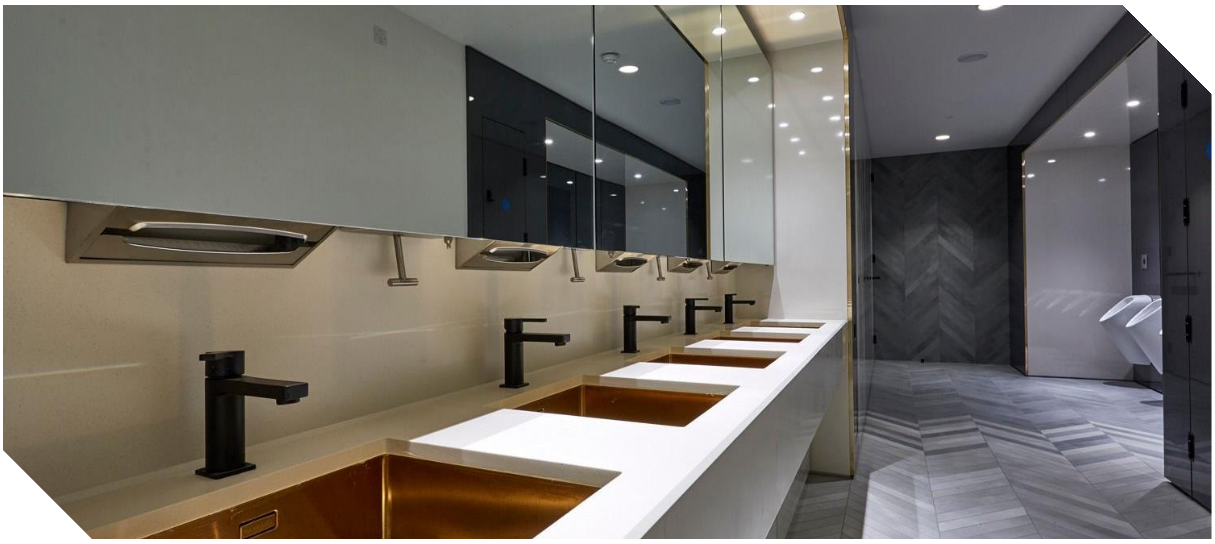
Maxwood Washrooms

Acoustic Performance of Partitions

Report 279D.RP.1.DRAFT // 30 June 2022



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Document Details

Title	Acoustic Performance of Partitions
Project	Maxwood Washrooms
Reference	279D.RP.1

Revision	Date	Author(s)	Reviewer
DRAFT	30 June 2022	RM	BHo

Contents

1.0 Introduction

1.1 Maxwood Washrooms (MW) are designers, manufacturers, and suppliers of high-end commercial washroom products, including a number of partition systems. There is a growing need to demonstrate the acoustic separation performance providing by their partition systems to prospective clients, system specifiers and other similar parties.

1.2 This report provides details of sound insulation testing undertaken at Maxwood Washrooms' showrooms in Farringdon, London. In-situ acoustic separation performance data is provided to empower the user of MW's systems to make informed decisions with regard to the selection and implementation of their products, when considering a project's acoustic requirements.

1.3 The testing set out within this report is not intended to be equivalent to or representative of laboratory test data, but instead provide a realistic indication of the performance that may be achieved on site by the MW partition systems.

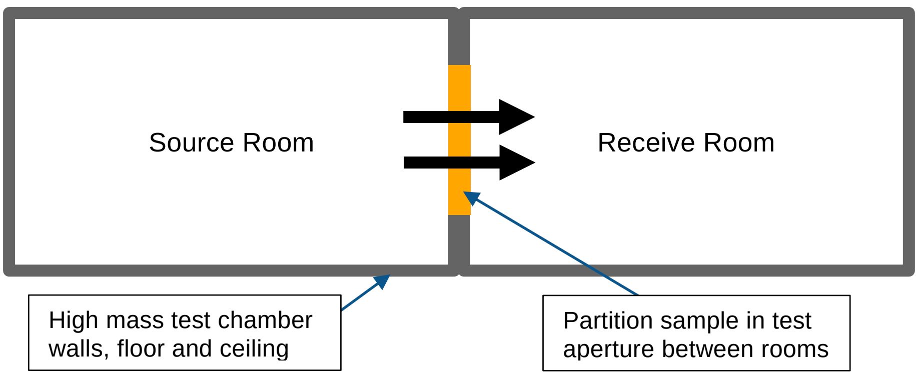
2.0 Principles of Acoustic Separation

2.1 The sound insulation between two adjacent spaces provide by a separating element can be described in myriad ways. There are however two main types of data that are typically available to define/describe sound insulation as described below.

Laboratory test data

2.2 Measurements of sound insulation are undertaken in laboratory test chambers, in accordance with specific testing standards. Lab testing of separating elements typically only considers sound transmission directly through the elements being tested and not via flanking pathways. This principle is visualised in the image below, with sound transmission pathways indicated by **black** arrows:

Image 2 – example laboratory acoustic test configuration



2.3 Laboratory test data for partition construction is typically provided (in the UK) in terms of decibel (dB) "sound reduction indices/index" (SRI), with the notation "R_w" or "R" depending on what is being presented. For example, a particular partition construction may be described as having a single figure rating of R_w 40 dB.

2.4 The SRI is calculated by correcting the measured reduction in noise level across a given separating element for both area of test sample and the reverberation time in the receiving space. This standardises the performance figure so the acoustic rating of different construction types can be easily compared.

2.5 It is important to understand that laboratory test data is not typically representative of the sound insulation performance a given partition construction would achieve when installed on site. This is because for a partition construction in-situ, sound energy will not only pass through the main separating element but around other adjoining elements such as walls, floor, ceilings and any gaps or weaknesses in construction that may be present.

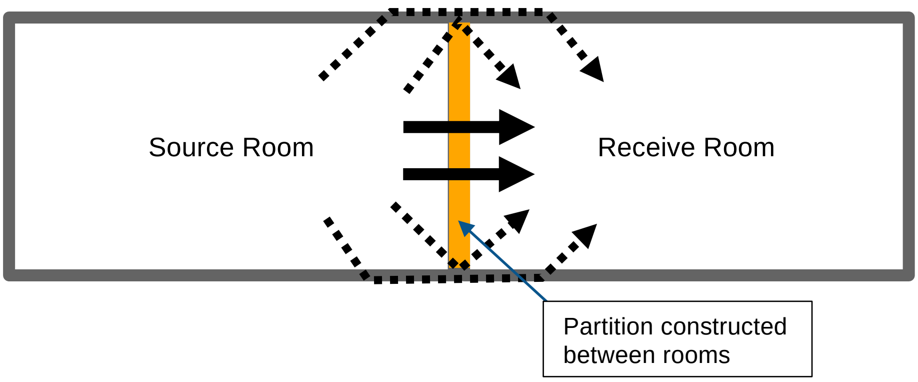
2.6 There is no fully reliable rule of thumb, or direct relationship between laboratory acoustic test performance and the sound insulation performance achieved on site, where significant flanking sound transmission pathways influence the measurements. The on-site sound insulation performance of a separating element will however almost always be of a lower magnitude that measured in a laboratory.

In-situ/Site Test Data

2.7 Similar to laboratory data, in-situ/on-site sound insulation test data may also be measured in accordance with specific testing standards (although in some instances, indicative measurements of on-site sound insulation may be undertaken which do not conform strictly to standards).

2.8 Unlike lab testing, in-situ/on-site testing will always include the effects of any flanking sound transmission pathways that may be present around an installed partition construction (even where these effects are negligible). The acoustic effects of deficiencies in construction will also be accounted for in in-situ/on-site test data. The above principles are again visualised in the image below, with direct sound transmission pathways indicated by **solid black** arrows and example flanking sound transmission routes as **dashed black arrows**:

Image 3 – Example on-site acoustic test configuration



2.9 There are several acoustic indices used to described in-situ/site sound insulation test performance, with the one of the simplest being a "level difference" (D), or weighted level difference (D_w), both in dB, these are essentially the simple reduction in noise provided between two spaces when tested on site (the single figure rating D_w is based on the third octave band level difference figures compared against reference curves).

2.10 Care must be taken when comparing level difference data from different separations however the data can provide an indication of the actual sound insulation performance a given separating elements in a particular configuration will achieve when installed on site.

2.11 Another index that is sometimes used is to describe in-situ/site acoustic separation is the apparent sound reduction index, R' (pronounced R "dash") or weighted apparent sound reduction index, R'_w (pronounced R "dash" W). These indices include the same area and receive room acoustic absorption corrections as described in section 2.4, but applied to on-site measured level difference data for a separating element, inclusive of flanking and workmanship effects.

2.12 Despite the very similar nomenclature and notation, the above site test data figures (R' and R'_w) and the laboratory equivalents (R and R_w) must not be confused or used interchangeably. To prevent potential for confusion, sound insulation test data has not been presented in terms of apparent sound reduction index.

2.13 The most important consideration to bear in mind is that laboratory data and in-situ/site test data is not directly comparable without careful consideration by an acoustic consultant or similar.

Other Ways of Describing Acoustic Separation

2.14 Another method that can be used to describe the acoustic separation between adjacent spaces is the used of Speech Privacy Potential (SPP). The SPP method combines the partition sound insulation performance, expressed in terms of installed R'_w or achieved D_w, with the background noise level in the receiving room, expressed in terms of Noise Rating level (NR). The higher the resulting value of SPP for a given adjacency, the higher the level of privacy between the rooms.

2.15 The principle with SPP is that the background noise in the receiving room will mask noise transferred from a source room, be that speech or noise from other activity. The higher the sound insulation performance between the two spaces, or the higher the noise level in the receiving space, the less perceptible noise from the source room can be expected to be. Whilst SPP related to predominately to speech privacy which is not necessarily the type of noise that may emanate from a washroom, it provides useful context when considering figures in terms of D_w.

2.16 The following table provides objective descriptions for SPP ratings between 60 (no privacy) and 85 (total privacy). Perceptibility of noise is subjective and therefore how people experience privacy may vary from the descriptions below. It is however a useful concept to help contextualise the results of the acoustic testing undertaken at the MW showrooms:

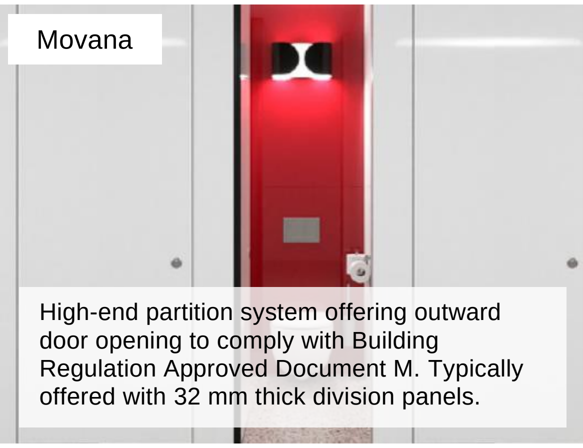
Table 1 SPP and corresponding subjective description of privacy for unamplified speech

Privacy Rating	**Speech Privacy Potential (SPP)**	**Description of Privacy**
Total Privacy	85	Shouting is only barely audible.
Highly Confidential	80	Normal voice levels not audible. Raised voices barely audible but not intelligible.
Excellent	75	Normal voice levels barely audible. Raised voices audible, but mostly unintelligible.
Good	70	Normal voices are audible but unintelligible most of the time. Raised voices are partially intelligible.
Fair	65	Normal voices audible and intelligible some of the time. Raised voices are intelligible.
Poor	60	Normal voices audible and intelligible most of the time.
None	< 60	No speech privacy.

2.17 The significance of background noise on speech privacy cannot be understated. Increasing the background noise by 5-10dB is easy to achieve and, providing the total level is not too high, can be quite acceptable. However, the enhancement of sound isolation by 5-10dB might require substantially more expensive constructions or a complete change to the configuration of a separating partition; with respect to the above table, a difference in SPP of 10 can be significant.

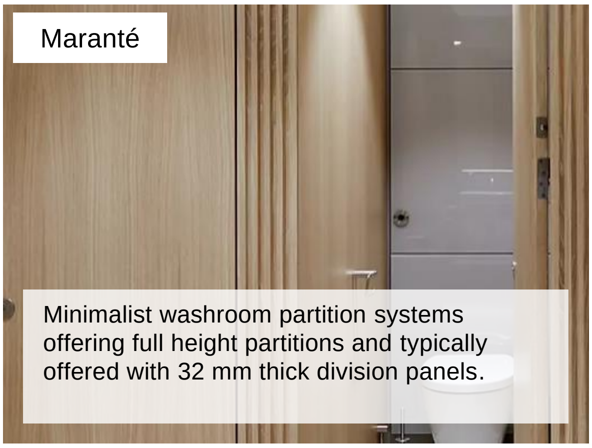
3.0 Partition Systems and Test Schedule

3.1 Four key MW partition/washroom systems have been tested as outlined below:



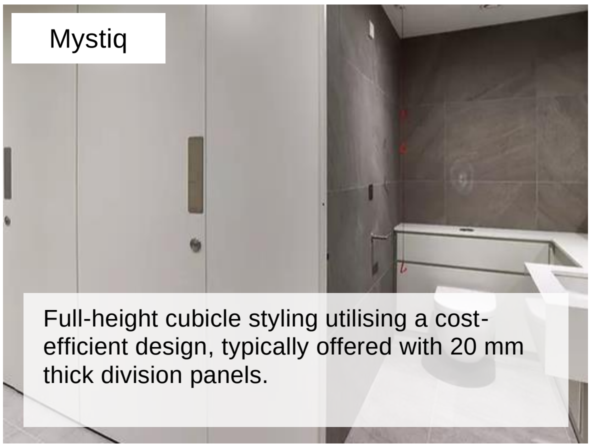
Movana

High-end partition system offering outward door opening to comply with Building Regulation Approved Document M. Typically offered with 32 mm thick division panels.



Maranté

Minimalist washroom partition systems offering full height partitions and typically offered with 32 mm thick division panels.



Mystiq

Full-height cubicle styling utilising a cost-efficient design, typically offered with 20 mm thick division panels.

Superloo

Designed as a space-saving single washroom units that fit into small spaces. Typically enclosed by plasterboard partitions and Superloo door system.

3.2 Each of the above system types can be provided with division panel thicknesses configured to meet specific project requirements. The washroom systems may also be used in combination with single stud plasterboard partitions instead of the standard division panels.

3.3 The following image below shows the arrangement of the washroom systems above within the MW showrooms. Cubicles have been given notional numbers for ease of reference.

Image 1 – Maxwood Washrooms Showroom Layout

Superloo shown in **grey**, Maranté cubicles **orange** (noting that the cubicle nearest to the Superloo had no door and was open to the meeting room space), Mystiq cubicles in **blue**, Movana cubicles in **red**, positioning of doors to each of the cubicles indicated by **black** lines.

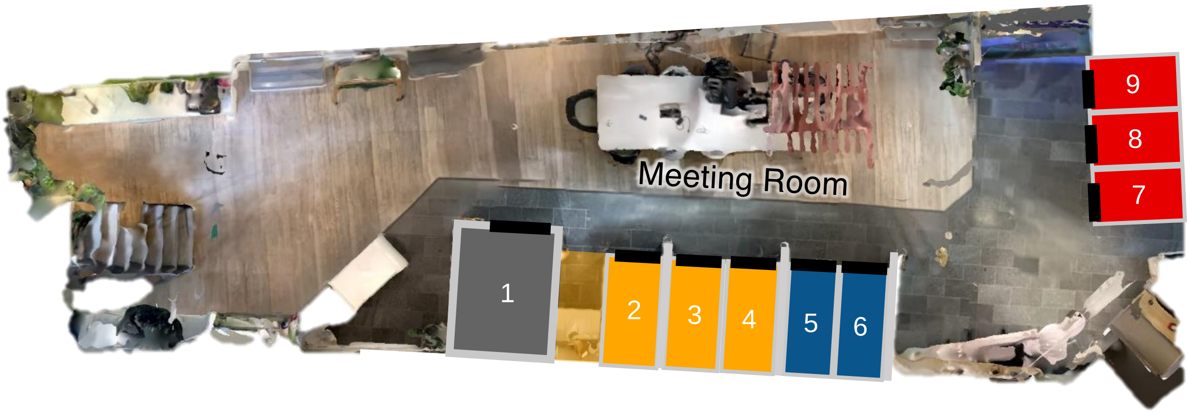


Image based on indicative LIDAR scan of showroom area (not to scale)

3.4 Sound insulation tests were undertaken across the separations set out in the table below. The full sound insulation test methodology is set out in Appendix A. It is important to note that all the cubicles tested as part of the exercise set out within this report fall below the size requirements for testing strictly in accordance with BS EN ISO 140-4:1998.

Table 2 Schedule of sound insulation tests

Test Ref.	Source Room (Ref)	Receive Room (Ref)	Separating Element
T1	Meeting Room	Superloo	Superloo door system and plasterboard surrounding partition
T2	Maranté (2)	Maranté (3)	Single frame plasterboard partition (circa 100 mm partition width)
T3	Maranté (2)	Meeting Room	Maranté door system
T4	Maranté (4)	Maranté (3)	Double skin Maranté 20 mm division, closed at base and soffit with aluminium channel. (a non-standard configuration)
T5	Mystiq (5)	Mystiq (6)	Mystiq 20 mm division, 30 mm gap to soffit at head of division.
T6	Movana (9)	Movana (8)	Movana 32 mm division. closed at base and soffit with aluminium channel.
T7	Movana (9)	Meeting Room	Movana door system

3.5 Door seals were not present in any of the partition systems and gaps above and below the doors to each cubicle were present. These gaps give rise to significant flanking sound transmission (sound passing around, rather than through separating elements). Tests T1, T3, T7 were indicative only and intended to provide an indication of the likely acoustic separation provided by a typical MW door layout.

4.0 Acoustic Performance

4.1 The results from the tests described in the previous section have been rationalised as set out in Table 3 . It is important to note that the achieved acoustic separation is not MW system specific, but instead controlled by the size of the gaps around separating elements/doors and the thickness/specification of the separating elements.

Table 3 Indicative Acoustic Performance of Maxwood Washroom Partition Systems

Typical Configuration	**Partition Detailing**	**dB D_w[1] (SPP description[2])**	**Comments**
20 mm division panels between cubicles	Circa 25 mm gaps at head and base of division panels. Same gaps above and below at doors to circulation spaces. No door seals	8 (No Privacy)	This achieve sound insulation performance is not influenced by thickness of the crucible division but instead entirely controlled by sound transmission via the described gaps.
32 mm division panels between cubicles	Head and base junction of division panels closed with aluminium channel sections. Circa 25 mm gaps above and below at doors to circulation spaces. No door seals	20 (Fair Privacy)	This achieves a sound insulation performance influenced by flanking sound transmission via the doors, at the division panel head and base details and through the panel itself. Other less significant flanking sound transmission pathways (such as via the cubicle end walls) is also likely to be affecting the result.
20 mm division panels to either side of timber studwork with fibreglass quilt in the cavity.	Head and base junction of division panels closed with aluminium channel sections. Circa 25 mm gaps above and below at doors to circulation spaces. No door seals	25 (Good Privacy)	This achieves a sound insulation performance influenced predominately by flanking sound transmission via the doors to the circulation spaces. Other less significant flanking sound transmission pathways (such as via the cubicle end walls) is also likely to be affecting the result. A small section of one side of the 20 mm division panel was also missing for display purposes, however the effects of this are expected to be negligible compared to the flanking sound transmission that was present.
Single skin plasterboard partition	Cubicle separated by full height plasterboard partition which extends 270 mm beyond the fronts of the cubicles. Circa 25 mm gaps above and below at doors to circulation spaces. No door seals	34 (Excellent Privacy)	This achieves a sound insulation performance influenced predominately by flanking sound transmission via the doors to the circulation spaces. Other less significant flanking sound transmission pathways (such as via the cubicle end walls) is also likely to be affecting the result.
Door between cubicle and circulation space	Circa 25 mm gaps above and below at doors to circulation spaces. No door seals	16 (Poor Privacy)	Presented figure is an average of the two indicative tests undertaken across MW door systems. Again, due to the gaps around the doors and lack of seals, the achieved performance will not be significantly affected by the material or thickness used for the doors.

[1] Measured sound insulation.
[2] Derived based on the British Council for Offices (BCO) noise criterion of NR45 for toilet areas, as set out in Chapter 11 (Acoustics) of the BCO Guide to Specification 2019. See Table 4 in this report for derived numerical SPP values.

4.2 A summary of the single figure results from the on-site acoustic tests described in section 3.0 is set out in the following table. Third octave band data is presented in Appendix B for completeness. It is important to note that these results relate specifically to the partition configurations tested on site.

Table 4 Acoustic Test Results

Test Ref.	Source Room (Ref)	Receive Room (Ref)	Single Figure Measured Acoustic Separation, dB	
			D_w	SPP
T1	Meeting Room	Superloo (1)	12	57 (No speech privacy)
T2	Maranté (2)	Maranté (3)	34	79 (Excellent)
T3	Maranté (2)	Meeting Room	19	64 (Poor)
T4	Maranté (4)	Maranté (4)	25	70 (Good)
T5	Mystiq (5)	Mystiq (6)	8	53 (No speech privacy)
T6	Movana (9)	Movana (8)	20	65 (Fair)
T7	Movana (9)	Meeting Room	17	62 (Poor)

4.3 The SPP figures/descriptions above are indicative only and the SPP achieved on site will be dependent on the level of ambient noise in receiving spaces. Such noise may be generated by building services (ventilation system), road traffic noise ingress or noise masking systems for example, the latter being where artificial background noise is generated through a dedicated speaker system. Such systems are not commonplace in bathroom/washroom areas but could be considered where higher levels of privacy are required. Background music in bathroom areas may also provide an amount of noise masking.

4.4 It is important that designers, system specifiers and other similar persons consider the data set out within this report in context. An acoustic consultant should be engaged with to seek further advice where higher levels of acoustic separation may be required.

A Note on Doors

4.5 In locations where acoustic separation/privacy is important between washroom cubicles and connected circulation spaces, acoustic separation can be greatly approved through the use of doors which are well sealed around the full perimeter and ensuring the partition systems are built full height and appropriately stopped at the head and base.

4.6 An acoustic consultant should be appointed to advise on the required configuration/detailing to achieve the above, if necessary. It must be borne in mind that ventilation of washroom spaces must be carefully considered where doors are well sealed. Ducted ventilation systems are typically required in such instances, offering both fresh air and extract. Air transfer grilles through wall and door elements can be significant sound transmission pathways and should either be avoided or acoustically rated products used where sound insulation is important.

A Note on Plasterboard Partitions

4.7 Laboratory test data for plasterboard partitions is publicly available from a number of drylining system suppliers. Based on this data, a partition comprising a single stud configuration using a 75 mm timber stud, with 15 mm standard plasterboard to each side and no insulation in the cavity can be expected to achieve a laboratory rating of approximately 37 dB R_w. A rating of approximately 40 dB R_w can be achieved by including 25mm glass fibre insulation in the cavity between the studs.

4.8 On projects where higher acoustic performance requirements may apply between washroom spaces, it is recommended that an acoustic consultant is engaged to determine an effective and appropriate design solution for separating partitions to achieve a given performance requirement, or to agree a performance standard which is both reasonable and achievable.

Appendix A: Acoustic Testing Methodology

Airborne Tests

The tests were conducted in general accordance with the procedures described within BS EN ISO 140-4:1998, noting that the rooms under test were too small for this testing standard to be strictly applicable as the cubicles were too small to achieve the required loudspeaker separations. All tests were undertaken on the 7th June 2022.

Tests were undertaken using the equipment set out in the following table. The calibration of the sound level analyser was checked before and after the test visit, and after each battery change, to ensure a consistent and acceptable degree of accuracy.

Table 1.1. Equipment used during testing

Item		**Product**		**Calibration**	
Ref.	**Description**	**Detail**	**Serial No.**	**Certificate**	**Expiry Date**
15AB	Sound level analyser	Norsonic 140	3346	U40402	08/03/2024
15AC	Acoustic calibrator	Norsonic 1255	25840	U40400	08/03/2023
15A9	Battery-powered active loudspeaker	JBL Eon One Compact	T0013-KK013326		
15AF	Wireless transmitter system	AKG PT/SR 420	767874-007		

Tests were undertaken to determine the Weighted Level Difference of the relevant sections of partition, over the frequency range of interest 100 – 3150 Hz.

Only the individual tester undertaking measurements in both the source or receive room was present in that room at the time of the tests. It is acknowledged that due to the small size of the test rooms, the tester present will have had an effect on the acoustic conditions with the rooms (in terms of reverberation time and measured noise level). However as the testing is intended to be indicative of on-site performance, where cubicles could reasonably be expected to be occupied, including the effects of a person in the test room is therefore deemed to be suitably representative.

The sound level analyser generates a pink noise signal, which is broadcast to the loudspeaker via the wireless transmitter system. Before tests were started checks were made for interference and adequate signal strength through the floor or wall under test, in order to ensure an uninterrupted pink noise signal during the tests.

The cabinet loudspeaker was located at a suitable position in the room with respect to floor plan, immovable obstacles, and room height, to generate as diffuse a sound field in the source room as reasonably practical. Again, due to the small size of the rooms, it is not reasonable to expect that a diffuse sound field would be achieved. The overall gain and graphic equalisation of the loudspeaker was adjusted to achieve a sufficiently high level in the receive room, and to ensure the source room noise level in each adjacent one-third octave band was suitably consistent over the frequency range of interest.

The sound level analyser was used to measure the L_{eq} generated noise level in each one-third octave bands over the frequency of interest in at least six 'fixed' (static) positions of both the source and receive rooms, and for at least 6 seconds at each position. A logarithmic mean of the measurements in each room were taken to be representative of the spatial average noise level in the room with the loudspeaker operating. These measurements were then repeated for a second loudspeaker position in the source room.

The level difference for each source position was then calculated in each one-third octave band by arithmetically subtracting the background corrected receive level (L_{Rcorr}, see below) from the source room level (L_S). The level differences obtained from each loudspeaker position were then arithmetically averaged to determine the measured level difference (D).

Each of the third octave band sound insulation readings were compared with the curve of reference values outlined in BS EN ISO 717-1:1997 to give an overall single number rating of airborne sound insulation, the Weighted Level Difference (D_w).

Correction for Background Noise

With the noise source disabled, measurements of the L_{eq} background noise level in the receive room were made in at least six 'fixed' (static) positions, and for at least 6 seconds at each position. A logarithmic mean of the measurements in each room were taken to be representative of the spatial average background noise level in the room.

The generated noise level measurements in the receive room (L_R), and for each source position, were corrected for background noise (L_B) in each one-third octave band and in accordance with ISO 140-4, as follows:

- $L_{Rcorr} = L_R$, where $(L_R – L_B) > 10$ dB
- $L_{Rcorr} = 10\log_{10}(10^{(L_R/10)} – 10^{(L_B/10)})$, where $(L_R – L_B) > 6$ dB and $(L_R – L_B) \leq 10$ dB
- $L_{Rcorr} = L_R – 1.3$dB, where $(L_R – L_B) \leq 6$dB

Where $(L_R – L_B) \leq 6$ dB, the achieved sound reduction performance is considered to be background noise limited.

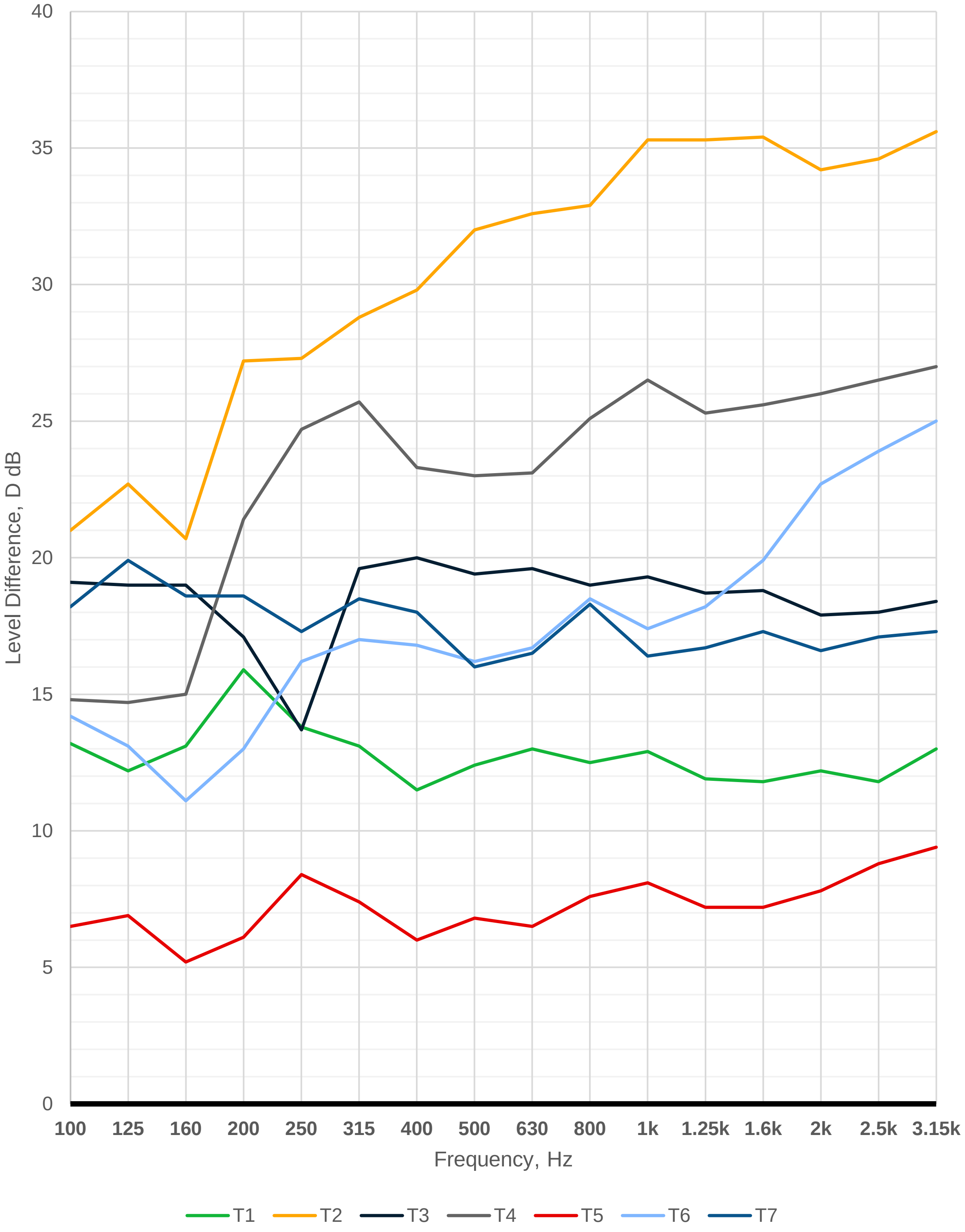
Reverberation Time

The reverberation times of receive rooms were measured in each third octave band using the sound source at one position, pink noise generator and sound level analyser, the analyser having the capability to measure the T_{20} reverberation time directly. No less than six 'fixed' (static) measurement positions were used in each receiver room. The arithmetic mean of measurements at each position are taken to be representative of the spatial average for the room.

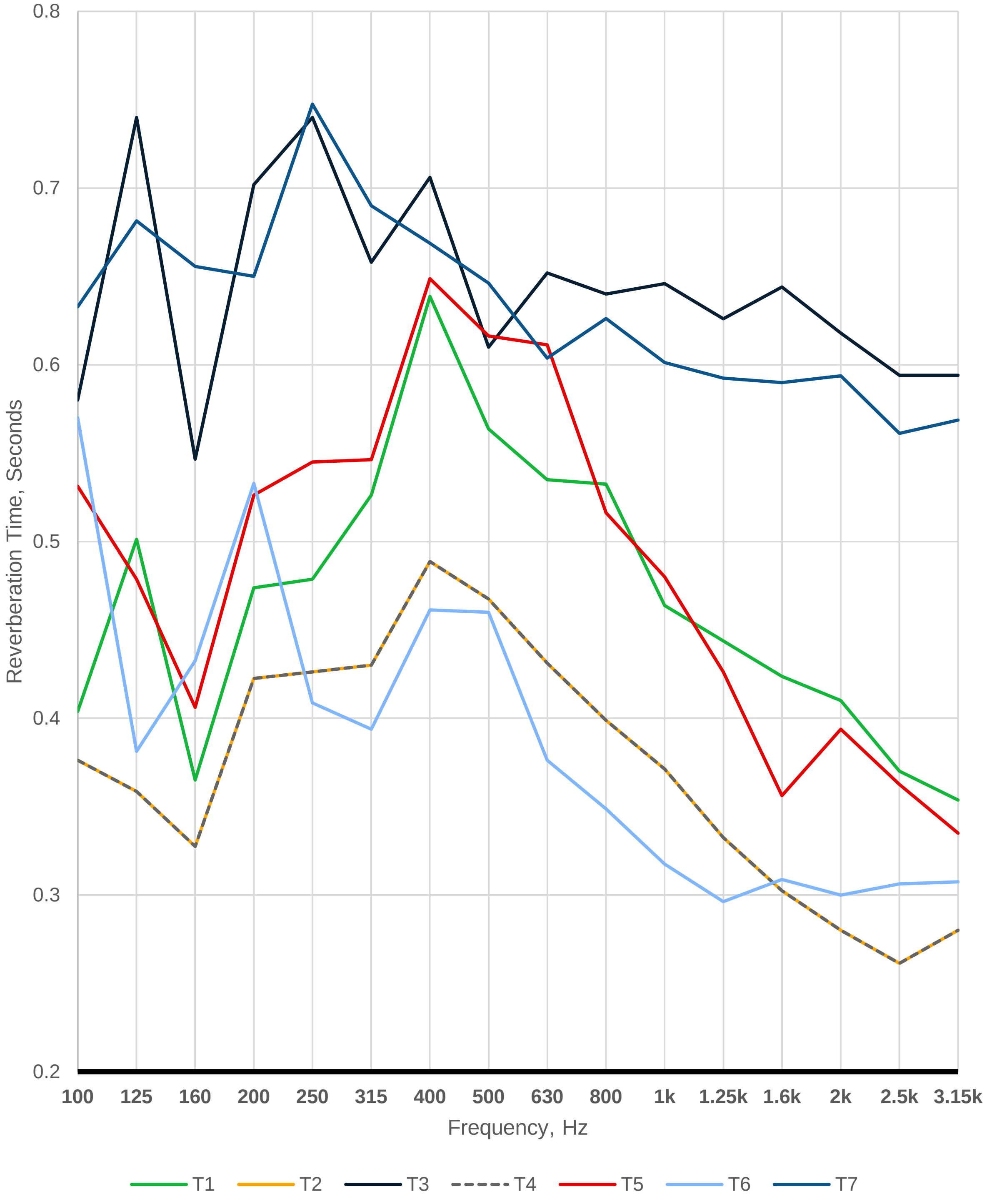
Appendix B: Detailed Test Data

Summary of Third Octave Band Acoustic Test Data

Level Difference



Receive Room Reverberation Time



Room Parameters and Summary Results

Table 5 Room Parameters and Summary Results

Test Ref.	Source Room (ref)	Receive Room (ref)	Area of Separation, m^2	Receive Room Volume, m^3	Level Difference, dB D
T1	Meeting Room	Superloo	7.8	6.0	12
T2	Maranté (2)	Maranté (3)	2.2	3.1	34
T3	Maranté (2)	Meeting Room	2.2	193.8	19
T4	Maranté (4)	Maranté (3)	2.2	3.1	25
T5	Mystiq (5)	Mystiq (6)	2.2	3.1	8
T6	Movana (9)	Movana (8)	2.1	3.1	20
T7	Movana (9)	Meeting Room	2.1	193.8	17