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Indicative Measurement of Airborne Sound Insulation of Building Elements in Accordance with ISO10140 Measurement Procedure, Weighted Sound Reduction Index (R_w) Calculation in Accordance with AS/NZS ISO 717.1

Performed on – FireCrunch Walls

Date: 27/07/2015

Clients: FireCrunch

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Date: 11/08/2015

Report AC-011-15/CT

1. Relevant standards 2
2. Testing facilities description 2
3. Description of procedure 3
Noise generation 3
Sound pressure levels readings of Source and Receiving rooms 3
Background Sound pressure levels readings in Receiving room 3
T2 Reverberation Time measurements 3
Measured L1, L2, B2 & T2 processing 3
4. Equipment 3
5. Tested product identification and description 4
6. Air temperature and humidity 4
7. Sound Reduction index of the specimen 5
Annexe A – R_w One-sheet reports 7
Annexe B – Drawings of the samples 11

1. Relevant standards

The measurements leading to the results presented in this report have been undertaken in accordance with standards which specify a method for measuring the airborne sound insulation of building elements:

- *ISO10140-1:2010 Acoustics –Laboratory measurement of sound insulation of building elements – Part 1: Application rules for specific products*
- *ISO10140-1:2010/Amd.1:2012 Acoustics –Laboratory measurement of sound insulation of building elements – Part 1: Application rules for specific products—Amendment 1*
- *ISO10140-2:2010 Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation*
- *ISO10140-4:2010 Acoustics – Laboratory measurement of sound insulation of building elements – Part 4: Measurement procedures and requirements*

The calculation method leading to the rating of the sound insulation of the samples tested is defined in:

- *AS/NZS ISO 717.1:2004 Acoustics—Rating of sound insulation in buildings and of building elements, Part 1: Airborne sound insulation*

It uses the results of the tests defined in ISO10140 to determine a single figure performance guide known as the "Weighted Average Sound Reduction Index", which is expressed in terms of a number of dB, followed by the suffix "R_w".

The test facility and equipment were in accordance with:

- *ISO10140-5:2010 Acoustics – Laboratory measurement of sound insulation of building elements – Part 5: Requirements for test facilities and equipment*

Repeatability has been estimated in accordance with:

- *ISO12999-1:2014 Acoustics – Determination and application of measurement uncertainties in building acoustics – Part 1: Sound insulation*

2. Testing facilities description

The test facilities consist of two acoustically "live" reverberant plane-parallel rooms. The Source room has a volume of 72m^3 and the Receiving room a volume of 82m^3. Sizes of the room (in m) and walls thickness are:

	H	W	D	Wall thickness
Source	3.26	5.21	4.23	Wall 259mm - Ceiling 428mm
Receiving	3.4	5.44	4.42	Wall 259 or 371mm - Ceiling 568mm

Internal and external walls consist of three layers of 13mm plasterboards which are installed on independent timber structures. All cavities are filled with R3.5 glasswool. Both rooms are isolated from the ground by a high density glass wool blanket foundation, and from the common specimen holder by a viscoelastic polyurethane mastic infill. Both rooms incorporate exposed elements that provide additional reflective surfaces to enhance sound diffusion within the room volumes.

A 2990mm wide x 2380mm high test specimen aperture separates the two rooms.

3. Description of procedure

Measurements were undertaken by Christophe Titry (testing officer)

Noise generation

A “Pink Noise” was generated as the reference sound spectrum. It was amplified and fed through to the omnidirectional source unit which was used to evenly radiate sound in a spherical distribution. This unit consists of twelve individual loud speakers configured around a dodecahedron.

Sound pressure levels readings of Source and Receiving rooms

Sound pressure levels (L1 and L2) were measured in the Source room and the Receiving room simultaneously via a calibrated microphone attached to a rotating boom. The booms were set in motion and readings were continuously averaged and recorded throughout the sweep (Radius = 1.1m) which last for a period of one minute.

L1 and L2 were measured for two source locations.

Background Sound pressure levels readings in Receiving room

Background noise level (B2) was measured in the Receiving room via a calibrated microphone for a period of one minute.

T2 Reverberation Time measurements

The Omni sound source was then moved into the Receiving room to undertake reverberation time measurements (T2). The sound field was built up within the Receiving room and abruptly cut off. The decay of the sound levels within the room was then measured. The build-up and decay readings were taken seven times along the path of the rotating microphone, rotating at a speed of 150 sec /revolution, for one source position. Reverberation times were undertaken in accordance with *WASO3382-2 Acoustics – Measurement of room acoustic parameters – Part 2: Reverberation time in ordinary rooms.*

Measured L1, L2, B2 & T2 processing

All measurements were performed in each one-third octave band of centre frequency 100 to 5000 Hz and were processed in order to get the “Weighted Average Sound Reduction Index”, R_w.

4. Equipment

Table 1 presents the list of the equipment used.

Table 1 – Equipment used for measurements

Equipment	Manufacturer	Type
Acoustic Analyser	*Norsonic*	NOR140 S/N 1405434 – Calibrated 13/01/2015 NOR140 S/N 1406170 – Calibrated 19/01/2015
Microphone	*Norsonic*	1225 S/N 142515 – Calibrated 13/01/2015 1225 S/N 212914 – Calibrated 19/01/2015
Preamplifier	*Norsonic*	1209 S/N 14250 – Calibrated 13/01/2015 1206 S/N 20436 – Calibrated 19/01/2015
Filter	*Norsonic*	1/3 octave S/N1405434 – Calibrated 13/01/2015 1/3 octave S/N1406170 – Calibrated 19/01/2015
Sound Calibrator	*Brüel & Kjær*	4231 - S/N 2558216 – Calibrated 02/09/2014
Digital Psychrometer	*Reed*	8706 - S/N 9811576 – Calibrated 29/10/2014
Wireless Transmission	*Sennheiser/Norsonic*	eW 100 G2 / Nor520A
Amplifier - Loudspeaker	*Brüel & Kjær*	2716 Power amplifier - 4269 loudspeaker
Rotating microphone boom	*Brüel & Kjær* *Norsonic*	3923 Nor265

5. Tested product identification and description

The test samples were walls and consisted of FireCrunch 10mm boards on Rondo steel stud frames, they were installed within the aperture that separates the Source and Receiving rooms. The boards joints and edges were sealed with Fuller Firesound sealant.

Walls tested

- Test 1 (from source to receiving room): FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres – frame filled 90mm Fletcher insulation Pink Partion 32 (25.6kg/m3) – 20mm gap – frame filled with 90mm Fletcher insulation Pink Partion 32 (25.6kg/m3) – FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres – curing time less than one hour
- Test 2 (from source to receiving room): FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres – frame filled 90mm Fletcher insulation Pink Partion 32 (25.6kg/m3) – FireCrunch board 10mm (950kg/m3) – curing time less than two hours
- Test 3 (from source to receiving room): FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres (no boards in receiving room) – curing time less than three hours.

6. Air temperature and humidity

Table 2 presents the air temperature and humidity for each test.

Table 2 Temperature and humidity summary

Test	Temp. Wet-bulb (℃) Src / Rec	Temp. Dry-bulb (℃) Src / Rec	Humidity (%) Src / Rec	Ref. #
Test #1	13.9 / 14.0	24.2 / 23.7	30.7 / 32.9	AC737WA7/2015
Test #2	13.1 / 13.8	21.7 / 22.5	36.8 / 36.9	AC738WA7/2015
Test #3	14.1 / 14.0	24.1 / 23.8	31.9 / 32.7	AC739WA7/2015

7. Sound Reduction index of the specimen

Table 3 presents the sound reduction index in each one-third octave band, the weighted sound reduction index and the adaption terms for each test.

Table 3 Sound reduction index for each 1/3 octave band, R_w, C and C_{tr}

Frequency (Hz)	R (Sound Reduction Index) (dB)		
	Test #1	Test #2	Test #3
	Ref. AC737WA7/2015	Ref. AC738WA7/2015	Ref. AC739WA7/2015
100	≥ 35.1‡	26.3	18.5
125	36.6	32	18.3
160	≥ 44‡	37.9	21.5
200	≥ 48.3‡	40.5	20
250	≥ 53.3‡	42	21.2
315	≥ 58‡	41.9	22.9
400	≥ 62.4‡	46.6	24.2
500	≥ 63.8‡	47.8	26.4
630	≥ 65.6‡	51	28.1
800	≥ 68.2‡	54.4	30.7
1000	≥ 72.3‡	56.2	31.8
1250	≥ 76.3‡	59.2	33.1
1600	≥ 75.7‡	59.1	33.9
2000	≥ 77‡	54.7	32.5
2500	71.9	45.7	26.2
3150	72.2	45.1	26.2
4000	≥ 78.1‡	50.6	30.4
5000	≥ 81.2‡	55.8	34.3
R_w	**62**	**49**	**29**
C	**-4**	**-2**	**-1**
C_{tr}	**-10**	**-6**	**-2**

Table 4 presents the corrections details for the tests (refers to symbol ‡ in Table 3).

Table 4 Corrections details for the specimen

Test	Frequency (Hz)	‡ symbol comment
AC737WA	5000	L2_1 was within 6 dB above the background noise level (-1.3 dB correction for L2)
AC737WA	100	*R1* larger than R'max (49.8 *d*B) - 15 dB (No correction)
AC737WA	160	*R1* larger than R'max (56.6 *d*B) - 15 dB (No correction)
AC737WA	200	*R1* larger than R'max (59.3 *d*B) - 15 dB (No correction)
AC737WA	250	*R1* larger than R'max (61.8 *d*B) - 15 dB (No correction)
AC737WA	315	*R1* larger than R'max (66.2 *d*B) - 15 dB (No correction)
AC737WA	400	*R1* larger than R'max (71.9 *d*B) - 15 dB (No correction)
AC737WA	500	*R1* larger than R'max (74.1 *d*B) - 15 dB (No correction)
AC737WA	630	*R1* larger than R'max (76.2 *d*B) - 15 dB (No correction)
AC737WA	1200	*R1* larger than R'max (77.1 *d*B) - 15 dB (No correction)
AC737WA	1000	*R1* larger than R'max (79.6 *d*B) - 15 dB (No correction)
AC737WA	1250	*R1* larger than R'max (82.7 *d*B) - 15 dB (No correction)
AC737WA	1600	*R1* larger than R'max (85.5 *d*B) - 15 dB (No correction)
AC737WA	2000	*R1* larger than R'max (89.4 *d*B) - 15 dB (No correction)
AC737WA	4000	*R1* larger than R'max (91.3 *d*B) - 15 dB (No correction)
AC737WA	5000	*R1* larger than R'max (84.2 *d*B) - 15 dB (No correction)
AC737WA	5000	L2_2 was within 6 dB above the background noise level (-1.3 dB correction for L2)
AC737WA	160	*R2* larger than R'max (56.6 *d*B) - 15 dB (No correction)
AC737WA	200	*R2* larger than R'max (59.3 *d*B) - 15 dB (No correction)
AC737WA	250	*R2* larger than R'max (61.8 *d*B) - 15 dB (No correction)
AC737WA	315	*R2* larger than R'max (66.2 *d*B) - 15 dB (No correction)
AC737WA	400	*R2* larger than R'max (71.9 *d*B) - 15 dB (No correction)
AC737WA	500	*R2* larger than R'max (74.1 *d*B) - 15 dB (No correction)
AC737WA	630	*R2* larger than R'max (76.2 *d*B) - 15 dB (No correction)
AC737WA	1200	*R2* larger than R'max (77.1 *d*B) - 15 dB (No correction)
AC737WA	1000	*R2* larger than R'max (79.6 *d*B) - 15 dB (No correction)
AC737WA	1250	*R2* larger than R'max (82.7 *d*B) - 15 dB (No correction)
AC737WA	1600	*R2* larger than R'max (85.5 *d*B) - 15 dB (No correction)
AC737WA	2000	*R2* larger than R'max (89.4 *d*B) - 15 dB (No correction)
AC737WA	4000	*R2* larger than R'max (91.3 *d*B) - 15 dB (No correction)
AC737WA	5000	*R2* larger than R'max (84.2 *d*B) - 15 dB (No correction)

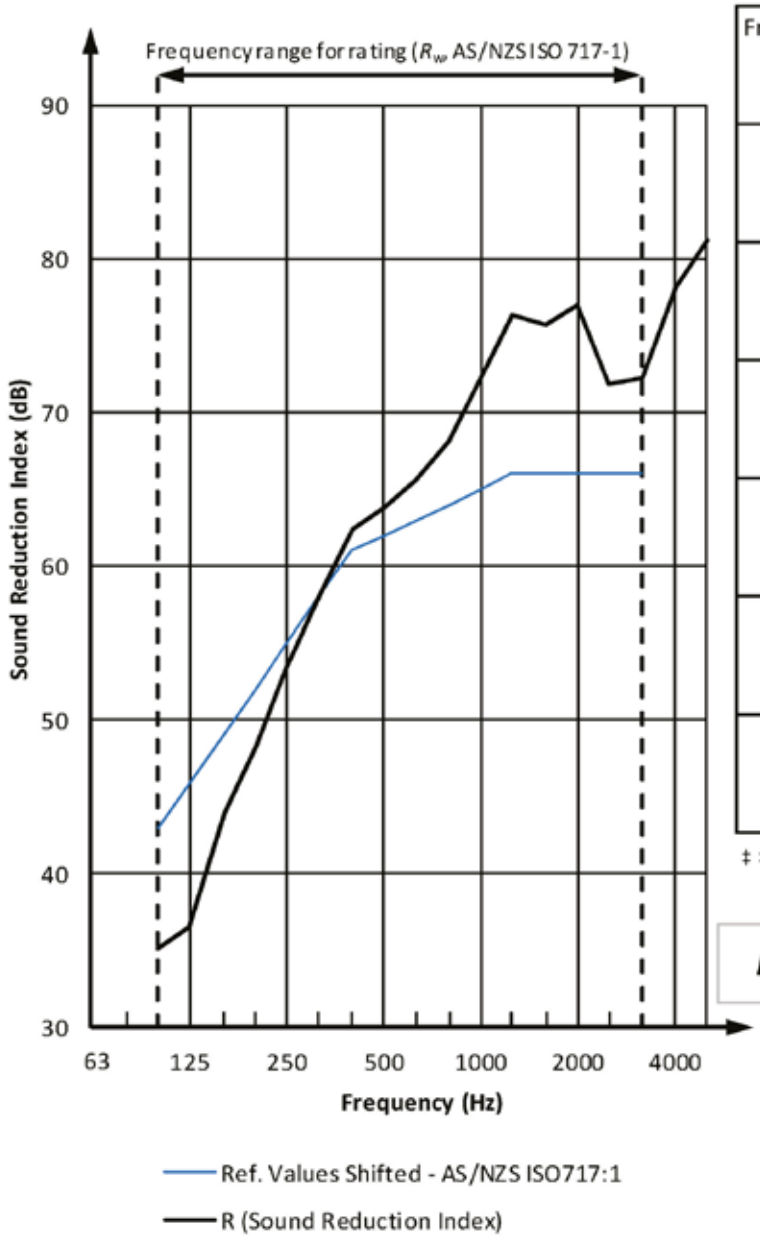
Annexe A – R_w One-sheet reports

Sound reduction index, *R*, in accordance with ISO 10140-2

Area of separating element: 7.12 m²
Source room volume: 72 m³
Receiving room volume: 82 m³
Date: 27/7/2015
Client: FireCrunch

Humidity (%, S/R): 30.7 / 32.9 ±3
Temperature (°C, S/R): 24.2 / 23.7 ±0.6
Static pressure (hPa): 1025 ±0.5%

AC737WA7/2015



Frequency f Hz	*R* 1/3 octave dB	*R* 1/1 octave dB
100	≥ 35.1‡	
125	36.6	37.2
160	≥ 44‡	
200	≥ 48.3‡	
250	≥ 53.3‡	51.5
315	≥ 58‡	
400	≥ 62.4‡	
500	≥ 63.8‡	63.7
630	≥ 65.6‡	
800	≥ 68.2‡	
1000	≥ 72.3‡	71.1
1250	≥ 76.3‡	
1600	≥ 75.7‡	
2000	≥ 77‡	74.3
2500	71.9	
3150	72.2	
4000	≥ 78.1‡	75.6
5000	≥ 81.2‡	

‡ : See report for details

$R_w(C;C_{tr})$ = 62 (-4;-10)

Evaluation based on laboratory measurement results obtained in one-third octave bands by an engineering method.

Wall: (from source to receiving room) FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres – frame filled 90mm Fletcher insulation Pink Partion 32 (25.6kg/m3) – 20mm gap – frame filled with 90mm Fletcher insulation Pink Partion 32 (25.6kg/m3) – FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres – joints and edges sealed with Fuller Firesound sealant

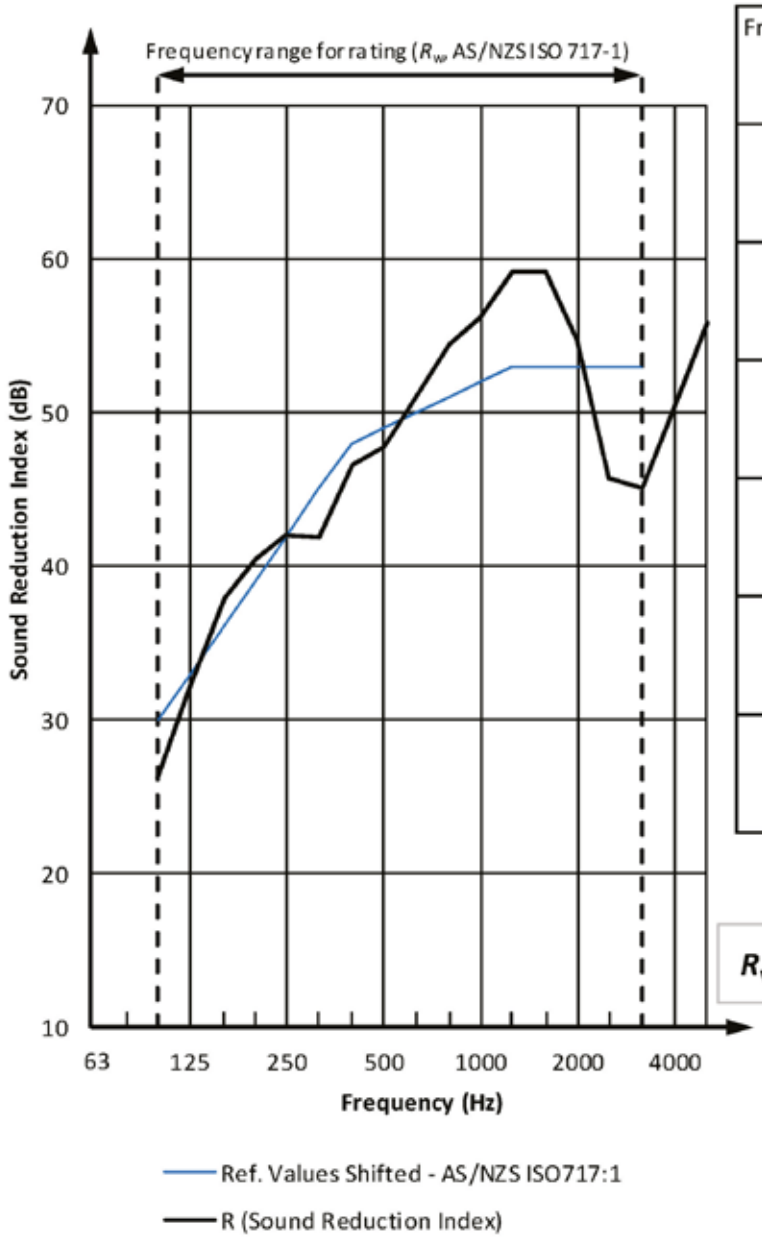
FireCrunch board

Sound reduction index, *R*, in accordance with ISO 10140-2

Area of separating element: 7.12 m²
Source room volume: 72 m³
Receiving room volume: 82 m³
Date: 27/7/2015
Client: FireCrunch

Humidity (%, S/R): 36.8 / 36.9 ±3
Temperature (°C, S/R): 21.7 / 22.5 ±0.6
Static pressure (hPa): 1025 ±0.5%

AC738WA7/2015



Frequency f Hz	*R* 1/3 octave dB	*R* 1/1 octave dB
100	26.3	
125	32	29.8
160	37.9	
200	40.5	
250	42	41.4
315	41.9	
400	46.6	
500	47.8	48.1
630	51	
800	54.4	
1000	56.2	56.2
1250	59.2	
1600	59.1	
2000	54.7	49.8
2500	45.7	
3150	45.1	
4000	50.6	48.5
5000	55.8	

$R_w(C;C_{tr})$ = 49 (-2;-6) dB

Evaluation based on laboratory measurement results obtained in one-third octave bands by an engineering method.

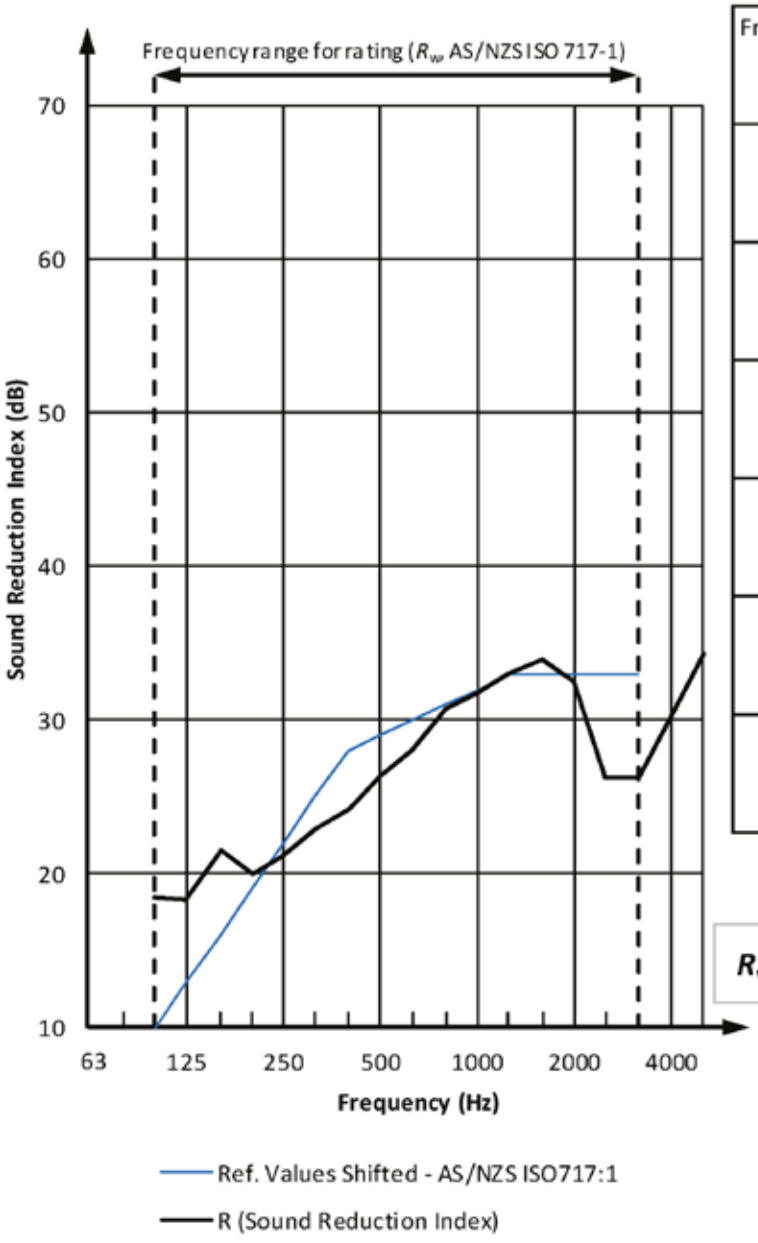
Wall: (from source to receiving room) FireCrunch board 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres – frame filled 90mm Fletcher insulation Pink Partion 32 (25.6kg/m3) – FireCrunch board 10mm (950kg/m3) – joints and edges sealed with Fuller Firesound sealant

Sound reduction index, *R*, in accordance with ISO 10140-2

Area of separating element: 7.12 m²
Source room volume: 72 m³
Receiving room volume: 82 m³
Date: 27/7/2015
Client FireCrunch

Humidity (%, S/R): 31.9 / 32.7 ±3
Temperature (°C, S/R): 24.1 / 23.8 ±0.6
Static pressure (hPa): 1025 ±0.5%

AC739WA7/2015



Frequency f Hz	*R* 1/3 octave dB	*R* 1/1 octave dB
100	18.5	
125	18.3	19.2
160	21.5	
200	20	
250	21.2	21.2
315	22.9	
400	24.2	
500	26.4	25.9
630	28.1	
800	30.7	
1000	31.8	31.8
1250	33.1	
1600	33.9	
2000	32.5	29.5
2500	26.2	
3150	26.2	
4000	30.4	29.1
5000	34.3	

$R_w(C;C_{tr})$ = 29 (-1;-2) dB

Evaluation based on laboratory measurement results obtained in one-third octave bands by an engineering method.

Wall: (from source to receiving room) FireCrunch board | 10mm (950kg/m3) on 90mm 0.55BMT Rondo steel studs at 600mm centres (no boards in receiving room) – joints and edge sealed with Fuller Firesound sealant.