (approval) of this Contractor Company. Any deviations from the required RASTI shall be agreed with this Contractor Company representative on a site by site basis".

3- BS 5839-8:2008, *Fire Detection and Fire Alarm Systems for Buildings – Part 8: Code of practice for the design, installation, commissioning and maintenance of voice alarm systems*.

This standard gives recommendations for the design, installation, commissioning and maintenance of voice alarm systems which automatically broadcast speech or

7 Direct level coverage refers to direct sound SPL coverage uniformity on the listening plane.

warning tones, in response to signals from their associated fire detection and alarm systems. It also covers systems that include a manual facility for the transmission of live voice messages, as well as automatically generated messages for emergency purposes. This standard is central to the two contractual documents mentioned above (1 and 2).

"The minimum value for intelligibility should be 0.5 STI. A lower STI figure may be acceptable to the interested parties in some very reverberant spaces, and areas with high background noise. Intelligibility should be assessed under the worst expected noise level conditions".

"In order to achieve a satisfactory level of intelligibility, the speech signal to background noise level ratio should be at least 10 dB when the noise has been measured as $L_{A10,t}$ where t is between 5 and 15 mins, according to the occupational noise. Uniformity of coverage might not be feasible throughout the entire space".

"The frequency response of the voice alarm system from the acoustic input to the acoustic output should be within the parameters defined in BS EN 54-16:2008".

4- BS EN 60849:1998, *Sound systems for emergency purposes.*

The purpose of this standard is to specify the performance requirements for sound systems which are primarily intended to broadcast information for the protection of lives within one or more specified areas in an emergency. The standard gives the characteristics and the methods of test necessary for the specification of the system. This standard is referred to in the two contractual documents mentioned above.

"The speech intelligibility over all of an area of coverage shall be greater than or equal to 0.7 on the common intelligibility scale (CIS). This CIS value corresponds to a score of the STI method of 0.5".

"The measurements shall be made at a sufficient number (n) of representative points, which shall be detailed in the system specification, in each area of coverage. The arithmetical average Lav of the intelligibility values on the CIS, and the standard deviation σ of the results, shall be calculated. The quantity (Lav – σ) shall exceed 0.7 of the CIS scale or equivalent".

"If the result is within ± σ of the limit, the measurements should be repeated, preferably at a larger number of points. The mean value of intelligibility, and its 95 % confidence interval, over the whole area of coverage shall be calculated, taking into account the shape of the statistical distribution of the results of the measurements".

“Measurement of SPL shall be in LCeq parameter measured for not less than 16 s at the measuring point when the system is in normal operation as an emergency sound system”.

“The A-weighted ambient noise level in the absence of the test signal shall be measured over a period sufficient to reasonably represent the test signal at the time of the intelligibility test. Measurements of the equivalent LAeq A-weighted sound pressure level shall be made at representative points over the area of coverage”.

“The total harmonic distortion of a sinusoidal signal giving the same sound pressure level at the measuring position as the STI test signal does not exceed 17 %”.

5- <u>BS EN 60268-16:2003 (2011), *Sound system equipment - Objective rating of speech intelligibility by speech transmission index*.</u>

The objective of this standard is to provide a comprehensive and standardised information of the STI method. However this standard does not provide STI criteria for certification of VA system, (for more information on the STI method as per 2003 revision see chapter 2). The 2003 revision of this standard is referred to in the two contractual documents mentioned above.

In this research project only the 2003 revision of this standard has been used. However for information and comparative purposes, recommended STI target values for different VA uses provided in the current revised version of the standard (2011) are presented below in table C:2

Intelligibility categories

Category	Nominal STI value	Type of message information	Examples of typical uses (for natural or reproduced voice)	Comment
F	0.54	Complex messages, familiar context	PA systems in shopping malls, public buildings offices, VA systems, cathedrals	Good quality PA systems
G	0.5	Complex messages, familiar context	Shopping malls, public buildings offices, VA systems	Target value for VA systems
H	0.46	Simple messages, familiar words	VA and PA systems in difficult acoustic environments	Normal lower limit for VA systems

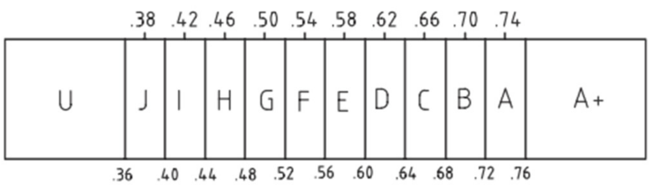


Table C:2 BS EN 60268-16: 2011 intelligibility categories and qualification bands of STI values

It can be appreciated that the current intelligibility qualification scheme aims at providing a more realistic, useful and flexible guidance approach than the previous version to account for the large variety of the metric uses and real world limitations.

6- BS 6259:1997, *Code of practice for the design, planning, installation, testing and maintenance of sound systems.*

The standard provides generic information on design, planning, installation, testing and maintenance of sound systems. It recommends accepted practice for the accomplishment of the defined tasks and their sequence as followed by competent practitioners. It does not provide specific performance criteria for VA alarm systems. This standard is referred to in the first document (London Underground 2004).

7- BS EN ISO 9921:2003, *Ergonomics- Assessment of speech communication.*

This generic standard recommends levels of speech-communication quality required for conveying comprehensive messages in different applications. Although it provides background information on speech communications, it does not contain relevant specific information, advice or performance criteria for VA alarm systems. It is not referred to in the London underground and *Contractor Company* specification documents (1 and 2 respectively). However, it contains the important subjective speech intelligibility qualification rating scale relative to numerical scores of STI. This subjective qualification rating scale was current until the release of BS EN 60268-16 :2011. It_has been used extensively in the industry as a means to translate to non specialist audiences the STI numerical scale._However its intelligibility rating was considered too generic and unrealistic in numerous applications and practical scenarios. For consistency intelligibility rating of this standard has been used throughout this research.

Intelligibility rating	Sentence score %	Meaningful PB-word score %	CVC_{EQB} -non-sensical word score %	STI
Excellent	100	> 98	> 81	> 0,75
Good	100	93 to 98	70 to 81	0,60 to 0,75
Fair	100	80 to 93	53 to 70	0,45 to 0,60
Poor	70 to 100	60 to 80	31 to 53	0,30 to 0,45
Bad	< 70	< 60	< 31	< 0,30

Table C:3 Intelligibility rating descriptors relative to STI scores scale.

This standard is not directly referred to in the two contractual documents mentioned above although its intelligibility rating was linked to BS EN 60268-16:2003.

8- <u>BS EN 54-24 2008, *Fire detection and fire alarm systems - Part 24: Components of voice alarm systems - Loudspeakers*.</u>

This part of the European standard EN54 specifies the minimum requirements that apply to VA loudspeakers and a common method for testing their operational performance against parameters specified by the manufacturers, such as physical construction and robustness under climatic and environmental conditions.

The only relevant requirement in this standard to this research is specified for electro-acoustical performance compliance, stipulating that "*the loudspeaker frequency response shall fit within the un-shaded area shown..*" in figure C:4, where the x axis indicates 1/3 octave band centre frequencies and y axis relative level in dB.

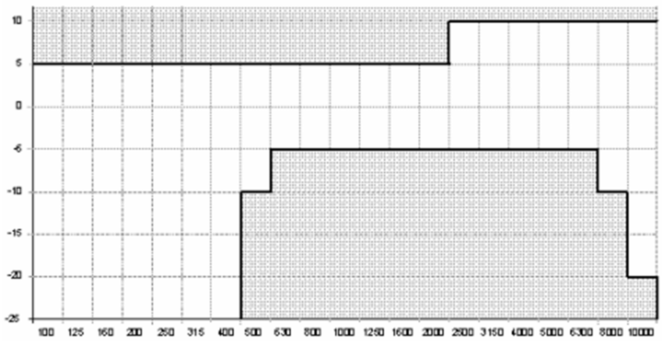


Figure C:4 VA loudspeaker compliance frequency response limits

This part of this standard is not referred to in the two contractual documents mentioned above (1 and 2). However the latest version of BS 5839-8 (2008) requires that VA loudspeakers "*should conform to BS EN 54-24*". Very few manufacturers were able to provide EN54 certified loudspeakers until close and past the deadline in April 2011.

Appendix D

D.1 The Simplified database

	RT20(sec)					RT20aver		Major potential factors					
Platform	250H	500Hz	1KHz	2KHz	4KHz	500/1K/2 K Hz	STI	Volume (m³)	Overbridg	Overbridge Closed	Ceiling Clad coverage	Platform Straigl	Openings Absorption (m
PLT1	3.5	4	3.3	2.6	1.7	3.30	0.43		NO	-	HALF	YES	25
PLT2	2.2	2.4	2.1	1.8	1.1	2.10	0.44	3046.7	NO	-	HALF	YES	37
PLT3	3.1	3	2.6	2.3	1.6	2.63	0.44	2812.3	2	NO	-	YES	73
PLT4	3.6	3.1	2.6	2.3	1.6	2.67	0.43	2812.3	NO	-	-	YES	40
PLT5	3.64	3.3	2.8	2.5	1.7	2.87	0.42	2812.3	NO	-	-	YES	26.5
PLT6	3.1	2.6	2.2	2.2	1.9	2.33	0.44	2812.3	2	YES	-	YES	26.5
PLT7	3.5	3.5	2.9	2.5	1.7	2.97	0.39	2812.3	NO	-	-	YES	25.96
PLT8	3.7	3.3	2.8	2.5	1.6	2.87	0.43	2812.3	2	NO	-	YES	41
PLT9	3.04	2.79	2.40	2.16	1.29	2.45	0.45	2968.6	NO	-	-	YES	31.48
PLT10	3.5	3	2.65	2.35	1.6	2.67	0.44	2968.6	NO	-	-	YES	31.48
PLT11	3.6	3.5	3	2.6	2.1	3.03	0.42	2812.3	NO	-	-	YES	30.46
PLT12	3.4	3.5	3.1	2.7	2.2	3.10	0.42	2812.3	NO	-	-	YES	30.46
PLT13	2.89	2.88	2.53	2.23	1.58	2.55	0.43	2812.3	NO	-	-	YES	24.5
PLT14	3.92	3.77	3.08	2.59	1.78	3.19	0.40	2812.3	3	NO	-	YES	39.5
PLT15	3.88	3.77	3.07	2.73	1.76	3.15	0.39	2812.3	NO	-	-	YES	24.5
PLT16	3.61	3.37	2.86	2.53	1.74	2.92	0.38	2812.3	NO		-	YES	24.5
PLT17	2.87	2.86	2.68	2.32	2.08	2.62	0.41	2968.6	2	YES	-	YES	24.5
PLT18	3.00	2.84	2.97	2.51	2.20	2.77	0.43	2968.6	NO	-	-	YES	24.5
PLT19	1.29	1.68	1.89	1.79	1.73	1.78	0.50	2812.3	NO	-	HALF	CURVED	27.4
PLT20	1.49	1.86	2.24	2.15	2.04	2.08	0.46	2812.3	NO	-	HALF	YES	33.9
PLT21	2.00	2.42	2.75	2.34	2.03	2.50	0.45	2756.5	NO	-	FULL	YES	29
PLT22	1.71	2.12	2.29	2.07	2.00	2.16	0.46	3133.5	NO	-	FULL	YES	36.1
PLT23	1.98	2.30	2.31	2.09	1.90	2.23	0.49	3133.5	NO	-	FULL	YES	42.1
PLT24	2.40	2.93	2.82	2.84	2.63	2.86	0.37	4044.6	NO	-	-	YES	44.1
PLT25	1.97	2.70	2.82	2.84	2.47	2.79	0.42	2968.6	NO	-	-	YES	41.8
PLT26	1.59	1.89	2.18	1.91	1.68	1.99	0.54	3109.9	NO	-	FULL	YES	61.8
PLT27	2.08	3.05	2.75	2.45	2.58	2.75	0.38	2968.6	NO	-	-	YES	54.04
PLT28	2.82	2.70	2.77	2.44	2.14	2.64	0.45	3463.3	NO	-	-	YES	46.04
PLT29	2.94	3.05	2.66	2.41	2.14	2.71	0.43	2812.3	2	YES	-	YES	20.92
PLT30	3.08	3.11	2.59	2.34	2.09	2.68	0.43	2812.3	NO	-	-	YES	20.92
PLT31	2.18	2.48	2.33	2.27	2.09	2.36	0.44	2812.3	3	NO	-	YES	37.134
PLT32	2.07	2.52	2.24	2.36	2.10	2.38	0.42	2812.3	2	NO	-	YES	35.31
PLT33	2.00	2.18	2.36	2.07	1.77	2.20	0.47	2880.8	NO	-	FULL	YES	49.8
PLT34	1.92	2.42	2.54	2.08	1.85	2.35	0.44	2880.8	1	NO	FULL	YES	77.8
PLT35	1.78	2.41	2.33	1.99	1.83	2.24	0.42	2880.8	NO	-	FULL	YES	133.846
PLT36	1.34	2.63	2.45	2.05	1.83	2.38	0.41	2880.8	NO	-	FULL	YES	91.846
PLT37	3.32	3.10	2.81	2.39	1.92	2.77	0.37	3749.8	NO	-	-	YES	31.676
PLT38	3.42	3.23	2.71	2.23	2.1	2.72	0.38	3749.8	NO	-	-	YES	31.676
PLT39	3.30	3.10	3.00	2.40	1.60	2.83	0.39	2812.3	NO	-	-	YES	20.92
PLT40	3.10	2.80	2.60	2.30	1.40	2.57	0.45	2812.3	2	NO	-	YES	35.92
PLT41	2.14	2.86	2.88	2.43	2.09	2.72	0.41	2812.3	NO	-	-	YES	21
PLT42	2.28	2.93	2.85	2.54	2.16	2.77	0.44	2812.3	NO	-	-	YES	21
PLT43	2.14	2.18	2.26	2.06	1.55	2.17	0.49	3176.9	NO	-	-	YES	35.08
PLT44	1.88	1.92	2.13	1.92	1.48	1.99	0.50	3176.9	NO	-	-	YES	29.56
PLT45	1.99	2.10	2.18	2.00	1.56	2.09	0.50	3176.9	2	YES	-	YES	43.08
PLT46	2.11	2.09	2.42	2.22	1.73	2.25	0.48	3176.9	NO	-	-	YES	29.56
PLT47	3.4	3.2	3	2.7	1.9	2.97	0.40	3176.9	NO	-	-	YES	27.04
PLT48	3.4	3.2	3	2.7	1.9	2.97	0.43	3176.9	NO	-	-	YES	27.04
PLT49	2.60	2.30	2.44	2.27	2.04	2.34	0.45	2812.3	NO	-	-	YES	41.3
PLT50	2.46	2.26	2.31	2.22	1.96	2.26	0.46	2540.2	*2*	YES	-	YES	41.3
PLT51	2.20	2.09	2.24	2.08	1.95	2.13	0.48	2540.2	*3*	YES	-	YES	41.3
PLT52	2.50	2.10	2.32	2.33	2.05	2.25	0.40	2812.3	NO	-	-	YES	41.3
PLT53	2.1	2.6	2.8	2.4	1.7	2.60	0.41	2812.3	2	YES	-	YES	28.84
PLT54	2.3	3	3.1	2.6	1.9	2.90	0.39	2812.3	NO	-	-	YES	28.84
PLT55	2.24	1.81	2.03	2.20	1.81	2.01	0.47	2812.3	NO	-	-	YES	25.68
PLT56	2.01	1.85	2.33	2.39	2.05	2.19	0.47	2812.3	NO	-	-	YES	22.68
PLT57	2.40	2.70	2.70	2.60	2.53	2.67	0.40	2812.3	2	YES	-	YES	24.0
PLT58	2.40	2.65	2.65	2.60	2.52	2.63	0.41	2812.3	2	YES	-	YES	24.0
PLT59	3.00	3.62	3.38	2.75	2.27	3.25	0.39	2968.6	NO	-	-	YES	28
PLT60	2.92	3.61	3.49	2.77	2.27	3.29	0.39	2968.6	NO	-	-	YES	28
PLT61	2.78	2.98	2.81	2.24	1.53	2.68	0.48	3906.0	NO	-	FULL	YES	65
PLT62	2.48	2.82	2.69	2.11	1.58	2.54	0.50	3176.9	NO	-	FULL	YES	53
PLT63	2.35	2.70	2.52	2.07	1.52	2.43	0.49	3176.9	NO	-	FULL	YES	57
PLT64	2.61	2.86	2.69	2.10	1.46	2.55	0.49	3906.0	NO	-	FULL	YES	41
PLT65	3.59	3.48	3.36	2.95	2.19	3.26	0.41	3463.3	NO	-	-	YES	31
PLT66	3.43	3.49	3.46	2.93	2.18	3.29	0.43	3463.3	NO	-	-	YES	31
PLT67	3.27	3.44	3.23	2.76	1.93	3.15	0.45	3176.9	NO	-	-	YES	21
PLT68	3.51	3.80	3.48	3.01	2.06	3.43	0.42	3176.9	2	YES	-	YES	21
PLT69	2.99	2.77	2.68	2.51	2.20	2.65	0.42	3046.7	4	YES	-	YES	47.36
PLT70	3.02	2.85	2.70	2.51	2.22	2.69	0.41	3046.7	3	YES	-	YES	32.36
PLT71	2.15	2.10	2.29	2.35	2.08	2.25	0.44	2958	NO	-	-	CURVED	44.28
PLT72	2.65	2.41	2.38	2.35	2.13	2.38	0.41	2958	NO	-	-	CURVED	50.12
PLT73	3.21	3.75	3.68	3.36	2.91	3.60	0.39	3463.3	NO	-	-	YES	25
PLT74	3.06	3.60	3.41	3.09	2.57	3.37	0.40	3463.3	NO	-	-	YES	25

D.2 London underground Platform A and St John's Wood platform measured data

		Frequency octave band (Hz)					
		125	**250**	**500**	**1000**	**2000**	**4000**
Platform A Measured	**RT20 (sec)**	2.4	3.0	2.8	2.7	2.5	2.2
	RT20aver	2.65					
	STI	0.45					
St John's Woood Measured	**RT (sec)**	6	4.8	4.1	3.3	2.6	1.9
	RTaver (sec)	3.33					
	STI	0.37					

Appendix E

Measured values are in indicated in red, CATT values in pink and Odeon in bold black. EDT and RT30 valures are in seconds, SPL and SPL(A) are in dB. Frequency octave bands (in yellow boxes) are in Hz. The rest of parameters are dimensionless. Average and standard deviation (std) on the far right columns (yellow heading) are calculated over the octave frequency bands (see below).

E.1 Ticket Hall 1

Measured and predicted evaluating parameters analysis

Receiver 1			125	250	500	1000	2000	4000	8000	SPL(A)	Average	std
			1.95	**2.32**	**2.87**	**2.91**	**3.16**	**2.91**	**2.42**			
EDT			1.85	2.26	2.65	2.84	3.07	2.92	2.4			
	Odeon-CATT discrepancy		5%	3%	8%	2%	3%	0%	1%		3%	3%
		EDT	***2.10***	***2.10***	***2.65***	***2.89***	***2.87***	***2.94***	***2.48***			
		STD	*0.25*	*0.17*	*0.12*	*0.07*	*0.02*	*0.02*	*0.03*			
		JND	*0.21*	*0.21*	*0.27*	*0.29*	*0.29*	*0.29*	*0.25*			
	Odeon relative error JND		*0.71*	*1.05*	*0.83*	*0.07*	*1.01*	*0.12*	*0.24*		0.58	0.42
	CATT relative errror JND		*1.19*	*0.76*	*0.00*	*0.17*	*0.70*	*0.08*	*0.32*		0.46	0.44
			1.88	**2.30**	**2.69**	**3.02**	**3.18**	**2.96**	**2.43**			
RT30			1.98	2.35	2.76	2.93	3.14	2.98	2.49			
	Odeon-CATT discrepancy		-5%	-2%	-3%	3%	1%	-1%	-2%		2%	1%
		RT30	**1.99**	**2.07**	**2.88**	**3.17**	**3.12**	**3.07**	**2.62**			
		STD	0.38	0.26	0.16	0.03	0.06	0.06	0.06			
		JND	0.20	0.21	0.29	0.32	0.31	0.31	0.26			
	Odeon relative error JND		*0.56*	*1.09*	*0.65*	*0.47*	*0.18*	*0.34*	*0.71*		0.57	0.29
	CATT relative errror JND		*0.06*	*1.33*	*0.40*	*0.75*	*0.05*	*0.28*	*0.49*		0.48	0.45
	Odeon EDT/RT		104%	101%	107%	96%	99%	98%	100%		101%	3%
	CATT EDT/RT		93%	96%	96%	97%	98%	98%	96%		96%	2%
		EDT/RT	105%	101%	92%	91%	92%	96%	95%		96%	5%
			80.8	**88.1**	**84.5**	**86**	**81.4**	**74.1**	**69.6**	**89.28**		
SPL			83.6	89.7	85.6	85.1	82.6	73.5	68.8	89.57		
	Odeon-CATT discrepancy		2.8	1.6	1.1	0.9	1.2	0.6	0.8	-0.29	1.09	0.88
	Odeon-CATT discrepancy %		3%	2%	1%	1%	1%	1%	1%		2%	1%
STI				**0.44**	**0.43**	**0.01**	**0.41**					
Receiver 2			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**SPL(A)**	**Average**	**std**
EDT			**1.89**	**2.33**	**2.73**	**2.98**	**3.31**	**3.1**	**2.42**			
			1.86	2.27	2.67	2.86	3.08	2.95	2.45			
	Odeon-CATT discrepancy		2%	3%	2%	4%	7%	5%	-1%		3%	2%
		EDT	*1.65*	*2.44*	*2.62*	*2.86*	*3.11*	*2.81*	*2.60*			
		STD	*0.25*	*0.17*	*0.14*	*0.09*	*0.12*	*0.05*	*0.06*			
		JND	*0.17*	*0.24*	*0.26*	*0.29*	*0.31*	*0.28*	*0.26*			
	Odeon relative error JND		*1.45*	*0.45*	*0.42*	*0.42*	*0.64*	*1.03*	*0.69*		0.73	0.39
	CATT relative errror JND		*1.27*	*0.70*	*0.19*	*0.00*	*0.10*	*0.50*	*0.58*		0.48	0.44
RT30			**2.03**	**2.34**	**2.7**	**2.97**	**3.17**	**2.98**	**2.47**			
			1.97	**2.34**	**2.76**	**2.92**	**3.13**	**2.97**	**2.49**			
	Odeon-CATT discrepancy		3%	0%	-2%	2%	1%	0%	-1%		1%	1%
		RT30	1.87	2.63	2.81	2.99	3.24	2.96	2.63			
		STD	0.31	0.21	0.07	0.08	0.04	0.06	0.11			
		JND	0.19	0.26	0.28	0.30	0.32	0.30	0.26			
	Odeon relative error JND		*0.86*	*1.12*	*0.41*	*0.07*	*0.23*	*0.05*	*0.61*		0.48	0.40
	CATT relative errror JND		*0.53*	*1.12*	*0.19*	*0.24*	*0.35*	*0.02*	*0.54*		0.43	0.36
	Odeon EDT/RT		93%	100%	101%	100%	104%	104%	98%		100%	4%
	CATT EDT/RT	EDT/RT	94%	97%	97%	98%	98%	99%	98%		97%	2%
		EDT/RT	88%	93%	93%	96%	96%	95%	99%		94%	3%
SPL			**80.9**	**87**	**85.5**	**86.5**	**83.3**	**75**	**69.1**	**90.07**		
			82.7	88.1	84.5	85.4	82.6	74.3	68.6	89.32		
	Odeon-CATT discrepancy		1.8	1.1	1	1.1	0.7	0.7	0.5	0.75	0.99	0.43
	Odeon-CATT discrepancy %		2%	1%	1%	1%	1%	1%	1%		1%	0%
STI				**0.43**	**0.42**	**0.00**	**0.4**					
Receiver 5			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**SPL(A)**	**Average**	**std**
EDT			**2.01**	**2.46**	**2.77**	**3.12**	**3.26**	**3.03**	**2.41**			
			1.87	2.27	2.64	2.83	3.04	2.94	2.47			
	Odeon-CATT discrepancy		7%	8%	5%	10%	7%	3%	-2%		6%	3%
		EDT	*1.87*	*2.10*	*2.55*	*2.74*	*3.11*	*2.94*	*2.47*			
		STD	*0.32*	*0.22*	*0.13*	*0.06*	*0.09*	*0.11*	*0.05*			
		JND	0.19	0.21	0.26	0.27	0.31	0.29	0.25			
	Odeon relative error JND		*0.75*	*1.71*	*0.86*	*1.39*	*0.48*	*0.31*	*0.24*		0.82	0.55
	CATT relative errror JND		*0.00*	*0.81*	*0.35*	*0.33*	*0.23*	*0.00*	*0.00*		0.25	0.29
RT30			**1.92**	**2.34**	**2.72**	**2.88**	**3.16**	**2.96**	**2.52**			
			1.96	2.34	2.75	2.92	3.13	2.97	2.48			
	Odeon-CATT discrepancy		2%	0%	1%	1%	-1%	0%	-2%		1%	1%
		RT30	2.01	2.19	2.63	2.81	3.20	3.09	2.66			
		STD	0.36	0.20	0.20	0.20	0.09	0.03	0.03			
		JND	0.20	0.22	0.26	0.28	0.32	0.31	0.27			
	Odeon relative error JND		*0.45*	*0.70*	*0.35*	*0.24*	*0.12*	*0.41*	*0.54*		0.40	0.19
	CATT relative errror JND		*0.25*	*0.70*	*0.46*	*0.39*	*0.22*	*0.38*	*0.69*		0.44	0.19
	Odeon EDT/RT		105%	105%	102%	108%	103%	102%	96%		103%	4%
	CATT EDT/RT		95%	97%	96%	97%	97%	99%	100%		97%	2%
		EDT/RT	93%	96%	97%	97%	97%	95%	93%		96%	2%
SPL			**81.7**	**88**	**85.4**	**85.3**	**82.1**	**73.2**	**68.2**	**89.25**		
			79.6	86.8	83.9	86.3	80.9	73.9	68.6	89.09		
	Odeon-CATT discrepancy		2.1	1.2	1.5	1	1.2	0.7	0.4	0.16	1.16	0.55
	Odeon-CATT discrepancy %		3%	1%	2%	1%	1%	1%	1%		0.01	0.01
STI				**0.42**	**0.41**	**0.01**	**0.40**					

Receiver 8			125	250	500	1000	2000	4000	8000	SPL(A)	Average	std
EDT			**1.94**	**2.39**	**2.78**	**3.06**	**3.25**	**3.05**	**2.48**			
			1.88	2.29	2.7	2.9	3.15	2.99	2.46			
	Odeon-CATT discrepancy		-3%	-4%	-3%	-5%	-3%	-2%	-1%		3%	1%
		EDT	2.10	2.08	2.73	2.82	3.11	2.86	2.55			
		STD	0.37	0.17	0.06	0.09	0.07	0.06	0.05			
		JND	0.21	0.21	0.27	0.28	0.31	0.29	0.26			
	Odeon relative error JND		*0.76*	*1.49*	*0.18*	*0.85*	*0.45*	*0.66*	*0.27*		0.67	0.44
	CATT relative errror JND		*1.05*	*1.01*	*0.11*	*0.28*	*0.13*	*0.45*	*0.35*		0.48	0.39
RT30			**1.89**	**2.37**	**2.71**	**2.95**	**3.17**	**3.01**	**2.42**			
			1.99	2.38	2.79	2.96	3.17	3.01	2.51			
	Odeon-CATT discrepancy		-5%	0%	-3%	0%	0%	0%	-4%		2%	2%
		RT	2.02	2.14	2.94	3.06	3.28	3.01	2.61			
		STD	0.31	0.21	0.10	0.04	0.02	0.06	0.02			
		JND	0.20	0.21	0.29	0.31	0.33	0.30	0.26			
	Odeon relative error JND		0.64	1.07	0.78	0.36	0.33	0.01	0.72		0.56	0.35
	CATT relative errror JND		0.14	1.12	0.51	0.33	0.33	0.01	0.37		0.40	0.36
	Odeon EDT/RT		103%	101%	103%	104%	103%	101%	102%		102%	1%
	CATT EDT/RT		94%	96%	97%	98%	99%	99%	98%		97%	2%
		EDT/RT	104%	97%	93%	92%	95%	95%	98%		96%	4%
SPL			**82.4**	**88.6**	**85.7**	**86.3**	**81.3**	**73.6**	**68.9**	**89.64**		
			80.2	87.1	84.1	85.2	82.4	74.1	69.4	89.01		
	Odeon-CATT discrepancy		2.2	1.5	1.6	1.1	1.1	0.5	0.5	0.64	1.21	0.61
	Odeon-CATT discrepancy %		3%	2%	2%	1%	1%	1%	1%		1%	1%
STI				**0.43**	**0.41**	**0.00**	**0.42**					

Receiver 11			125	250	500	1000	2000	4000	8000	SPL(A)	Average	std
EDT			**1.93**	**2.39**	**2.8**	**3.07**	**3.3**	**3.03**	**2.48**			
			1.87	2.27	2.67	2.86	3.11	2.98	2.49			
	Odeon-CATT discrepancy		-3%	-5%	-5%	-7%	-6%	-2%	0%		4%	2%
		EDT	*2.00*	*2.54*	*2.63*	*2.92*	*3.11*	*2.93*	*2.56*			
		STD	*0.25*	*0.15*	*0.03*	*0.07*	*0.19*	*0.11*	*0.05*			
		JND	0.20	0.25	0.26	0.29	0.31	0.29	0.26			
	Odeon relative error JND		*0.35*	*0.59*	*0.65*	*0.51*	*0.61*	*0.34*	*0.31*		0.48	0.14
	CATT relative errror JND		*0.65*	*1.06*	*0.15*	*0.21*	*0.00*	*0.17*	*0.27*		0.36	0.37
RT30			**1.89**	**2.34**	**2.75**	**2.99**	**3.22**	**3.00**	**2.43**			
			2.01	2.40	2.82	2.98	3.19	3.02	2.50			
	Odeon-CATT discrepancy		6%	3%	3%	0%	-1%	1%	3%		2%	2%
		RT	**2.12**	**2.62**	**2.78**	**3.04**	**3.23**	**3.07**	**2.62**			
		STD	0.22	0.14	0.22	0.05	0.11	0.06	0.02			
		JND	0.21	0.26	0.28	0.30	0.32	0.31	0.26			
	Odeon relative error JND		1.09	1.08	0.12	0.15	0.04	0.24	0.72		0.49	0.46
	CATT relative errror JND		0.53	0.85	0.13	0.18	0.13	0.17	0.46		0.35	0.27
	Odeon EDT/RT		102%	102%	102%	103%	102%	101%	102%		102%	1%
	CATT EDT/RT		93%	95%	95%	96%	97%	99%	100%		96%	2%
		EDT/RT	94%	97%	94%	96%	96%	95%	98%		96%	1%
SPL			**81.2**	**85.8**	**82.3**	**85.8**	**78.8**	**73.2**	**68.4**	**88.12**		
			79.1	87.5	83.8	84.6	79.8	73.8	69	88.10		
	Odeon-CATT discrepancy		2.1	1.7	1.5	1.2	1	0.6	0.6	0.03	1.24	0.56
	Odeon-CATT discrepancy %		3%	2%	2%	1%	1%	1%	1%		0.02	0.01
STI				**0.41**	**0.40**	**0.00**	**0.42**					

Prediction error and discrepancies spatial averages and standard deviation

	125	250	500	1000	2000	4000	8000	Average	std
EDT									
Odeon relative Error JND	0.75	0.86	0.49	0.42	0.57	0.51	0.41	0.57	0.17
std	0.43	0.42	0.25	0.30	0.32	0.35	0.20	0.32	0.09
CATT relative Error JND	0.8	0.9	0.2	0.2	0.2	0.2	0.3	0.41	0.31
std	0.52	0.16	0.13	0.13	0.27	0.22	0.21	0.23	0.14
RT30									
Odeon relative Error JND	0.72	1.01	0.46	0.26	0.18	0.21	0.66	0.50	0.31
std	0.26	0.17	0.26	0.16	0.11	0.18	0.08	0.17	0.07
CATT relative Error JND	0.30	1.02	0.34	0.38	0.22	0.17	0.51	0.42	0.29
std	0.22	0.25	0.17	0.22	0.13	0.16	0.12		
EDT									
Odeon-CATT discrepancy	4%	5%	5%	6%	5%	2%	1%		
std	0.02	0.02	0.02	0.03	0.02	0.02	0.01		
RT30									
Odeon-CATT discrepancy	4%	1%	2%	1%	1%	0%	2%		
std	0.02	0.01	0.01	0.01	0.01	0.00	0.01		
SPL									
Odeon-CATT discrepancy	2.2	1.4	1.3	1.1	1.0	0.6	0.6		
std	0.37	0.26	0.27	0.11	0.21	0.08	0.15		
Odeon-CATT discrepancy %	3%	2%	2%	1%	1%	1%	1%		
std	0.004	0.003	0.003	0.001	0.003	0.001	0.002		

STI analysis. Values are rating of STI scale (0 to 1) except relative error in JND units

	Receiver position						
Parameter	**R1**	**R2**	**R5**	**R8**	**R11**	**Average**	**std**
STI Odeon	0.44	0.43	0.42	0.43	0.41	0.43	0.01
STI CATT	0.43	0.42	0.41	0.41	0.4	0.41	0.01
STI IR Survey	0.41	0.4	0.4	0.42	0.42	0.41	0.01
STI JND	0.05	0.05	0.05	0.05	0.05	0.05	0.00
STI Odeon- CATT discrepancy	0.01	0.01	0.01	0.02	0.01	0.01	0.00
Odeon relative error JND	0.6	0.6	0.4	0.2	0.2	0.40	0.18
CATT relative error JND	0.4	0.4	0.2	0.2	0.4	0.32	0.10

SPL analysis. Values are in dB except discrepancy in JND units

	125	250	500	1000	2000	4000	8000	dBA
Odeon	81.4	87.5	84.7	86.0	81.4	73.8	68.8	89.3
std	0.66	1.11	1.41	0.47	1.65	0.76	0.56	0.7
CATT	81.0	87.8	84.4	85.3	81.7	73.9	68.9	89.0
std	1.99	1.15	0.73	0.62	1.26	0.30	0.33	0.56
Discrepancy	0.4	-0.34	0.3	0.66	-0.28	-0.1	-0.04	0.26
Discrepancy JND	0.18	-0.17	0.15	0.33	-0.14	-0.05	-0.02	0.13

E.2 Ticket Hall 2

Measured and predicted evaluating parameters analysis

Receiver 1			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			**1.54**	**1.05**	**1.07**	**1.38**	**1.53**	**1.52**	**1.42**			
			1.61	1.13	1.25	1.46	1.59	1.47	1.26			
	Odeon-CATT discrepancy		-4%	-7%	-14%	-5%	-4%	3%	13%		7%	4%
		EDT		*0.92*	*1.31*	*1.36*	*1.69*	*1.67*	*1.45*			
		STD		*0.15*	*0.02*	*0.21*	*0.17*	*0.06*	*0.06*			
		JND		*0.09*	*0.13*	*0.14*	*0.17*	*0.17*	*0.15*			
	Odeon relative error JND			*1.44*	*1.86*	*0.14*	*0.95*	*0.88*	*0.22*		0.91	0.67
	CATT relative errror JND			*2.31*	*0.49*	*0.73*	*0.59*	*1.18*	*1.32*		1.10	0.68
RT30			**1.48**	**1.03**	**1.11**	**1.33**	**1.44**	**1.46**	**1.35**			
			1.83	1.35	1.47	1.65	1.78	1.58	1.20			
	Odeon-CATT discrepancy		-19%	-24%	-24%	-19%	-19%	-8%	13%		18%	6%
		RT30			**1.01**	**1.51**	**1.74**	**1.69**	**1.45**			
		STD			0.07	0.09	0.11	0.05	0.05			
		JND			0.10	0.15	0.17	0.17	0.15			
	Odeon relative error JND				*0.94*	*1.19*	*1.73*	*1.36*	*0.72*		1.19	0.39
	CATT relative errror JND				*4.49*	*0.93*	*0.22*	*0.65*	*1.75*		1.61	1.70
	Odeon EDT/RT		104%	102%	96%	104%	106%	104%	105%		103%	0.03
	CATT EDT/RT		88%	84%	85%	88%	89%	93%	105%		90%	0.07
		EDT/RT			129%	90%	97%	99%	100%		103%	0.15
SPL			**85.7**	**86.9**	**84**	**81.7**	**82.4**	**81.7**	**67.7**	**88.84**		
			83.5	85.3	85.1	80.8	81.9	81	67.1	88.41		
	Odeon-CATT discrepancy		2.2	1.6	1.1	0.9	0.5	0.7	0.6	0.42	1.09	0.61
	Odeon-CATT discrepancy %		2.6%	1.9%	1.3%	1.1%	0.6%	0.9%	0.9%		1.3%	1%
STI				**0.51**	**0.52**	**-0.006**	**0.50**					
Receiver 3			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**1.5**	**1.08**	**1.25**	**1.33**	**1.56**	**1.49**	**1.42**			
			1.58	1.1	1.23	1.42	1.56	1.42	1.22			
	Odeon-CATT discrepancy		-5%	-2%	2%	-6%	0%	5%	16%		5%	5%
		EDT		*0.78*	*1.28*	*1.49*	*1.62*	*1.64*	*1.48*			
		STD		*0.06*	*0.04*	*0.12*	*0.04*	*0.06*	*0.13*			
		JND		*0.08*	*0.13*	*0.15*	*0.16*	*0.16*	*0.15*			
	Odeon relative error JND			*3.91*	*0.26*	*1.04*	*0.34*	*0.93*	*0.39*		1.15	1.39
	CATT relative errror JND			*4.17*	*0.42*	*0.44*	*0.34*	*1.36*	*1.75*		1.41	1.47
RT30			**1.53**	**0.88**	**1.1**	**1.26**	**1.48**	**1.37**	**1.41**			
			1.92	**1.37**	**1.51**	**1.71**	**1.87**	**1.65**	**1.23**			
	Odeon-CATT discrepancy		-20%	-36%	-27%	-26%	-21%	-17%	15%		23%	7%
		RT30			1.36	1.57	1.81	1.67	1.41			
		STD			0.05	0.06	0.07	0.11	0.02			
		JND			0.14	0.16	0.18	0.17	0.14			
	Odeon relative error JND				*1.91*	*1.98*	*1.84*	*1.80*	*0.02*		1.51	0.84
	CATT relative errror JND				*1.11*	*0.88*	*0.31*	*0.12*	*1.29*		0.74	0.51
	Odeon EDT/RT		98%	123%	114%	106%	105%	109%	101%		108%	8%
	CATT EDT EDT/RT		82%	80%	81%	83%	83%	86%	99%		85%	6%
		EDT/RT			94%	95%	89%	98%	105%		96%	6%
SPL			**85.8**	**86.3**	**85.5**	**81.2**	**82.2**	**80.4**	**68.4**	**88.65**		
			84.2	85.1	84.7	80.5	82.9	81.8	67.8	88.79		
	Odeon-CATT discrepancy		1.6	1.2	0.8	0.7	0.7	1.4	0.6	-0.14	1.00	0.40
	Odeon-CATT discrepancy %		2%	1%	1%	1%	1%	2%	1%		1%	0%
STI				**0.5**	**0.52**	**-0.022**	**0.47**					
Receiver 5			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**1.6**	**1.05**	**1.21**	**1.27**	**1.44**	**1.42**	**1.44**			
			1.55	1.07	1.2	1.39	1.54	1.44	1.24			
	Odeon-CATT discrepancy		3%	-2%	1%	-9%	-6%	-1%	16%		6%	5%
		EDT		*0.88*	*1.18*	*1.55*	*1.91*	*1.84*	*1.51*			
		STD		*0.08*	*0.13*	*0.07*	*0.06*	*0.08*	*0.02*			
		JND		0.09	0.12	0.15	0.19	0.18	0.15			
	Odeon relative error JND			*1.94*	*0.22*	*1.80*	*2.45*	*2.28*	*0.46*		1.52	0.95
	CATT relative errror JND			*2.16*	*0.13*	*1.03*	*1.93*	*2.17*	*1.78*		1.53	0.80
RT30			**1.5**	**0.92**	**1.11**	**1.27**	**1.47**	**1.37**	**1.35**			
			1.86	1.35	1.48	1.66	1.8	1.59	1.21			
	Odeon-CATT discrepancy		19%	32%	25%	23%	18%	14%	-12%		20%	7%
		RT30			1.33	1.65	1.89	1.69	1.41			
		STD			0.07	0.12	0.13	0.04	0.02			
		JND			0.13	0.16	0.19	0.17	0.14			
	Odeon relative error JND				*1.68*	*2.29*	*2.21*	*1.91*	*0.45*		1.71	0.74
	CATT relative errror JND				*1.09*	*0.08*	*0.46*	*0.61*	*1.44*		0.74	0.54
	Odeon EDT/RT		107%	114%	109%	100%	98%	104%	107%		105%	5%
	CATT EDT/RT		83%	79%	81%	84%	86%	91%	102%		87%	8%
		EDT/RT			89%	94%	101%	109%	107%		100%	8%
SPL			**86.2**	**86.3**	**85.8**	**81.3**	**82.5**	**80.9**	**68.2**	**88.92**		
			84.4	85.1	85	80.1	81.7	80.1	67.8	88.02		
	Odeon-CATT discrepancy		1.8	1.2	0.8	1.2	0.8	0.8	0.4	0.91	1.00	0.45
	Odeon-CATT discrepancy %		2%	1%	1%	1%	1%	1%	1%		1%	1%
STI				**0.51**	**0.52**	**-0.01**	**0.48**					

Receiver 6			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**1.59**	**1.04**	**1.22**	**1.27**	**1.47**	**1.49**	**1.37**			
			1.53	1.06	1.19	1.37	1.52	1.43	1.23			
	Odeon-CATT discrepancy		-4%	2%	-2%	8%	3%	-4%	-10%		5%	3%
		EDT		0.76	1.18	1.61	1.66	1.62	1.40			
		STD		0.23	0.15	0.16	0.17	0.04	0.07			
		JND		0.08	0.12	0.16	0.17	0.16	0.14			
	Odeon relative error JND			*3.74*	*0.38*	*2.13*	*1.15*	*0.83*	*0.20*		1.40	1.33
	CATT relative errror JND			*4.01*	*0.13*	*1.51*	*0.85*	*1.19*	*1.20*		1.48	1.32
RT30			**1.45**	**0.91**	**1.1**	**1.31**	**1.56**	**1.38**	**1.35**			
			1.83	1.32	1.45	1.63	1.78	1.57	1.19			
	Odeon-CATT discrepancy		-21%	-31%	-24%	-20%	-12%	-12%	13%		19%	7%
		RT			1.24	1.51	1.76	1.68	1.43			
		STD			0.07	0.06	0.07	0.05	0.02			
		JND			0.12	0.15	0.18	0.17	0.14			
	Odeon relative error JND				1.15	1.30	1.13	1.78	0.55		1.18	0.44
	CATT relative errror JND				1.67	0.82	0.12	0.64	1.67		0.98	0.68
	Odeon EDT/RT		110%	114%	111%	97%	94%	108%	101%		105%	8%
	CATT EDT/RT		84%	80%	82%	84%	85%	91%	103%		87%	8%
		EDT/RT			95%	107%	94%	97%	98%		98%	5%
SPL			**85.8**	**88.8**	**85.8**	**81.3**	**83.4**	**81.1**	**68.2**	**89.48**		
			84.1	87.2	84.7	80.6	82.2	80.3	67.6	88.41		
	Odeon-CATT discrepancy		1.7	1.6	1.1	0.7	1.2	0.8	0.6	1.07	1.10	0.43
	Odeon-CATT discrepancy %		2%	2%	1%	1%	1%	1%	1%		1%	0%
STI				**0.52**	**0.52**	**0.00**	**0.49**					
Receiver 8			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**1.69**	**1.12**	**1.2**	**1.49**	**1.66**	**1.49**	**1.4**			
			1.64	1.11	1.25	1.45	1.6	1.44	1.18			
	Odeon-CATT discrepancy		-3%	-1%	4%	-3%	-4%	-3%	-16%		5%	5%
		EDT		*0.79*	*1.38*	*1.50*	*1.73*	*1.63*	*1.37*			
		STD		*0.18*	*0.13*	*0.09*	*0.03*	*0.07*	*0.03*			
		JND		0.08	0.14	0.15	0.17	0.16	0.14			
	Odeon relative error JND			*4.19*	*1.31*	*0.05*	*0.39*	*0.84*	*0.21*		1.16	1.55
	CATT relative errror JND			*4.06*	*0.95*	*0.31*	*0.73*	*1.15*	*1.40*		1.43	1.34
RT30			**1.51**	**0.94**	**1.13**	**1.35**	**1.57**	**1.54**	**1.38**			
			2.00	1.42	1.58	1.79	1.97	1.76	1.27			
	Odeon-CATT discrepancy		32%	51%	40%	33%	25%	14%	-8%		29%	15%
		RT			**1.34**	**1.64**	**1.82**	**1.76**	**1.46**			
		STD			0.15	0.06	0.09	0.03	0.04			
		JND			0.13	0.16	0.18	0.18	0.15			
	Odeon relative error JND				1.59	1.78	1.37	1.24	0.57		1.31	0.46
	CATT relative errror JND				1.76	0.90	0.83	0.01	1.32		0.96	0.65
	Odeon EDT/RT		112%	119%	106%	110%	106%	97%	101%		107%	7%
	CATT EDT/RT		82%	78%	79%	81%	81%	82%	93%		82%	5%
		EDT/RT			103%	91%	95%	93%	94%		95%	5%
SPL			**85.2**	**87.4**	**85.8**	**80.3**	**82.6**	**80.7**	**67.9**	**88.84**		
			83.4	86.1	85.1	79.2	82.1	79.9	67.5	88.07		
	Odeon-CATT discrepancy		1.8	1.3	0.7	1.1	0.5	0.8	0.4	0.77	0.94	0.49
	Odeon-CATT discrepancy %		2%	2%	1%	1%	1%	1%	1%		1.2%	1%
STI				**0.51**	**0.53**	**-0.02**	**0.47**					
Receiver 12			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**1.56**	**1.16**	**1.16**	**1.5**	**1.55**	**1.52**	**1.35**			
			1.73	1.15	1.32	1.54	1.7	1.51	1.25			
	Odeon-CATT discrepancy		11%	-1%	14%	3%	10%	-1%	-7%		7%	5%
		EDT		*0.96*	*1.08*	*1.37*	*1.69*	*1.58*	*1.22*			
		STD		*0.04*	*0.04*	*0.02*	*0.12*	*0.14*	*0.06*			
		JND		0.10	0.11	0.14	0.17	0.16	0.12			
	Odeon relative error JND			*2.14*	*0.71*	*0.97*	*0.84*	*0.37*	*1.03*		1.01	0.60
	CATT relative errror JND			*2.04*	*2.19*	*1.26*	*0.05*	*0.44*	*0.21*		1.03	0.94
RT30			**1.53**	**0.97**	**1.18**	**1.34**	**1.58**	**1.55**	**1.40**			
			1.82	1.34	1.47	1.64	1.78	1.62	1.27			
	Odeon-CATT discrepancy		19%	38%	25%	22%	13%	5%	-9%		19%	11%
		RT			**1.23**	**1.57**	**1.88**	**1.83**	**1.54**			
		STD			0.15	0.06	0.09	0.03	0.04			
		JND			0.12	0.16	0.19	0.18	0.15			
	Odeon relative error JND				0.39	1.49	1.60	1.53	0.91		1.18	0.52
	CATT relative errror JND				1.97	0.41	0.53	1.15	1.75		1.16	0.70
	Odeon EDT/RT		102%	120%	98%	112%	98%	98%	96%		103%	9%
	CATT EDT/RT		95%	86%	90%	94%	96%	93%	98%		93%	4%
		EDT/RT			88%	87%	90%	86%	79%		86%	4%
SPL			**83.1**	**86**	**85.3**	**79.1**	**83.3**	**79.1**	**66.3**	**88.39**		
			81.2	84.3	84.8	79.8	82.5	78.8	65.9	87.88		
	Odeon-CATT discrepancy		1.9	1.7	0.5	0.7	0.8	0.3	0.4	0.52	0.90	0.64
	Odeon-CATT discrepancy %		2%	2%	1%	1%	1%	0%	1%		1.1%	1%
STI				**0.49**	**0.50**	**-0.01**	**0.47**					

Prediction error and discrepancies spatial averages and standard deviation

	125	250	500	1000	2000	4000	8000	Average	std
EDT									
Odeon relative Error JND		3.1	1.0	1.1	1.0	1.0	0.4	1.3	0.93
std		1.22	0.68	0.95	0.68	0.51	0.32	0.7	0.32
CATT relative Error JND		3.1	0.7	0.9	0.7	1.2	1.3	1.3	0.91
std		1.05	0.78	0.47	0.65	0.55	0.57	0.7	0.21
RT30									
Odeon relative Error JND			1.28	1.67	1.65	1.60	0.54	1.3	0.48
std			0.56	0.42	0.37	0.27	0.30	0.4	0.12
CATT relative Error JND			2.01	0.67	0.41	0.53	1.54	1.0	0.70
std			1.26	0.35	0.26	0.41	0.21		
EDT									
Odeon-CATT discrepancy	5%	2%	6%	6%	4%	3%	13%		
std	0.03	0.02	0.06	0.03	0.03	0.02	0.04		
RT30									
Odeon-CATT discrepancy	22%	35%	28%	24%	18%	12%	12%		
std	0.05	0.09	0.06	0.05	0.05	0.05	0.03		
SPL									
Odeon-CATT discrepancy	1.8	1.4	0.8	0.9	0.8	0.8	0.5		
std	0.21	0.23	0.23	0.22	0.26	0.35	0.11		
Odeon-CATT discrepancy %	2%	2%	1%	1%	1%	1%	1%		
std	0.003	0.003	0.003	0.003	0.003	0.004	0.002		

STI analysis. Values are rating of STI scale (0 to 1) except relative error in JND units

	Receiver position							
Parameter	**R1**	**R3**	**R5**	**R6**	**R8**	**R12**	**Average**	**std**
STI Odeon	0.51	0.5	0.51	0.52	0.51	0.49	0.51	0.01
STI CATT	0.52	0.52	0.52	0.52	0.53	0.5	0.52	0.01
STI IR Measured	0.5	0.47	0.48	0.49	0.47	0.47	0.48	0.01
STI JND	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
STI Odeon- CATT discrepancy	-0.01	-0.02	-0.01	0.00	-0.02	-0.01	-0.01	0.01
Odeon relative error JND	0.2	0.6	0.6	0.6	0.8	0.4	0.53	0.21
CATT relative error JND	0.4	1	0.8	0.6	1.2	0.6	0.77	0.29

SPL analysis. Values are in dB except discrepancy in JND units

	Frequency (Hz)							
	125	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**
Odeon	85.3	87.0	85.4	80.8	82.7	80.7	67.8	88.9
std	1.1	1.0	0.7	1.0	0.5	0.9	0.8	0.4
CATT	83.5	85.5	84.9	80.2	82.2	80.3	67.3	88.3
std	1.18	1.00	0.19	0.60	0.43	1.02	0.73	0.34
Discrepancy	1.8	1.4	0.5	0.6	0.5	0.3	0.5	0.6
Discrepancy JND	0.9	0.7	0.2	0.3	0.3	0.2	0.3	0.3

E.3 Platform 1

Measured and predicted evaluating parameters analysis

Receiver 1			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			2.04	2.24	2.12	2.14	2.21	1.96	1.51			
			2.45	2.68	2.48	2.5	2.41	2.05	1.6			
	Odeon-CATT discrepancy		-17%	-16%	-15%	-14%	-8%	-4%	-6%		11%	5%
		EDT	2.58	2.85	2.67	2.78	2.55	2.23	1.58			
		STD	0.26	0.14	0.11	0.13	0.08	0.09	0.07			
		JND	0.26	0.29	0.27	0.28	0.26	0.22	0.16			
	Odeon relative error JND		2.08	2.14	2.05	2.30	1.35	1.21	0.42		1.65	0.68
	CATT relative errror JND		0.49	0.60	0.71	1.01	0.56	0.81	0.15		0.62	0.27
RT30			2.25	2.32	2.21	2.19	2.23	1.9	1.42			
			2.98	2.93	2.73	2.71	2.5	1.97	1.49			
	Odeon-CATT discrepancy		-24%	-21%	-19%	-19%	-11%	-4%	-5%		15%	8%
		RT30	2.56	3.08	2.76	2.85	2.60	2.30	1.56			
		STD	0.32	0.16	0.11	0.08	0.03	0.02	0.03			
		JND	0.26	0.31	0.28	0.28	0.26	0.23	0.16			
	Odeon relative error JND		1.22	2.47	1.98	2.31	1.43	1.74	0.92		1.72	0.57
	CATT relative errror JND		1.63	0.49	0.09	0.48	0.40	1.43	0.48		0.71	0.58
	Odeon EDT/RT		91%	97%	96%	98%	99%	103%	106%		98%	5%
	CATT EDT/RT		82%	91%	91%	92%	96%	104%	107%		95%	9%
		EDT/RT	101%	93%	97%	98%	98%	97%	101%		98%	3%
SPL			82.3	88.6	84.2	85.4	79.7	72.8	69.4	88.64		
			80.8	87.2	83.1	84.7	78.9	72.3	69.6	87.77		
	Odeon-CATT discrepancy		1.5	1.4	1.1	0.7	0.8	0.5	-0.2	0.86	0.83	0.58
	Odeon-CATT discrepancy %		1.9%	1.6%	1.3%	0.8%	1.0%	0.7%	0.3%		1.1%	0.5%
STI			0.44	0.44	0.00	0.46						
Receiver 3			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			2.1	2.32	2.19	2.19	2.25	1.93	1.54			
			2.36	2.6	2.39	2.41	2.34	1.99	1.56			
	Odeon-CATT discrepancy		-11%	-11%	-8%	-9%	-4%	-3%	-1%		7%	4%
		EDT	2.38	2.67	2.70	2.73	2.64	2.28	1.53			
		STD	0.34	0.12	0.13	0.10	0.04	0.05	0.03			
		JND	0.24	0.27	0.27	0.27	0.26	0.23	0.15			
	Odeon relative error JND		1.18	1.31	1.89	1.98	1.48	1.53	0.07		1.35	0.64
	CATT relative errror JND		0.09	0.26	1.15	1.17	1.14	1.27	0.20		0.75	0.54
RT30			2.09	2.29	2.16	2.14	2.11	1.89	1.41			
			2.96	2.92	2.73	2.7	2.48	1.95	1.47			
	Odeon-CATT discrepancy		-29%	-22%	-21%	-21%	-15%	-3%	-4%		16%	10%
		RT30	2.26	2.71	2.67	2.80	2.60	2.25	1.55			
		STD	0.46	0.24	0.11	0.09	0.03	0.04	0.02			
		JND	0.23	0.27	0.27	0.28	0.26	0.22	0.16			
	Odeon relative error JND		0.74	1.54	1.90	2.35	1.88	1.59	0.91		1.56	0.57
	CATT relative errror JND		3.12	0.78	0.24	0.35	0.45	1.33	0.52		0.97	1.02
	Odeon EDT/RT		100%	101%	101%	102%	107%	102%	109%		103%	3%
	CATT EDT	EDT/RT	80%	89%	88%	89%	94%	102%	106%		93%	9%
		EDT/RT	106%	99%	101%	98%	102%	101%	99%		101%	3%
SPL			82.7	89.5	84.8	85.9	80	73.1	69.5	89.17		
			80.8	87.9	83.4	84.7	78.9	72.2	68.8	87.90		
	Odeon-CATT discrepancy		1.9	1.6	1.4	1.2	1.1	0.9	0.7	1.26	1.26	0.41
	Odeon-CATT discrepancy %		2.4%	1.8%	1.7%	1.4%	1.4%	1.2%	1.0%		1.6%	0.4%
STI			0.43	0.44	-0.01	0.45						
Receiver 5			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			2.13	2.48	2.28	2.27	2.35	1.93	1.36			
			2.2	2.42	2.23	2.26	2.17	1.88	1.51			
	Odeon-CATT discrepancy		-3%	2%	2%	0%	8%	3%	-10%		4%	4%
		EDT	2.35	2.84	2.55	2.55	2.45	2.09	1.52			
		STD	0.32	0.05	0.12	0.10	0.08	0.05	0.05			
		JND	0.24	0.28	0.26	0.26	0.24	0.21	0.15			
	Odeon relative error JND		0.94	1.28	1.06	1.11	0.40	0.77	1.08		0.95	0.29
	CATT relative errror JND		0.64	1.49	1.25	1.15	1.14	1.01	0.10		0.97	0.46
RT30			2.1	2.29	2.19	2.19	2.17	1.88	1.43			
			2.83	2.83	2.62	2.61	2.38	1.91	1.45			
	Odeon-CATT discrepancy		26%	19%	16%	16%	9%	2%	1%		13%	9%
		RT30	2.46	2.94	2.76	2.59	2.46	2.20	1.52			
		STD	0.34	0.05	0.08	0.11	0.06	0.03	0.02			
		JND	0.25	0.29	0.28	0.26	0.25	0.22	0.15			
	Odeon relative error JND		1.46	2.21	2.05	1.56	1.18	1.45	0.59		1.50	0.54
	CATT relative errror JND		1.51	0.37	0.49	0.06	0.33	1.32	0.46		0.65	0.54
	Odeon EDT/RT		101%	108%	104%	104%	108%	103%	95%		103%	5%
	CATT EDT/RT		78%	86%	85%	87%	91%	98%	104%		90%	9%
		EDT/RT	96%	97%	93%	98%	99%	95%	100%		97%	3%
SPL			83.1	89.7	85.1	86.7	79.9	73.5	69.9	89.64		
			81.3	88.4	83.9	85.7	79.2	72.7	69.5	88.62		
	Odeon-CATT discrepancy		1.8	1.3	1.2	1	0.7	0.8	0.4	1.02	1.03	0.46
	Odeon-CATT discrepancy %		2.2%	1.5%	1.4%	1.2%	0.9%	1.1%	0.6%		1.3%	0.5%
STI			0.42	0.44	-0.02	0.42						

Receiver 8			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			**2.39**	**2.58**	**2.33**	**2.51**	**2.34**	**2.04**	**1.53**			
			2.27	**2.48**	**2.29**	**2.32**	**2.24**	**1.96**	**1.5**			
	Odeon-CATT discrepancy		-5%	-4%	-2%	-8%	-4%	-4%	-2%		4%	2%
		EDT	2.70	2.82	2.67	2.64	2.41	2.12	1.48			
		STD	0.14	0.13	0.08	0.14	0.07	0.09	0.05			
		JND	0.27	0.28	0.27	0.26	0.24	0.21	0.15			
	Odeon relative error JND		*1.15*	*0.85*	*1.26*	*0.48*	*0.27*	*0.36*	*0.36*		0.68	0.41
	CATT relative errror JND		*1.59*	*1.21*	*1.41*	*1.20*	*0.69*	*0.74*	*0.16*		1.00	0.50
RT30			**2.17**	**2.51**	**2.29**	**2.26**	**2.18**	**1.96**	**1.35**			
			2.83	2.82	2.62	2.61	2.37	1.91	1.45			
	Odeon-CATT discrepancy		-23%	-11%	-13%	-13%	-8%	3%	-7%		11%	7%
		RT	2.49	2.98	2.91	2.67	2.47	2.15	1.49			
		STD	0.41	0.09	0.05	0.05	0.05	0.03	0.06			
		JND	0.25	0.30	0.29	0.27	0.25	0.21	0.15			
	Odeon relative error JND		1.28	1.57	2.13	1.52	1.16	0.87	0.95		1.35	0.43
	CATT relative errror JND		1.38	0.53	1.00	0.21	0.39	1.10	0.28		0.70	0.46
	Odeon EDT/RT		110%	103%	102%	111%	107%	104%	113%		107%	4%
	CATT EDT/RT		80%	88%	87%	89%	95%	103%	103%		92%	9%
		EDT/RT	109%	95%	92%	99%	98%	99%	99%		98%	5%
SPL			**83.3**	**89.6**	**84.4**	**86.5**	**80.2**	**73.2**	**69.5**	89.45		
			81.6	87.8	82.9	85.2	79.3	72.7	69.1	88.15		
	Odeon-CATT discrepancy		1.7	1.8	1.5	1.3	0.9	0.5	0.4	1.30	1.16	0.57
	Odeon-CATT discrepancy %		2.1%	2.1%	1.8%	1.5%	1.1%	0.7%	0.6%		1.4%	0.6%
STI			**0.41**	**0.43**	**-0.02**	**0.43**						
Receiver 11			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**2.26**	**2.56**	**2.27**	**2.32**	**2.37**	**2.04**	**1.43**			
			2.52	2.74	2.54	2.57	2.49	2.15	1.63			
	Odeon-CATT discrepancy		12%	7%	12%	11%	5%	5%	14%		9%	4%
		EDT	*2.25*	*2.87*	*2.72*	*2.29*	*2.27*	*2.07*	*1.40*			
		STD	*0.37*	*0.24*	*0.12*	*0.16*	*0.09*	*0.05*	*0.05*			
		JND	0.23	0.29	0.27	0.23	0.23	0.21	0.14			
	Odeon relative error JND		*0.04*	*1.08*	*1.66*	*0.13*	*0.45*	*0.15*	*0.20*		0.53	0.61
	CATT relative errror JND		*1.20*	*0.45*	*0.67*	*1.22*	*0.98*	*0.38*	*1.63*		0.93	0.46
RT30			**2.50**	**2.44**	**2.62**	**2.45**	**2.44**	**2.16**	**1.60**			
			2.95	2.91	2.71	2.70	2.47	1.96	1.49			
	Odeon-CATT discrepancy		18%	19%	3%	10%	1%	-9%	-7%		10%	7%
		RT	**2.48**	**3.16**	**2.71**	**2.51**	**2.43**	**2.12**	**1.48**			
		STD	0.46	0.21	0.14	0.06	0.10	0.03	0.04			
		JND	0.25	0.32	0.27	0.25	0.24	0.21	0.15			
	Odeon relative error JND		0.08	2.29	0.32	0.21	0.06	0.18	0.79		0.56	0.80
	CATT relative errror JND		1.89	0.78	0.01	0.78	0.18	0.76	0.04		0.64	0.66
	Odeon EDT/RT		90%	105%	87%	95%	97%	94%	89%		94%	6%
	CATT EDT/RT		85%	94%	94%	95%	101%	110%	109%		98%	9%
		EDT/RT	91%	91%	101%	91%	93%	98%	94%		94%	4%
SPL			**82.9**	**89.6**	**84.8**	**85.8**	**79.1**	**73.4**	**69.2**	89.01		
			80.9	88	83.4	84.5	78	72.6	68.4	87.69		
	Odeon-CATT discrepancy		2	1.6	1.4	1.3	1.1	0.8	0.8	1.32	1.29	0.43
	Odeon-CATT discrepancy %		2.5%	1.8%	1.7%	1.5%	1.4%	1.1%	1.2%		1.6%	0.5%
STI			**0.43**	**0.43**	**0.00**	**0.46**						

Prediction error and discrepancies spatial averages and standard deviation

	125	250	500	1000	2000	4000	8000	Average	std
EDT									
Odeon relative Error JND	1.2	1.5	1.8	1.3	0.9	0.9	0.3	1.14	0.47
std	0.74	0.62	0.33	0.95	0.55	0.64	0.20	0.58	0.25
CATT relative Error JND	0.8	0.8	1.0	1.1	0.9	0.8	0.4	0.85	0.22
std	0.59	0.52	0.33	0.08	0.26	0.33	0.66		
RT30									
Odeon relative Error JND	0.95	2.01	1.68	1.59	1.14	1.17	0.83	1.34	0.43
std	0.56	0.43	0.76	0.86	0.67	0.64	0.15	0.58	0.24
CATT relative Error JND	1.90	0.59	0.37	0.37	0.35	1.19	0.36	0.73	0.60
std	0.71	0.19	0.40	0.27	0.10	0.27	0.20		
EDT									
Odeon-CATT discrepancy	9%	8%	8%	8%	6%	4%	7%		
std	0.05	0.06	0.06	0.05	0.02	0.01	0.05		
RT30									
Odeon-CATT discrepancy	24%	18%	14%	16%	9%	4%	5%		
std	0.04	0.04	0.07	0.04	0.05	0.03	0.02		
SPL									
Odeon-CATT discrepancy	1.8	1.5	1.3	1.1	0.9	0.7	0.4		
std	0.75	0.65	0.56	0.50	0.41	0.33	0.30		
Odeon-CATT discrepancy %	2.2%	1.8%	1.6%	1.3%	1.2%	1.0%	0.7%		
std	0.002	0.002	0.002	0.003	0.002	0.003	0.004		

STI analysis. Values are rating of STI scale (0 to 1) except relative error in JND units

Parameter	R1	R3	R5	R8	R11	Average	std
STI Odeon	0.44	0.43	0.42	0.41	0.43	0.43	0.01
STI CATT	0.44	0.44	0.44	0.43	0.43	0.44	0.01
STI IR Survey	0.46	0.45	0.42	0.43	0.46	0.44	0.02
STI JND	0.05	0.05	0.05	0.05	0.05	0.05	0.00
STI Odeon- CATT discrepancy	0	-0.01	-0.02	-0.02	0	0.01	0.01
Odeon relative error JND	-0.4	-0.4	0	-0.4	-0.6	0.36	0.22
CATT relative error JND	-0.4	-0.2	0.4	0	-0.6	0.32	0.23

SPL analysis. Values are in dB except discrepancy in JND units

	Frequency (Hz)							
	125	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**
Odeon	82.9	89.4	84.7	86.1	79.8	73.2	69.5	89.18
std	0.38	0.45	0.36	0.53	0.42	0.27	0.25	0.4
CATT	81.1	87.9	83.3	85.0	78.9	72.5	69.1	88.03
std	0.36	0.43	0.38	0.49	0.51	0.23	0.50	0.37
Discrepancy	1.78	1.54	1.32	1.1	0.92	0.7	0.4	1.15
Discrepancy JND	0.89	0.77	0.66	0.55	0.46	0.35	0.21	0.58

E.4 Platform 2

Measured and predicted evaluating parameters analysis

Receiver 1			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			**1.45**	**2.03**	**2.28**	**2.21**	**2.07**	**1.89**	**1.31**			
			1.81	2.15	2.26	2.22	2.24	2.01	1.42			
	Odeon-CATT discrepancy		-20%	-6%	1%	0%	-8%	-6%	-8%		7%	6%
		EDT		***1.94***	***2.19***	***2.07***	***2.32***	***2.21***	***1.50***			
		STD		*0.09*	*0.06*	*0.09*	*0.04*	*0.05*	*0.02*			
		JND		*0.19*	*0.22*	*0.21*	*0.23*	*0.22*	*0.15*			
	Odeon relative error JND			*0.48*	*0.43*	*0.67*	*1.09*	*1.43*	*1.27*		0.89	0.43
	CATT relative errror JND			*1.10*	*0.33*	*0.72*	*0.36*	*0.89*	*0.53*		0.66	0.30
RT30			**1.57**	**2.04**	**2.38**	**2.3**	**2.1**	**1.96**	**1.41**			
			2.37	**2.36**	**2.33**	**2.32**	**2.36**	**2**	**1.5**			
	Odeon-CATT discrepancy		-34%	-14%	2%	-1%	-11%	-2%	-6%		10%	12%
		RT30		2.10	2.31	2.33	2.22	2.12	1.61			
		STD		0.15	0.09	0.03	0.10	0.10	0.02			
		JND		0.21	0.23	0.23	0.22	0.21	0.16			
	Odeon relative error JND			*0.28*	*0.29*	*0.13*	*0.55*	*0.74*	*1.26*		0.54	0.41
	CATT relative errror JND			*1.25*	*0.07*	*0.04*	*0.62*	*0.55*	*0.70*		0.54	0.45
	Odeon EDT/RT		92%	100%	96%	96%	99%	96%	93%		96%	3%
	CATT EDT/RT		76%	91%	97%	96%	95%	101%	95%		93%	8%
		EDT/RT		92%	95%	89%	105%	104%	93%		96%	7%
SPL			**82.2**	**89.6**	**85.2**	**86.2**	**79.9**	**72.9**	**68.8**	89.37		
			80.3	**87.9**	**83.9**	**85.1**	**79.1**	**72.3**	**68.4**	88.21		
	Odeon-CATT discrepancy		1.9	1.7	1.3	1.1	0.8	0.6	0.4	1.15	1.11	0.56
	Odeon-CATT discrepancy %		2%	2%	2%	1%	1%	1%	1%		1.4%	0.6%
STI			**0.42**	**0.44**	-0.02	**0.46**						
Receiver 2			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			1.78	2.11	2.3	2.31	2.14	2.09	1.4			
			1.7	2.02	2.15	2.09	2.12	1.88	1.38			
	Odeon-CATT discrepancy		5%	4%	7%	11%	1%	11%	1%		6%	4%
		EDT		*1.98*	*2.47*	*2.10*	*2.39*	*2.15*	*1.54*			
		STD		*0.09*	*0.08*	*0.08*	*0.11*	*0.09*	*0.04*			
		JND		*0.20*	*0.25*	*0.21*	*0.24*	*0.21*	*0.15*			
	Odeon relative error JND			*0.63*	*0.70*	*0.99*	*1.03*	*0.28*	*0.90*		0.75	0.28
	CATT relative errror JND			*0.18*	*1.31*	*0.05*	*1.11*	*1.25*	*1.03*		0.82	0.56
RT30			**1.58**	**2**	**2.37**	**2.15**	**2.06**	**2.03**	**1.38**			
			2.22	**2.25**	**2.24**	**2.22**	**2.27**	**1.91**	**1.44**			
	Odeon-CATT discrepancy		-29%	-11%	6%	-3%	-9%	6%	-4%		10%	9%
		RT30		**1.88**	**2.40**	**1.95**	**2.35**	**2.08**	**1.58**			
		STD		0.18	0.16	0.10	0.03	0.02	0.04			
		JND		0.19	0.24	0.20	0.23	0.21	0.16			
	Odeon relative error JND			*0.64*	*0.11*	*1.01*	*1.22*	*0.26*	*1.25*		0.75	0.49
	CATT relative errror JND			*1.97*	*0.65*	*1.37*	*0.32*	*0.84*	*0.87*		1.00	0.58
	Odeon EDT/RT		113%	106%	97%	107%	104%	103%	101%		104%	5%
	CATT EDT	EDT/RT	77%	90%	96%	94%	93%	98%	96%		92%	7%
		EDT/RT		106%	103%	108%	102%	103%	98%		103%	3%
SPL			**82.4**	**89.5**	**85.2**	**86.5**	**80**	**73.2**	**69.8**	89.53		
			80.3	**87.9**	**83.9**	**85.1**	**78.9**	**72.7**	**69.4**	88.20		
	Odeon-CATT discrepancy		2.1	1.6	1.3	1.4	1.1	0.5	0.4	1.33	1.20	0.60
	Odeon-CATT discrepancy %		3%	2%	2%	2%	1%	1%	1%		1.5%	0.7%
STI			**0.43**	**0.45**	**-0.02**	**0.46**						
Receiver 3			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**1.72**	**2.05**	**2.12**	**2.19**	**2.13**	**1.96**	**1.35**			
			1.85	**2.1**	**2.19**	**2.16**	**2.2**	**2.04**	**1.55**			
	Odeon-CATT discrepancy		-7%	-2%	-3%	1%	-3%	-4%	-13%		5%	4%
		EDT		*2.31*	*2.50*	*2.38*	*2.29*	*2.07*	*1.70*			
		STD		*0.24*	*0.11*	*0.09*	*0.05*	*0.06*	*0.08*			
		JND		0.23	0.25	0.24	0.23	0.21	0.17			
	Odeon relative error JND			*1.13*	*1.53*	*0.79*	*0.70*	*0.54*	*2.05*		1.12	0.58
	CATT relative errror JND			*0.91*	*1.25*	*0.91*	*0.40*	*0.15*	*0.87*		0.75	0.40
RT30			**1.64**	**2.23**	**2.6**	**2.42**	**2.27**	**2.01**	**1.45**			
			2.28	2.25	2.24	2.23	2.29	1.97	1.48			
	Odeon-CATT discrepancy		28%	1%	-16%	-9%	1%	-2%	2%		8%	10%
		RT30		2.35	2.56	2.31	2.31	2.12	1.63			
		STD		0.22	0.18	0.07	0.12	0.13	0.06			
		JND		0.24	0.26	0.23	0.23	0.21	0.16			
	Odeon relative error JND			*0.52*	*0.15*	*0.48*	*0.18*	*0.50*	*1.10*		0.49	0.34
	CATT relative errror JND			*0.44*	*1.26*	*0.34*	*0.10*	*0.69*	*0.91*		0.62	0.42
	Odeon EDT/RT		105%	92%	82%	90%	94%	98%	93%		93%	7%
	CATT EDT/RT		81%	93%	98%	97%	96%	104%	105%		96%	8%
		EDT/RT		98%	98%	103%	99%	98%	104%		100%	3%
SPL			**81.6**	**88.1**	**83.9**	**85.8**	**80.1**	**73.5**	**70**	88.81		
			79.8	**86.6**	**82.3**	**84.6**	**79.4**	**72.9**	**69.5**	87.64		
	Odeon-CATT discrepancy		1.8	1.5	1.6	1.2	0.7	0.6	0.5	1.17	1.13	0.53
	Odeon-CATT discrepancy %		2%	2%	2%	1%	1%	1%	1%		1.4%	0.6%
STI			**0.45**	**0.41**	0.04	0.43						

Receiver 4			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			1.77	2.6	2.9	2.69	2.39	2.24	1.5			
			1.98	2.3	2.41	2.38	2.44	2.16	1.5			
	Odeon-CATT discrepancy		12%	-12%	-17%	-12%	2%	-4%	0%		8%	6%
		EDT		2.13	2.70	2.47	2.15	1.98	1.55			
		STD		0.06	0.06	0.10	0.10	0.05	0.14			
		JND		0.21	0.27	0.25	0.21	0.20	0.16			
	Odeon relative error JND			2.21	0.73	0.91	1.14	1.34	0.34		1.11	0.64
	CATT relative errror JND			0.81	1.08	0.35	1.37	0.94	0.34		0.81	0.41
RT30			1.75	2.38	2.89	2.56	2.35	2.15	1.52			
			2.4	2.34	2.45	2.42	2.38	2.05	1.46			
	Odeon-CATT discrepancy		-27%	2%	18%	6%	-1%	5%	4%		9%	10%
		RT		2.37	2.65	2.74	2.21	2.03	1.56			
		STD		0.17	0.09	0.09	0.05	0.08	0.06			
		JND		0.24	0.27	0.27	0.22	0.20	0.16			
	Odeon relative error JND			0.03	0.90	0.66	0.64	0.59	0.27		0.51	0.31
	CATT relative errror JND			0.14	0.76	1.17	0.77	0.10	0.66		0.60	0.41
	Odeon EDT/RT		101%	109%	100%	105%	102%	104%	99%		103%	4%
	CATT EDT/RT		83%	98%	98%	98%	103%	105%	103%		98%	7%
		EDT/RT		90%	102%	90%	97%	97%	99%		96%	5%
SPL			81.8	87.7	84.1	85.6	81.9	73.6	70.6	89.10		
			79.9	86	83.2	84.9	81.3	73.1	70.1	88.31		
	Odeon-CATT discrepancy		1.9	1.7	0.9	0.7	0.6	0.5	0.5	0.79	0.97	0.59
	Odeon-CATT discrepancy %		2%	2%	1%	1%	1%	1%	1%		1.2%	0.7%
STI			0.43	0.45	-0.018	0.41						
Receiver 5			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			1.7	2.04	2.39	2.3	2.25	2.01	1.36			
			1.83	2.13	2.23	2.18	2.21	2.03	1.53			
	Odeon-CATT discrepancy		8%	4%	-7%	-5%	-2%	1%	13%		6%	4%
		EDT		2.40	2.49	2.30	2.03	1.91	1.56			
		STD		0.18	0.07	0.15	0.13	0.13	0.11			
		JND		0.24	0.25	0.23	0.20	0.19	0.16			
	Odeon relative error JND			1.50	0.40	0.01	1.07	0.53	1.30		0.80	0.58
	CATT relative errror JND			1.13	1.04	0.53	0.87	0.63	0.21		0.74	0.34
RT30			1.73	2.25	2.68	2.43	2.33	1.98	1.38			
			2.31	2.26	2.37	2.35	2.31	1.99	1.4			
	Odeon-CATT discrepancy		34%	0%	-12%	-3%	-1%	1%	1%		7%	12%
		RT		2.60	2.71	2.51	2.43	2.12	1.48			
		STD		0.19	0.14	0.06	0.10	0.03	0.04			
		JND		0.26	0.27	0.25	0.24	0.21	0.15			
	Odeon relative error JND			1.35	0.10	0.30	0.39	0.67	0.70		0.58	0.44
	CATT relative errror JND			1.31	1.25	0.62	0.47	0.62	0.57		0.81	0.37
	Odeon EDT/RT		98%	91%	89%	95%	97%	102%	99%		96%	4%
	CATT EDT/RT		79%	94%	94%	93%	96%	102%	109%		95%	9%
		EDT/RT		92%	92%	92%	84%	90%	105%		93%	7%
SPL			82.6	89.2	84.8	86.5	80.9	74.4	60.4	89.58		
			80.7	88	83.7	85	79.6	73	58.9	88.22		
	Odeon-CATT discrepancy		1.9	1.2	1.1	1.5	1.3	1.4	1.5	1.36	1.41	0.26
	Odeon-CATT discrepancy %		2%	1%	1%	2%	2%	2%	3%		1.8%	0.5%
STI			0.43	0.40	0.03	0.43						

Prediction error and discrepancies spatial averages and standard deviation

	125	250	500	1000	2000	4000	8000	Average	std
EDT									
Odeon relative Error JND		1.1	0.5	0.6	0.9	0.8	1.0	0.81	0.22
std		0.76	0.24	0.39	0.40	0.53	0.39	0.45	0.18
CATT relative Error JND		0.8	1.0	0.5	0.8	0.8	0.6	0.75	0.18
std		0.38	0.39	0.33	0.44	0.41	0.35		
RT30									
Odeon relative Error JND		0.56	0.31	0.52	0.60	0.55	0.92	0.58	0.20
std		0.50	0.34	0.34	0.39	0.19	0.42	0.36	0.10
CATT relative Error JND		1.02	0.80	0.71	0.46	0.56	0.74	0.71	0.20
std		0.73	0.49	0.56	0.26	0.28	0.15		
EDT									
Odeon-CATT discrepancy	10%	6%	7%	6%	3%	5%	7%		
std	0.06	0.03	0.06	0.05	0.03	0.04	0.06		
RT30									
Odeon-CATT discrepancy	30%	6%	11%	4%	5%	3%	4%		
std	0.03	0.06	0.07	0.03	0.05	0.02	0.02		
SPL									
Odeon-CATT discrepancy	1.9	1.5	1.2	1.2	0.9	0.7	0.7		
std	0.79	0.66	0.56	0.56	0.45	0.45	0.50		
Odeon-CATT discrepancy %	2.4%	1.8%	1.5%	1.4%	1.1%	1.0%	1.0%		
std	0.001	0.002	0.003	0.004	0.004	0.005	0.009		

STI analysis. Values are rating of STI scale (0 to 1) except error in JND units

Position	R1	R2	R3	R4	R5	Average	std
STI Odeon	0.42	0.43	0.45	0.43	0.43	0.43	0.01
STI CATT	0.44	0.45	0.41	0.45	0.40	0.43	0.02
STI IR Survey	0.46	0.46	0.43	0.41	0.43	0.44	0.02
STI JND	0.05	0.05	0.05	0.05	0.05	0.05	0.00
STI Odeon- CATT discrepancy	-0.02	-0.02	0.04	-0.02	0.03	0.03	0.01
Odeon relative error JND	-0.8	-0.6	0.4	0.4	0	0.44	0.30
CATT relative error JND	-0.4	-0.2	-0.4	0.8	-0.6	0.48	0.23

SPL analysis. Values are in dB except discrepancy in JND units

	Frequency (Hz)							
	125	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**
Odeon	82.1	88.8	84.6	86.1	80.6	73.5	67.9	89.28
std	0.41	0.86	0.61	0.41	0.85	0.56	4.25	0.3
CATT	80.2	87.3	83.4	84.9	79.7	72.8	67.3	88.12
std	0.36	0.92	0.68	0.21	0.96	0.32	4.71	0.27
Discrepancy	1.92	1.54	1.24	1.18	0.9	0.72	0.7	1.16
Discrepancy JND	0.96	0.77	0.62	0.59	0.45	0.36	0.33	0.58

E.5 Platform 3

Measured and predicted evaluating parameters analysis

Receiver 1			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			2.03	2.06	1.88	2.19	2.16	1.96	1.43			
			2.89	2.79	2.64	2.82	2.86	2.26	1.53			
	Odeon-CATT discrepancy		-30%	-26%	-29%	-22%	-24%	-13%	-7%		22%	9%
		EDT		2.14	2.02	2.09	2.32	2.09	1.59			
		STD		0.02	0.02	0.03	0.02	0.02	0.03			
		JND		0.21	0.20	0.21	0.23	0.21	0.16			
	Odeon relative error JND			0.39	0.71	0.49	0.70	0.64	1.03		0.66	0.22
	CATT relative errror JND			3.01	3.05	3.51	2.31	0.79	0.40		2.18	1.29
RT30			1.97	1.97	1.9	2.15	2.22	1.93	1.33			
			3.38	3.24	2.96	3.01	3.08	2.21	1.49			
	Odeon-CATT discrepancy		-42%	-39%	-36%	-29%	-28%	-13%	-11%		28%	12%
		RT30		2.23	1.82	2.19	2.23	1.90	1.53			
		STD	0.11	0.08	0.15	0.05	0.04	0.05	0.01			
		JND	0.00	0.22	0.18	0.22	0.22	0.19	0.15			
	Odeon relative error JND			1.17	0.46	0.18	0.04	0.18	1.30		0.56	0.55
	CATT relative errror JND			4.53	6.30	3.75	3.82	1.66	0.26		3.39	2.14
	Odeon EDT/RT		103%	105%	99%	102%	97%	102%	108%		102%	3%
	CATT EDT/RT		86%	86%	89%	94%	93%	102%	103%		93%	7%
		EDT/RT		96%	111%	95%	104%	110%	104%		104%	7%
SPL			83.7	88.6	86.2	85.7	79.2	73.4	69.8	89.15		
			81.3	86.4	83.9	84.1	77.8	72.3	68.6	87.36		
	Odeon-CATT discrepancy		2.4	2.2	2.3	1.6	1.4	1.1	1.2	1.79	1.74	0.55
	Odeon-CATT discrepancy %		3%	3%	3%	2%	2%	2%	2%		2.2%	0.6%
STI				0.41	0.39	0.02	0.46					
Receiver 2			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			2.2	2.17	2.25	2.44	2.53	2.19	1.67			
			2.49	2.43	2.31	2.48	2.54	2.09	1.55			
	Odeon-CATT discrepancy		-12%	-11%	-3%	-2%	0%	5%	8%		6%	4%
		EDT		1.91	2.04	2.10	1.98	1.83	1.58			
		STD	0.04	0.09	0.05	0.04	0.12	0.05	0.06			
		JND	0.00	0.19	0.20	0.21	0.20	0.18	0.16			
	Odeon relative error JND			1.34	1.03	1.62	2.78	1.99	0.59		1.56	0.77
	CATT relative errror JND			2.70	1.32	1.81	2.83	1.45	0.17		1.71	0.98
RT30			2.19	2.15	2.12	2.3	2.37	2.1	1.53			
			3.29	3.16	2.93	2.97	3.03	2.15	1.48			
	Odeon-CATT discrepancy		-33%	-32%	-28%	-23%	-22%	-2%	3%		20%	13%
		RT30		1.92	1.95	2.14	2.30	2.02	1.60			
		STD		0.17	0.09	0.08	0.11	0.06	0.03			
		JND		0.19	0.19	0.21	0.23	0.20	0.16			
	Odeon relative error JND			1.22	0.88	0.76	0.31	0.41	0.41		0.66	0.35
	CATT relative errror JND			6.49	5.03	3.90	3.19	0.65	0.72		3.33	2.33
	Odeon EDT/RT		100%	101%	106%	106%	107%	104%	109%		105%	3%
	CATT EDT/RT	EDT/RT	76%	77%	79%	84%	84%	97%	105%		86%	11%
		EDT/RT		100%	105%	98%	86%	90%	99%		96%	7%
SPL			83.3	86.9	85.7	85.2	80.1	73.2	69.4	88.75		
			81.1	85.7	84.2	83.3	78.5	71.9	67.7	87.09		
	Odeon-CATT discrepancy		2.2	1.2	1.5	1.9	1.6	1.3	1.7	1.66	1.63	0.35
	Odeon-CATT discrepancy %		3%	1%	2%	2%	2%	2%	3%		2.1%	0.5%
STI				0.4	0.41	-0.01	0.46					
Receiver 3			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			2.4	2.38	2.27	2.44	2.54	2.21	1.67			
			2.73	2.65	2.51	2.71	2.78	2.25	1.64			
	Odeon-CATT discrepancy		14%	11%	11%	11%	9%	2%	-2%		9%	5%
		EDT		2.85	2.82	2.72	2.57	2.57	1.90			
		STD		0.15	0.03	0.07	0.19	0.11	0.05			
		JND		0.29	0.28	0.27	0.26	0.26	0.19			
	Odeon relative error JND			1.65	1.95	1.02	0.12	1.40	1.20		1.22	0.63
	CATT relative errror JND			0.70	1.10	0.02	0.82	1.24	1.35		0.87	0.48
RT30			2.31	2.13	2.07	2.38	2.37	2.14	1.54			
			3.35	3.20	2.92	2.97	3.04	2.17	1.49			
	Odeon-CATT discrepancy		45%	50%	41%	25%	28%	1%	-3%		28%	20%
		RT		2.51	2.46	2.62	2.57	2.23	1.68			
		STD		0.16	0.04	0.04	0.05	0.05	0.02			
		JND		0.25	0.25	0.26	0.26	0.22	0.17			
	Odeon relative error JND			1.52	1.59	0.92	0.77	0.40	0.85		1.01	0.46
	CATT relative errror JND			2.74	1.87	1.33	1.84	0.27	1.15		1.53	0.83
	Odeon EDT/RT		104%	112%	110%	103%	107%	103%	108%		107%	4%
	CATT EDT/RT		81%	83%	86%	91%	91%	104%	110%		92%	11%
		EDT/RT		113%	115%	104%	100%	115%	113%		110%	6%
SPL			82.6	86.6	85.1	84.5	83.3	74	69.6	89.16		
			81	85.3	83.3	83.7	81.9	72.8	68.7	87.93		
	Odeon-CATT discrepancy		1.6	1.3	1.8	0.8	1.4	1.2	0.9	1.24	1.29	0.36
	Odeon-CATT discrepancy %		2%	2%	2%	1%	2%	2%	1%		1.6%	0.4%
STI				0.38	0.39	-0.01	0.44					

Receiver 5			125	250	500	1000	2000	4000	8000	dB(A)	Average	std
EDT			**2.28**	**2.18**	**2.27**	**2.34**	**2.41**	**2.16**	**1.47**			
			2.89	2.77	2.62	2.83	2.87	2.33	1.68			
	Odeon-CATT discrepancy		-21%	-21%	-13%	-17%	-16%	-7%	-13%		16%	5%
		EDT		*2.07*	*2.23*	*2.35*	*2.42*	*2.17*	*1.57*			
		STD		*0.12*	*0.13*	*0.06*	*0.09*	*0.11*	*0.05*			
		JND		0.21	0.22	0.23	0.24	0.22	0.16			
	Odeon relative error JND			*0.53*	*0.19*	*0.03*	*0.05*	*0.05*	*0.64*		0.25	0.27
	CATT relative errror JND			*3.38*	*1.76*	*2.06*	*1.85*	*0.74*	*0.70*		1.75	0.99
RT30			**2.22**	**2.14**	**2.08**	**2.31**	**2.43**	**2.18**	**1.51**			
			3.34	3.18	2.92	2.96	3.02	2.2	1.52			
	Odeon-CATT discrepancy		34%	33%	29%	22%	20%	1%	1%		20%	14%
		RT30		2.31	2.23	2.62	2.49	2.33	1.69			
		STD		0.25	0.08	0.05	0.08	0.05	0.05			
		JND		0.23	0.22	0.26	0.25	0.23	0.17			
	Odeon relative error JND			*0.73*	*0.67*	*1.19*	*0.23*	*0.65*	*1.07*		0.76	0.34
	CATT relative errror JND			*3.77*	*3.09*	*1.29*	*2.14*	*0.56*	*1.01*		1.98	1.26
	Odeon EDT/RT		103%	102%	109%	101%	99%	99%	97%		102%	4%
	CATT EDT/RT		87%	87%	90%	96%	95%	106%	111%		96%	9%
		EDT/RT		90%	100%	90%	97%	93%	93%		94%	4%
SPL			**84.3**	**87.2**	**86.4**	**84.7**	**81.1**	**73.1**	**69**	**88.95**		
			82.6	**85.4**	**85.2**	**83.6**	**79.8**	**71.9**	**67.7**	87.71		
	Odeon-CATT discrepancy		1.7	1.8	1.2	1.1	1.3	1.2	1.3	1.24	1.37	0.27
	Odeon-CATT discrepancy %		2%	2%	1%	1%	2%	2%	2%		1.7%	0.3%
STI				**0.42**	**0.41**	**0.01**	**0.5**					
Receiver 8			**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**Average**	**std**
EDT			**2.19**	**2.21**	**2.12**	**2.37**	**2.38**	**2.05**	**1.61**			
			2.58	**2.52**	**2.38**	**2.56**	**2.61**	**2.13**	**1.53**			
	Odeon-CATT discrepancy		18%	14%	12%	8%	10%	4%	-5%		10%	5%
		EDT		2.73	2.59	2.69	2.44	2.15	1.51			
		STD		0.07	0.06	0.09	0.07	0.06	0.05			
		JND		0.27	0.26	0.27	0.24	0.21	0.15			
	Odeon relative error JND			*1.90*	*1.82*	*1.18*	*0.23*	*0.44*	*0.64*		1.04	0.71
	CATT relative errror JND			*0.77*	*0.82*	*0.47*	*0.72*	*0.07*	*0.11*		0.49	0.33
RT30			**2.1**	**2.08**	**1.95**	**2.15**	**2.35**	**2.04**	**1.45**			
			3.31	**3.18**	**2.87**	**2.97**	**3.04**	**2.15**	**1.44**			
	Odeon-CATT discrepancy		-37%	-35%	-32%	-28%	-23%	-5%	1%		23%	14%
		RT		1.96	1.95	2.10	2.15	1.93	1.55			
		STD		0.20	0.10	0.12	0.08	0.09	0.02			
		JND		0.20	0.20	0.21	0.21	0.19	0.16			
	Odeon relative error JND			0.59	0.01	0.23	0.93	0.55	0.65		0.49	0.33
	CATT relative errror JND			6.20	4.71	4.13	4.14	1.12	0.72		3.50	2.14
	Odeon EDT/RT		104%	106%	109%	110%	101%	100%	111%		106%	4%
	CATT EDT/RT		78%	79%	83%	86%	86%	99%	106%		88%	11%
		EDT/RT		139%	133%	128%	113%	111%	98%		120%	16%
SPL			**83.9**	**87.9**	**85.8**	**85.1**	**82.2**	**74.3**	**69.6**	**89.33**		
			82	**86.3**	**84.8**	**83.9**	**80.9**	**73.2**	**68.5**	88.11		
	Odeon-CATT discrepancy		1.9	1.6	1	1.2	1.3	1.1	1.1	1.22	1.31	0.32
	Odeon-CATT discrepancy %		2%	2%	1%	1%	2%	2%	2%		1.6%	0.4%
STI			**0.39**	**0.40**	**-0.01**	**0.5**						

Prediction error and discrepancies spatial averages and standard deviation

	125	250	500	1000	2000	4000	8000	Average	std
EDT									
Odeon relative Error JND		1.1	1.1	0.8	0.9	0.7	0.7	0.90	0.17
std		0.65	0.66	0.61	1.09	0.75	0.19	0.66	0.29
CATT relative Error JND		2.1	1.6	1.6	1.7	0.9	0.5	1.40	0.58
std		1.28	0.88	1.38	0.92	0.53	0.51		
RT30									
Odeon relative Error JND		1.05	0.72	0.66	0.46	0.44	0.86	0.70	0.23
std		0.38	0.58	0.44	0.38	0.18	0.35	0.38	0.13
CATT relative Error JND		4.75	4.20	2.88	3.03	0.85	0.77	2.75	1.65
std		1.59	1.73	1.44	1.01	0.55	0.34		
EDT									
Odeon-CATT discrepancy	19%	17%	14%	12%	12%	6%	7%		
std	0.07	0.07	0.10	0.08	0.09	0.04	0.04		
RT30									
Odeon-CATT discrepancy	38%	38%	33%	25%	24%	4%	4%		
std	0.05	0.08	0.05	0.03	0.04	0.05	0.04		
SPL									
Odeon-CATT discrepancy	1.96	1.62	1.56	1.32	1.40	1.18	1.24		
std	0.85	0.75	0.78	0.66	0.58	0.49	0.57		
Odeon-CATT discrepancy %	2.4%	1.9%	1.9%	1.6%	1.8%	1.6%	1.8%		
std	0.004	0.005	0.006	0.005	0.002	0.001	0.004		

STI analysis. Values are rating of STI scale (0 to 1) except relative error in JND units

Position	R1	R2	R3	R5	R8	Average	std
STI Odeon	0.41	0.4	0.38	0.42	0.39	0.40	0.02
STI CATT	0.39	0.41	0.39	0.41	0.4	0.40	0.01
STI IR Survey	0.46	0.46	0.44	0.5	0.5	0.47	0.03
STI JND	0.05	0.05	0.05	0.05	0.05	0.05	0.00
STI Odeon- CATT discrepancy	0.02	-0.01	-0.01	0.01	-0.01	0.01	0.00
Odeon relative error JND	-1	-1.2	-1.2	-1.6	-2.2	1.44	0.48
CATT relative error JND	-1.4	-1	-1	-1.8	-2	1.44	0.46

SPL analysis. Values are in dB except discrepancy in JND units

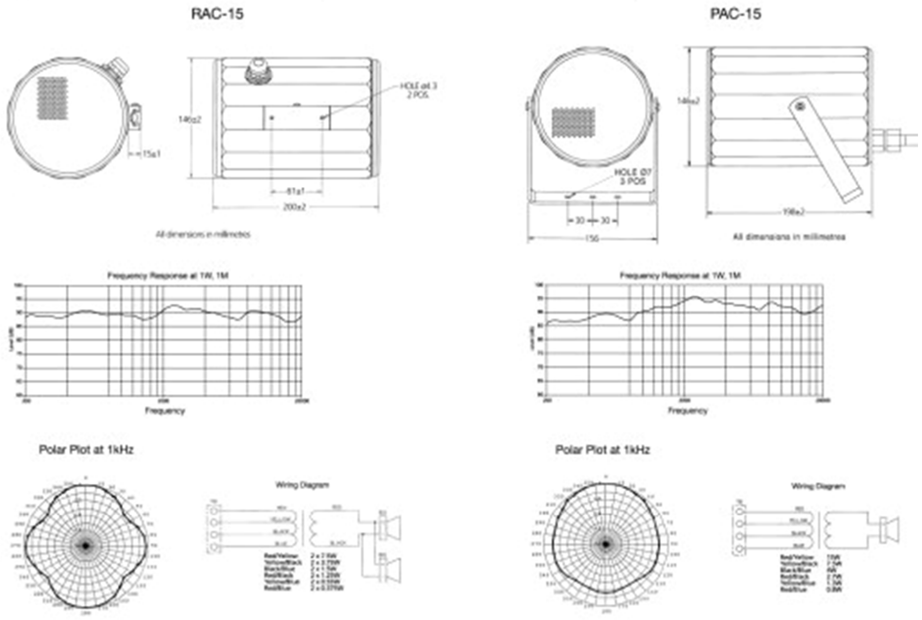
	Frequency (Hz)							
	125	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**
Odeon	83.6	87.4	85.8	85.0	81.2	73.6	69.5	89.07
std	0.65	0.81	0.50	0.47	1.63	0.52	0.30	0.2
CATT	81.6	85.8	84.3	83.7	79.8	72.4	68.2	87.64
std	0.68	0.51	0.75	0.30	1.68	0.57	0.50	0.41
Discrepancy	1.96	1.62	1.56	1.32	1.4	1.18	1.2	1.43
Discrepancy JND	0.98	0.81	0.78	0.66	0.7	0.59	0.62	0.71

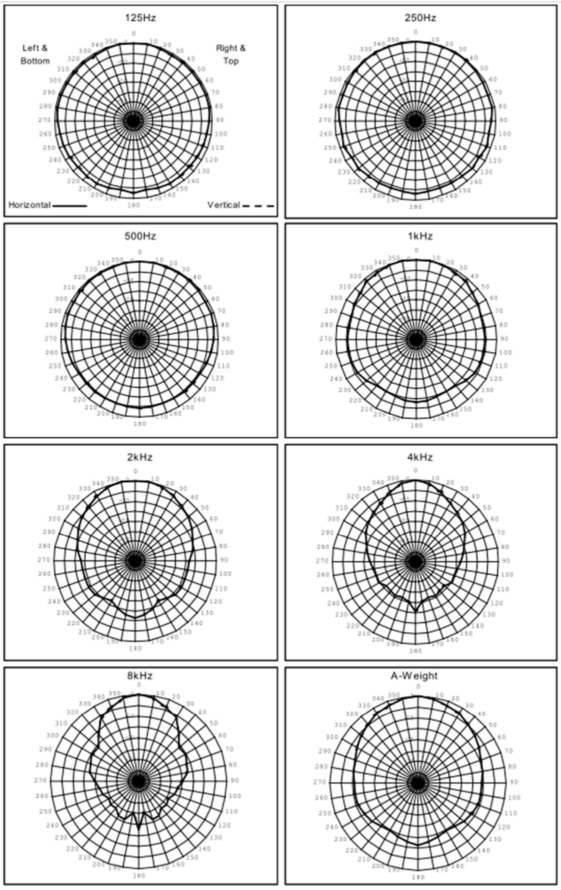
Appendix F

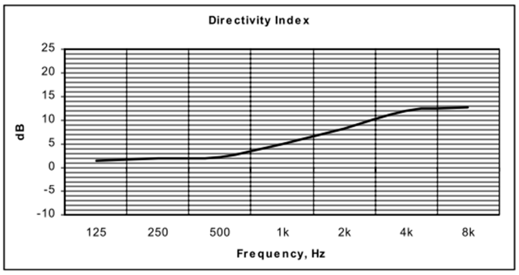
F.1 Projector PAC15 loudspeaker electro-acoustic characteristics

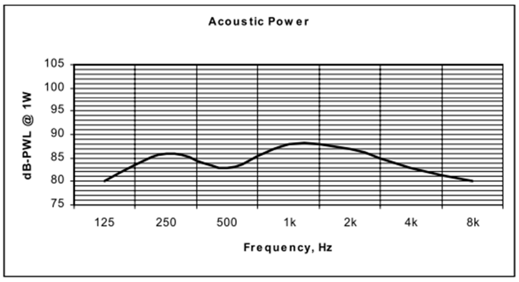
Technical Specifications

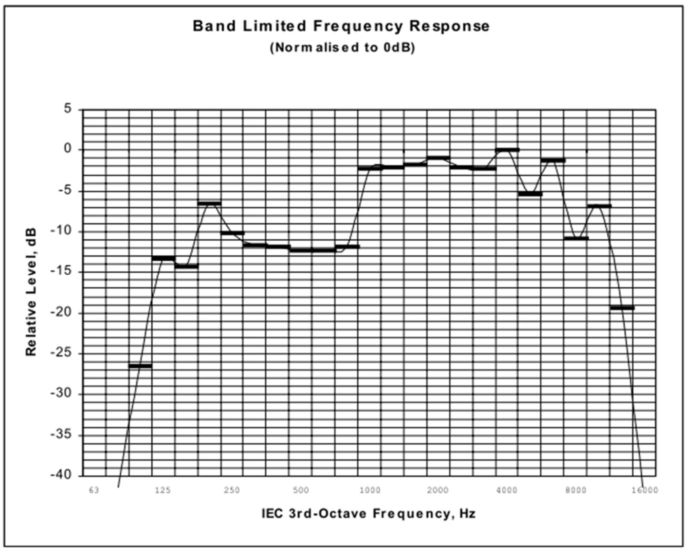
Model	RAC-15	PAC-15
Rated power	2 x 7.5W	15W
Maximum power, RMS	15W	20W
Material	Aluminium	Aluminium
Colour/finish	White to RAL 9010	White to RAL 9010
Sound pressure level, power W/1m	98dB	104dB
1W at 1 metre	90dB	92dB
Nett weight	2.6Kg	2.4Kg
IP Norm	54	54
Max/min ambient temperature	90°C to - 40°C	90°C to - 40°C
Effective frequency range	140-20,000Hz	120-20,000Hz
Dispersion at 1,000Hz	130° conical	130° conical
Terminal	0.5m fire rated cable	0.5m fire rated cable
Mounting	Slide bracket	"U" bracket
Transformer power tappings	0.75, 1.1, 2.5, 3.0, 7.5, 15W	0.8, 1.3, 2.7, 4.0, 7.5, 15W
Imput impedance standard model	13.3k, 9.1k, 4.0k, 3.3k, 1.3k, 666 ohms	12.5k, 7.7k, 3.7k 2.5k 1.3k, 666 ohms
Impedance	4 ohms	8 ohms




125Hz
Left & Bottom
Right & Top
Horizontal
Vertical
250Hz
500Hz
1kHz
2kHz
4kHz
8kHz
A-Weight


Directivity Index
dB
Frequency, Hz


Acoustic Power
dB-PWL @ 1W
Frequency, Hz


Band Limited Frequency Response
(Normalised to 0dB)
Relative Level, dB
IEC 3rd-Octave Frequency, Hz

F:2 Column CM20 loudspeaker electro-acoustic characteristics

CM - 15 / 20 / 40

CM20

Weatherproof Column Loudspeakers

The slimline CM range of column speakers has been designed for installation with the kind of appeal normally associated with foreground music. These robust yet attractive loudspeakers are designed to give high quality sound reproduction. Complete with an easily fitted rugged stainless steel swivel bracket arrangement these weatherproof speakers can be used in airports, the rail industry, churches, small theatres and other places of entertainment.

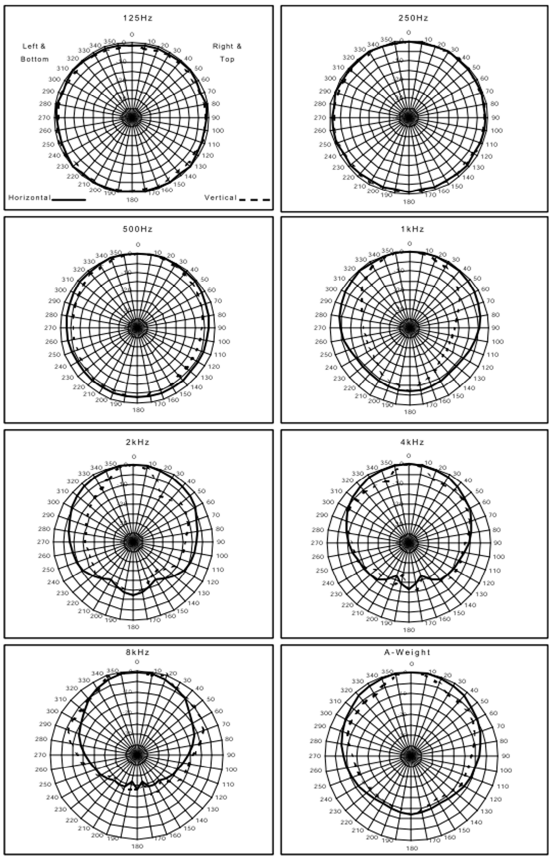
With an ingress protection rating of IP65 and BS5839, part 8 compliant as standard, these units represent an affordable and elegant high quality solution for music and speech reproduction.

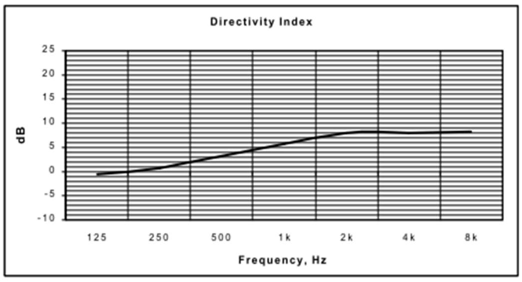
Features

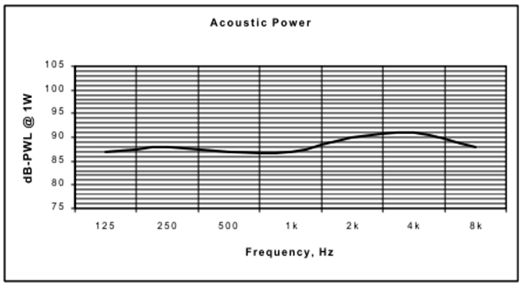
> Up to 109 dB(A)
> 15, 20 and 40W units
> BS5839-8 Compliant as standard
> IP65
> Aluminium
> Switchable between 100V line transformer and 8 ohms

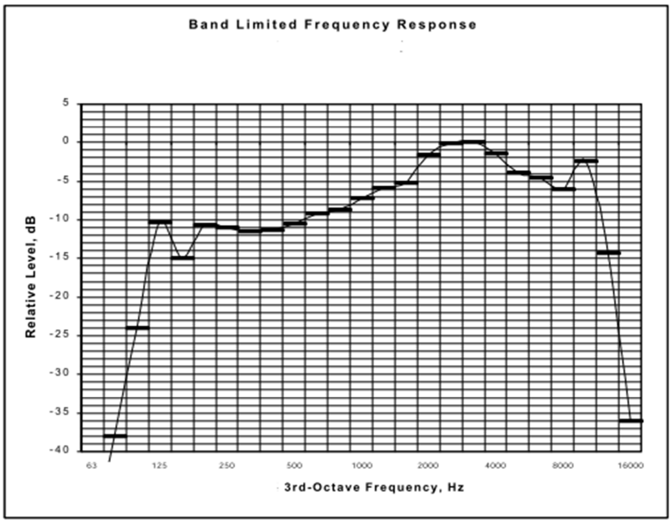
Technical Specifications

Model	CM-15	CM-20	CM-40
Power	15W - 100V line only	20W - 100V line / 4 ohms	40W - 100V line / 8 ohms
Output	101dB(A) @ 15W	106dB(A) @ 20W	109dB(A) @ 40W
Sensitivity	89dB(A) @ 1W	91dB(A) @ 1W	93dB(A) @ 1W
Tappings (100V)	1.25, 2.5, 5, 10, 15W	1.25, 2.5, 5, 10, 20W	2.5, 5, 10, 20, 40W
Frequency range	150 - 18,000	100 - 20,000	100 - 20,000
Dispersion @ 1kHz	180° Horiz / 70° Vert	180° Horiz / 70° Vert	200° Horiz / 90° Vert
Temperature	- 20°C to + 50°C		
Protection	IP65		
Cable entry Industrial version	1 x M25 entry with conduit adaptor	1 x M25 entry with conduit adaptor Pt8 - 2 x M20 entries with glands	Pt8 - 2 x M20 entries with glands
Mounting	Tilt & turn bracket		
Weight	1.7kg	2.7kg	3.8kg
Material	Aluminium		
BS5839-8	-	Yes	Yes
Colour	White		


125Hz
Left & Bottom
Right & Top
Horizontal
Vertical
250Hz
500Hz
1kHz
2kHz
4kHz
8kHz
A-Weight


Directivity Index
dB
25
20
15
10
5
0
-5
-10
125
250
500
1k
2k
4k
8k
Frequency, Hz

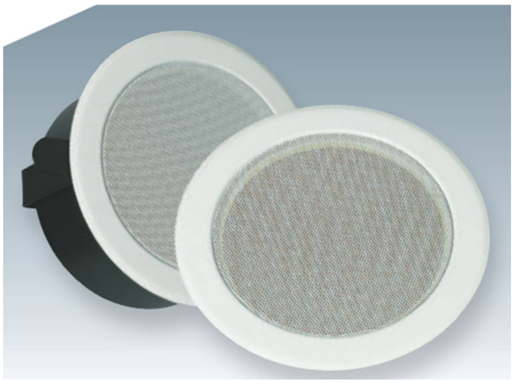

Acoustic Power
dB-PWL @ 1W
105
100
95
90
85
80
75
125
250
500
1k
2k
4k
8k
Frequency, Hz

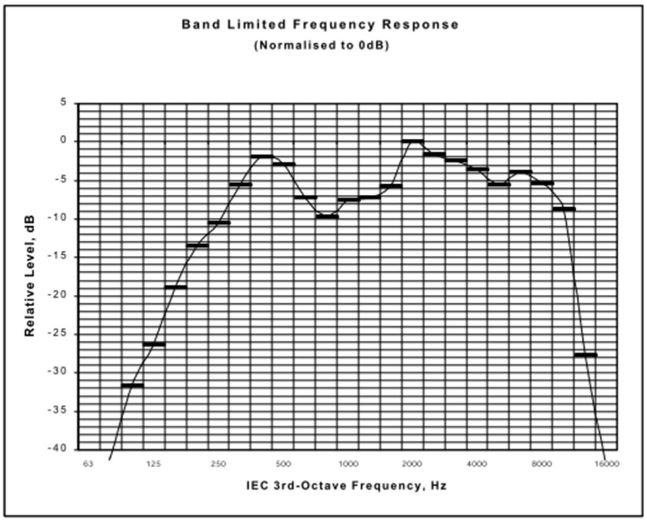

Band Limited Frequency Response
Relative Level, dB
5
0
-5
-10
-15
-20
-25
-30
-35
-40
63
125
250
500
1000
2000
4000
8000
16000
3rd-Octave Frequency, Hz

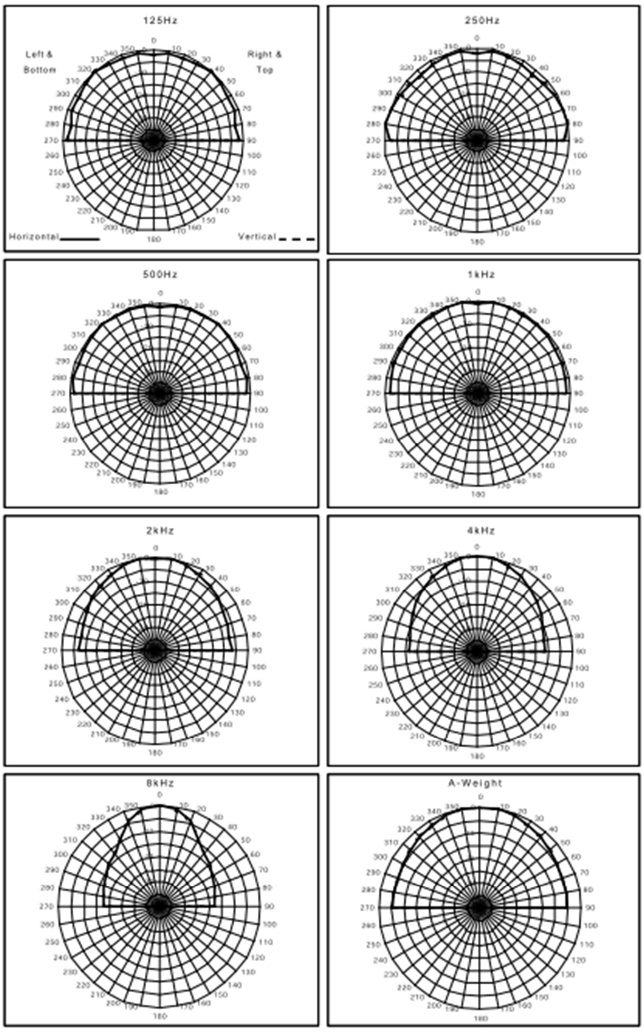
F.3 Ceiling loudspeaker MC5 electro-acoustic characteristics

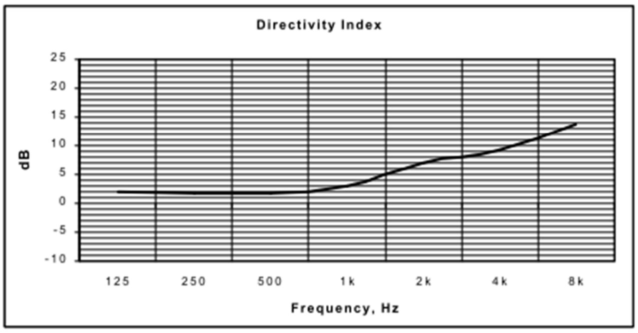
Technical Specifications

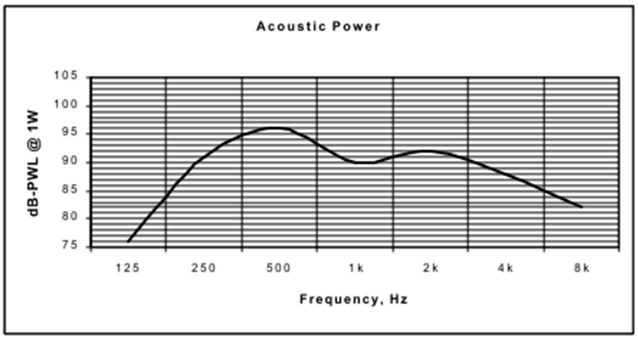
Model	MC-5FT
Power	10W
Material	Mild Steel
Colour/finish	White RAL 9010
Sound pressure level, power W/1m	103dB
1 W 1 metre	93
Nett weight	1.6Kg
Max/min ambient temperature	– 20°C to + 50°C
Effective frequency range	100-15,000Hz
Dispersion at 1,000hz	150° conical
Ceiling cutout required	165mm
Terminations	Ceramic block
Mounting	Mounting bracket
Transformer power tappings	0.75, 1.5, 3.0, 6.0, 10W
Input impedance standard model	13.33k, 6.6k, 3.3k, 1.66k, 1.0k ohms
Impedance	8 ohms



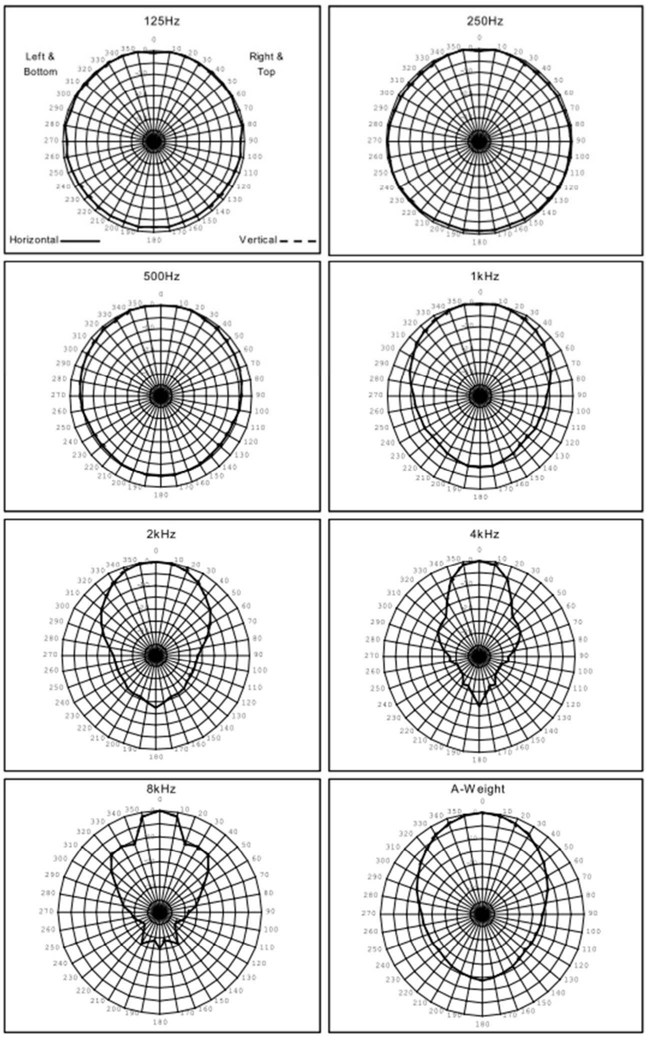



125Hz
Left & Bottom
Right & Top
Horizontal
Vertical
250Hz
500Hz
1kHz
2kHz
4kHz
8kHz
A-Weight

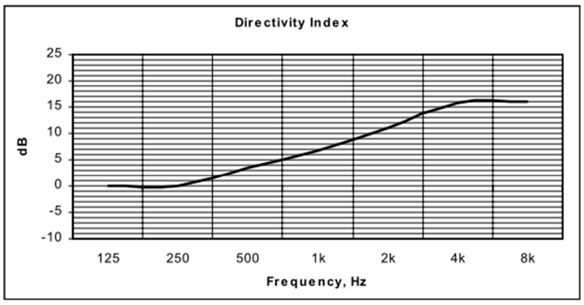

Directivity Index
dB
25
20
15
10
5
0
-5
-10
125
250
500
1k
2k
4k
8k
Frequency, Hz

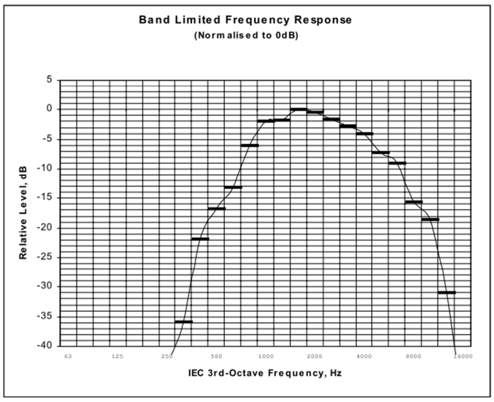

Acoustic Power
dB-PWL @ 1W
105
100
95
90
85
80
75
125
250
500
1k
2k
4k
8k
Frequency, Hz

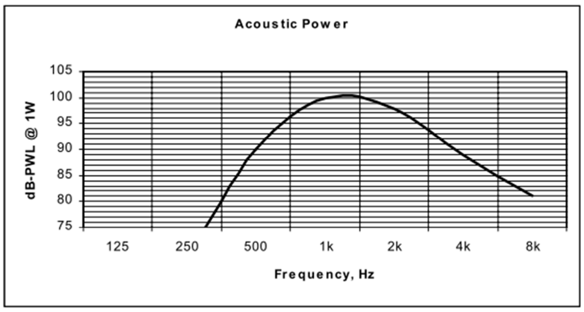
F:4 Highly directional projector loudspeaker MHS20T electro-acoustic characteristics



TECHNICAL SPECIFICATIONS	
Rated power, Watts	20
Tappings 100 volt line, Watts	20/10/5/2.5/1.25
Transformer Impedance, Ohms, 100V	500/1k/2k/4k
Tappings 70.7 volt line, Watts	10/5/2.5/1.25
Driver impedance, Ohms	20
Effective frequency range, Hz (BSEN60268-5)	300-16,500
S.P.L. @ 1m, 1 watt, dB, Test Signal Bandwidth 100Hz-10 kHz	101
S.P.L. @ Full power Octave Bandwidth, dB	114
Acoustic Power (dB-PWL@1 watt) 1 k/2kHz, dB	100/98
Dispersion at 1k/2k Hz, Degrees	120/80
Directivity Axial Q factor, 1k/2kHz	4.7/12.5
Dimensions, front & depth, mm	Ø217x297
Net weight, Kgs	2.7
Colour/Finish	Grey RAL7035
Material	Die cast aluminium housing
Mounting	Lockable stainless steel U bracket







F:5 Prediction results averaged over five test positions and standard deviation for seven different loudspeaker configurations

		f (Hz)						
		125	250	500	1000	2000	4000	8000
ORIGINAL	EDT	2.36	2.58	2.39	2.41	2.33	2.01	1.56
	EDT std	0.13	0.13	0.13	0.13	0.13	0.10	0.06
	RT 30	2.91	2.88	2.68	2.67	2.44	1.94	1.47
	RT30 std	0.07	0.05	0.06	0.05	0.06	0.03	0.02
	D50	25.2	22.9	27.6	25.56	35.5	37.9	47.76
	D50 std	1.29	0.79	1.36	1.43	1.49	1.80	1.21
	EDT/RT30	0.81	0.9	0.89	0.905	0.95	1.03	1.06
Project wall	EDT	2.33	2.54	2.36	2.37	2.20	1.97	1.22
	EDT std	0.12	0.13	0.13	0.12	0.11	0.09	0.05
	RT 30	2.84	2.83	2.68	2.60	2.27	1.91	1.19
	RT30 std	0.06	0.05	0.06	0.06	0.05	0.03	0.03
	D50	26.60	23.08	24.86	29.18	38.56	43.96	66.78
	D50 std	1.01	0.57	0.65	1.30	1.30	1.53	1.23
	EDT/RT30	0.82	0.89	0.88	0.912	0.97	1.03	1.03
HighProjetc	EDT	2.36	2.59	2.36	2.294	2.18	1.95	1.226
	EDT std	0.12	0.12	0.12	0.111	0.1	0.07	0.099
	RT 30	2.85	2.86	2.59	2.412	2.17	1.88	1.166
	RT30 std	0.06	0.15	0.14	0.102	0.05	0.04	0.049
	D50	25.9	23	27.9	33.46	46.4	59.6	74.72
	D50 std	1.4	1.01	1.36	1.496	1.64	2.2	3.349
	EDT/RT30	0.83	0.91	0.91	0.951	1	1.04	1.051
Project Ceiling	EDT	2.28	2.50	2.32	2.32	2.15	1.88	1.16
	EDT std	0.11	0.12	0.11	0.12	0.09	0.08	0.02
	RT 30	2.85	2.85	2.69	2.61	2.28	1.91	1.18
	RT30 std	0.06	0.05	0.06	0.06	0.05	0.03	0.02
	D50	27.18	23.72	26.18	28.88	37.20	45.14	67.36
	D50 std	0.90	0.89	1.11	1.11	1.70	1.83	0.66
	EDT/RT30	0.8	0.88	0.86	0.89	0.94	0.98	0.98
Project Low	EDT	2.30	2.52	2.34	2.33	2.15	1.87	1.10
	EDT std	0.13	0.13	0.12	0.12	0.10	0.06	0.02
	RT 30	2.80	2.81	2.65	2.58	2.26	1.91	1.19
	RT30 std	0.07	0.06	0.07	0.07	0.05	0.04	0.03
	D50	36.9	36.1	39.4	43.28	54.1	61.2	77.90
	D50 std	1.25	1.42	1.47	1.59	1.76	1.96	1.13
	EDT/RT30	0.82	0.9	0.88	0.906	0.95	0.98	0.93
Column @3m	EDT	2.35	2.57	2.38	2.41	2.32	2.00	1.23
	EDT std	0.12	0.12	0.12	0.12	0.12	0.10	0.02
	RT 30	2.93	2.90	2.70	2.68	2.45	1.95	1.18
	RT30 std	0.06	0.05	0.06	0.05	0.06	0.03	0.02
	D50	24.98	22.80	27.18	25.16	32.22	34.28	49.74
	D50 std	1.08	0.59	0.93	0.58	1.59	1.65	3.03
	EDT/RT30	0.8	0.88	0.88	0.899	0.95	1.03	1.04
Column 7m	EDT	2.36	2.58	2.40	2.42	2.33	2.01	1.23
	EDT std	0.13	0.13	0.11	0.12	0.12	0.08	0.03
	RT 30	2.93	2.91	2.70	2.68	2.45	1.95	1.18
	RT30 std	0.06	0.05	0.06	0.06	0.06	0.03	0.02
	D50	25.04	23.34	26.90	25.22	31.96	33.36	46.68
	D50 std	1.89	2.29	3.29	2.63	7.65	9.14	13.51
	EDT/RT30	0.81	0.89	0.89	0.902	0.95	1.03	1.04

STI	R1	R3	R5	R8	R11	Average	std
Original	0.44	0.44	0.44	0.43	0.43	0.44	0.01
Project on wall	0.47	0.47	0.46	0.46	0.46	0.46	0.00
HiProject on wall	0.50	0.50	0.49	0.49	0.49	0.50	0.00
Project on ceiling	0.47	0.47	0.46	0.46	0.46	0.46	0.00
Project low	0.54	0.54	0.53	0.53	0.54	0.54	0.01
Column 3m	0.42	0.44	0.43	0.43	0.46	0.44	0.01
Column 7m	0.41	0.46	0.41	0.40	0.45	0.43	0.03

F:6 Prediction results averaged over five test positions and corresponding standard deviation for various air temperatures at 50% RH on platform 1.

	f (Hz)						
EDT	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
EDT (15℃)	2.376	2.602	2.43	2.458	2.316	1.872	1.288
std	0.13	0.13	0.13	0.13	0.13	0.10	0.03
EDT (20℃)	2.36	2.584	2.386	2.412	2.33	2.006	1.56
std	0.13	0.13	0.13	0.13	0.13	0.10	0.06
EDT (25℃)	2.34	2.55	2.35	2.36	2.29	2.06	1.84
std	0.13	0.13	0.12	0.13	0.12	0.11	0.07
EDT (30℃)	2.324	2.536	2.316	2.296	2.242	2.078	2.09
std	0.12	0.12	0.12	0.11	0.12	0.10	0.08
RT30							
RT30 (15℃)	2.93	2.898	2.734	2.704	2.422	1.816	1.236
std	0.08	0.05	0.06	0.05	0.06	0.03	0.03
RT30 (20℃)	2.91	2.882	2.682	2.666	2.44	1.94	1.47
std	0.07	0.05	0.06	0.05	0.06	0.03	0.02
RT30 (25℃)	2.78	2.81	2.59	2.55	2.39	2.03	1.75
std	0.20	0.10	0.09	0.08	0.05	0.06	0.07
RT30 (30℃)	2.912	2.848	2.61	2.526	2.328	2.036	1.96
std	0.06	0.05	0.05	0.06	0.06	0.03	0.02
D50							
D50 (15℃)	24.84	22.88	27.664	25.38	35.74	40.26	54.4
std	1.0431	1.1649	0.9947	1.011	1.155	1.988	1.53
D50 (20℃)	25.16	22.92	27.62	25.56	35.54	37.92	47.76
std	1.2896	0.7887	1.3572	1.431	1.493	1.796	1.21
D50 (25℃)	25.36	22.9	28.04	25.9	35.82	38.48	48.88
std	0.6877	0.7778	1.3831	0.941	1.291	2.495	13.18
D50 (30℃)	25.3	23.02	28.5	27	36.86	37.02	38.32
std	1.1091	0.923	1.0368	1.223	1.322	1.659	0.638
total SPL							
SPL (15℃)	83.96	91.08	86.56	87.84	82.02	75.14	61.94
std	0.29	0.22	0.21	0.24	0.26	0.24	0.11
SPL (20℃)	84.04	91.16	86.64	87.88	82.06	75.44	62.62
std	0.24	0.27	0.24	0.25	0.22	0.24	0.13
SPL (25℃)	84.02	91.16	86.64	87.82	82.06	75.62	63.26
std	0.27	0.27	0.24	0.26	0.27	0.27	0.15
SPL (30℃)	84.00	91.10	86.58	87.74	82.00	75.68	63.76
std	0.24	0.30	0.19	0.24	0.23	0.26	0.09

	15ºC [ref]	20ºC	25ºC	30ºC
STI	0.444	0.436	0.431	0.428
std	0.004	0.004	0.004	0.005

F:7 Parameters prediction results averaged over five test positions and corresponding standard deviation for various air relative humidity values at 20C° on platform 1.

	f (Hz)						
EDT	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
EDT (RH 20%)	2.352	2.578	2.388	2.358	2.026	1.348	0.83
std	0.13	0.13	0.13	0.12	0.11	0.05	0.03
EDT (RH 40%)	2.356	2.578	2.392	2.418	2.284	1.858	1.288
std	0.14	0.14	0.12	0.13	0.12	0.09	0.03
EDT (RH 60%)	2.36	2.58	2.39	2.41	2.33	2.01	1.56
std	0.13	0.13	0.13	0.13	0.13	0.10	0.06
EDT (RH 80%)	2.362	2.588	2.384	2.398	2.344	2.19	2.242
std	0.13	0.13	0.13	0.13	0.13	0.12	0.10
RT30	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
RT30 (RH 20%)	2.902	2.882	2.702	2.582	2.032	1.292	0.772
std	0.06	0.04	0.05	0.06	0.04	0.03	0.02
RT30 (RH 40%)	2.898	2.882	2.696	2.672	2.392	1.804	1.226
std	0.06	0.04	0.05	0.05	0.06	0.03	0.03
RT30 (RH 60%)	2.80	2.83	2.63	2.62	2.42	1.96	1.49
std	0.21	0.10	0.10	0.08	0.05	0.06	0.06
RT30 (RH 80%)	2.918	2.91	2.698	2.646	2.476	2.162	2.102
std	0.05	0.05	0.05	0.05	0.06	0.03	0.02
D50	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
D50 (RH 20%)	25.36	23	27.54	26.18	39.8	51.38	71.74
std	0.9236	1.0223	1.4926	1.507	1.944	1.82	1.476
D50 (RH 40%)	25.08	22.9	27.64	25.42	35.62	40.38	54.22
std	1.1649	1.3266	1.2381	1.297	1.377	1.855	1.11
D50 (RH 60%)	25.16	22.92	27.62	25.56	35.54	37.92	47.76
std	1.2896	0.7887	1.3572	1.431	1.493	1.796	1.21
D50 (RH 80%)	24.66	22.82	27.68	25.62	34.8	35.28	35.94
std	1.0065	1.0035	1.3424	0.955	1.639	1.605	0.847
SPL	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
SPL (RH 20%)	83.92	91.08	86.6	87.68	81.46	73.78	60.28
std	0.2168	0.1924	0.2236	0.239	0.195	0.249	0.11
SPL (RH 40%)	83.84	91.04	86.52	87.74	81.92	75.1	61.94
std	0.2608	0.2608	0.2168	0.261	0.217	0.224	0.134
SPL (RH 60%)	84.04	91.16	86.64	87.88	82.06	75.44	62.62
std	0.2408	0.2702	0.2408	0.249	0.219	0.241	0.13
SPL (RH 80%)	84.04	91.2	86.66	87.86	82.14	75.86	64.04
std	0.251	0.2449	0.2191	0.27	0.241	0.27	0.134

	RH %			
	20	**40**	**50**	**80**
STI	0.481	0.445	0.436	0.419
std	0.004	0.005	0.004	0.004

F:8 Prediction results averaged over five test position and corresponding standards deviation for different platform surfaces scattering coefficients

	f(Hz)						
EDT	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
0%	2.62	2.85	2.62	2.61	2.48	2.08	1.60
std	0.04	0.05	0.14	0.06	0.08	0.08	0.05
5%	2.51	2.71	2.60	2.62	2.35	2.07	1.56
std	0.11	0.07	0.15	0.12	0.11	0.15	0.06
10%	2.37	2.57	2.44	2.42	2.30	2.00	1.55
std	0.06	0.06	0.07	0.06	0.08	0.06	0.04
High	2.24	2.45	2.28	2.31	2.23	1.98	1.53
std	0.05	0.07	0.06	0.08	0.08	0.09	0.02
Measured	2.45	2.81	2.66	2.60	2.46	2.16	1.50
std	0.18	0.08	0.07	0.19	0.14	0.09	0.07
JND	0.25	0.28	0.27	0.26	0.25	0.22	0.15
RT30							
0%	3.50	3.40	3.07	3.02	2.68	1.94	1.44
std	0.09	0.07	0.05	0.04	0.05	0.03	0.01
5%	2.91	2.88	2.68	2.67	2.44	1.94	1.47
std	0.07	0.05	0.06	0.05	0.06	0.03	0.02
10%	2.65	2.70	2.52	2.52	2.33	1.95	1.48
std	0.08	0.05	0.06	0.06	0.04	0.03	0.02
High	2.57	2.67	2.48	2.44	2.29	2.00	1.49
std	0.08	0.18	0.24	0.13	0.10	0.09	0.02
Measured	2.44	2.96	2.73	2.67	2.51	2.21	1.53
std	0.11	0.17	0.04	0.15	0.08	0.07	0.03
JND	0.24	0.30	0.27	0.27	0.25	0.22	0.15
D50							
0%	24.54	22.50	27.24	25.26	34.94	37.88	47.38
std	0.78	0.80	0.97	0.90	1.15	1.51	0.98
5%	25.16	22.92	27.62	25.56	35.54	37.92	47.76
std	1.29	0.79	1.36	1.43	1.49	1.80	1.21
10%	24.98	23.18	28.14	25.62	35.70	38.42	48.24
std	1.56	0.80	1.13	1.43	1.34	1.65	0.67
High	25.50	23.52	28.64	25.90	36.62	38.60	49.74
std	1.09	1.94	1.82	1.93	2.28	3.18	1.44
Measured	n/a	n/a	n/a	n/a	n/a	n/a	n/a
total SPL							
0%	84.02	91.16	86.62	87.88	82.04	75.36	62.58
std	0.22	0.19	0.22	0.22	0.19	0.22	0.13
5%	84.04	91.16	86.64	87.88	82.06	75.44	62.62
std	0.24	0.27	0.24	0.25	0.22	0.24	0.13
10%	84.08	91.26	86.80	87.98	82.28	75.72	62.78
std	0.35	0.36	0.37	0.34	0.35	0.33	0.16
High	84.02	91.24	86.76	87.98	82.28	75.78	62.78
std	0.26	0.34	0.31	0.29	0.29	0.25	0.11
Measured	n/a	n/a	n/a	n/a	n/a	n/a	n/a

	Receiver Position						
	R1	**R3**	**R5**	**R8**	**R11**	**Averg**	**std**
0%	0.43	0.44	0.44	0.44	0.42	0.43	0.006
5%	0.44	0.44	0.44	0.43	0.43	0.44	0.00
10%	0.44	0.45	0.44	0.43	0.44	0.44	0.00
High	0.45	0.45	0.43	0.43	0.44	0.44	0.01
Measured	0.46	0.45	0.42	0.43	0.46	0.44	0.018

F:9 EDT (sec) predictions for different absorption arrangement cases

Absorption arrangement case	f (Hz)						
R1	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.66	2.95	2.7	2.73	2.62	2.25	1.62
REF Crosspassages open (0%)	**2.45**	**2.68**	**2.48**	**2.5**	**2.41**	**2.05**	**1.6**
C 1 Absorbing plane centered (+4%)	2.49	2.34	1.85	1.85	1.78	1.51	1.22
D 1 Absorbing plane by speakers (+4%)	2.49	2.31	1.78	1.84	1.72	1.46	1.2
E 3 Continuos Absorbing planes (+12%)	2.55	1.89	1.18	1.21	1.15	0.94	0.84
F 3 Spaced Absorbing planes (+12%)	2.54	1.91	1.22	1.26	1.18	0.98	0.84
B End Walls (+1.2%)	2.29	2.2	1.95	1.97	1.97	1.75	1.45
R2	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.55	2.82	2.59	2.62	2.51	2.14	1.53
REF Crosspassages open (0%)	2.36	2.6	2.39	2.41	2.34	1.99	1.56
C 1 Absorbing plane centered (+4%)	2.4	2.26	1.75	1.79	1.72	1.42	1.16
D 1 Absorbing plane by speakers (+4%)	2.42	2.25	1.72	1.79	1.7	1.39	1.17
E 3 Continuos Absorbing planes (+12%)	2.47	1.82	1.12	1.16	1.04	0.86	0.8
F 3 Spaced Absorbing planes (+12%)	2.48	1.83	1.15	1.18	1.07	0.91	0.8
B End Walls (+1.2%)	2.21	2.1	1.83	1.84	1.83	1.64	1.38
R5	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.37	2.61	2.42	2.44	2.36	2.04	1.51
REF Crosspassages open (0%)	2.2	2.42	2.23	2.26	2.17	1.88	1.51
C 1 Absorbing plane centered (+4%)	2.23	2.1	1.62	1.63	1.55	1.39	1.14
D 1 Absorbing plane by speakers (+4%)	2.22	2.09	1.59	1.63	1.54	1.38	1.13
E 3 Continuos Absorbing planes (+12%)	2.31	1.65	1.05	1.06	1.05	0.91	0.81
F 3 Spaced Absorbing planes (+12%)	2.31	1.68	1.09	1.11	1.07	0.95	0.79
B End Walls (+1.2%)	2.04	1.95	1.67	1.68	1.64	1.58	1.46
R8	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.41	2.64	2.46	2.48	2.38	2.08	1.5
REF Crosspassages open (0%)	2.27	2.48	2.29	2.32	2.24	1.96	1.5
C 1 Absorbing plane centered (+4%)	2.29	2.15	1.65	1.66	1.62	1.42	1.15
D 1 Absorbing plane by speaker (+4%)	2.3	2.15	1.62	1.67	1.57	1.4	1.14
E 3 Continuos Absorbing planes (+12%)	2.36	1.71	1.07	1.08	1.04	0.94	0.78
F 3 Spaced Absorbing planes (+12%)	2.36	1.73	1.11	1.13	1.09	0.97	0.81
B End Walls (+1.2%)	2.09	2.01	1.72	1.73	1.72	1.63	1.42
R11	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.65	2.91	2.7	2.73	2.62	2.26	1.66
REF Crosspassages open (0%)	2.52	2.74	2.54	2.57	2.49	2.15	1.63
C 1 Absorbing plane centered (+4%)	2.53	2.38	1.91	1.92	1.85	1.57	1.2
D 1 Absorbing plane by speakers (+4%)	2.53	2.37	1.84	1.92	1.8	1.53	1.2
E 3 Continuos Absorbing planes (+12%)	2.58	1.95	1.24	1.27	1.16	0.99	0.81
F 3 Spaced Absorbing planes (+12%)	2.58	1.97	1.29	1.32	1.23	1.01	0.88
B End Walls (+1.2%)	2.34	2.28	2	2.01	2.01	1.81	1.46
EDT std	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	0.13	0.15	0.13	0.14	0.13	0.10	0.07
REF Crosspassages open (0%)	0.13	0.13	0.13	0.13	0.13	0.10	0.06
C 1 Absorbing plane centered (+4%)	0.13	0.12	0.12	0.12	0.12	0.08	0.03
D 1 Absorbing plane by speakers (+4%)	0.13	0.11	0.11	0.12	0.11	0.06	0.03
E 3 Continuos Absorbing planes (+12%)	0.12	0.12	0.08	0.09	0.06	0.05	0.02
F 3 Spaced Absorbing planes (+12%)	0.12	0.12	0.08	0.09	0.07	0.04	0.04
B End Walls (+1.2%)	0.13	0.13	0.14	0.14	0.16	0.09	0.03
EDT Averages Absolute	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (- 2%)	2.53	2.79	2.57	2.60	2.50	2.15	1.56
B Crosspassages open (Ref) (0%)	2.36	2.58	2.39	2.41	2.33	2.01	1.56
JND	0.24	0.26	0.24	0.24	0.23	0.20	0.16
C 1 Absorbing plane centered (+4%)	2.39	2.25	1.76	1.77	1.70	1.46	1.17
D 1 Absorbing plane by speakers (+4%)	2.39	2.23	1.71	1.77	1.67	1.43	1.17
E 3 Continuos Absorbing planes (+12%)	2.45	1.80	1.13	1.16	1.09	0.93	0.81
F 3 Spaced Absorbing planes (+12%)	2.56	2.01	1.47	1.48	1.30	1.05	0.84
B End Walls (+1.2%)	2.24	2.05	1.69	1.70	1.68	1.53	1.31

F:10 RT30 (sec) predictions for different absorption arrangement cases

Absorption arrangement case	f (Hz)						
R1	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.97	2.98	2.79	2.77	2.56	2.09	1.49
REF Crosspassages open (0%)	2.98	2.93	2.73	2.71	2.5	1.97	1.49
C 1 Absorbing plane centered (+4%)	2.98	2.8	2.6	2.55	2.18	1.61	1.19
D 1 Absorbing plane by speakers (+4%)	2.97	2.8	2.56	2.61	2	1.58	1.17
E 3 Continuos Absorbing planes (+12%)	2.95	2.76	2.67	2.63	1.93	1.42	0.88
F 3 Spaced Absorbing planes (+12%)	2.99	2.81	2.75	2.69	2.03	1.43	0.88
B End Walls (+1.2%)	2.48	2	1.67	1.69	1.66	1.54	1.37
R2	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.93	2.97	2.76	2.75	2.54	2.06	1.47
REF Crosspassages open (0%)	2.96	2.92	2.73	2.7	2.48	1.95	1.47
C 1 Absorbing plane centered (+4%)	2.96	2.79	2.56	2.53	2.13	1.58	1.16
D 1 Absorbing plane by speakers (+4%)	2.96	2.79	2.53	2.58	2.01	1.55	1.14
E 3 Continuos Absorbing planes (+12%)	2.94	2.75	2.62	2.57	1.88	1.4	0.86
F 3 Spaced Absorbing planes (+12%)	2.99	2.78	2.69	2.63	1.95	1.4	0.86
B End Walls (+1.2%)	2.21	2.1	1.83	1.84	1.83	1.64	1.38
R5	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.87	2.93	2.71	2.71	2.48	2.04	1.45
REF Crosspassages open (0%)	2.83	2.83	2.62	2.61	2.38	1.91	1.45
C 1 Absorbing plane centered (+4%)	2.87	2.67	2.4	2.35	2.02	1.52	1.14
D 1 Absorbing plane by speakers (+4%)	2.84	2.67	2.3	2.36	1.91	1.48	1.12
E 3 Continuos Absorbing planes (+12%)	2.85	2.58	2.37	2.35	1.82	1.24	0.85
F 3 Spaced Absorbing planes (+12%)	2.87	2.6	2.47	2.46	1.92	1.27	0.85
B End Walls (+1.2%)	2.33	1.96	1.65	1.67	1.63	1.49	1.33
R8	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.85	2.92	2.7	2.71	2.48	2.03	1.44
REF Crosspassages open (0%)	2.83	2.82	2.62	2.61	2.37	1.91	1.45
C 1 Absorbing plane centered (+4%)	2.84	2.65	2.38	2.33	2	1.51	1.14
D 1 Absorbing plane by speakers (+4%)	2.83	2.65	2.28	2.34	1.89	1.48	1.12
E 3 Continuos Absorbing planes (+12%)	2.84	2.55	2.33	2.34	1.78	1.26	0.86
F 3 Spaced Absorbing planes (+12%)	2.85	2.58	2.47	2.42	1.87	1.27	0.86
B End Walls (+1.2%)	2.33	1.96	1.65	1.67	1.63	1.5	1.32
R11	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	2.96	2.97	2.77	2.76	2.55	2.07	1.48
REF Crosspassages open (0%)	2.95	2.91	2.71	2.7	2.47	1.96	1.49
C 1 Absorbing plane centered (+4%)	2.94	2.76	2.55	2.51	2.14	1.58	1.19
D 1 Absorbing plane by speakers (+4%)	2.53	2.37	1.84	1.92	1.8	1.53	1.2
E 3 Continuos Absorbing planes (+12%)	2.92	2.71	2.57	2.59	1.92	1.39	0.9
F 3 Spaced Absorbing planes (+12%)	2.97	2.76	2.74	2.7	2.01	1.4	0.89
B End Walls (+1.2%)	2.45	2	1.68	1.7	1.67	1.55	1.38
RT std	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	0.05	0.03	0.04	0.03	0.04	0.02	0.02
REF Crosspassages open (0%)	0.07	0.05	0.06	0.05	0.06	0.03	0.02
C 1 Absorbing plane centered (+4%)	0.06	0.07	0.10	0.11	0.08	0.04	0.03
D 1 Absorbing plane by speakers (+4%)	0.18	0.17	0.29	0.28	0.09	0.04	0.03
E 3 Continuos Absorbing planes (+12%)	0.05	0.10	0.15	0.14	0.06	0.08	0.02
F 3 Spaced Absorbing planes (+12%)	0.07	0.11	0.14	0.13	0.07	0.08	0.02
B End Walls (+1.2%)	0.11	0.06	0.08	0.07	0.08	0.06	0.03
RT Averages Absolute	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassage blocked (- 2%)	2.92	2.95	2.75	2.74	2.52	2.06	1.47
B Crosspassage open (Ref) (0%)	2.91	2.88	2.68	2.67	2.44	1.94	1.47
JND	0.29	0.29	0.27	0.27	0.24	0.19	0.15
C 1 Absorbing plane centered (+4%)	2.92	2.73	2.50	2.45	2.09	1.56	1.16
D 1 Absorbing plane by speakers (+4%)	2.83	2.66	2.30	2.36	1.92	1.52	1.15
E 3 Continuos Absorbing planes (+12%)	2.90	2.67	2.51	2.50	1.87	1.34	0.87
F 3 Spaced Absorbing planes (+12%)	2.93	2.71	2.62	2.58	1.96	1.35	0.87
B End Walls (+1.2%)	2.36	2.00	1.70	1.71	1.68	1.54	1.36

F:11 SPL (dB) predictions for different absorption arrangement cases

Absorption arrangement case	f (Hz)						
R1	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	84.2	91.4	86.8	88.1	82.2	75.6	62.6
REF Crosspassages open (0%)	83.9	91	86.5	87.7	81.9	75.3	62.6
C 1 Absorbing plane centered (+4%)	84	90.3	85.1	86.2	80.8	74.1	61.7
D 1 Absorbing plane by speakers (+4%)	84	89.8	84	84.3	80.4	74	61.8
E 3 Continuos Absorbing planes (+12%)	84.1	89.1	83.2	84.2	79.3	72.7	60.6
F 3 Spaced Absorbing planes (+12%)	84.1	89.1	83.2	84.1	79.2	72.6	60.5
B End Walls (+1.2%)	83.5	90	85.2	86.4	80.9	74.4	62.1
R2	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	84.4	91.6	87	88.3	82.4	75.9	62.8
REF Crosspassages open (0%)	83.8	90.9	86.4	87.7	81.9	75.2	62.7
C 1 Absorbing plane centered (+4%)	83.8	90.2	85.1	86.1	80.8	74.2	61.8
D 1 Absorbing plane by speakers (+4%)	83.9	89.7	84	84.1	80.3	74	61.8
E 3 Continuos Absorbing planes (+12%)	84	89	83.2	84.1	80.3	74	61.8
F 3 Spaced Absorbing planes (+12%)	84	89.1	83.1	84.2	79.3	72.8	60.5
B End Walls (+1.2%)	83.5	90	85.5	86.6	81.1	74.6	62.4
R5	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	84.7	91.8	87.3	88.5	82.6	76	62.8
REF Crosspassages open (0%)	84.3	91.4	86.9	88.1	82.3	75.7	62.7
C 1 Absorbing plane centered (+4%)	84.3	90.7	85.5	86.6	81.2	74.5	61.9
D 1 Absorbing plane by speakers (+4%)	84.4	90.2	84.4	84.7	80.7	74.3	61.9
E 3 Continuos Absorbing planes (+12%)	84.5	90.2	84.4	84.7	80.7	74.3	61.9
F 3 Spaced Absorbing planes (+12%)	84.6	89.5	83.5	84.4	79.6	73	60.6
B End Walls (+1.2%)	84.1	90	86.3	87.6	81.8	75.4	62.6
R8	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	84.6	91.8	87.2	88.4	82.5	75.9	62.8
REF Crosspassages open (0%)	84.3	91.5	86.9	88.2	82.3	75.7	62.7
C 1 Absorbing plane centered (+4%)	84.4	90.7	85.5	86.7	81.2	74.6	61.8
D 1 Absorbing plane by speakers (+4%)	84.4	90.2	84.5	84.7	80.8	74.4	61.8
E 3 Continuos Absorbing planes (+12%)	84.6	89.5	83.6	84.6	79.6	73	60.7
F 3 Spaced Absorbing planes (+12%)	84.6	89.5	83.5	84.6	79.5	72.9	60.5
B End Walls (+1.2%)	84.2	91	86.4	87.6	81.8	75.4	62.6
R11	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	84.1	91.2	86.7	87.9	82.1	75.4	62.3
REF Crosspassages open (0%)	83.9	91	86.5	87.7	81.9	75.3	62.4
C 1 Absorbing plane centered (+4%)	83.9	90.3	85	86.1	80.7	74.1	61.5
D 1 Absorbing plane by speakers (+4%)	84	89.8	84	84.2	81.3	74	61.5
E 3 Continuos Absorbing planes (+12%)	84.1	89	83.1	84	79.2	72.6	60.4
F 3 Spaced Absorbing planes (+12%)	84.1	89	83.1	84	79.2	72.6	60.2
B End Walls (+1.2%)	83.6	90.2	85.4	86.6	81	74.6	62
SPL std	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	0.25	0.26	0.25	0.24	0.21	0.25	0.22
REF Crosspassages open (0%)	0.24	0.27	0.24	0.25	0.22	0.24	0.13
C 1 Absorbing plane centered (+4%)	0.26	0.24	0.24	0.29	0.24	0.23	0.15
D 1 Absorbing plane by speakers (+4%)	0.24	0.24	0.25	0.28	0.39	0.19	0.15
E 3 Continuos Absorbing planes (+12%)	0.27	0.51	0.54	0.31	0.65	0.78	0.71
F 3 Spaced Absorbing planes (+12%)	0.29	0.24	0.20	0.24	0.18	0.18	0.15
B End Walls (+1.2%)	0.34	0.43	0.55	0.59	0.44	0.48	0.28
SPL Averages Absolute	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	84.4	91.56	87	88.24	82.36	75.76	62.66
REF Crosspassages open (0%)	84.04	91.16	86.64	87.88	82.06	75.44	62.62
C 1 Absorbing plane centered (+4%)	84.08	90.44	85.24	86.34	80.94	74.3	61.74
D 1 Absorbing plane by speakers (+4%)	84.14	89.94	84.18	84.4	80.7	74.14	61.76
E 3 Continuos Absorbing planes (+12%)	84.26	89.36	83.5	84.32	79.82	73.32	61.08
F 3 Spaced Absorbing planes (+12%)	84.28	89.24	83.28	84.26	79.36	72.78	60.46
B End Walls (+1.2%)	83.78	90.24	85.76	86.96	81.32	74.88	62.34

F:12 D50 (%) predictions for different absorption arrangement cases

Absorption arrangement case	f (Hz)						
R1	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	24	22	26.5	24.8	34.1	37.6	46.7
REF Crosspassages open (0%)	26.2	23.3	28.6	25.9	36.5	39.2	47.9
C 1 Absorbing plane centered (+4%)	25.4	27.6	39	36.4	46.8	50.4	58.3
D 1 Absorbing plane by speakers (+4%)	25.7	26.3	37.8	33.3	47.4	50.6	57.7
E 3 Continuos Absorbing planes (+12%)	24.5	35.4	57.2	55.3	64.3	68.9	72.3
F 3 Spaced Absorbing planes (+12%)	24.5	34.9	57.4	55.6	65.6	68.1	73.4
B End Walls (+1.2%)	27.33	27.6	35.9	33.5	45.8	47.2	53
R2	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	23.8	22	26.3	24	33.5	36.5	46.6
REF Crosspassages open (0%)	26.7	24.1	29.2	27.7	37.3	39.9	47.2
C 1 Absorbing plane centered (+4%)	26.6	27.7	39.6	37.2	48.1	50.7	56.5
D 1 Absorbing plane by speakers (+4%)	25.8	27.4	38.4	33.7	48.6	50.9	56.8
E 3 Continuos Absorbing planes (+12%)	25.5	36.1	57.3	55.2	64.9	67	72.5
F 3 Spaced Absorbing planes (+12%)	24.6	36.3	56.8	54.9	64.3	68.1	72.7
B End Walls (+1.2%)	27.8	28.7	36.9	33.9	45	46	49.8
R5	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	23	20.7	24.9	23.3	32	34.1	46.8
REF Crosspassages open (0%)	24	22.7	26.5	24.7	33.9	36.3	47.1
C 1 Absorbing plane centered (+4%)	22.9	25.6	36.2	33.8	43.6	46.3	57.1
D 1 Absorbing plane by speakers (+4%)	23.5	27.4	38.4	33.7	48.6	50.9	56.8
E 3 Continuos Absorbing planes (+12%)	23.1	33.3	53.1	52.7	62.1	64.9	72.4
F 3 Spaced Absorbing planes (+12%)	23.2	33.5	54.5	53	61.8	64.7	72.2
B End Walls (+1.2%)	24.8	24.4	29.6	29	38.3	38.9	47.6
R8	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	22	20.8	25	23.1	31.7	34.6	46.5
REF Crosspassages open (0%)	23.8	22.3	26	23.9	34.1	35.8	46.8
C 1 Absorbing plane centered (+4%)	23.4	25.2	35.8	34.1	43.6	46	57.5
D 1 Absorbing plane by speakers (+4%)	23.4	24.3	35.1	31.9	43.8	45.9	56
E 3 Continuos Absorbing planes (+12%)	22.3	33.2	53.9	52.4	61.2	64	72.7
F 3 Spaced Absorbing planes (+12%)	23	32.7	54.2	53.5	61.6	65.6	73.8
B End Walls (+1.2%)	24.8	24.4	29.9	27.8	37.9	38.3	47.5
R11	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	24	21.2	26.9	24.3	35	37.2	49.8
REF Crosspassages open (0%)	25.1	22.2	27.8	25.6	35.9	38.4	49.8
C 1 Absorbing plane centered (+4%)	23.9	26.8	38.1	36	47.1	50.1	59.7
D 1 Absorbing plane by speakers (+4%)	23.8	25.7	37.1	33.8	47.2	50.1	59
E 3 Continuos Absorbing planes (+12%)	23.5	34.5	56.6	55.2	64	67.5	75.9
F 3 Spaced Absorbing planes (+12%)	23	34.6	58	55.2	65	68.9	76.1
B End Walls (+1.2%)	26.1	27.5	35.1	32.4	44.1	45.1	54
D50 std	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassages blocked (-2%)	0.86	0.63	0.91	0.70	1.40	1.57	1.41
REF Crosspassages open (0%)	1.29	0.79	1.36	1.43	1.49	1.80	1.21
C 1 Absorbing plane centered (+4%)	1.53	1.14	1.68	1.48	2.10	2.34	1.24
D 1 Absorbing plane by speakers (+4%)	1.21	1.30	1.37	0.79	1.97	2.14	1.14
E 3 Continuos Absorbing planes (+12%)	1.25	1.27	1.97	1.47	1.57	1.99	1.54
F 3 Spaced Absorbing planes (+12%)	0.82	1.38	1.73	1.13	1.85	1.82	1.51
B End Walls (+1.2%)	1.39	1.99	3.47	2.75	3.81	4.18	3.01
D50 Averages Absolute	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
A Crosspassage blocked (- 2%)	23.36	21.34	25.92	23.9	33.26	36	47.28
B Crosspassage open (Ref) (0%)	25.16	22.92	27.62	25.56	35.54	37.92	47.76
JND	5.032	4.584	5.524	5.112	7.108	7.584	9.552
C 1 Absorbing plane centered (+4%)	24.44	26.58	37.74	35.5	45.84	48.7	57.82
D 1 Absorbing plane by speakers (+4%)	24.44	26.22	37.36	33.28	47.12	49.68	57.26
E 3 Continuos Absorbing planes (+12%)	23.78	34.5	55.62	54.16	63.3	66.46	73.16
F 3 Spaced Absorbing planes (+12%)	23.66	34.4	56.18	54.44	63.66	67.08	73.64
B End Walls (+1.2%)	26.166	26.52	33.48	31.32	42.22	43.1	50.38

F:13 STI predictions for different absorption arrangement cases

Absorption arrangement case	Receiver position R1	R2	R5	R8	R11	AVERAGE	std
A Crosspassages blocked (-1%)	0.422	0.423	0.423	0.422	0.421	**0.422**	0.001
REF Crosspassages open (0%)	0.440	0.440	0.440	0.430	0.430	**0.436**	0.005
C 1 Absorbing strip centered (+4%)	0.493	0.497	0.491	0.489	0.489	**0.4918**	0.003
D 1 Absorbing strip by speakers (+4%)	0.493	0.495	0.491	0.488	0.486	**0.4906**	0.004
E 3 Continuos Absorbing strips (+12%)	0.581	0.583	0.579	0.576	0.578	**0.5794**	0.003
F 3 Spaced Absorbing strips (+12%)	0.581	0.582	0.578	0.576	0.578	**0.579**	0.002
B End Walls (+1.2%)	0.48	0.482	0.466	0.462	0.473	**0.4726**	0.009

F:14 Firesound sound absorption material technical characteristics

H&H Group Ltd

Fire, Smoke and Toxicity Ratings

All thicknesses of **FireSound** achieve Euroclass Reaction to Fire Classification B–s2, d0 when tested in accordance with BS EN 13501-1.

30mm and 50mm **FireSound** meet the requirements of London Underground Standard 2-01001-002 for stations and tunnels with respect to Flammability, Toxic Fume and Smoke Emission requirements.

Thermal Conductivity - 0.040 W/mK @ 10ºC

Building Regulation Classification

FireSound panels are designed to assist clients in meeting the requirements of Building Bulletin 93 in educational facilities.

FireSound	Absorber Classification
30mm	C
50mm	A
75mm	A
100mm	A

Acoustic Performance

Product	Thickness mm	Sound Absorption Coefficient* 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
FireSound	30	0.08	0.42	1.00	1.00	1.00	1.00
	50	0.29	0.68	1.00	1.00	1.00	1.00
	75	0.50	0.81	1.00	1.00	1.00	1.00
	100	0.61	0.88	1.00	1.00	1.00	1.00

* The figures quoted are when **FireSound** is applied directly to a wall or ceiling.

Dimensions and Weight

Product	Nominal Thickness mm	Length mm	Width mm	Nominal Weight kg/m²
FireSound	30	2500	306	6
	50	2500	266 and 475	9
	75	2500	425	10
	100	2500	375	11

Note: Other thicknesses, widths and lengths may be available subject to minimum order quantities. Further details available on request

Moisture Resistance

FireSound panels will withstand high levels of humidity with no detrimental effect. The sound absorbing infill is moisture resistant.

Handling and Storage

FireSound should be stored flat, under cover in a dry, well-ventilated area protected from dirt and dust. Care should be taken when handling to prevent damage and scratching.

Application and Fixing

FireSound panels are generally fixed to walls by retaining them between colour co-ordinated metal top, bottom and end channels with concealed fixings. Further details available on request.

When fixing **FireSound** panels horizontally - below ceilings, soffits, etc. contact **Hodgson & Hodgson Group Ltd** for specialist advice.

For Further Information
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Appendix G

G.1 Evaluating parameter predictions values at receiver 9 for increasing number of platform loudspeakers

Number of Speakers	EDT (500Hz) (sec)	RT30 (500Hz) (sec)	EDT(500Hz)/ RT30(500Hz)	EDT (2kHz) (sec)	RT30 (2kHz) (sec)	EDT(2kHz)/ RT30(2kHz)	SPL (dBA)	STI
1	1.33	2.45	0.54	1.1	2.3	0.48	84.4	0.71
3	1.76	2.63	0.67	1.57	2.4	0.65	87.1	0.62
5	1.81	2.56	0.71	1.78	2.37	0.75	88.3	0.57
7	1.91	2.59	0.74	1.91	2.38	0.80	89.2	0.54
9	1.98	2.59	0.76	1.95	2.38	0.82	89.7	0.51
11	2.03	2.58	0.79	1.95	2.39	0.82	90.2	0.50
13	2.06	2.67	0.77	1.99	2.44	0.82	90.5	0.48
15	2.08	2.61	0.80	2.02	2.39	0.85	90.8	0.47
17	2.13	2.61	0.82	2.07	2.38	0.87	91	0.46
19	2.19	2.6	0.84	2.11	2.37	0.89	91.1	0.46
21	2.23	2.58	0.86	2.17	2.35	0.92	91.3	0.45
23	2.28	2.56	0.89	2.21	2.34	0.94	91.4	0.45
Sabine RT	2.15	2.15	1.00	2.08	2.08	1.00	-	-

G.2 Evaluating parameter predictions values at receiver 8 for increasing number of platform loudspeakers

Number of Speakers	EDT (500Hz) (sec)	RT30 (500Hz) (sec)	EDT(500Hz)/ RT30(500Hz)	EDT (2kHz) (sec)	RT30 (2kHz) (sec)	EDT(2kHz)/ RT30(2kHz)	SPL (dBA)	STI
1	1.87	2.52	0.74	1.57	2.35	0.67	82.4	0.61
3	1.83	2.63	0.70	1.89	2.4	0.79	86.4	0.57
5	1.87	2.56	0.73	1.88	2.38	0.79	87.9	0.53
7	1.96	2.59	0.76	1.94	2.38	0.82	88.8	0.50
9	1.98	2.58	0.77	1.96	2.39	0.82	89.4	0.48
11	2.06	2.57	0.80	2.01	2.39	0.84	89.9	0.47
13	2.13	2.67	0.80	2.05	2.44	0.84	90.1	0.45
15	2.09	2.6	0.80	2.06	2.39	0.86	90.6	0.44
17	2.14	2.61	0.82	2.08	2.38	0.87	90.8	0.43
19	2.17	2.59	0.84	2.12	2.37	0.89	90.9	0.43
21	2.2	2.58	0.85	2.14	2.35	0.91	91	0.42
23	2.24	2.56	0.88	2.2	2.34	0.94	91.2	0.41
Measured	2.67	2.76	0.97	2.41	2.47	0.98	-	0.43
Sabine RT	2.15	2.15	1	2.08	2.08	1	-	0.412

G.3 Evaluating parameter prediction differences between receivers 8 and 9 for increasing number of platform loudspeakers

Number of Speakers	EDT (sec) @500Hz (R9)-(R8)	RT30 (sec) @500Hz (R9)-(R8)	EDT (sec) @2kHz (R9)-(R8)	RT30 (sec) @2kHz (R9)-(R8)	SPL(dBA) (R9)-(R8)	STI (R9)-(R8)
1	-0.54	-0.07	-0.47	-0.05	2	0.107
3	-0.07	0	-0.32	0	0.7	0.047
5	-0.06	0	-0.1	-0.01	0.4	0.032
7	-0.05	0	-0.03	0	0.4	0.032
9	0	0.01	-0.01	-0.01	0.3	0.03
11	-0.03	0.01	-0.06	0	0.3	0.03
13	-0.07	0	-0.06	0	0.4	0.033
15	-0.01	0.01	-0.04	0	0.2	0.029
17	-0.01	0	-0.01	0	0.2	0.031
19	0.02	0.01	-0.01	0	0.2	0.029
21	0.03	0	0.03	0	0.3	0.031
23	0.04	0	0.01	0	0.2	0.031