MEASUREMENT REPORT

ON-SITE MEASUREMENT TO DETERMINE THE PERFORMANCE OF SOUND LEVEL INSULATION OF DES ENCLOSED BLIND

2 April 2015

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1. INTRODUCTION

DES Building Innovate Sdn. Bhd. commissioned SIRIM Berhad to measure performance of the 6 enclosed blinds samples. The measurements were carried out at DES Building Innovate Sdn. Bhd. (Address: 6, Jalan IKS Juru Jaya, Taman IKS Juru Jaya, 14100 Simpang Ampat, Pulau Pinang, Malaysia) testing cell (refer to Appendix 1 for the cell setup and dimensions) from 20th to 21st January 2015.

2. OBJECTIVE

The objective of this measurement is to determine the performance of DES enclosed blinds sound (noise) level insulation (reduction).

3. DESCRIPTION OF THE SAMPLES

Six (6) samples were mounted in a vertical aperture on a wall between two side-by-side rooms. The sound levels in these two rooms were measured and calculated to determine the sound transmission loss from source room to receiving room. The samples are:

I. Sample 1 (EB1) : 4mm tempered clear glass + 19mm air space with Enclosed Blind + 4mm tempered clear glass
II. Sample 2 (EB2) : 4mm tempered clear glass + 19mm air space with Enclosed Blind + 5mm tempered light green glass
III. Sample 3 (EB3) : 4mm tempered clear glass + 19mm air space with Enclosed Blind + 6.38mm laminated clear float glass
IV. Sample 4 (DG4) : 4mm tempered clear glass + 19mm air space + 6.38mm laminated clear float glass
V. Sample 5 (DG5) : 4mm tempered clear glass + 8mm air space + 6.38mm laminated clear float glass
VI. Sample 6 (DG6) : 4mm tempered clear glass + 8mm air space + 4mm tempered clear glass

Refer Appendix 2 for detail of samples description.

4. MEASUREMENT PROCEDURE

Enclosed blind samples were mounted in a vertical aperture as shown in Figure 4.1 enclosed blinds setup.

The measurement procedures involved a noise source fed to loudspeakers in the source room and sound levels were being measured in both the Source and Receiver rooms. The detail of test cell specification including build dimension is shown in Appendix 1.

Noise was generated via an amplifier output to a loudspeaker. The loud speaker was positioned in the top corner of the source room opposite the sample under measure. Figure 4.2 shows the loudspeakers location. The noise level of the source was varied from frequency 50Hz to 5,000Hz.

Sound Level Meter Positions: Two sound level meters were placed in the centre of the source and receiving rooms.

Figure 4.3 shows the sound level meter. Two sound level meters were used: TES 1350A; Serial No. 120303890, 131011245; Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015.

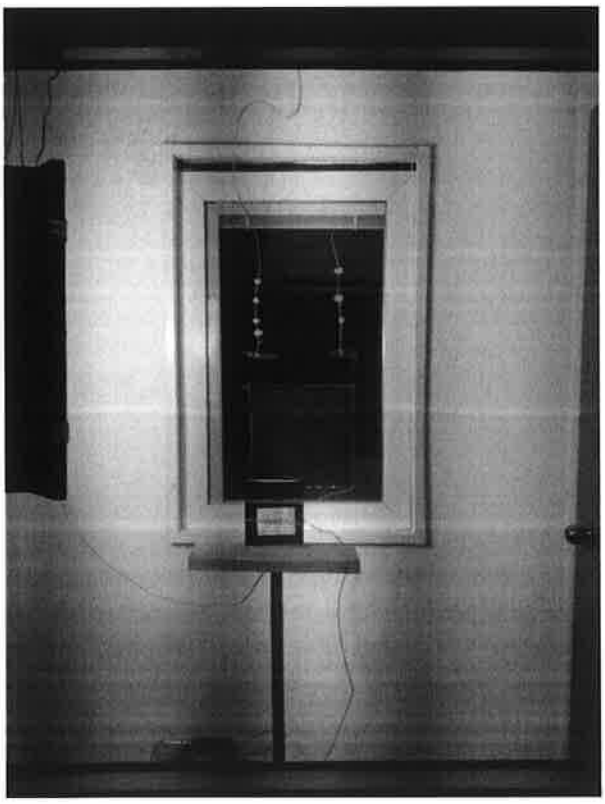


Figure 4.1 Enclosed Blinds Setup

Figure 4.2 Loudspeakers Location

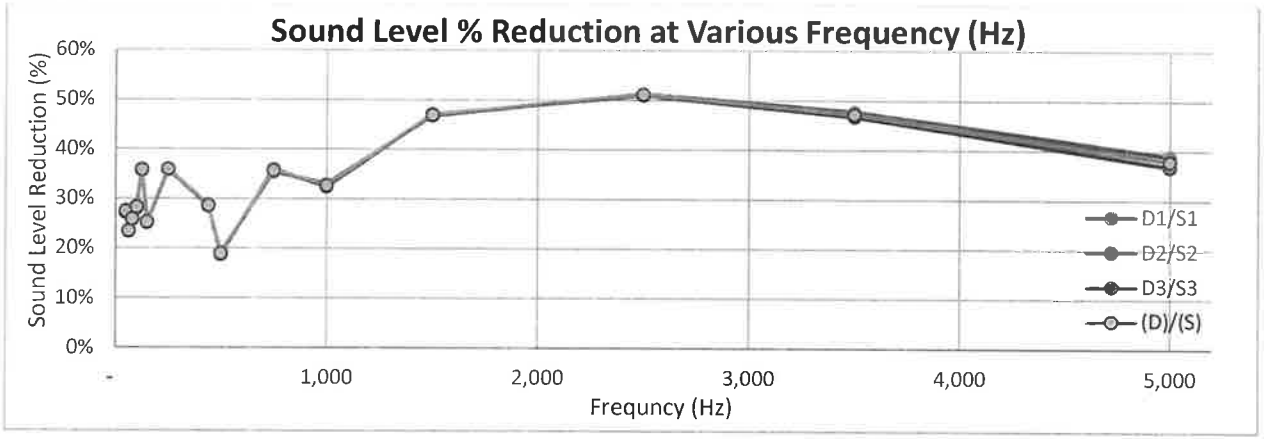
Figure 4.3 Sound Level Meter

5. RESULTS

5.1 Sample 1

Client : DES Building Innovate Sdn. Bhd. Date measured: 21-Jan-15
Test Sample : 1 Type of measurement: Field measurement of sound level at a source room and a receiving room provided by DES
Description : 4mm tempered clear + 4mm tempered clear (19mm gap)
Sound Level Meter: TES 1350A; Serial No. 120303890, 131011245
Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015

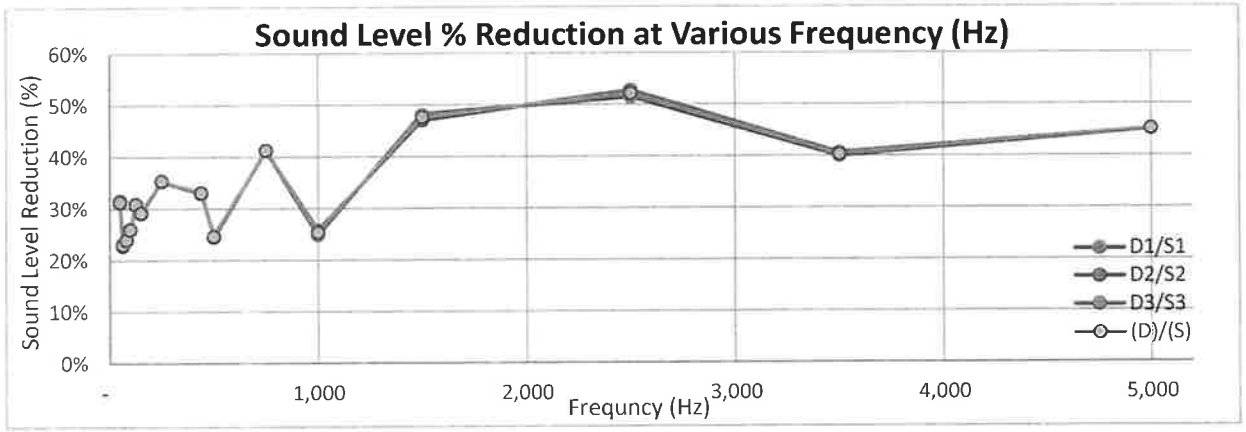
No	Freq	Source (S) dB					Receiving (R) dB					Reduction (S)-(R) dB			Average Reduction		% Reduction			Average Reduction	
	Hz	S1	S2	S3	Aver		R1	R2	R3	Aver		S1-R1	S2-R2	S3-R3	(S)-(R)	DB	D1/S1	D2/S2	D3/S3	(D)/(S)	%
1	50	88.2	89.0		88.6	min	63.8	64.8		64.3	min	24.4	24.2		24.3	min	28%	27%		27%	min
2	63	66.7	66.4		66.6	66.4	51.1	50.8		51.0	50.8	15.6	15.6		15.6	15.6	23%	23%		23%	19%
3	80	73.5	73.4		73.5	Max	54.5	54.4		54.5	Max	19.0	19.0		19.0	Max	26%	26%		26%	Max
4	100	73.5	73.1		73.3	105.1	52.6	52.6		52.6	78.4	20.9	20.5		20.7	53.8	28%	28%		28%	51%
5	125	81.5	81.6		81.6		52.4	52.3		52.4		29.1	29.3		29.2		36%	36%		36%	
6	150	104.5	104.8		104.7		77.9	78.4		78.2		26.6	26.4		26.5		25%	25%		25%	
7	250	81.5	81.7		81.6		52.3	52.3		52.3		29.2	29.4		29.3		36%	36%		36%	
8	440	89.0	88.6		88.8		63.6	63.2		63.4		25.4	25.4		25.4		29%	29%		29%	
9	500	83.7	83.2		83.5		67.7	67.6		67.7		16.0	15.6		15.8		19%	19%		19%	
10	750	92.7	92.6		92.7		59.9	59.3		59.6		32.8	33.3		33.1		35%	36%		36%	
11	1,000	87.8	87.7		87.8		58.9	59.3		59.1		28.9	28.4		28.7		33%	32%		33%	
12	1,500	100.4	100.2		100.3		53.4	53.0		53.2		47.0	47.2		47.1		47%	47%		47%	
13	2,500	105.1	105.0		105.1		51.2	51.4		51.3		53.9	53.6		53.8		51%	51%		51%	
14	3,500	104.5	103.2		103.9		54.6	54.9		54.8		49.9	48.3		49.1		48%	47%		47%	
15	5,000	84.6	82.0		83.3		51.6	51.8		51.7		33.0	30.2		31.6		39%	37%		38%	



5.2 Sample 2

Client : DES Building Innovate Sdn. Bhd. Date measured: 21-Jan-15
Test Sample : 2 Type of measurement: Field measurement of sound level at a source room and a receiving room provided by DES
Description : 4mm tempered clear + 5mm tempered light green (19mm gap)
Sound Level Meter: TES 1350A; Serial No. 120303890, 131011245
Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015

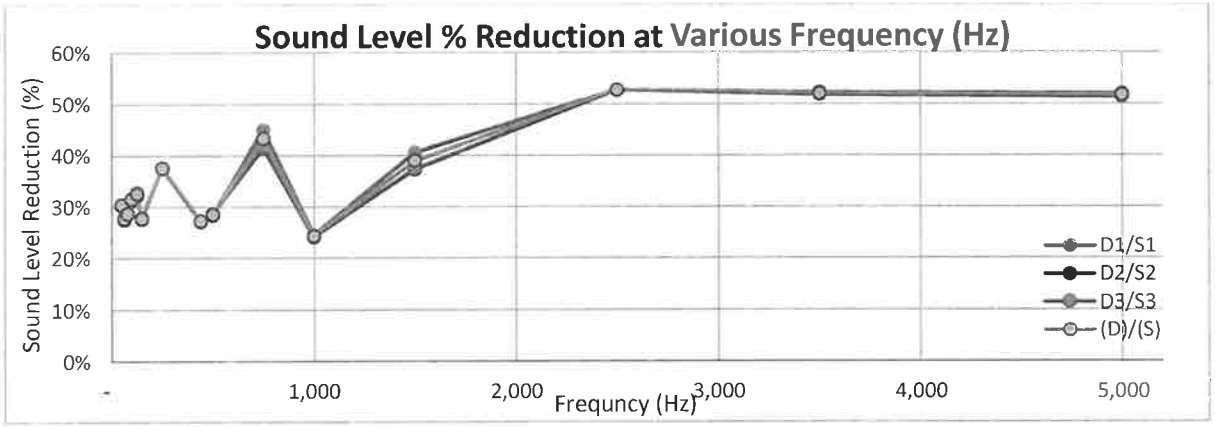
No	Freq	Source (S) dB					Receiving (R) dB					Reduction (S)-(R) dB			Average Reduction		% Reduction			Average Reduction	
	Hz	S1	S2	S3	Aver		R1	R2	R3	Aver		S1-R1	S2-R2	S3-R3	(S)-(R)	DB	D1/S1	D2/S2	D3/S3	(D)/(S)	%
1	50	83.9	82.7		83.3	min	57.8	56.6		57.2	min	26.1	26.1		26.1	min	31%	32%		31%	min
2	63	67.3	66.9		67.1	66.9	51.7	51.6		51.7	51.1	15.6	15.3		15.5	15.5	23%	23%		23%	23%
3	80	69.3	69.2		69.3	Max	52.7	52.6		52.7	Max	16.6	16.6		16.6	Max	24%	24%		24%	Max
4	100	74.0	73.6		73.8	109.1	54.7	54.5		54.6	70	19.3	19.1		19.2	56.9	26%	26%		26%	52%
5	125	74.1	74.0		74.1		51.1	51.2		51.2		23.0	22.8		22.9		31%	31%		31%	
6	150	97.6	96.6		97.1		69.2	68.4		68.8		28.4	28.2		28.3		29%	29%		29%	
7	250	89.0	88.7		88.9		57.5	57.3		57.4		31.5	31.4		31.5		35%	35%		35%	
8	440	94.6	94.1		94.4		63.4	62.9		63.2		31.2	31.2		31.2		33%	33%		33%	
9	500	82.2	82.5		82.4		61.9	62.3		62.1		20.3	20.2		20.3		25%	24%		25%	
10	750	89.9	89.7		89.8		52.8	52.7		52.8		37.1	37.0		37.1		41%	41%		41%	
11	1,000	93.2	94.0		93.6		70.0	69.8		69.9		23.2	24.2		23.7		25%	26%		25%	
12	1,500	103.1	101.7		102.4		53.4	53.8		53.6		49.7	47.9		48.8		48%	47%		48%	
13	2,500	109.1	109.1		109.1		52.9	51.5		52.2		56.2	57.6		56.9		52%	53%		52%	
14	3,500	90.8	91.2		91.0		54.5	54.2		54.4		36.3	37.0		36.7		40%	41%		40%	
15	5,000	95.8	95.4		95.6		52.5	52.3		52.4		43.3	43.1		43.2		45%	45%		45%	



5.3 Sample 3

Client : DES Building Innovate Sdn. Bhd. Date measured: 21-Jan-15
Test Sampl : 3 Type of measurement: Field measurement of sound level at a source room and a receiving room provided by DES
Descriptior : 4mm tempered clear + 6.38mm laminated clear (19mm gap)
Sound Level Meter: TES 1350A; Serial No. 120303890, 131011245
Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015

No	Freq	Source (S) dB					Receiving (R) dB					Reduction (S)-(R) dB			Average Reduction		% Reduction			Average Reduction	
	Hz	S1	S2	S3	Aver		R1	R2	R3	Aver		S1-R1	S2-R2	S3-R3	(S)-(R)	DB	D1/S1	D2/S2	D3/S3	(D)/(S)	%
1	50	81.5	81.0		81.3	min	56.8	56.3		56.6	min	24.7	24.7		24.7	min	30%	30%		30%	min
2	63	67.2	66.7		67.0	66.7	48.3	48.3		48.3	47.6	18.9	18.4		18.7	18.7	28%	28%		28%	24%
3	80	69.0	68.8		68.9	Max	49.2	49.0		49.1	Max	19.8	19.8		19.8	Max	29%	29%		29%	Max
4	100	73.4	73.1		73.3	107.6	50.1	50.2		50.2	73.3	23.3	22.9		23.1	56.8	32%	31%		32%	53%
5	125	72.2	71.6		71.9		48.4	48.5		48.5		23.8	23.1		23.5		33%	32%		33%	
6	150	95.3	95.0		95.2		68.9	68.5		68.7		26.4	26.5		26.5		28%	28%		28%	
7	250	87.8	87.6		87.7		54.8	54.6		54.7		33.0	33.0		33.0		38%	38%		38%	
8	440	92.3	92.1		92.2		67.2	66.9		67.1		25.1	25.2		25.2		27%	27%		27%	
9	500	83.5	83.6		83.6		59.8	59.6		59.7		23.7	24.0		23.9		28%	29%		29%	
10	750	88.0	88.2		88.1		48.3	51.5		49.9		39.7	36.7		38.2		45%	42%		43%	
11	1,000	96.0	96.7		96.4		72.4	73.3		72.9		23.6	23.4		23.5		25%	24%		24%	
12	1,500	96.3	96.8		96.6		57.1	60.6		58.9		39.2	36.2		37.7		41%	37%		39%	
13	2,500	107.6	107.5		107.6		50.8	50.8		50.8		56.8	56.7		56.8		53%	53%		53%	
14	3,500	99.3	99.7		99.5		47.8	47.6		47.7		51.5	52.1		51.8		52%	52%		52%	
15	5,000	100.6	101.3		101.0		48.9	48.6		48.8		51.7	52.7		52.2		51%	52%		52%	



5.4 Sample 4

Client : DES Building Innovate Sdn. Bhd.
Test Sample : 4
Description : 4mm tempered clear + 6.38mm laminated clear (double glaze) (19mm gap)
Sound Level Meter: TES 1350A; Serial No. 120303890, 131011245
Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015

Date meaured: 20-Jan-15
Type of measurement: Field measurement of sound level at a source room and a receiving room provided by DES

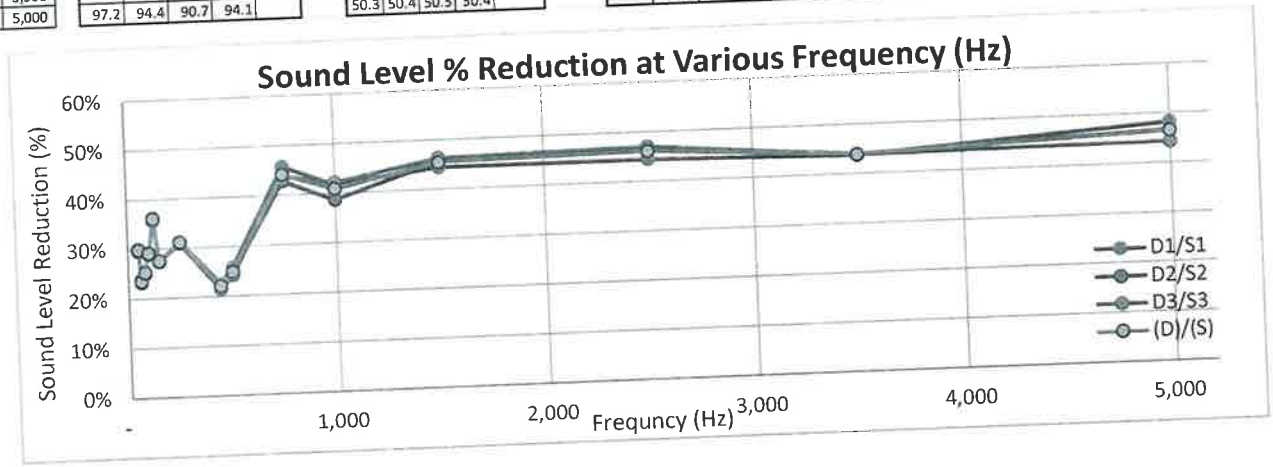
No	Freq
	Hz
1	50
2	63
3	80
4	100
5	125
6	150
7	250
8	440
9	500
10	750
11	1,000
12	1,500
13	2,500
14	3,500
15	5,000

Source (S) dB				
S1	S2	S3	Aver	
87.2	87.9	88.2	87.8	min
66.4	66.6	66.1	66.4	66.1
72.7	72.4	72.1	72.4	Max
72.5	72.7	72.6	72.6	105.6
79.9	80.8	80.7	80.5	
105.6	105.5	105.2	105.4	
82.8	82.4	82.2	82.5	
86.1	86.4	85.8	86.1	
82.7	82.9	82.8	82.8	
96.8	95.5	94.8	95.7	
88.3	86.7	85.5	86.8	
98.1	99.7	100.7	99.5	
94.0	97.7	98.0	96.6	
96.6	97.2	97.4	97.1	
97.2	94.4	90.7	94.1	

Receiving (R) dB				
R1	R2	R3	Aver	
61.4	61.6	62.0	61.7	min
50.9	50.7	50.7	50.8	49.5
54.2	54.1	54.0	54.1	Max
51.5	51.5	51.4	51.5	76.7
51.4	51.5	51.5	51.5	
76.7	76.5	76.3	76.5	
56.9	56.7	56.8	56.8	
66.6	67.3	67.3	67.1	
61.4	62.4	62.7	62.2	
52.5	54.7	53.3	53.5	
51.5	53.2	49.5	51.4	
54.5	54.3	54.1	54.3	
52.2	52.0	51.9	52.0	
54.4	54.5	54.7	54.5	
50.3	50.4	50.5	50.4	

Reduction (S)-(R) dB			Average Reduction	
S1-R1	S2-R2	S3-R3	(S)-(R)	DB
25.8	26.3	26.2	26.1	min
15.5	15.9	15.4	15.6	15.6
18.5	18.3	18.1	18.3	Max
21.0	21.2	21.2	21.1	45.2
28.5	29.3	29.2	29.0	
28.9	29.0	28.9	28.9	
25.9	25.7	25.4	25.7	
19.5	19.1	18.5	19.0	
21.3	20.5	20.1	20.6	
44.3	40.8	41.5	42.2	
36.8	33.5	36.0	35.4	
43.6	45.4	46.6	45.2	
41.8	45.7	46.1	44.5	
42.2	42.7	42.7	42.5	
46.9	44.0	40.2	43.7	

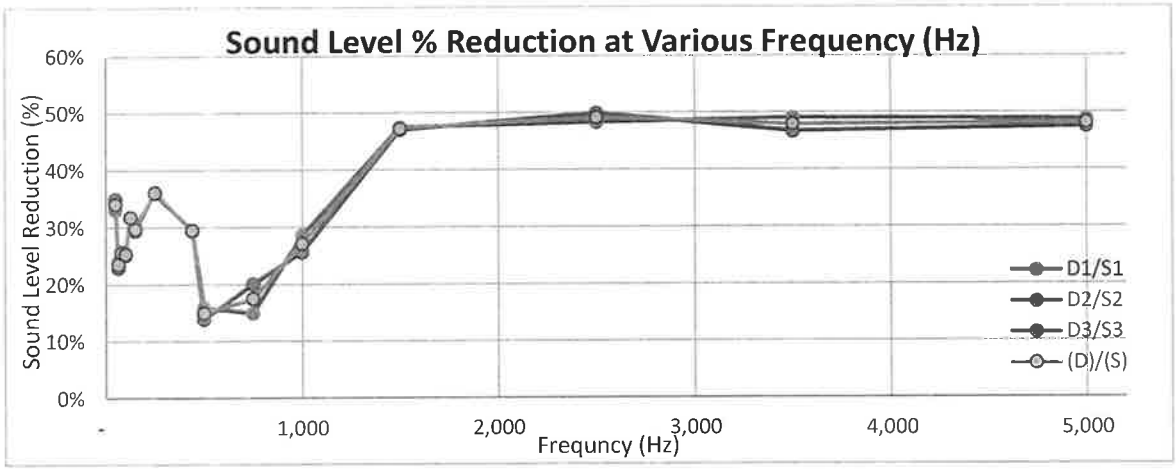
% Reduction			Average Reduction	
D1/S1	D2/S2	D3/S3	(D)/(S)	%
30%	30%	30%	30%	min
23%	24%	23%	24%	22%
25%	25%	25%	25%	Max
29%	29%	29%	29%	46%
36%	36%	36%	36%	
27%	27%	27%	27%	
31%	31%	31%	31%	
23%	22%	22%	22%	
26%	25%	24%	25%	
46%	43%	44%	44%	
42%	39%	42%	41%	
44%	46%	46%	45%	
44%	47%	47%	46%	
44%	44%	44%	44%	
48%	47%	44%	46%	



5.5 Sample 5

Client : DES Building Innovate Sdn. Bhd. Date measured: 20-Jan-15
Test Sample : 5 Type of measurement: Field measurement of sound level at a source room and a receiving room provided by DES
Description : 4mm tempered clear + 6.38mm laminated clear (double glaze) (8mm gap)
Sound Level Meter: TES 1350A; Serial No. 120303890, 131011245
Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015

No	Freq	Source (S) dB					Receiving (R) dB					Reduction (S)-(R) dB			Average Reduction		% Reduction			Average Reduction	
	Hz	S1	S2	S3	Aver		R1	R2	R3	Aver		S1-R1	S2-R2	S3-R3	(S)-(R)	DB	D1/S1	D2/S2	D3/S3	(D)/(S)	%
1	50	81.9	83.5		82.7	min	54.7	54.3		54.5	min	27.2	29.2		28.2	min	33%	35%		34%	min
2	63	68.2	67.1		67.7	67.1	51.8	51.7		51.8	50.9	16.4	15.4		15.9	12.9	24%	23%		24%	15%
3	80	73.7	73.1		73.4	Max	54.7	54.6		54.7	Max	19.0	18.5		18.8	Max	26%	25%		26%	Max
4	100	72.2	71.5		71.9	109	53.8	53.5		53.7	74	18.4	18.0		18.2	52.8	25%	25%		25%	49%
5	125	76.6	76.6		76.6		52.2	52.2		52.2		24.4	24.4		24.4		32%	32%		32%	
6	150	102.5	104.5		103.5		71.7	73.7		72.7		30.8	30.8		30.8		30%	29%		30%	
7	250	85.5	85.3		85.4		54.7	54.4		54.6		30.8	30.9		30.9		36%	36%		36%	
8	440	79.1	74.7		76.9		55.7	52.7		54.2		23.4	22.0		22.7		30%	29%		30%	
9	500	88.0	84.9		86.5		74.0	73.1		73.6		14.0	11.8		12.9		16%	14%		15%	
10	750	80.4	80.9		80.7		68.4	64.7		66.6		12.0	16.2		14.1		15%	20%		17%	
11	1,000	97.6	95.7		96.7		69.7	71.2		70.5		27.9	24.5		26.2		29%	26%		27%	
12	1,500	101.5	97.5		99.5		53.3	51.6		52.5		48.2	45.9		47.1		47%	47%		47%	
13	2,500	105.8	109.0		107.4		54.7	54.6		54.7		51.1	54.4		52.8		48%	50%		49%	
14	3,500	106.4	101.3		103.9		54.2	54.0		54.1		52.2	47.3		49.8		49%	47%		48%	
15	5,000	100.0	97.0		98.5		51.2	50.9		51.1		48.8	46.1		47.5		49%	48%		48%	



5.6 Sample 6

Client : DES Building Innovate Sdn. Bhd. Date measured: 20-Jan-15
Test Sample : 6 Type of measurement: Field measurement of sound level at a source room and a receiving room provided by DES
Description : 4mm tempered clear + 4mm tempered clear (double glaze) (8mm gap)
Sound Level Meter: TES 1350A; Serial No. 120303890, 131011245
Calibrated Date: 24 Oct 2014, Due Date: 24 Oct 2015

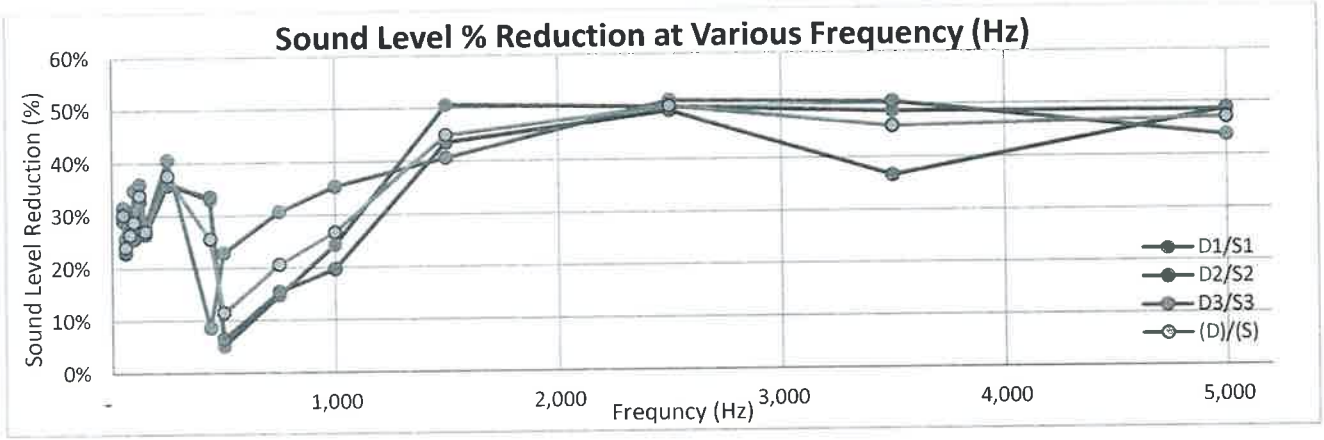
No	Freq
	Hz
1	50
2	63
3	80
4	100
5	125
6	150
7	250
8	440
9	500
10	750
11	1,000
12	1,500
13	2,500
14	3,500
15	5,000

Source (S) dB				
S1	S2	S3	Aver	
84.3	85.4	83.2	84.3	min
66.4	66.3	65.8	66.2	65.8
73.5	73.7	72.7	73.3	Max
72.1	71.8	76.7	73.5	**106.4**
77.0	77.2	77.8	77.3	
104.8	105.7	102.1	104.2	
85.2	85.5	84.0	84.9	
81.9	82.3	75.1	79.8	
79.5	79.7	79.7	79.6	
81.9	82.7	89.7	84.8	
96.9	94.0	103.0	98.0	
98.6	96.7	97.0	97.4	
106.2	105.0	99.3	103.5	
106.4	**82.0**	104.5	97.6	
98.3	99.1	89.2	95.5	

Receiving (R) dB				
R1	R2	R3	Aver	
59.3	60.5	56.9	58.9	min
50.9	51.1	48.9	50.3	48.5
54.5	54.5	52.9	54.0	Max
53.6	53.4	50.0	52.3	**77.8**
51.8	51.9	49.8	51.2	
76.7	77.8	73.5	76.0	
54.2	54.9	49.9	53.0	
54.9	54.7	68.6	59.4	
75.4	74.5	61.5	70.5	
69.8	69.9	62.2	67.3	
73.4	75.5	66.6	71.8	
48.6	54.6	57.6	53.6	
53.2	53.3	48.5	51.7	
54.5	52.0	51.7	52.7	
50.5	50.7	50.1	50.4	

Reduction (S)-(R) dB			Average Reduction	
S1-R1	S2-R2	S3-R3	(S)-(R)	DB
25.0	24.9	26.3	25.4	min
15.5	15.2	16.9	15.9	9.2
19.0	19.2	19.8	19.3	Max
18.5	18.4	26.7	21.2	51.8
25.2	25.3	28.0	26.2	
28.1	27.9	28.6	28.2	
31.0	30.6	34.1	31.9	
27.0	27.6	6.5	20.4	
4.1	5.2	18.2	9.2	
12.1	12.8	27.5	17.5	
23.5	18.5	36.4	26.1	
50.0	42.1	39.4	43.8	
53.0	51.7	50.8	51.8	
51.9	30.0	52.8	44.9	
47.8	48.4	39.1	45.1	

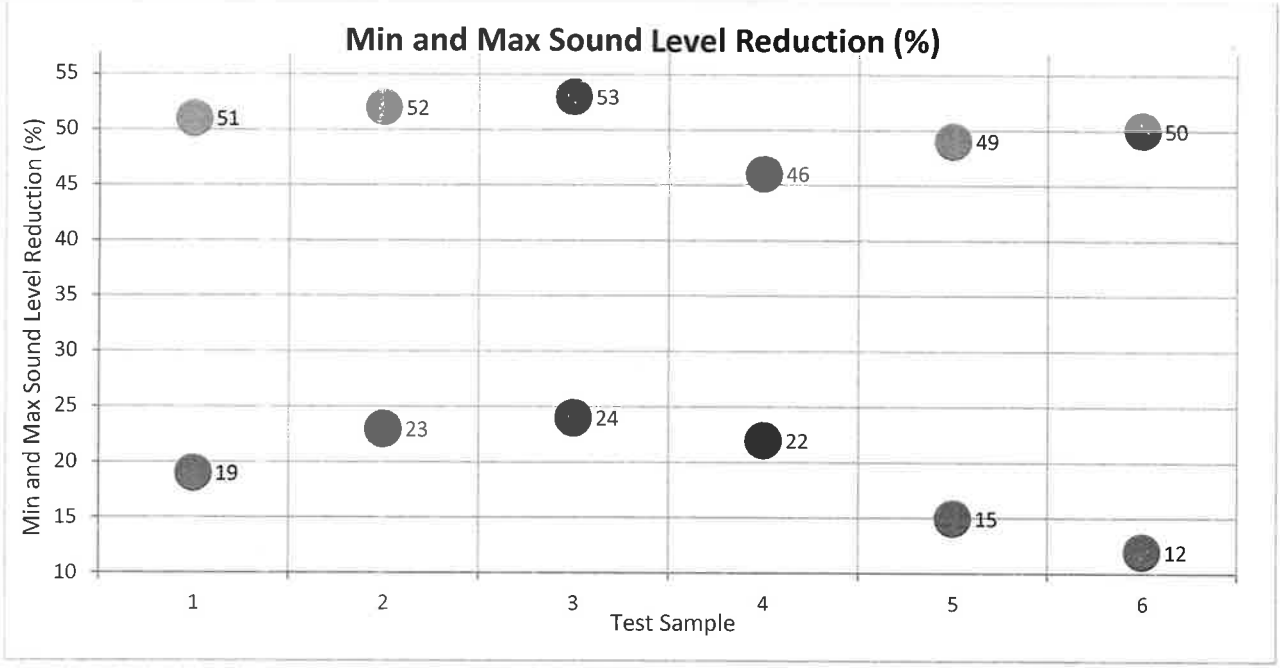
% Reduction			Average Reduction	
D1/S1	D2/S2	D3/S3	(D)/(S)	%
30%	29%	32%	30%	min
23%	23%	26%	24%	12%
26%	26%	27%	26%	Max
26%	26%	35%	29%	50%
33%	33%	36%	34%	
27%	26%	28%	27%	
36%	36%	41%	38%	
33%	34%	9%	26%	
5%	7%	23%	12%	
15%	15%	31%	21%	
24%	20%	35%	27%	
51%	44%	41%	45%	
50%	49%	51%	50%	
49%	37%	51%	46%	
49%	49%	44%	47%	



6. SUMMARY

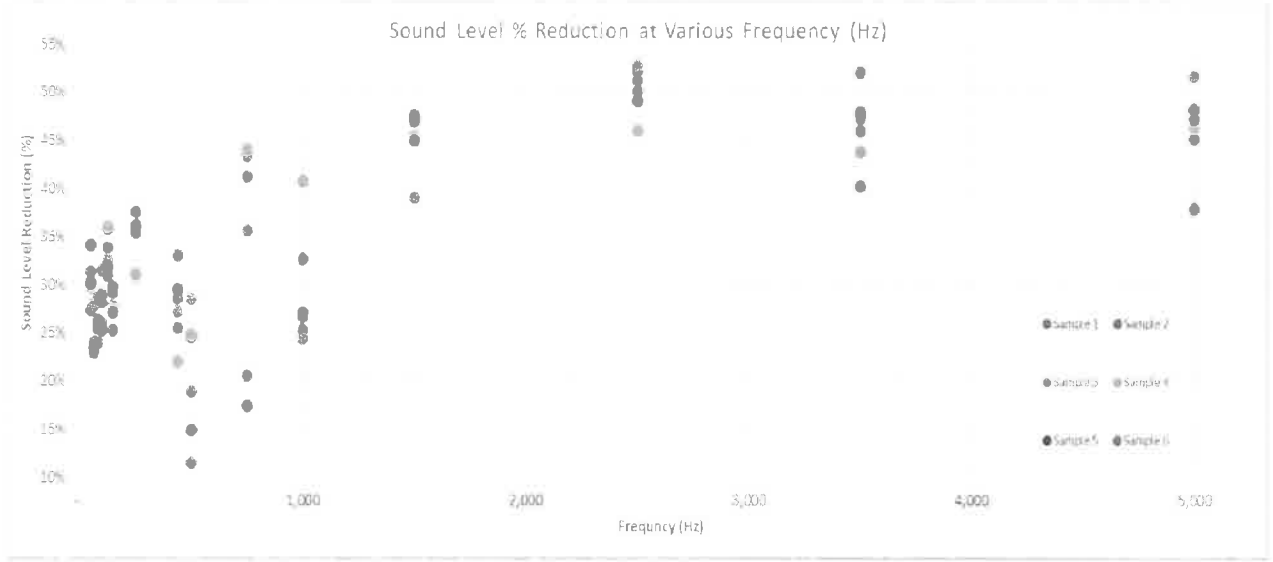
The minimum and maximum sound level insulations (reductions) for each sample are tabulated as follows:

Sound % reduction	Test sample					
	1	2	3	4	5	6
Min	19	23	24	22	15	12
Max	51	52	53	46	49	50



The percentages of sound insulation (reduction) for each sample at various frequencies are tabulated as follows:

No	Freq	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5		Sample 6	
	Hz	(D)/(S)	%	(D)/(S)	%	(D)/(S)	%	(D)/(S)	%	(D)/(S)	%	(D)/(S)	%
1	50	27%	min	31%	min	30%	min	30%	min	34%	min	30%	min
2	63	23%	19%	23%	23%	28%	24%	24%	22%	24%	15%	24%	12%
3	80	26%	Max	24%	Max	29%	Max	25%	Max	26%	Max	26%	Max
4	100	28%	51%	26%	52%	32%	53%	29%	46%	25%	49%	29%	50%
5	125	36%		31%		33%		36%		32%		34%	
6	150	25%		29%		28%		27%		30%		27%	
7	250	36%		35%		38%		31%		36%		38%	
8	440	29%		33%		27%		22%		30%		26%	
9	500	19%		25%		29%		25%		15%		12%	
10	750	36%		41%		43%		44%		17%		21%	
11	1,000	33%		25%		24%		41%		27%		27%	
12	1,500	47%		48%		39%		45%		47%		45%	
13	2,500	51%		52%		53%		46%		49%		50%	
14	3,500	47%		40%		52%		44%		48%		46%	
15	5,000	38%		45%		52%		46%		48%		47%	



The commonly stated range of human hearing frequency is 20Hz to 20,000Hz. However, humans are most sensitive to frequencies between 2,000 and 5,000Hz. Thus, the measurements were carried out applying noise frequencies ranging from 50Hz to 5,000Hz. Sound reductions have more fluctuation at lower frequencies and more stable when above 2000Hz.

From the measurements collected, DES enclosed blinds are capable of insulating noise, in the percentage range from 38%-53%, for frequencies between 2,000 and 5,000Hz.

It is observed that the most efficient sound insulation for all the enclosed blinds is at frequency 2,500Hz, ranging from 46-53% reduction. At the frequencies between 2,000 and 5,000Hz, sample 3 has the best sound insulation. Sample 5 has the second highest sound reduction percentage at 3,500Hz and 5,000Hz. Details rankings are shown in table below.

Freq	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Reduction Ranking (1 best, 6 lowest)					
Hz	Sound reduction						1	2	3	4	5	6
2,500	51%	52%	53%	46%	49%	50%	Sample 3	Sample 2	Sample 1	Sample 6	Sample 5	Sample 4
3,500	47%	40%	52%	44%	48%	46%	Sample 3	Sample 5	Sample 1	Sample 6	Sample 4	Sample 2
5,000	38%	45%	52%	46%	48%	47%	Sample 3	Sample 5	Sample 6	Sample 4	Sample 2	Sample 1

7. REFERENCES

1. ASTM E336-14, Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings, ASTM International, West Conshohocken, PA, 2014, www.astm.org
2. ISO 10140-2:2010, Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 2: Measurement of airborne sound insulation
3. ISO 717-1:2013, Acoustics -- Rating of sound insulation in buildings and of building elements -- Part 1: Airborne sound insulation
4. ISO 16283-1:2014, Acoustics -- Field measurement of sound insulation in buildings and of building elements -- Part 1: Airborne sound insulation