Test Report **Ref: 7536-R01**

Submitted to:

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In accordance with our quality assurance procedures, this report is countersigned by:

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Transmission loss tests on a range of Invotek floor to ceiling partition systems

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1. Introduction

1.1. ISVR Consulting were engaged by Invotek, Poole, to undertake measurements on a range of floor to ceiling partition systems to establish their Airborne Sound Insulation.

1.2. The samples supplied for testing were described as follows:

- Straw Board 100 with RS 140 quilt.
- Straw Board 100 with RS 80 quilt.
- Straw Board 100 with RS 45 quilt.
- Straw Board 75 with RS 45 quilt.
- Straw Board 75 with RS 60 quilt.
- Straw Board 75 with no quilt.

1.3. The Transmission Loss or Sound Reduction Index relates the incident Sound Power to the transmitted Sound Power through the sample.

1.4. The Transmission Loss measurements were performed in the Reverberant Suite of the Rayleigh Laboratories of the ISVR, University of Souhampton. The tests were carried out on the 25th May 2006.

1.5. The Transmission Loss test was carried out according to BS EN ISO 140-3: 1995 and the British Standard BS 2750: Part 3: 1995, "Acoustics - Measurement of sound insulation in buildings and of building elements Part 3. Laboratory Measurement of airborne sound insulation of building elements".

BS EN ISO 717-1: 1997, "Acoustics – Rating of sound insulation in buildings and of building elements" was also used.

2. Measurement Method

2.1 Each floor to ceiling system was installed by Invotek trained personnel into the door aperture between the two reverberant chambers. The free area sample size was 4.29 m^2.

2.2 A broad band sound field was generated in the Small Reverberant Chamber (source room). This was sampled by making two circular microphone traverses, lasting a combined time of 240 seconds and continuously averaging the one-third octave spectra.

2.3 The transmitted sound field was sampled in the Large Reverberant Chamber (receiver room), again for two circular paths.

2.4 The Reverberation Times in one-third octave bands were determined for the receiver room.

2.5 The Sound Reduction Indices for each one-third octave band were calculated from the test data and the single-number rating of airborne sound insulation derived.

3. Results

3.1 The results are presented as Tables 1 to 7 and Graphs 1 to 6.

3.2 The Sound Reduction Indices R are calculated from the level difference between the rooms on either side of the panel in accordance with the standard BS EN ISO 140-3: 1995.

3.3 The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* (SRI) and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

3.4 At the request of Invotek two extra calculations were carried out on the test results. The first was to calculate an average of the sound reduction index *R* (SRI) over the 100 Hz to 3150 Hz frequency range. The second was to calculate an average of the sound reduction index *R* (SRI) over the 400 Hz to 2500 Hz frequency range. These averages are purely the arithmetic average over the specified frequency range and are not part of the calculations required in any of the published standards quoted in this report. The results of these calculations are shown in Table 7.

Freq. /Hz	Source /dB	Receiver /dB	RT60 /s	Diff /dB	*R* (SRI) /dB
100	88.3	69.0	5.8	19.3	15.8
125	85.9	64.8	8.2	21.1	19.0
160	86.1	61.4	11.1	24.7	24.0
200	91.9	62.3	9.8	29.6	28.4
250	94.6	58.6	9.5	36.0	34.6
315	94.8	55.4	9.8	39.3	38.1
400	96.3	53.8	8.9	42.5	40.8
500	95.1	50.0	8.3	45.1	43.2
630	93.4	46.8	8.2	46.6	44.6
800	94.7	46.2	7.5	48.5	46.1
1000	96.1	48.3	6.9	47.8	45.1
1250	95.6	48.9	6.6	46.7	43.7
1600	97.5	47.6	5.9	49.9	46.5
2000	98.4	46.3	5.5	52.0	48.3
2500	96.2	42.3	4.9	53.9	49.7
3150	92.0	36.2	4.3	55.7	50.9
4000	91.4	32.1	3.5	59.3	53.6
5000	89.6	28.3	2.9	61.3	54.8

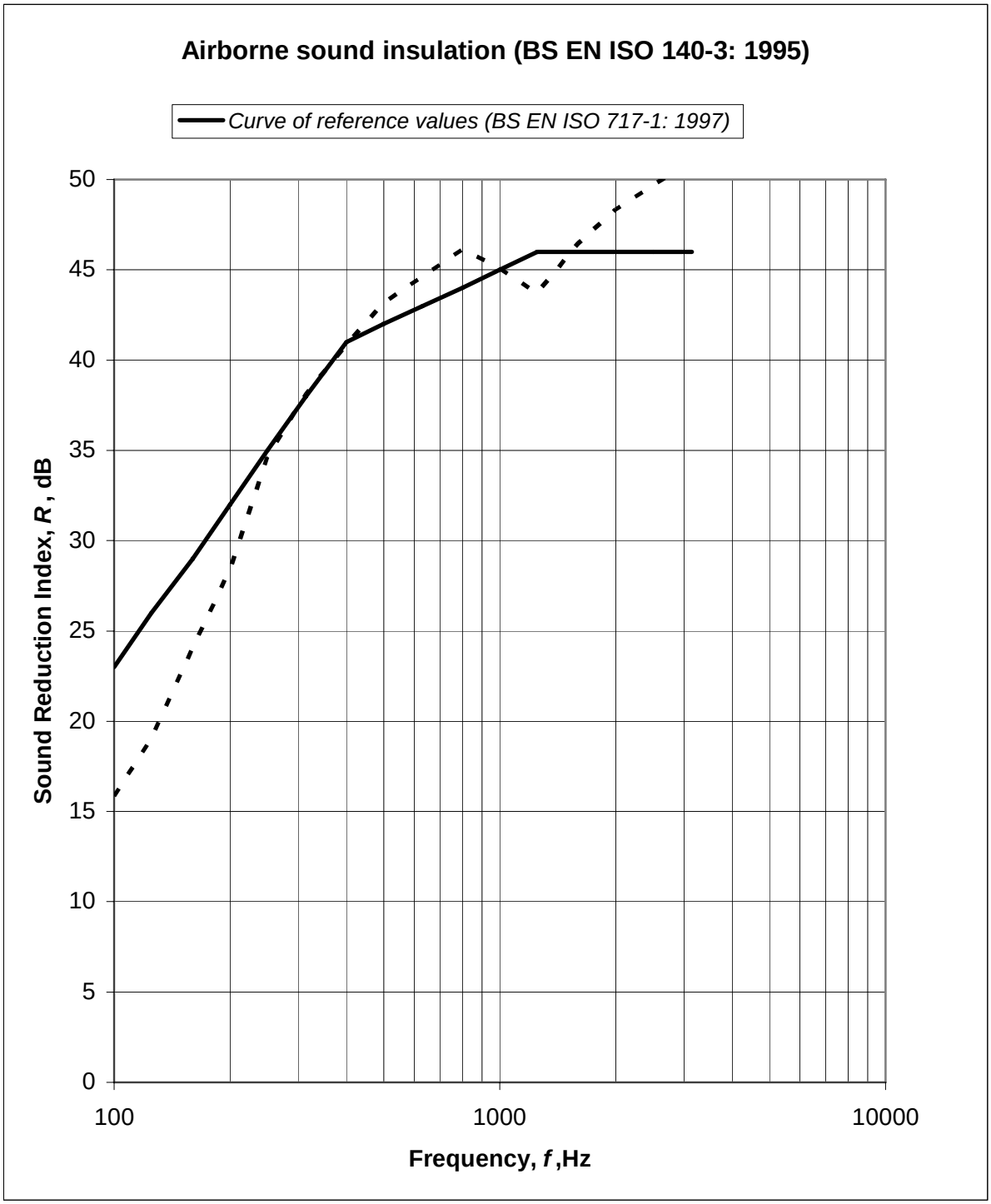
Weighted Sound Reduction Index R_W = 42 (BS EN ISO 717-1: 1997).

The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

Table 1: Straw Board 100 with RS 140 quilt

Invotek

Straw Board 100 with RS140 quilt



Rating according to 717-1(R_w) = 42

Graph 1: Straw Board 100 with RS 140 quilt

Freq. /Hz	Source /dB	Receiver /dB	RT60 /s	Diff /dB	*R* (SRI) /dB
100	89.1	74.0	5.8	15.1	11.6
125	90.3	70.7	8.2	19.7	17.7
160	89.8	61.1	11.1	28.6	27.9
200	92.6	57.0	9.8	35.6	34.4
250	92.3	52.7	9.5	39.5	38.1
315	95.2	52.4	9.8	42.8	41.6
400	96.0	52.0	8.9	44.0	42.4
500	95.0	48.2	8.3	46.8	44.9
630	93.9	45.7	8.2	48.2	46.2
800	94.0	43.7	7.5	50.3	47.9
1000	96.1	46.6	6.9	49.5	46.7
1250	95.5	46.7	6.6	48.8	45.8
1600	97.3	46.5	5.9	50.8	47.4
2000	98.1	46.3	5.5	51.8	48.1
2500	96.0	42.4	4.9	53.6	49.4
3150	91.7	35.6	4.3	56.1	51.3
4000	91.2	31.7	3.5	59.4	53.7
5000	89.4	28.1	2.9	61.3	54.8

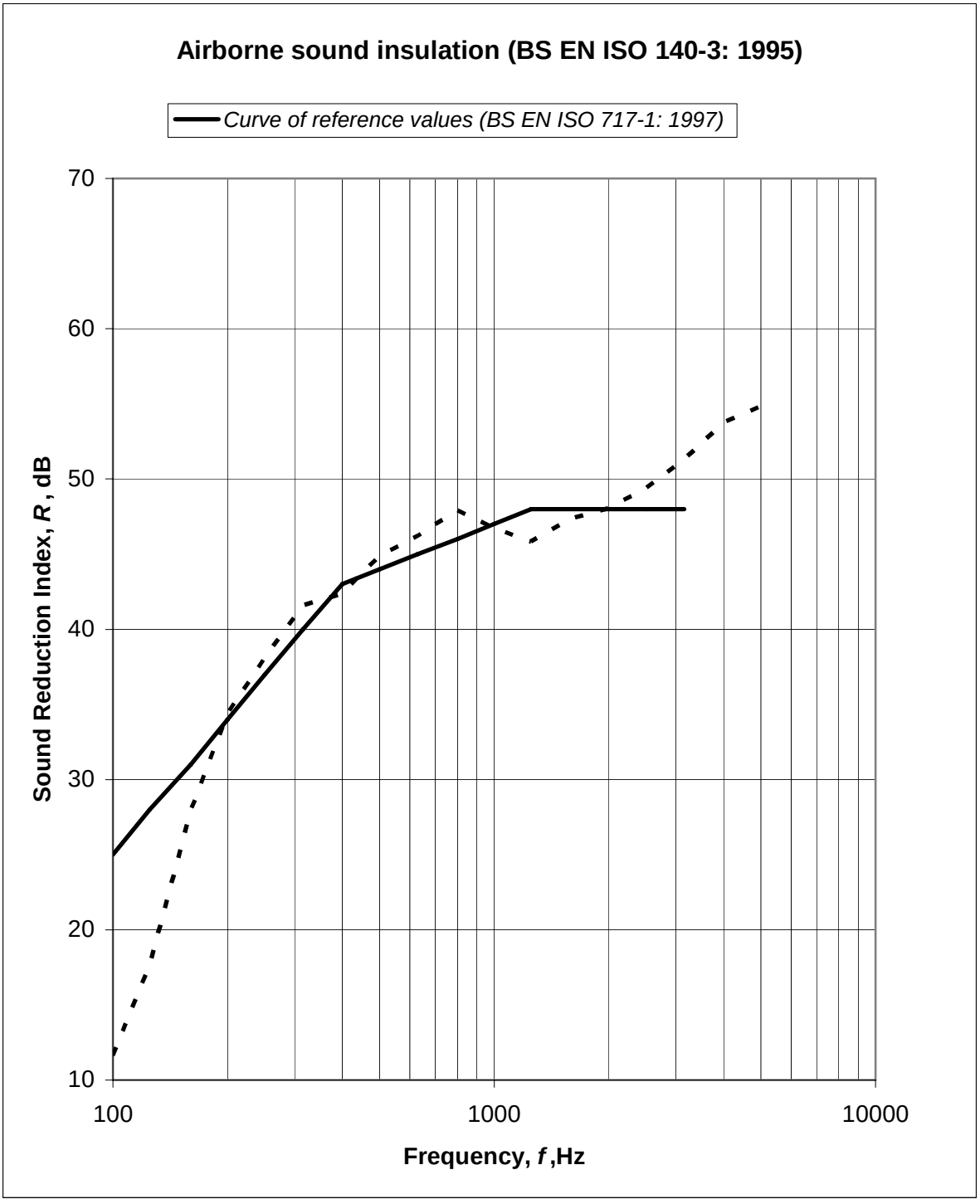
Weighted Sound Reduction Index R_W = 44 (BS EN ISO 717-1: 1997).

The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

Table 2: Straw Board 100 with RS 80 quilt

Invotek

Straw Board 100 with RS80 quilt



Rating according to 717-1(Rw) = 44

Graph 2: Straw Board 100 with RS 80 quilt

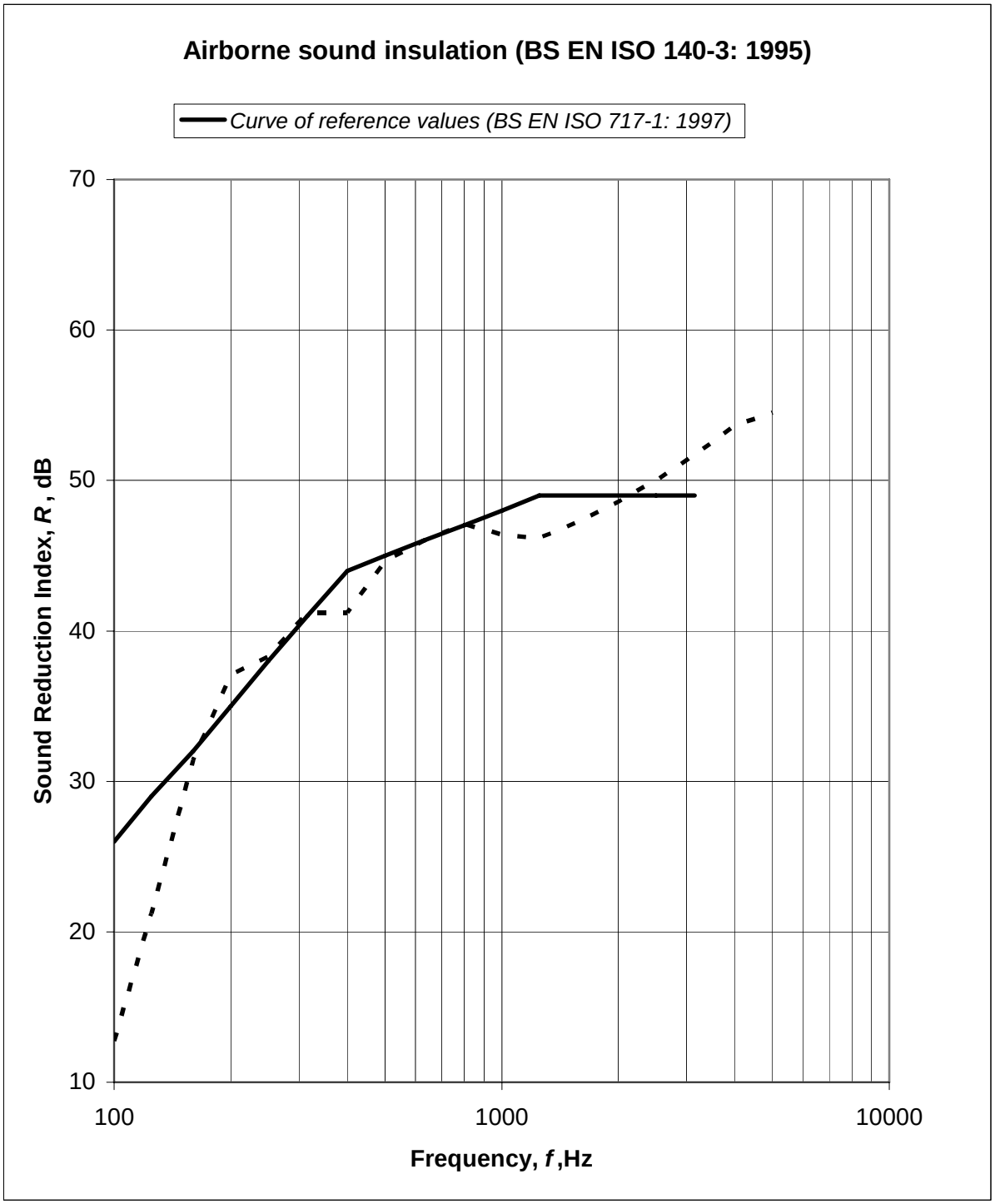
Freq. /Hz	Source /dB	Receiver /dB	RT60 /s	Diff /dB	*R* (SRI) /dB
100	88.8	72.6	5.8	16.2	12.7
125	90.5	67.3	8.2	23.2	21.2
160	89.8	57.7	11.1	32.1	31.4
200	92.6	54.3	9.8	38.3	37.1
250	92.3	52.6	9.5	39.7	38.3
315	95.2	52.7	9.8	42.4	41.2
400	95.8	53.0	8.9	42.9	41.2
500	95.1	48.5	8.3	46.5	44.6
630	93.9	45.9	8.2	48.0	46.0
800	94.0	44.5	7.5	49.5	47.1
1000	96.1	46.9	6.9	49.2	46.4
1250	95.5	46.4	6.6	49.1	46.1
1600	97.3	46.5	5.9	50.8	47.3
2000	98.1	45.8	5.5	52.3	48.6
2500	96.0	41.8	4.9	54.2	50.0
3150	91.7	35.2	4.3	56.5	51.7
4000	91.2	31.8	3.5	59.4	53.7
5000	89.4	28.4	2.9	61.0	54.5

Weighted Sound Reduction Index R_W = 45 (BS EN ISO 717-1: 1997).

The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

Table 3: Straw Board 100 with RS 45 quilt

Invotek
Straw Board 100 with RS45 quilt



Rating according to 717-1(Rw) = 45

Graph 3: Straw Board 100 with RS 45 quilt

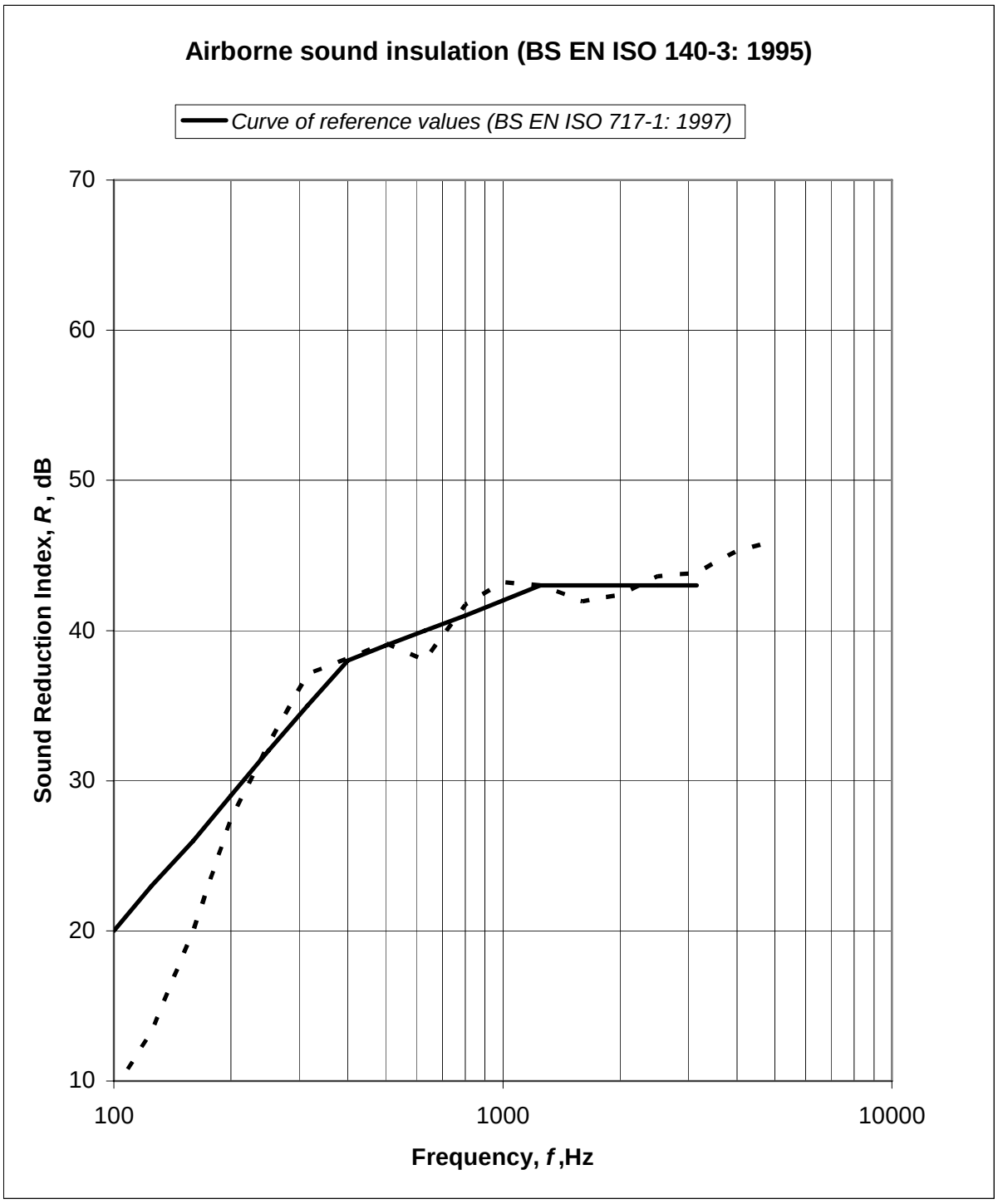
Freq. /Hz	Source /dB	Receiver /dB	RT60 /s	Diff /dB	*R* (SRI) /dB
100	89.3	76.5	5.8	12.8	9.3
125	90.2	74.9	8.2	15.3	13.3
160	89.0	68.4	11.1	20.7	20.0
200	92.4	63.7	9.8	28.6	27.4
250	92.3	58.5	9.5	33.8	32.4
315	95.1	56.8	9.8	38.3	37.1
400	95.9	56.1	8.9	39.8	38.1
500	95.1	54.0	8.3	41.1	39.2
630	93.9	53.9	8.2	40.0	38.0
800	94.0	49.9	7.5	44.1	41.7
1000	96.1	50.1	6.9	46.0	43.2
1250	95.5	49.5	6.6	46.0	43.0
1600	97.3	51.9	5.9	45.4	41.9
2000	98.2	52.1	5.5	46.1	42.4
2500	96.1	48.2	4.9	47.8	43.6
3150	91.8	43.1	4.3	48.7	43.8
4000	91.1	40.1	3.5	51.0	45.3
5000	89.4	36.9	2.9	52.5	46.0

Weighted Sound Reduction Index R_W = 39 (BS EN ISO 717-1: 1997).

The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

Table 4: Straw Board 75 with RS 45 quilt

Invotek
Straw Board 75 with RS 45 quilt



Rating according to 717-1(Rw) = 39

Graph 4: Straw Board 75 with RS 45 quilt

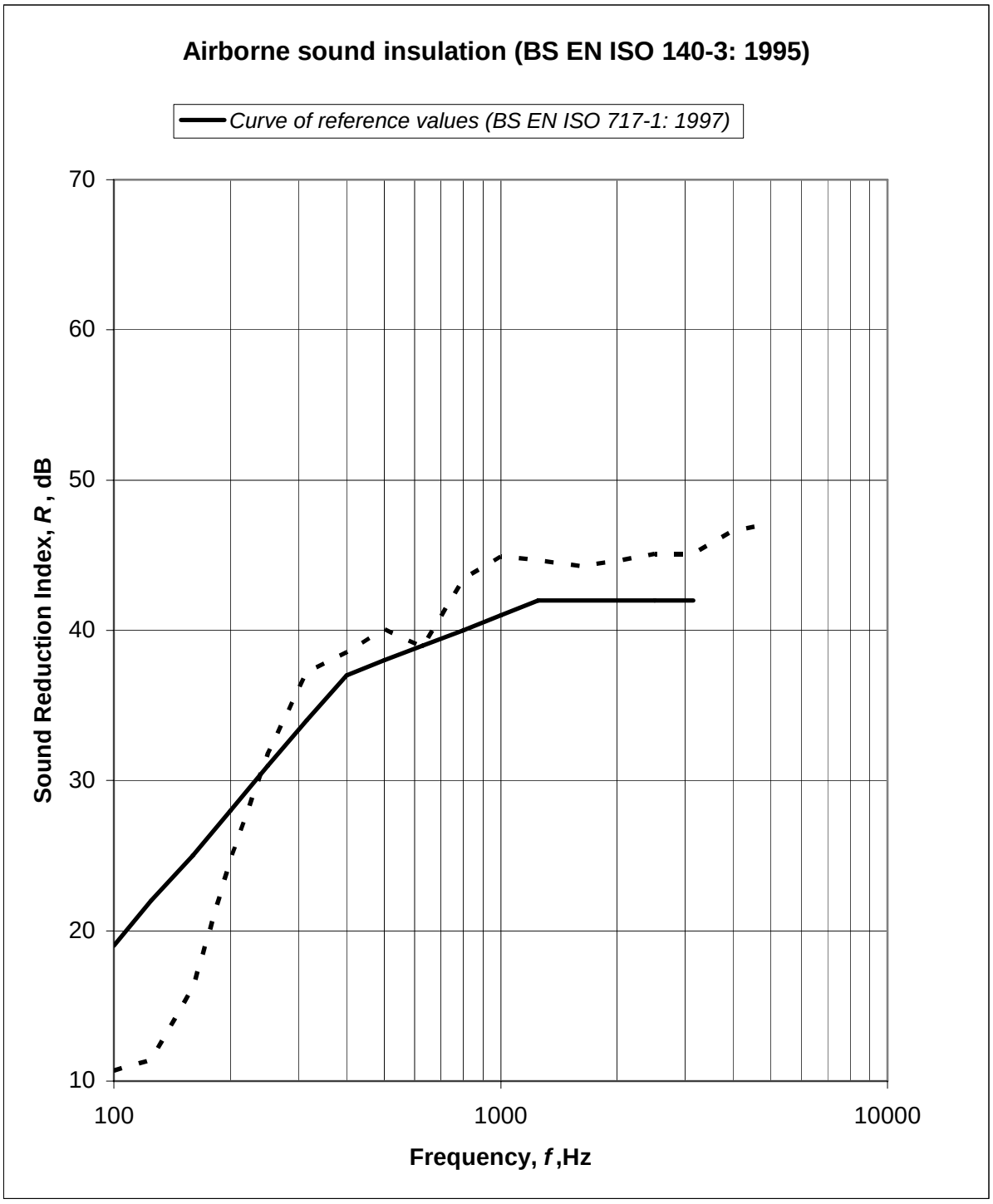
Freq. /Hz	Source /dB	Receiver /dB	RT60 /s	Diff /dB	*R* (SRI) /dB
100	89.6	75.5	5.8	14.2	10.7
125	90.1	76.7	8.2	13.4	11.4
160	88.7	71.8	11.1	16.9	16.2
200	92.4	66.5	9.8	25.9	24.7
250	92.2	59.0	9.5	33.1	31.8
315	95.0	56.6	9.8	38.4	37.2
400	95.8	55.6	8.9	40.2	38.5
500	95.0	53.1	8.3	42.0	40.0
630	93.9	53.0	8.2	40.9	38.9
800	94.0	48.2	7.5	45.8	43.4
1000	96.1	48.4	6.9	47.7	44.9
1250	95.5	47.9	6.6	47.6	44.7
1600	97.3	49.6	5.9	47.7	44.3
2000	98.1	49.8	5.5	48.3	44.6
2500	96.1	46.7	4.9	49.3	45.1
3150	91.8	41.9	4.3	49.9	45.1
4000	91.1	38.7	3.5	52.4	46.7
5000	89.4	35.8	2.9	53.6	47.1

Weighted Sound Reduction Index R_W = 38 (BS EN ISO 717-1: 1997).

The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

Table 5: Straw Board 75 with RS 75 quilt

Invotek
Straw Board 75 with RS 60 quilt



Rating according to 717-1(Rw) = 38

Graph 5: Straw Board 75 with RS 75 quilt

Freq. /Hz	Source /dB	Receiver /dB	RT60 /s	Diff /dB	*R* (SRI) /dB
100	89.8	75.3	5.8	14.5	11.1
125	90.3	77.2	8.2	13.1	11.1
160	88.7	72.5	11.1	16.2	15.5
200	92.2	71.8	9.8	20.4	19.2
250	92.1	70.6	9.5	21.5	20.1
315	95.1	69.1	9.8	26.0	24.8
400	95.9	66.0	8.9	30.0	28.4
500	95.0	60.6	8.3	34.4	32.5
630	93.9	57.4	8.2	36.6	34.5
800	94.0	52.3	7.5	41.7	39.3
1000	96.1	51.8	6.9	44.3	41.5
1250	95.5	50.6	6.6	45.0	42.0
1600	97.3	51.2	5.9	46.1	42.6
2000	98.2	51.2	5.5	47.0	43.3
2500	96.0	49.8	4.9	46.2	42.0
3150	91.8	49.2	4.3	42.6	37.8
4000	91.1	43.8	3.5	47.3	41.6
5000	89.4	38.0	2.9	51.4	44.9

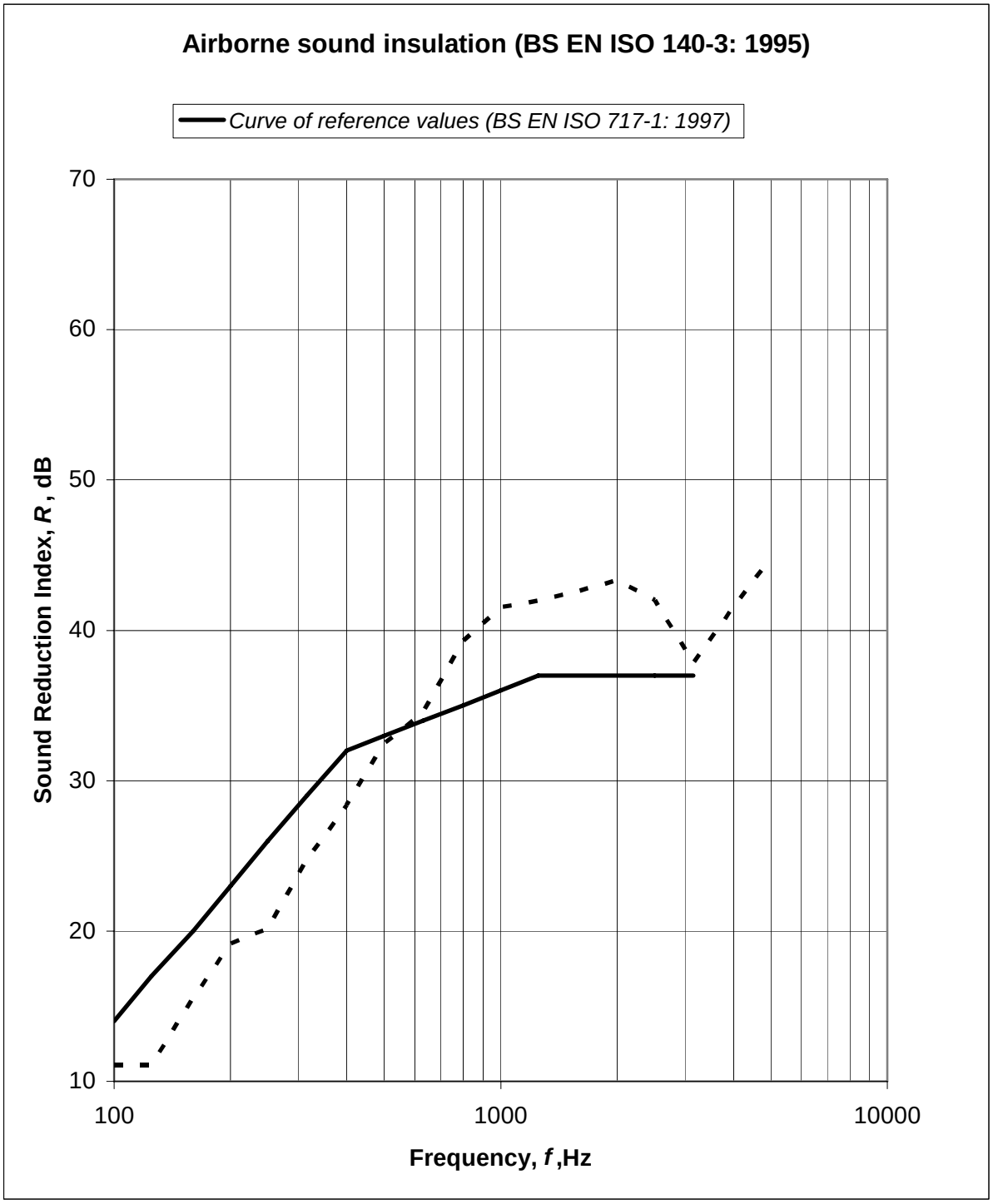
Weighted Sound Reduction Index R_W = 33 (BS EN ISO 717-1: 1997).

The Weighted Sound Reduction Index R_w is a single-figure value based on comparison between the measured values of *R* and standard weighting curves over the frequency range 100-3150 Hz, using the procedure in BS EN ISO 717-1: 1997.

Table 6: Straw Board 75 with no quilt

Invotek

Straw Board 75 with no quilt



Rating according to 717-1(Rw) = 33

Graph 6: Straw Board 75 with no quilt

At the request of Invotek two extra calculations were carried out on the test results. The first was to calculate an average of the sound reduction index *R* (SRI) over the 100 Hz to 3150 Hz frequency range. The second was to calculate an average of the sound reduction index *R* (SRI) over the 400 Hz to 2500 Hz frequency range. These averages are purely the arithmetic average over the specified frequency range and are not part of the calculations required in any of the published standards quoted in this report. The results of these calculations are shown in the Table below.

	BS EN ISO 140-3:1995, BS 2750-3:1995 (100-3150 Hz) SRI Average	**Speech Range (400-2500 Hz) SRI Average**	**ISO 717-1:1997, BS 5821-3:1984 Rw**
Straw Board 100 with RS 140 quilt	38.7 dB	45.3 dB	42.0 dB
Straw Board 100 with RS 80 quilt	40.1 dB	46.5 dB	44.0 dB
Straw Board 100 with RS 45 quilt	40.7 dB	46.4 dB	45.0 dB
Straw Board 75 with RS 45 quilt	34.7 dB	41.2 dB	39.0 dB
Straw Board 75 with RS 60 quilt	35.1 dB	42.7 dB	38.0 dB
Straw Board 75 with no quilt	30.4 dB	38.5 dB	33.0 dB

Table 7: Average *R* (SRI) values calculated over a limited frequency range

Appendix 1: Instrumentation and Calibration

1.1 Measuring Equipment

1.1.1 Noise Generation

Noise Generator	Brüel and Kjær	type 1405
Power Amplifier	Third Generation	type HP400
Loudspeaker	Vitavox	Double Thunderbolt

1.1.2 Noise Measurement

Precision Microphones	Brüel and Kjær	type 4134
Preamplifiers	Brüel and Kjær	type 2619
Digital Frequency Analyzer	Brüel and Kjær	type 2133
Pistonphone Calibrator	Brüel and Kjær	type 4220

1.1.3 Reverberation Time Measurement

Precision Microphone	Brüel and Kjær	type 4134
Preamplifier	Brüel and Kjær	type 2619
Digital Frequency Analyzer	Brüel and Kjær	type 2133
Power Amplifier	Third Generation	type HP400
Loudspeaker	Vitavox	Double Thunderbolt

1.2 System Calibration

The noise measuring system was calibrated by applying the microphone calibrator (type 4220) to each transducer and adjusting the Analyzer to the reference level prior to the measurement session. The level was also checked at the end of the session to ensure that no drift or fault had occurred.

The above equipment is calibrated against the transfer standards below.

1.3 Traceability

1.3.1 Microphones

ISVR Consulting hold two transfer standard Microphones, type 4145, serial numbers 375091 and 375617. The most recent calibration was carried out by AV Calibration Ltd. This is fully documented in Certificates 0509281 and 0509282 dated 13th September 2005. A transfer standard Pistonphone, type 4220, serial number 966195 and a transfer standard calibrator, type 4231, serial number 2162524 are also held. These were calibrated by AV Calibration Ltd and are documented in certificate numbers 02017 and 02029, dated 7th and 12th September 2005 respectively. AV Calibration Ltd are UKAS Accredited (no 0653) and the Standards are traceable to the National Physical Laboratory, Teddington, England.

1.3.2 Instrumentation

A Digital Voltmeter (Fluke type 8050A) and a Frequency Counter (Marconi type 2430A) are used with these Transfer Standards to calibrate the above equipment. Both instruments were calibrated by ASAP Calibration Services (UKAS Accredited Laboratory No 0072) and carry certificates numbered N1144542E and N1144543E dated 13th September 2005 and 6th October 2005 respectively.

The instrumentation complies with the requirements for a type 1 instrument, as specified in BS EN 61672:2003, BS EN 60942:2003 and BS EN IEC 61260:1996.

Appendix 2: Acoustic Environment

2.1 Large Reverberation Chamber - Receiver Room

2.1.1 Construction

The chamber is constructed of reinforced concrete and is separated from the foundations and neighbouring walls by rubber vibration isolators. It is designed with an inclined ceiling and non-parallel walls to ensure a uniform distribution (with frequency) of the normal acoustic modes of the room.

2.1.2 Dimensions

Mean edge lengths	9.15 m
	6.25 m
	6.10 m - height
Volume	348 m^3
Surface Area	302 m^2

2.1.3 Walls and Ceiling

All inside surfaces of the chamber are finished with a hard gloss paint to give a high reflection coefficient. The walls are 305 mm thick, and the ceiling, which is 460 mm thick, includes two removable sections (1.75 m x 0.86 m) which provide access for a chain hoist capable of carrying loads up to 2000 Kg, and an entry for a 4000 Watt siren driven horn. Connections to the equipment in the chamber may be made via any of five cable ports in the walls. A glazed window (305 mm x 305 mm) permits visual observation from the control area.

2.1.4 Floor Area

The floor is 305 mm thick and has a steel vibration isolated pad (2.1 m x 3.6 m) set into it. This pad may be used for mounting test rigs or vibrators without structural vibrations being transmitted to the chamber.

2.1.5 Doors

One set of double doors connects the chamber and the corridor; another set opens into the small reverberation chamber and incorporates removable panels (1.07 m x 1.07 m) for transmission loss measurements. The doorway (2.4 m x 2.0 m) may be used for testing larger panels. The doors (2.56 m x 2.26 m x 130 mm thick) are a sandwich construction of wood wool, wood and steel, and have an average transmission loss in excess of 50 dB.

2.1.6 Ventilation and Lighting

At each corner of the floor there is an air inlet vent, and there are four outlet vents situated high up on one wall. With all vents open the air is changed at a rate of 100 m^3 per minute. When not required the vents are covered by steel plates and these have diagonal stiffeners to reduce panel vibrations. The chamber is lit by six sodium discharge lights mounted on the wall at 3 m above the floor.

2.2 Small Reverberation Chamber - Source Room

2.2.1 Construction

The chamber is a smaller version of the large reverberation chamber and is also designed with plane, non-parallel walls and an inclined ceiling.

2.2.2 Dimensions

Mean edge lengths	6.4 m
	4.6 m
	4.3 m - height
Volume	131 m^3
Surface Area	153 m^2

2.2.3 Walls and Ceiling

As in the large chamber, the walls and ceiling are 305 mm thick and are finished with a hard gloss paint to give a high reflection coefficient. In one wall there are four cable ports, and a double glazed window allowing observation from the control area.

2.2.4 Doors

The doors are of the same sandwich construction as the large chamber doors. Three sets of these double doors connect this chamber to a larger reverberation chamber, a large anechoic chamber and a common control area.

2.2.5 Ventilation and Lighting

There are four air inlet vents in the floor at the corners, and three outlet vents near the top of one wall, and the ventilation system is capable of a maximum air movement of 100 m^3 per minute. The chamber is lit by two sodium discharge lights mounted on the walls at a height of 3 m.