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TEST REPORT No : 4217 **DATE OF ISSUE : 13 September 2019**

BS EN ISO 10140-2:2010

Acoustics – Laboratory Measurement of Sound Insulation of Building Elements

Part 2: Measurements of Airborne Sound Insulation

Client:	Storm Windows
Job Number:	ACOUS/04217
Test Sample:	Various window samples
Date(s) of Test:	20 & 22 August 2019

Signed: . . . . . D Wong-McSweeney
Laboratory Manager

Approved: . . . . . S M Furlong
Specialist Acoustics Technician

Contents

Client/Manufacturer Details: Storm Windows
James Scott Road
Halesowen
West Midlands
B63 2QT

Date Order Received: 13 June 2019

1. Test Samples

The following sample was installed in the 3600 × 2400 mm aperture of the transmission suite of the University of Salford Acoustic Test Laboratory. The test specimen was installed in accordance with Appendix C: Windows of BS EN ISO 10140-1:2016 Part 1: Application rules for specific products.

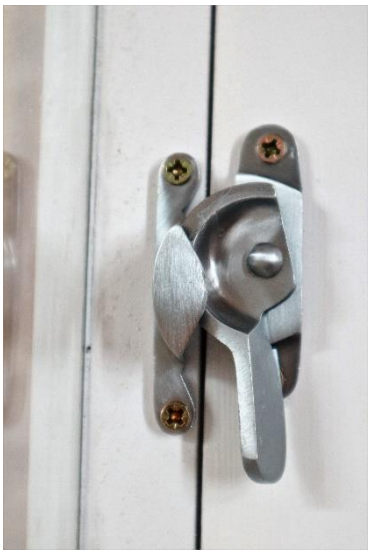
1.1. Description of Test Samples

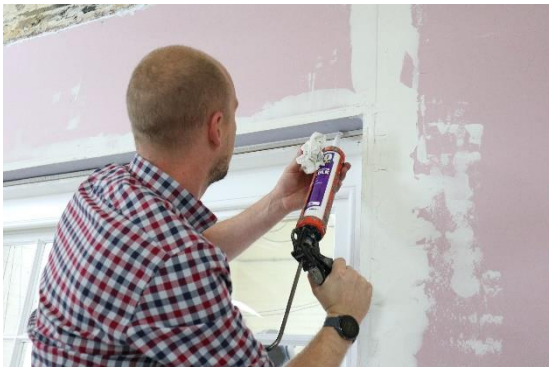
A plasterboard partition was used to reduce the size of the aperture in the transmission suite. The partition was supported by two independent, 50 mm, metal stud frames, spaced by 120 mm. Further stud framing was used to form an opening in which samples would later be mounted. The outer faces of the partition were lined with three layers of 15 mm plasterboard and the resulting cavity contained two layers of 50 mm mineral wool. The reveal of the sample aperture was lined with a further two layers of plasterboard.




Test Reference: **4217-3983**
Sample Reference: Horizontal Sliding Unit
Sample Description: Window

The sample window, a York Slider, was delivered as a pre-built unit weighing 82.50 kg. The window frame was fixed to a wooden surround that was 235 mm deep. It was lifted into the aperture such that the sashes would open sideways and it was flush with the source room side of the partition. A gap between the top of the window and the aperture was filled with a section of plasterboard. All joins between the window and the aperture were sealed with No Nonsense Decorator's Caulk, both in the source room and the receiver room.







The temperature of the glazing was approximately 21°C. The window was opened and closed prior to testing with the latch securely closed.

Mass per unit area:	38.4 kg/m^2 (measured)
Thickness:	4.0 mm (glazing, measured)

Test Reference: **4217-3984**

Sample Reference: Horizontal Sliding Unit & Secondary Glazing

Sample Description: Window & Secondary Glazing

Metal tracks with two-channels were added to the receiver room side of the window that was installed in the previous test, 4217-3947. The tracks were screwed to the wooden surround, directly adjacent to the window frame, around the periphery of the window. Two glazing units with thin metal frames were slotted into the tracks, one in each channel, where they were free to slide sideways. One piece of glazing was measured to have a mass per unit area of 10.0 kg/m^2 and had a nominal thickness of 4 mm. The outer glazing unit had a brush seal on its trailing edge. The glazing-to-glazing distances for the two sashes of the window were 134 mm and 63 mm.

The periphery of the metal tracks was sealed to the wooden surround with caulking. The leaves of the secondary glazing were opened and closed prior to testing and the primary window was un-altered from the previous test 4217-3948.

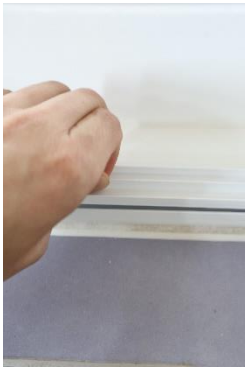
Mass per unit area:	48.4 kg/m^2 (calculated)
Thickness:	142 mm (left sash, calculated)
	71 mm (right sash, calculated)

Test Reference:	**4217-3985**
Sample Reference:	Horizontal Sliding Unit & SG, Sealed
Sample Description:	Window & Secondary Glazing

Caulking was used to cover the join between the two glazing units of the secondary glazing. This sealed over the brush seal and the secondary glazing was now inoperable. No other changes were made so the mass per unit area and thicknesses were unchanged from the previous test, 4217-3985.

Test Reference:	**4217-3986**
Sample Reference:	Horizontal Sliding Unit & Secondary Glazing 50 mm
Sample Description:	Window & Secondary Glazing

The tracks for the secondary glazing were moved from being directly adjacent to the window frame to approximately 50 mm. This increased the inter-glazing distances for the two sashes to 182 and 110 mm and the nominal total thicknesses to 190 mm and 118 mm for the two sashes. The join between the tracks and the surround were again sealed with caulking. The primary window was unchanged from the previous tests (4217-3984 and 3985) and the mass per unit area was also unchanged. The secondary glazing was opened and closed prior to testing.



Test Reference: **4217-3987**

Sample Reference: Sash Box Window (latch open)

Sample Description: Window

The sample from the previous tests (4217-3983 to 3987) was removed entirely. The aperture was re-configured to be 1260 × 1750 mm, i.e. a rotation of 90°. The same primary window unit from the previous tests was re-installed with the sashes sliding up and down. The window frame was flush with the partition on the source room side. A section of plasterboard was used to fill a gap between the top of the sample and the aperture. After ensuring the sample was fitted squarely using packers, it was fixed to the aperture with screws. The periphery was sealed with decorator's caulk on both the source and receiver room sides.

The temperature of the glass was measured to be 22.1°C. The window was opened and closed after which the latch was left un-locked.

Mass per unit area:	38.4 kg/m^2 (measured)
Thickness:	4.0 mm (glazing, measured)

Test Reference: **4217-3988**

Sample Reference: Sash Box Window (latch closed)

Sample Description: Window

The latch between the two sashes of the sample installed for the previous test (4217-3987) was closed tightly. No other changes were made.

Test Reference: **4217-3989**

Sample Reference: Sash Box Window & LVSS Staff Bead

Sample Description: Window & Secondary Glazing

Metal angles with magnetic strips were fixed to the left and right staff beads of the primary window while metal channels were fixed to the top and bottom staff beads. This frame was sealed to the staff bead with caulking. A glazing unit, measured to be 18.25 kg in mass and have 3.8 mm toughened glass, was slotted into the top and bottom channels. It was held in place by the magnetic strips to either side and fixed with screws at the bottom. The unit consisted of a fixed upper panel and sliding lower panel both held in channels to each side.






The glass-to-glass separation was measured to be approximately 100 mm and 50 mm for the top and bottom sashes respectively and the temperature of the secondary glazing was measured to be 22.5°C. The opening part of the secondary glazing unit was opened and closed prior to testing.

Total mass per unit area:	50.3 kg/m^2 (total, calculated)
Glass-to-glass separation:	100 mm (top sash, measured)
	50 mm (bottom sash, measured)
Thickness:	108 mm (top sash, calculated)
	58 mm (bottom sash, calculated)

Test Reference: **4217-3990**

Sample Reference: Sash Box Window & LVSS Staff Bead + mineral wool

Sample Description: Window & Secondary Glazing

A section of mineral wool was laid loosely on the transom between the primary and secondary glazing. No further changes were made.

Test Reference: **4217-3991**

Sample Reference: Sash Box Window & LVSS 100 mm glass to glass

Sample Description: Window & Secondary Glazing

The metal angles and channels were removed from the staff bead. New, longer angles and channels were fitted to the wooden surround of the primary window and sealed with caulking. A new secondary glazing unit, similar in construction to that of test 4217-3989 and with a measured mass per unit area of 11.4 kg/m^2, was installed. The glazing was nominally 4 mm toughened glass. The glass-to-glass distance between the primary and secondary glazing was measured to be approximately 163 mm for the top sash and 120 mm for the bottom sash.

Mass per unit area:	49.8 kg/m^2 (total, calculated)
Total thickness:	171 mm (top sash, calculated)
	128 mm (bottom sash, calculated)

Test Reference: **4217-3992**

Sample Reference: Sash Box Window & Slimline Unit, Staff Bead

Sample Description: Window & Secondary Glazing

The secondary glazing unit and its support structure were removed from the primary glazing unit. Metal angle, lined with a magnetic strip, was fixed to the staff beads either side of the primary window on the receiver room side. A metal channel was fixed to the staff bead at the top of the window. Into this, a glazed unit with a single piece of 4 mm toughened glass was inserted. The lower edge of the frame of the glazed unit was lined with a resilient plastic strip to form a seal with the bottom staff bead. The supporting framework for the secondary glazing was sealed to the staff bead with caulking.

Mass per unit area:	10.1 kg/m^2 (secondary only, measured)
	48.5 kg/m^2 (total, calculated)
Glass-to-glass separation:	100 mm (top sash, estimated)
	50 mm (bottom sash, nominal)
Total thickness:	108 mm (top sash, estimated)
	58 mm (bottom sash, estimated)

Test Reference:	**4217-3993**
Sample Reference:	Sash Box Window & Slimline Unit, Staff Bead
Sample Description:	Window & Secondary Glazing

The secondary glazing unit was removed and re-installed. No changes were made.

Test Reference: **4217-3994**

Sample Reference: Sash Box Window & Slimline ×2

Sample Description: Window & Secondary Glazing & Tertiary Glazing

The secondary glazing installed on the staff bead for the previous test (4217-3993) was retained. A tertiary glazed unit was installed on the surround of the primary window. This was accomplished by fixing metal angles with magnetic strips to the left and right and a channel at the top. The distance from the primary window frame to the outer face of the tertiary metal angle was measured to be 45 mm. A glazed unit of nominal 4 mm toughened glass, with mass per unit area of 10.6 kg/m^2, was lifted into place. As with the secondary glazing, there was no channel at the bottom and a resilient plastic strip formed a seal to the window surround.

Mass per unit area:	59.1 kg/m^2 (total, calculated)
Thickness:	158 mm (top sash, estimated)
	108 mm (bottom sash, calculated)

Test Reference: **4217-3995**

Sample Reference: Sash Box Window & Slimline on Reveal

Sample Description: Window & Secondary Glazing

The secondary glazing and its supporting metal work were removed from the staff bead of the primary window. What remained was the primary glazing and the secondary glazing that was fixed to the wooden surround. No further changes were made.

Mass per unit area:	49.0 kg/m^2 (total, calculated)
Thickness:	158 mm (top sash, estimated)
	108 mm (bottom sash, calculated)

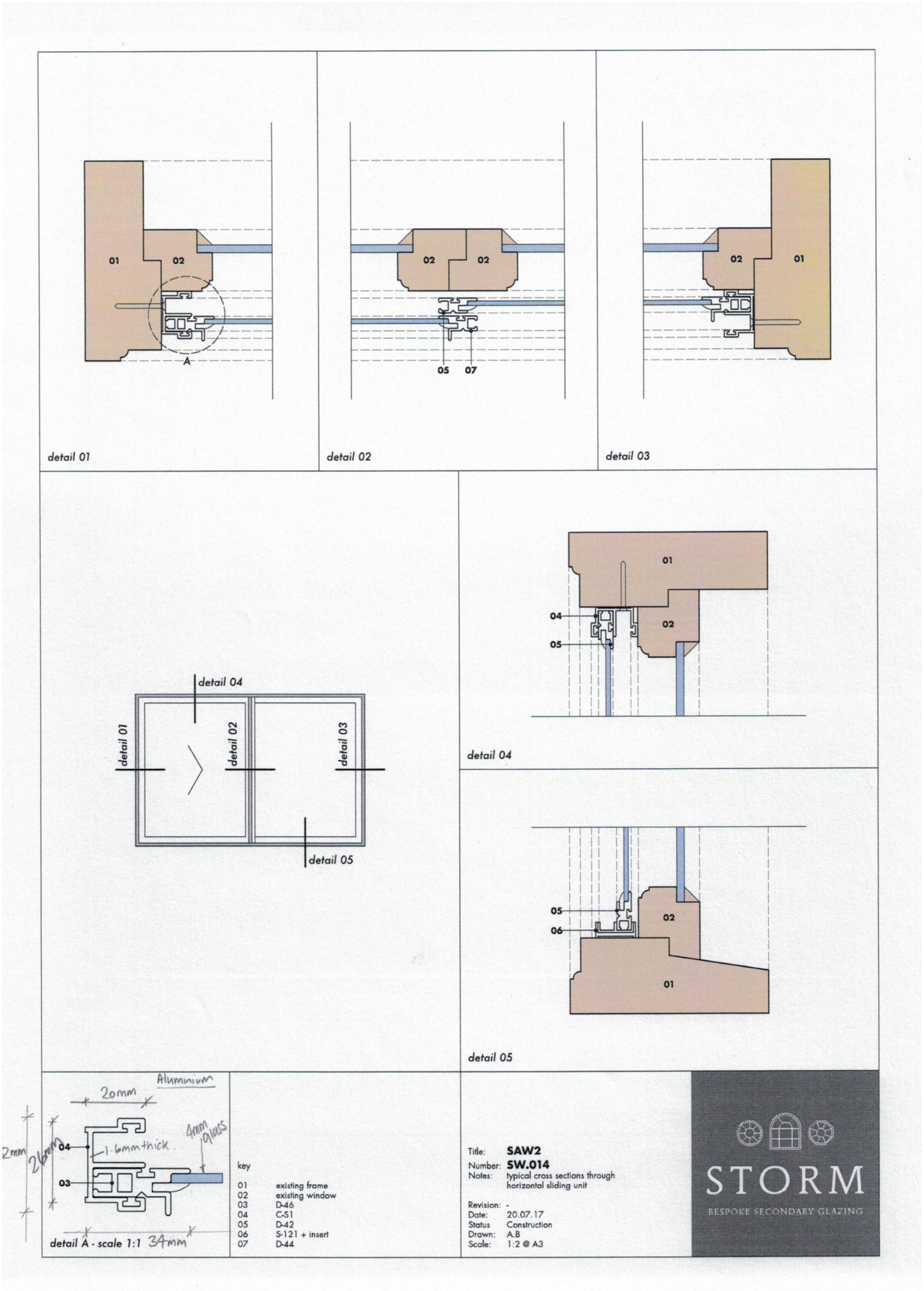
Test Reference:	**4217-3996**
Sample Reference:	Sash Box Window & Slimline on Reveal Latch Open
Sample Description:	Window & Secondary Glazing

The latch on the primary window was unlocked. No further changes were made.

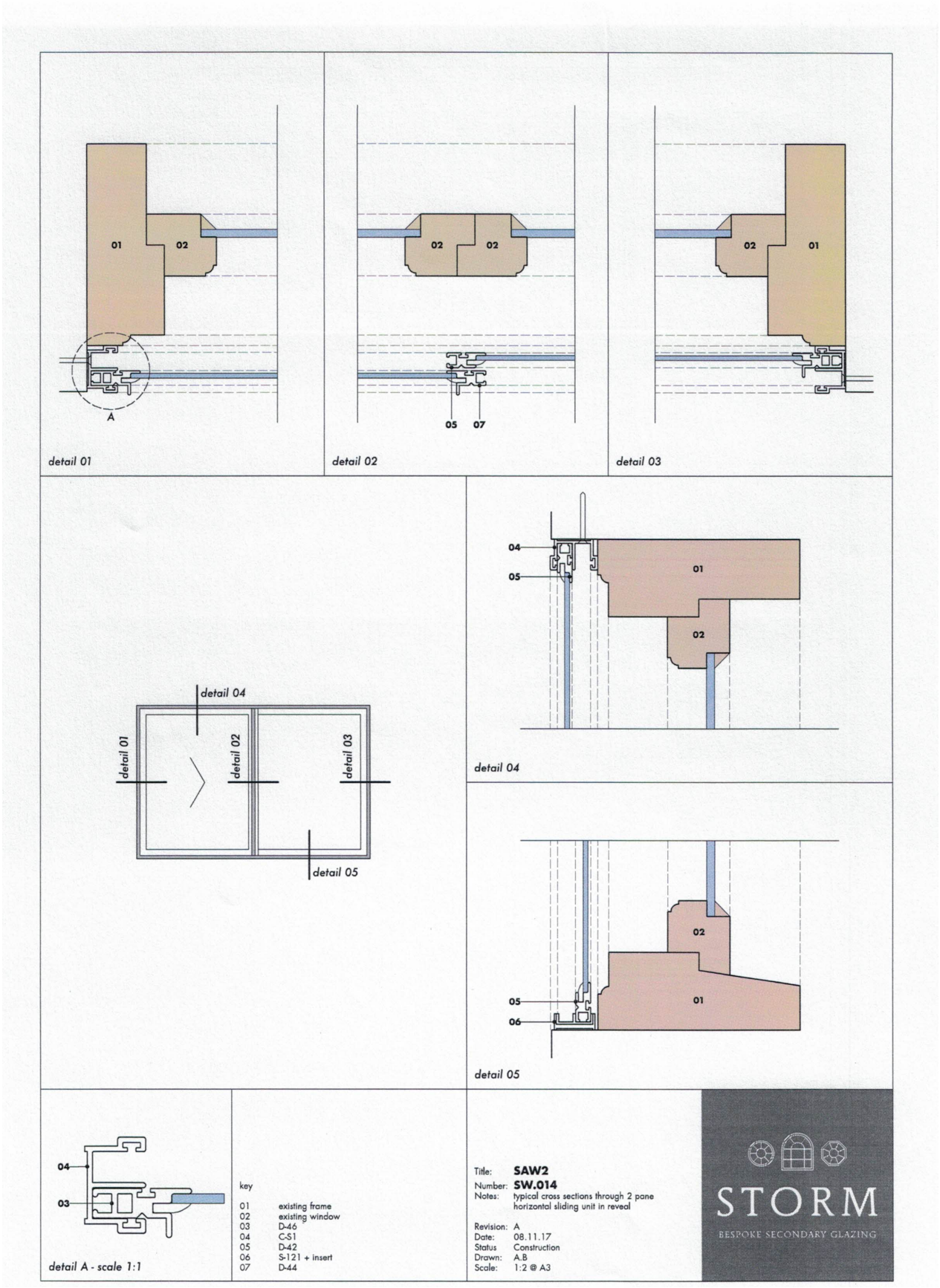
1.2. Sectional Drawings

Sectional diagrams, as supplied by the client, can be found on the following pages.

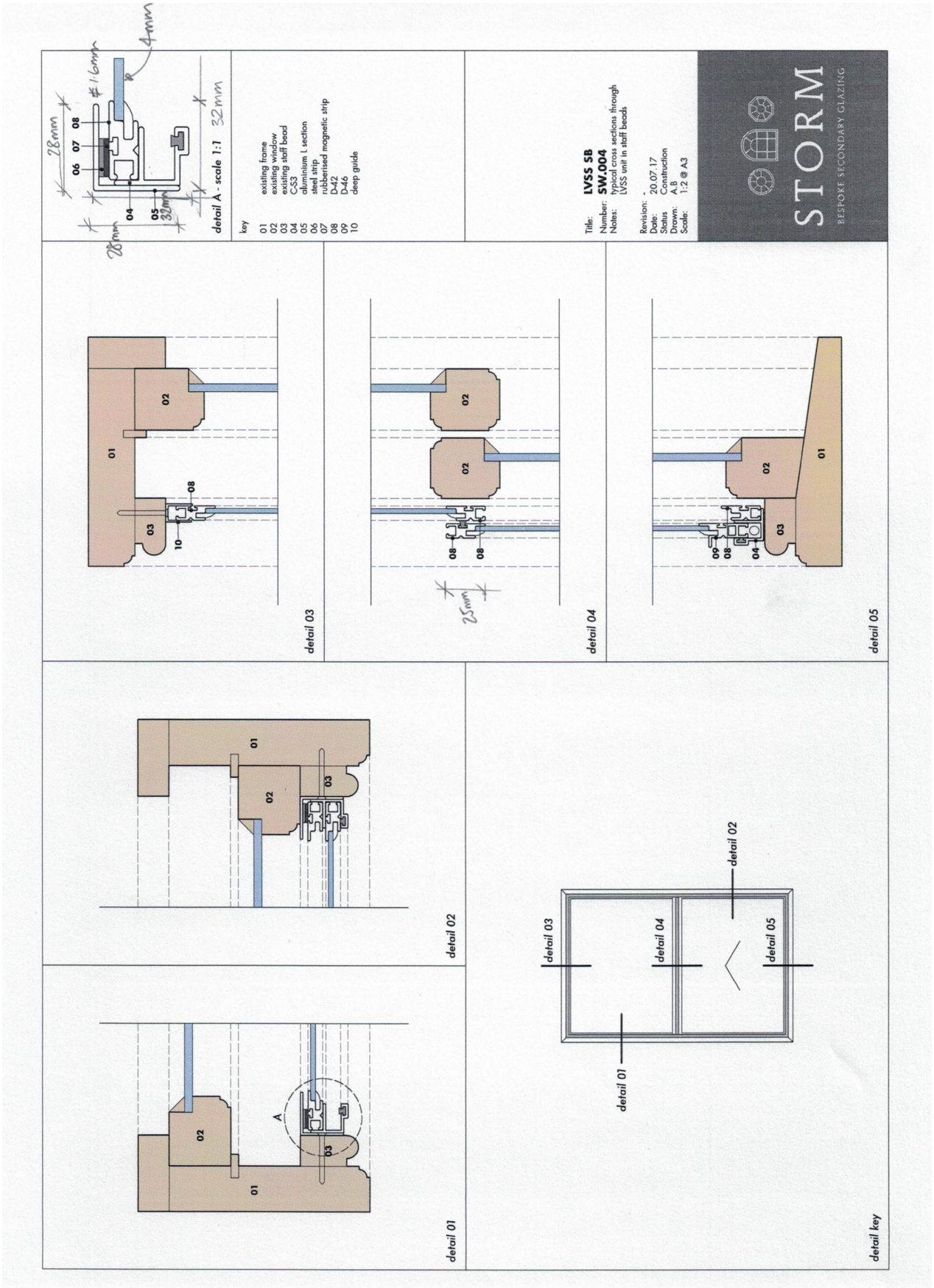
Test Reference: 4217-3984 and 3985



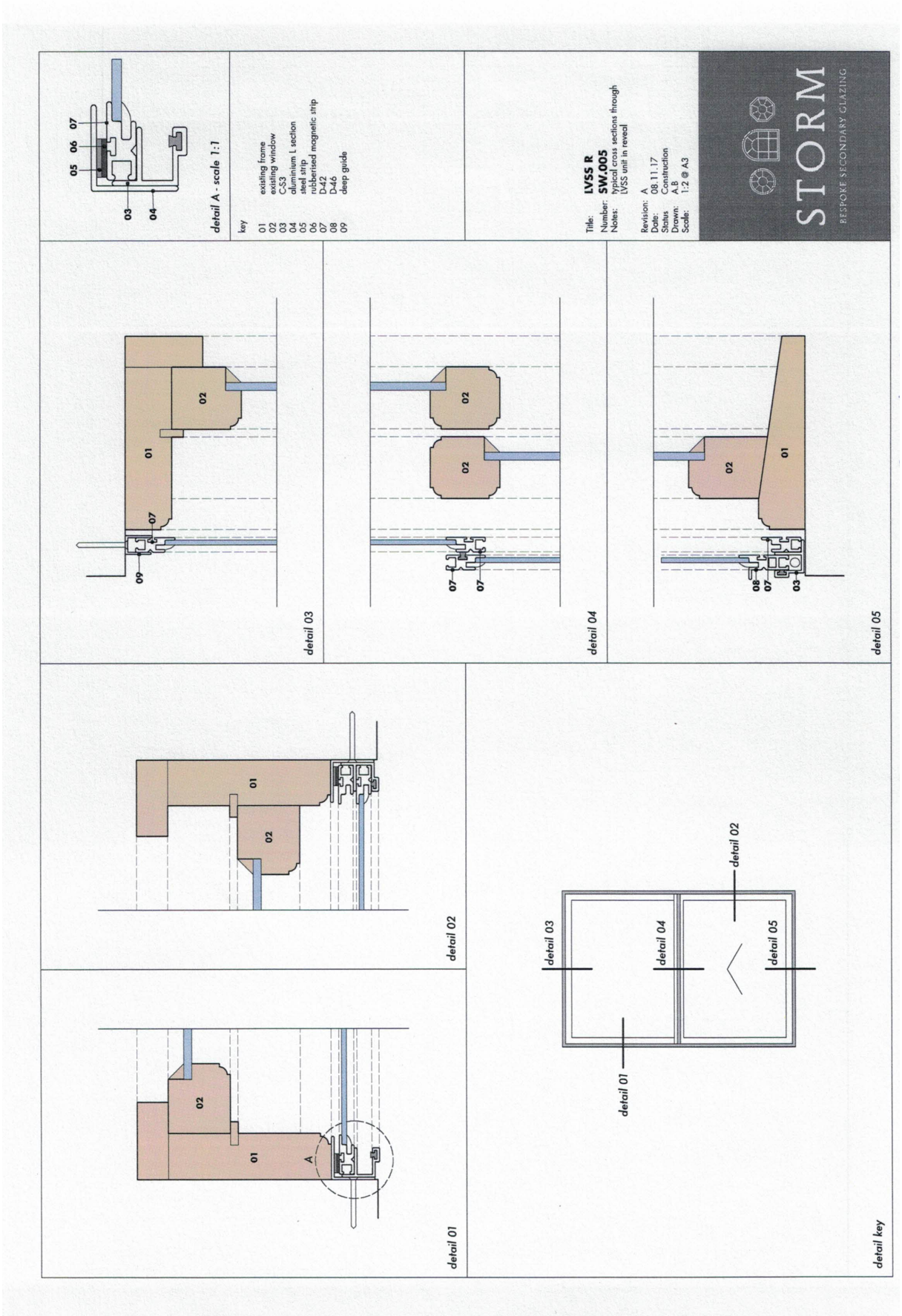
Test Reference: 4217-3986



Test Reference: 4217-3989 and 3990



Test Reference: 4217-3991



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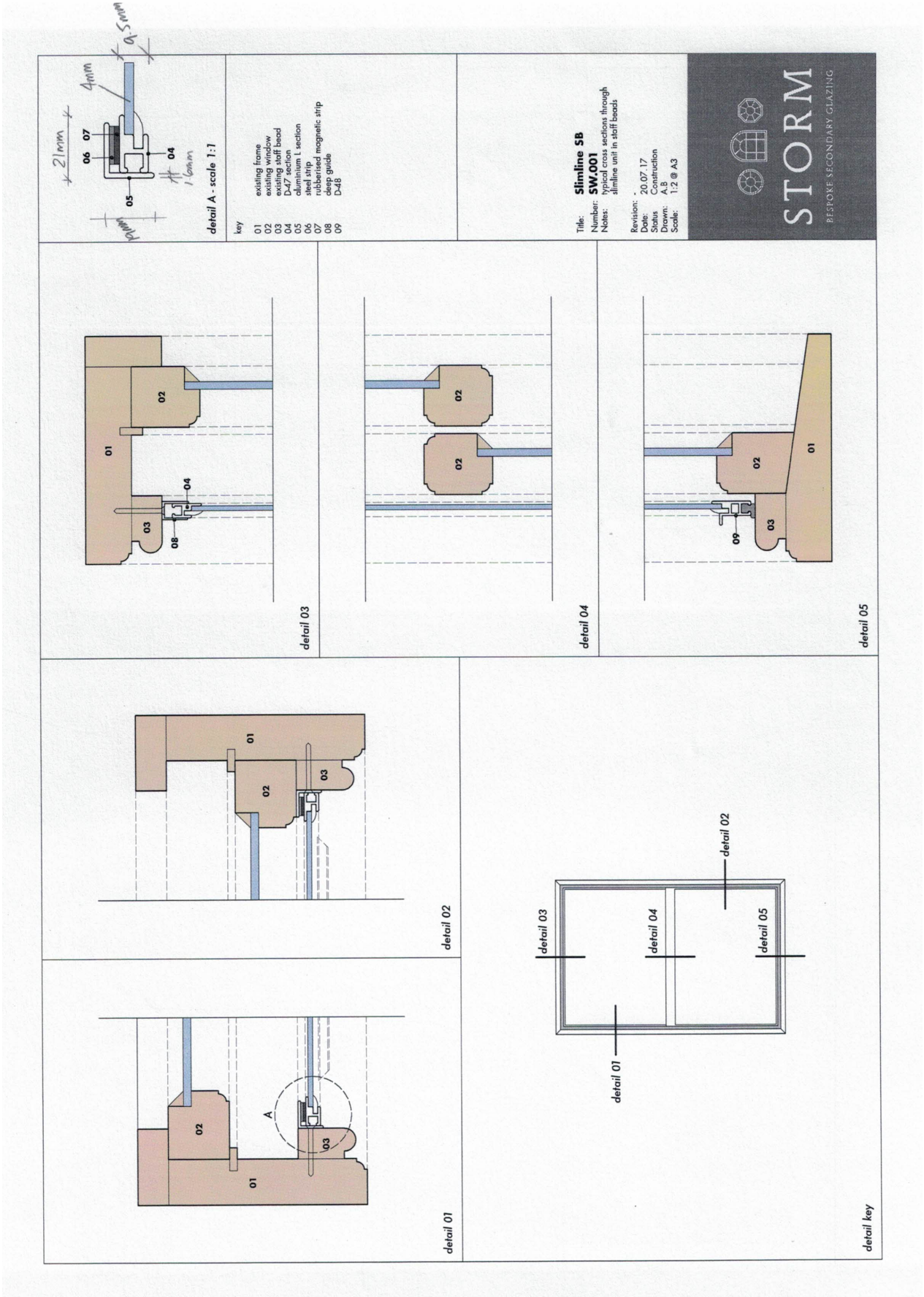

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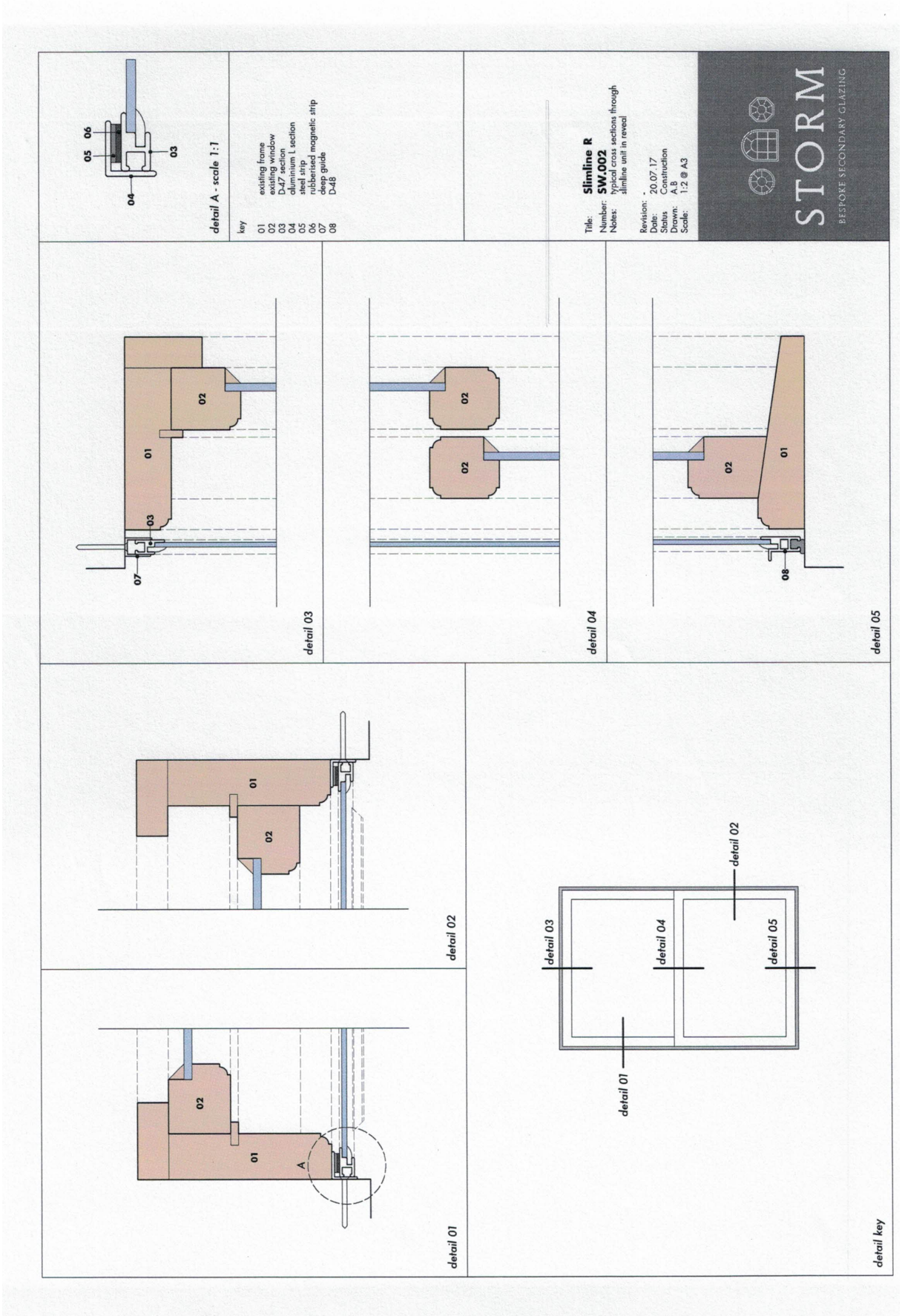


2. Description of Test Procedure

The test procedure adopted follows that detailed in BS EN ISO 10140-2:2010, "Acoustics – Laboratory measurements of sound insulation of building elements; Part 2: Measurement of airborne sound insulation".

The measurements are performed in the large transmission suite at the University of Salford. The suite comprises two structurally isolated reverberant rooms, the source (136 m^3) and receiver rooms, with a test opening between them in which the test specimen is installed. The walls of the receiver room are 330 mm thick and made from dense brick, whilst the soffit is made from reinforced concrete. The walls of the source room are 215 mm thick except for the wall adjacent to the receiver room which is 330 mm thick. Both rooms have been designed with hard surfaces and non-parallel walls. The smaller source room has 4 plywood diffusers and the larger receiving room has 11 plywood diffusers, to increase the diffusivity of the sound field in these areas.

The test involves producing a known sound field in the source room and measuring the resultant sound level difference between the source room and the receiving room with the specimen installed in the test aperture. This level difference is then corrected so as to take into account the equivalent absorption area of the receiving room.

The Sound Reduction Index, R (dB), is defined in BS EN ISO 10140-2: 2010 as:

$$R = L_1 - L_2 + 10 \log_{10} \frac{S}{A} \qquad (1)$$

where:

L_1 is the average sound pressure level in the source room (dB)

L_2 is the average sound pressure level in the receiving room (dB)

S is the area of the test specimen (m^2)

A is the equivalent absorption area of the receiving room (m^2)

2.1. Generation of Sound Field in the Source Room

Wide band, random noise from the generator in the real time analyser was amplified and reproduced in the source room using alternately one of two/three fixed loudspeaker systems, (**La**, **Lb** and **Lc**). Omni-directional loudspeakers were used. The output of the generator was set with the intention that the sound pressure level in the receiving room was at least 15 dB higher than the background level in any frequency band. The loudspeakers were positioned at such a distance from the test specimen that the direct radiation upon it was not dominant.

2.2. Frequency Range of Measurements

The sound pressure levels were measured using one-third octave band filters. Measurements covered all the one-third octave bands having centre frequencies in the range from 50 Hz to 5000 Hz.

2.3. Measurement of Sound Pressure Levels

Sound pressure levels were measured simultaneously in the source and receiving rooms using loudspeaker **La** as the sound source. Measurements were recorded at 6 fixed microphone positions in each room, using an averaging time of 16 seconds and the average level in each room was calculated on an energy basis in each one-third octave frequency band. The procedure was then repeated with loudspeaker **Lb** and **Lc** as the sound source. The overall average level difference in each frequency band was then calculated as the arithmetic average of the two sets of results.

For each set of microphone/loudspeaker positions, the distances separating microphones from other microphones, room boundaries and diffusers, were greater than 0.7 m and the distances separating microphones from the sound source and the test specimen were greater than 1.0 m.

2.4. Measurement and Evaluation of the Equivalent Absorption Areas

The correction term of equation (1) containing the equivalent absorption area, *A*, was evaluated from the reverberation time and calculated using Sabine's formula:

$$A = \frac{0.16\ V}{T} \qquad (2)$$

where:

V is the volume of the receiving room (m^3)

T is the reverberation time (s)

The reverberation time of the receiving room was measured using a decay technique. The decays were produced by exciting the room with wide band random noise and stopping the excitation once the room became saturated. The resulting decaying sound field was monitored at 6 fixed microphone positions using a one-third octave band real time analyser. The sound spectrum was sampled at 32 millisecond intervals and stored in memory. Five decays were measured at each microphone position and averaged. The time taken for the sound to decay by a given amount was measured and then extrapolated to determine the reverberation time. The measurements were repeated using an alternative sound source. The results from each set of positions were averaged (ie 60 reverberation decays at each frequency).

3. Equipment

Equipment	Laboratory Equipment Record No.
2 × Norwegian Electronics 1/3 octave band real time analyser type 850 with in-built random noise generator	RTA3-01 to 12
Quad 510 power amplifier	PA7
Norsonic Sound Calibrator type 1251	C8
2 × Norsonic Dodecahedron Loudspeakers	LS10-LS11
3 × Norsonic Dodecahedron Loudspeakers	LS12-LS14
3 × Bruel & Kjaer random incidence condenser microphones type 4166 in the source room	M2-M4
3 × G.R.A.S. random incidence condenser microphones type 40AP in the source room	M21, M22, M30
2 × Bruel &Kjaer random incidence condenser microphone type 4166 in the receiving room	M9, M18
4 × G.R.A.S. random incidence condenser microphones type 40AP in the receiving room	M20, M31, M19, M32
Environmental sensor data logger, hygrometers and barometer	HL1, HG1, HG2, BM2
Toshiba TECRA R850 119 laptop computer and related peripheral equipment (network switch, printer, monitor etc.)	RTA3-00
Yamaha GQ1031BII graphic equalizer	GEQ1

4. Results

The sound reduction indices at one-third octave band intervals, *R*, are given in the tables overleaf.

Source room volume:	136 m3
Receiving room volume:	220 m^3
Sample sizes:	1750 mm × 1260 mm

Also given in the attached tables and computed from the one-third octave band sound reduction indices, is the weighted sound reduction index, R_w, calculated according to ISO 717-1:2013. This evaluation is based on laboratory measurement results obtained by an engineering method.

The results here presented relate only to the items tested and described in this report.

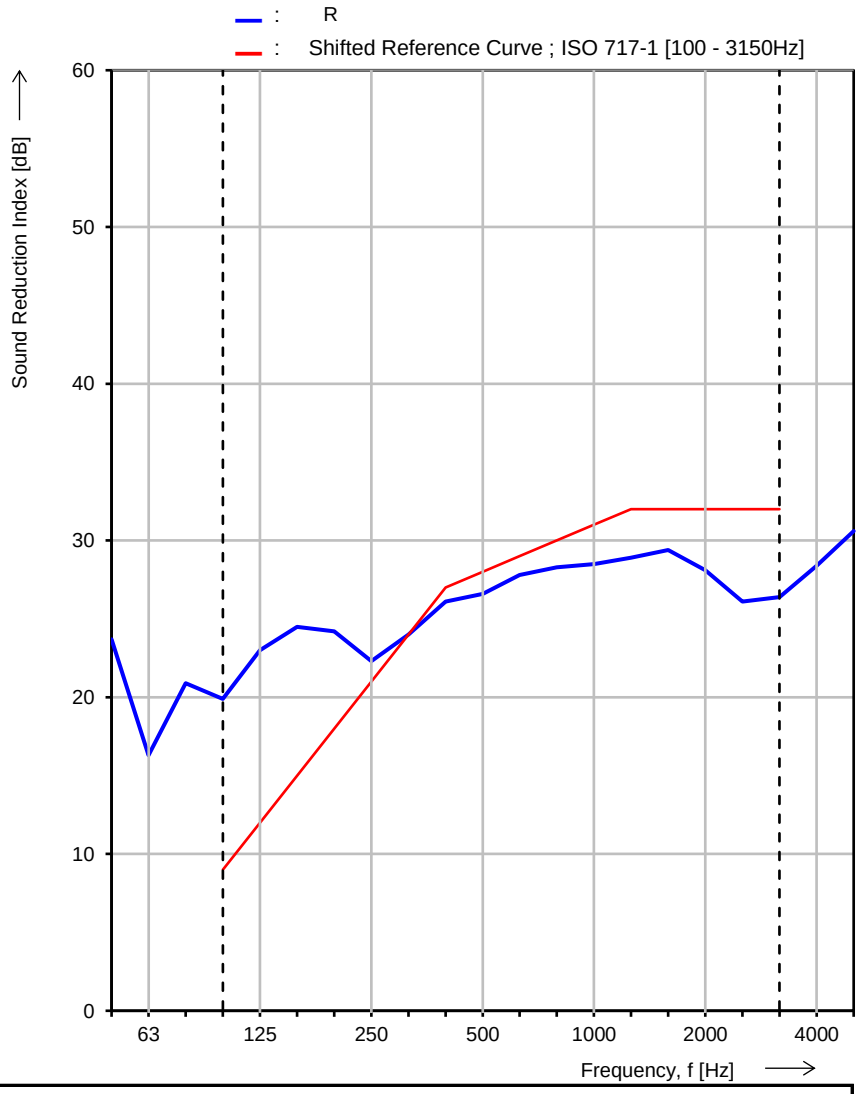
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Horizontal Sliding Unit
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	20 August 2019
Manufacturer:	Client		
Description:	Window		

Source Room Volume:	136 m^3	Ambient Pressure:	101.8 kPa
Source Room Temperature:	20.7 °C	Measured Mass per unit area:	38.4 kg/m^2
Source Room Relative Humidity:	54.9 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.7 °C		
Receiving Room Relative Humidity:	55.9 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	23.7
63	16.3
80	20.9
100	19.9
125	23.0
160	24.5
200	24.2
250	22.3
315	24.0
400	26.1
500	26.6
630	27.8
800	28.3
1000	28.5
1250	28.9
1600	29.4
2000	28.1
2500	26.1
3150	26.4
4000	28.4
5000	30.6



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 28 (-1 ; -1) dB

$C_{50\text{-}3150}$ = 0 dB ; $C_{50\text{-}5000}$ = 0 dB ; $C_{100\text{-}5000}$ = 0 dB

$C_{tr,50\text{-}3150}$ = -2 dB ; $C_{tr,50\text{-}5000}$ = -2 dB ; $C_{tr,100\text{-}5000}$ = -1 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3983	Signature:	
Date: 20 August 2019		Operator:	D. Wong-McSweeney

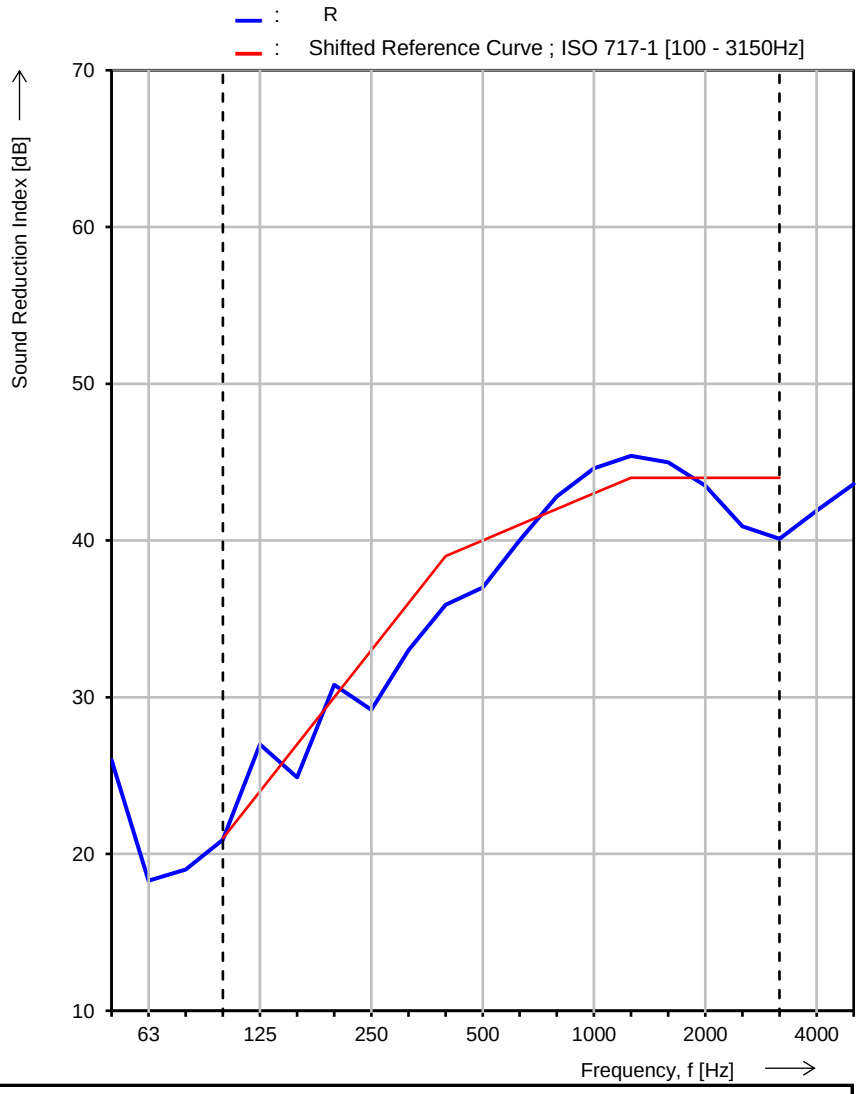
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Horizontal Sliding Unit & *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	20 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*Secondary Glazing	

Source Room Volume:	136 m^3	Ambient Pressure:	101.9 kPa
Source Room Temperature:	20.7 °C	Calculated Mass per unit area:	48.4 kg/m^2
Source Room Relative Humidity:	54.8 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.8 °C		
Receiving Room Relative Humidity:	55.7 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	26.0
63	18.3
80	19.0
100	20.9
125	27.0
160	24.9
200	30.8
250	29.2
315	33.0
400	35.9
500	37.0
630	40.0
800	42.8
1000	44.6
1250	45.4
1600	45.0
2000	43.5
2500	40.9
3150	40.1
4000	41.9
5000	43.6



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 40 (-1 ; -5) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -1 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -7 dB ; $C_{tr,50\text{-}5000}$ = -7 dB ; $C_{tr,100\text{-}5000}$ = -5 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3984	Signature:	
Date: 20 August 2019		Operator:	D. Wong-McSweeney

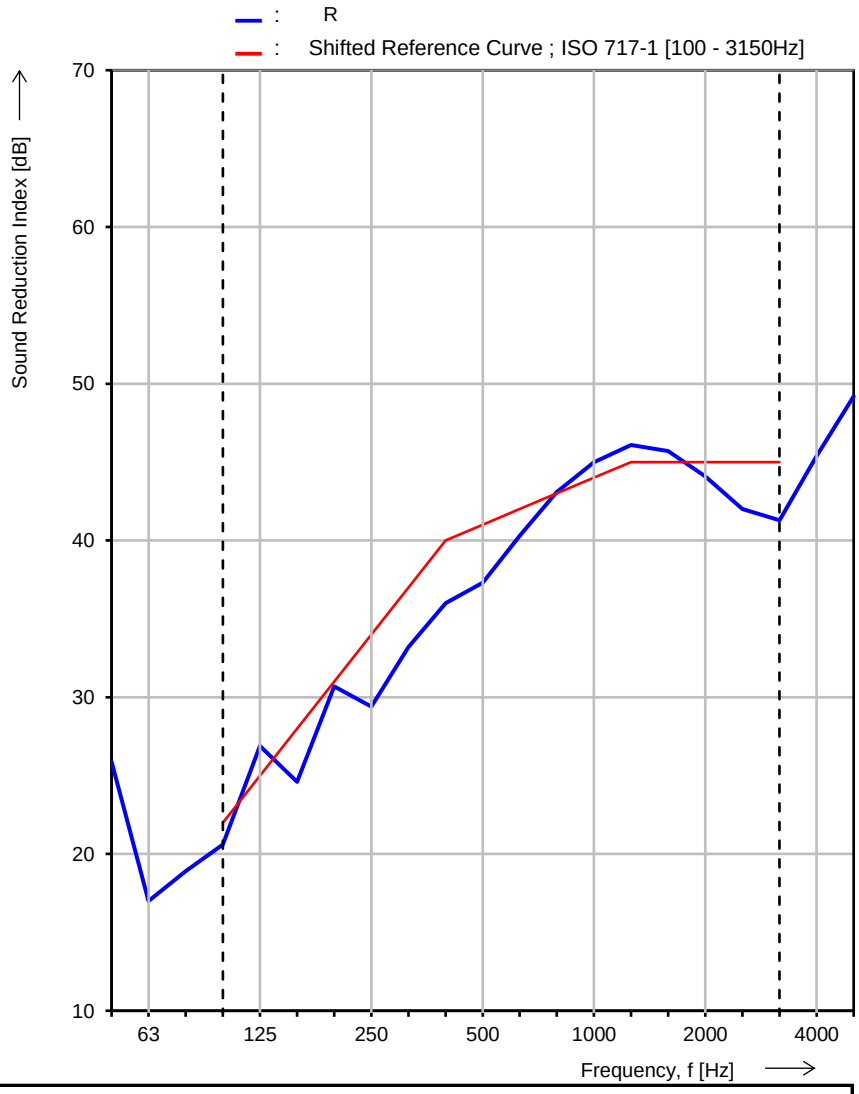
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Horizontal Sliding Unit & *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	20 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*Secondary Glazing, Sealed	

Source Room Volume:	136 m^3	Ambient Pressure:	101.9 kPa
Source Room Temperature:	20.7 °C	Calculated Mass per unit area:	48.4 kg/m^2
Source Room Relative Humidity:	54.7 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.7 °C		
Receiving Room Relative Humidity:	55.6 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	25.9
63	17.0
80	18.9
100	20.6
125	26.9
160	24.6
200	30.7
250	29.4
315	33.2
400	36.0
500	37.3
630	40.3
800	43.1
1000	45.0
1250	46.1
1600	45.7
2000	44.1
2500	42.0
3150	41.3
4000	45.4
5000	49.2



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 41 (-2 ; -6) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -1 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -8 dB ; $C_{tr,50\text{-}5000}$ = -8 dB ; $C_{tr,100\text{-}5000}$ = -6 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3985	Signature:	
Date: 20 August 2019		Operator:	D. Wong-McSweeney

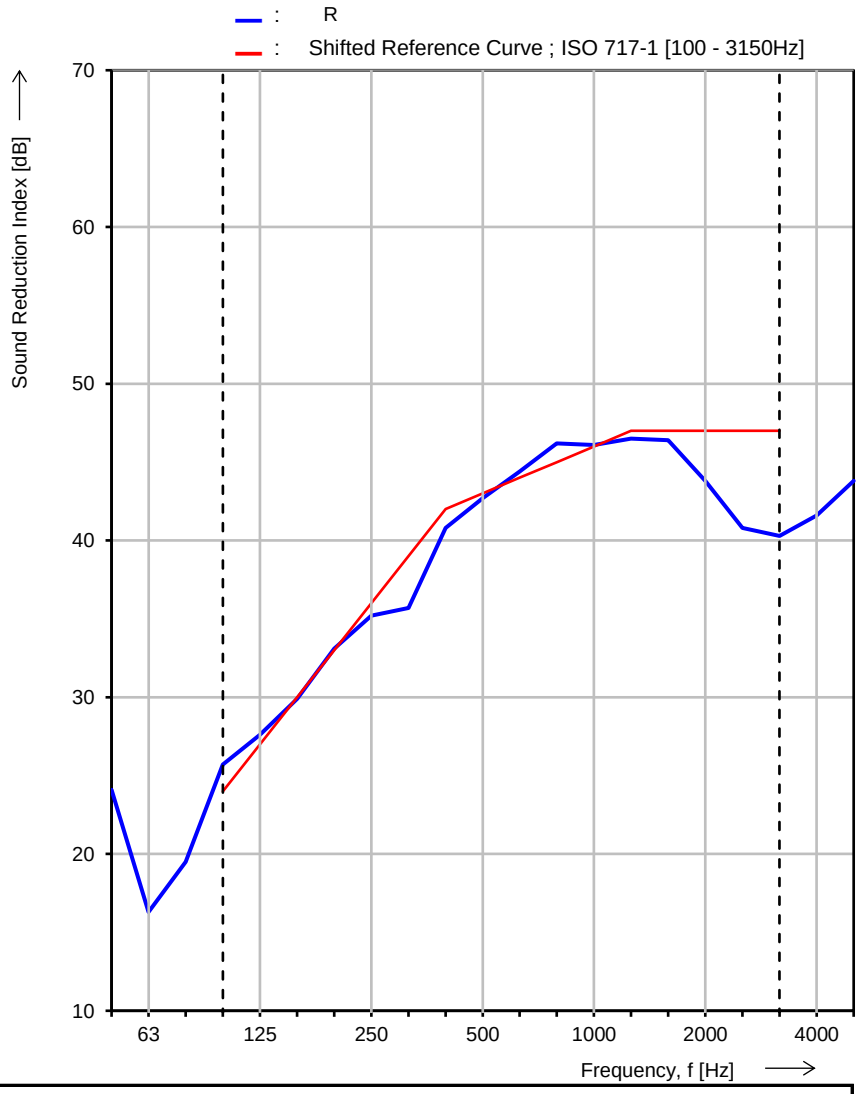
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Horizontal Sliding Unit & *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	20 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*Secondary Glazing 50 mm	

Source Room Volume:	136 m^3	Ambient Pressure:	101.9 kPa
Source Room Temperature:	20.8 °C	Calculated Mass per unit area:	48.4 kg/m^2
Source Room Relative Humidity:	54.8 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.8 °C		
Receiving Room Relative Humidity:	55.2 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	24.1
63	16.3
80	19.5
100	25.7
125	27.6
160	29.9
200	33.1
250	35.2
315	35.7
400	40.8
500	42.7
630	44.4
800	46.2
1000	46.1
1250	46.5
1600	46.4
2000	43.8
2500	40.8
3150	40.3
4000	41.6
5000	43.8



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 43 (-2 ; -4) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -2 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -8 dB ; $C_{tr,50\text{-}5000}$ = -8 dB ; $C_{tr,100\text{-}5000}$ = -4 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3986	Signature:	
Date: 20 August 2019		Operator:	D. Wong-McSweeney

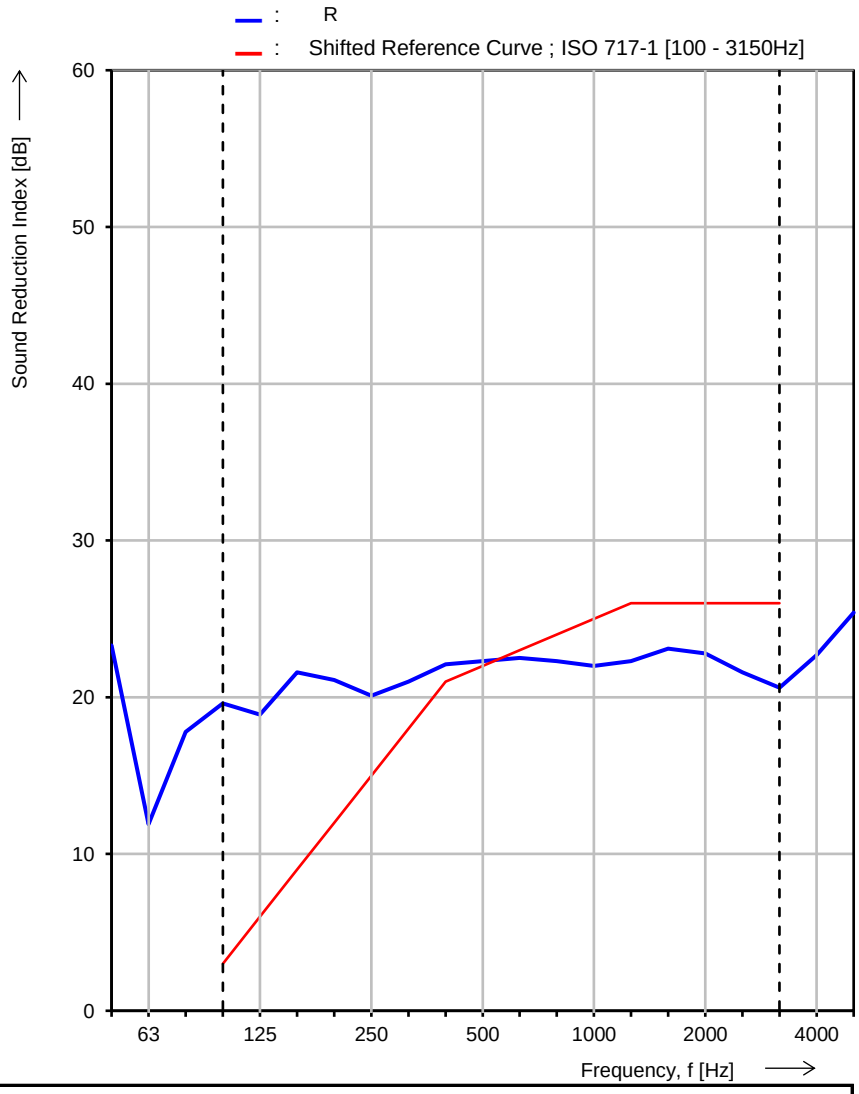
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window (latch open)
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window		

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.7 °C	Measured Mass per unit area:	38.4 kg/m^2
Source Room Relative Humidity:	61.3 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.8 °C		
Receiving Room Relative Humidity:	61.1 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	23.3
63	11.9
80	17.8
100	19.6
125	18.9
160	21.6
200	21.1
250	20.1
315	21.0
400	22.1
500	22.3
630	22.5
800	22.3
1000	22.0
1250	22.3
1600	23.1
2000	22.8
2500	21.6
3150	20.6
4000	22.7
5000	25.4



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 22 (0 ; 0) dB

$C_{50\text{-}3150}$ = 1 dB ; $C_{50\text{-}5000}$ = 0 dB ; $C_{100\text{-}5000}$ = 0 dB

$C_{tr,50\text{-}3150}$ = 0 dB ; $C_{tr,50\text{-}5000}$ = 0 dB ; $C_{tr,100\text{-}5000}$ = 0 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3987	Signature:	
Date: 22 August 2019		Operator:	E. Kalavsky

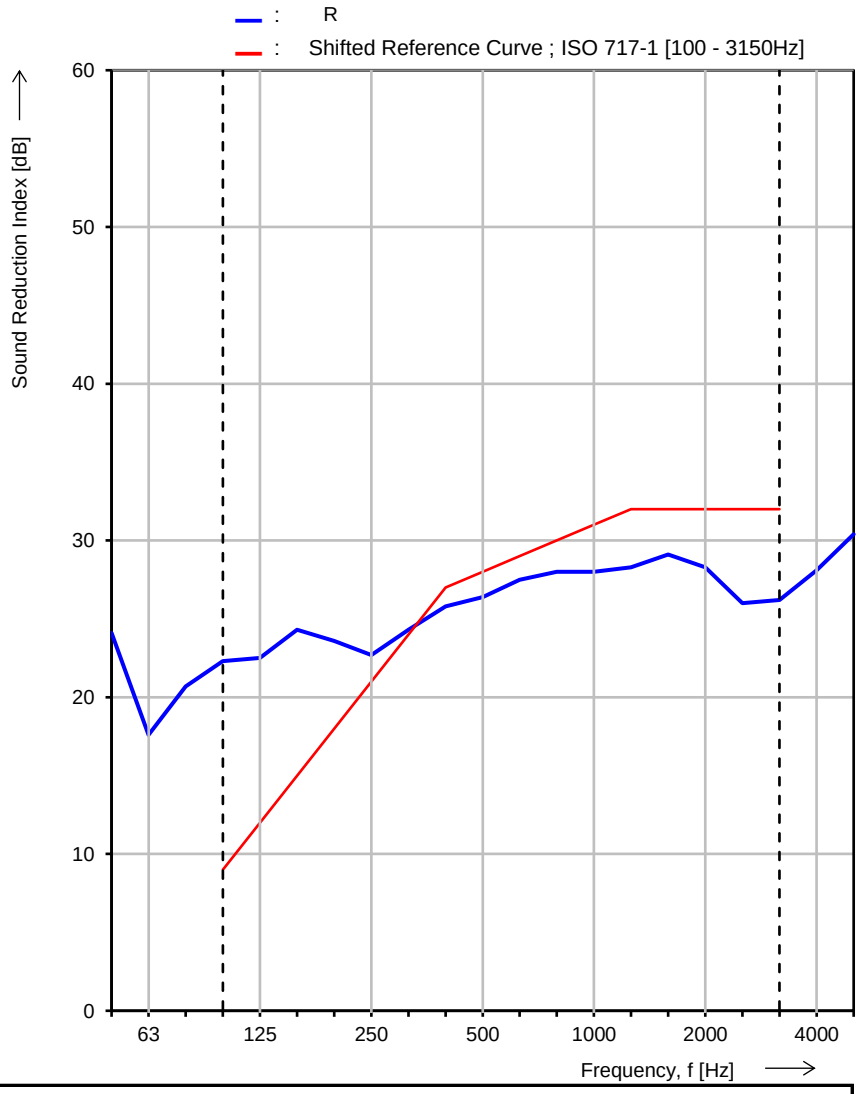
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window (latch closed)
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window		

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.8 °C	Measured Mass per unit area:	38.4 kg/m^2
Source Room Relative Humidity:	61.2 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.8 °C		
Receiving Room Relative Humidity:	62.3 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	24.1
63	17.6
80	20.7
100	22.3
125	22.5
160	24.3
200	23.6
250	22.7
315	24.3
400	25.8
500	26.4
630	27.5
800	28.0
1000	28.0
1250	28.3
1600	29.1
2000	28.3
2500	26.0
3150	26.2
4000	28.1
5000	30.4



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 28 (-1 ; -1) dB

$C_{50\text{-}3150}$ = 0 dB ; $C_{50\text{-}5000}$ = -1 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -2 dB ; $C_{tr,50\text{-}5000}$ = -2 dB ; $C_{tr,100\text{-}5000}$ = -1 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3988	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

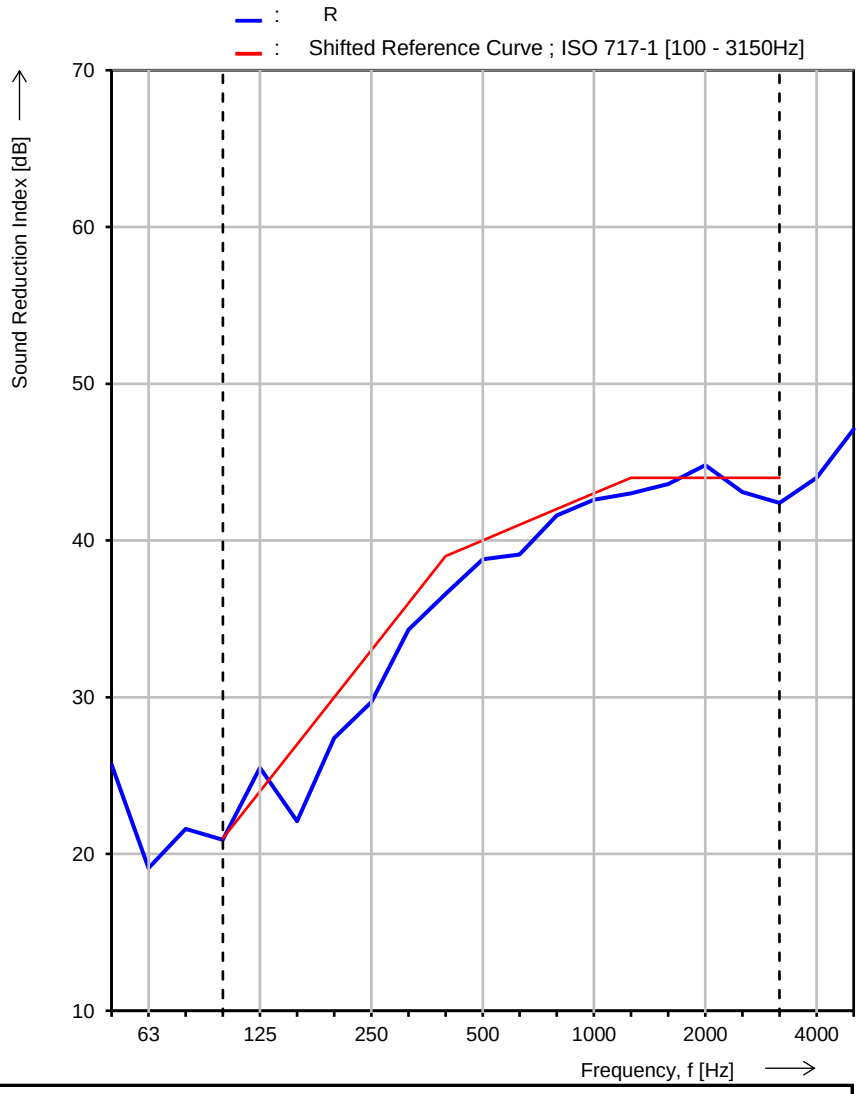
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & LVSS *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing *Staff Bead		

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.8 °C	Calculated Mass per unit area:	50.3 kg/m^2
Source Room Relative Humidity:	61.5 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.0 °C		
Receiving Room Relative Humidity:	62.9 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	25.7
63	19.1
80	21.6
100	20.9
125	25.5
160	22.1
200	27.4
250	29.7
315	34.3
400	36.6
500	38.8
630	39.1
800	41.6
1000	42.6
1250	43.0
1600	43.6
2000	44.8
2500	43.1
3150	42.4
4000	44.0
5000	47.1



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 40 (-2 ; -6) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -1 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -7 dB ; $C_{tr,50\text{-}5000}$ = -7 dB ; $C_{tr,100\text{-}5000}$ = -6 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3989	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

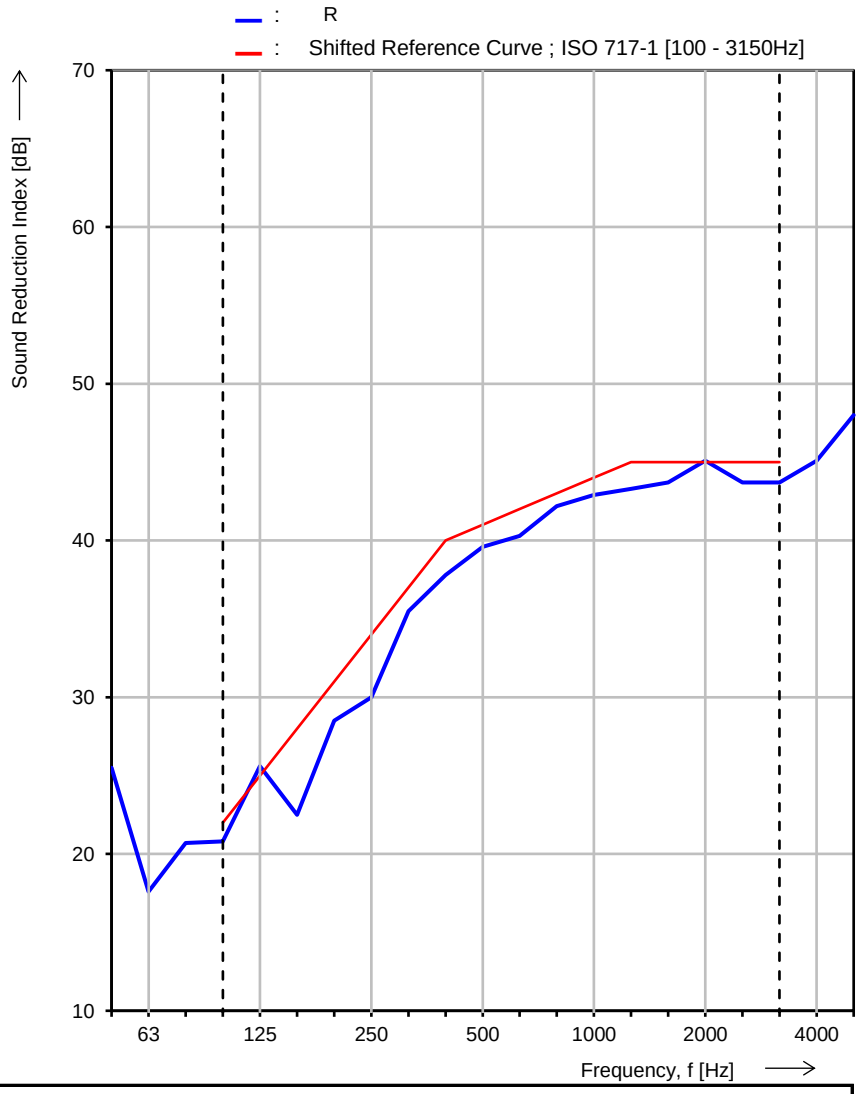
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & LVSS *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*Staff Bead + Mineral Wool	

Source Room Volume:	136 m^3	Ambient Pressure:	101.6 kPa
Source Room Temperature:	20.9 °C	Calculated Mass per unit area:	50.3 kg/m^2
Source Room Relative Humidity:	61.1 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	20.9 °C		
Receiving Room Relative Humidity:	63.7 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	25.5
63	17.6
80	20.7
100	20.8
125	25.6
160	22.5
200	28.5
250	30.0
315	35.5
400	37.8
500	39.6
630	40.3
800	42.2
1000	42.9
1250	43.3
1600	43.7
2000	45.1
2500	43.7
3150	43.7
4000	45.1
5000	48.0



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 41 (-2 ; -6) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -2 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -8 dB ; $C_{tr,50\text{-}5000}$ = -8 dB ; $C_{tr,100\text{-}5000}$ = -6 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3990	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

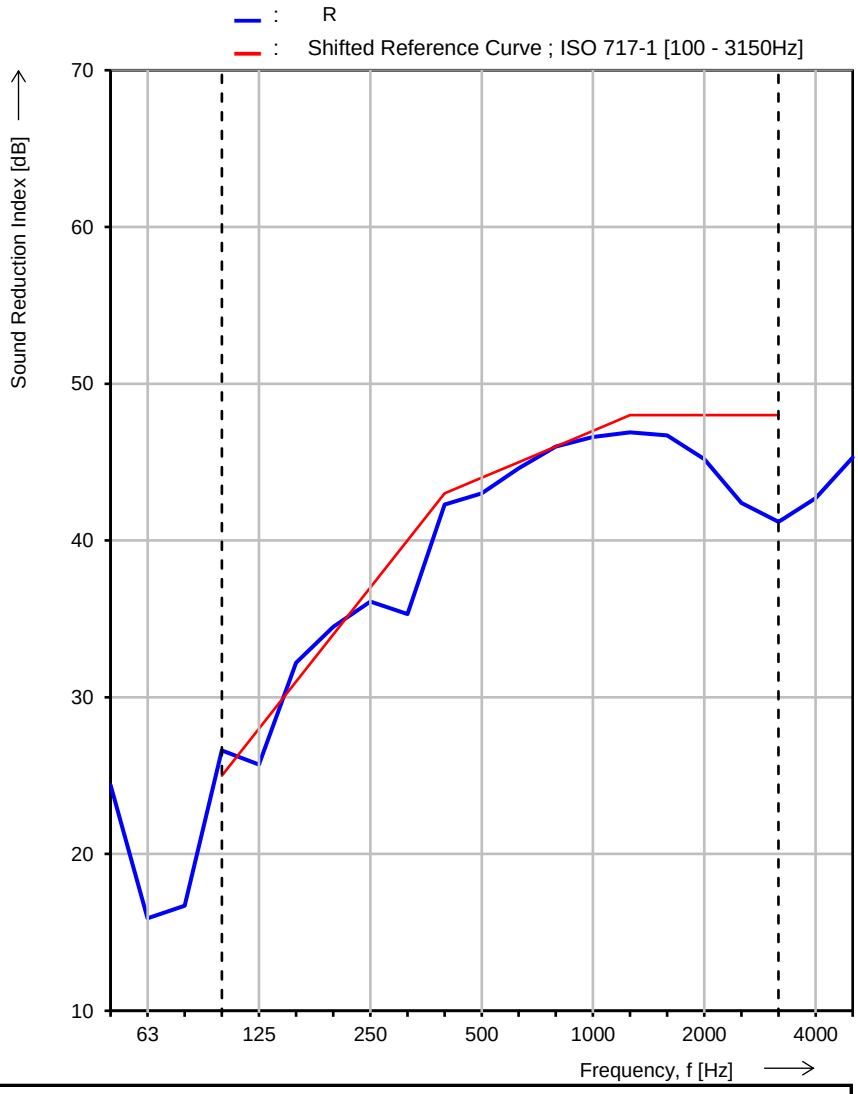
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & LVSS *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*100 mm Glass-Glass	

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.9 °C	Calculated Mass per unit area:	49.8 kg/m^2
Source Room Relative Humidity:	61.9 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.0 °C		
Receiving Room Relative Humidity:	65.2 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	24.4
63	15.9
80	16.7
100	26.6
125	25.7
160	32.2
200	34.5
250	36.1
315	35.3
400	42.3
500	43.0
630	44.6
800	46.0
1000	46.6
1250	46.9
1600	46.7
2000	45.2
2500	42.4
3150	41.2
4000	42.7
5000	45.3



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 44 (-2 ; -5) dB

$C_{50\text{-}3150}$ = -2 dB ; $C_{50\text{-}5000}$ = -2 dB ; $C_{100\text{-}5000}$ = -2 dB

$C_{tr,50\text{-}3150}$ = -10 dB ; $C_{tr,50\text{-}5000}$ = -10 dB ; $C_{tr,100\text{-}5000}$ = -5 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3991	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

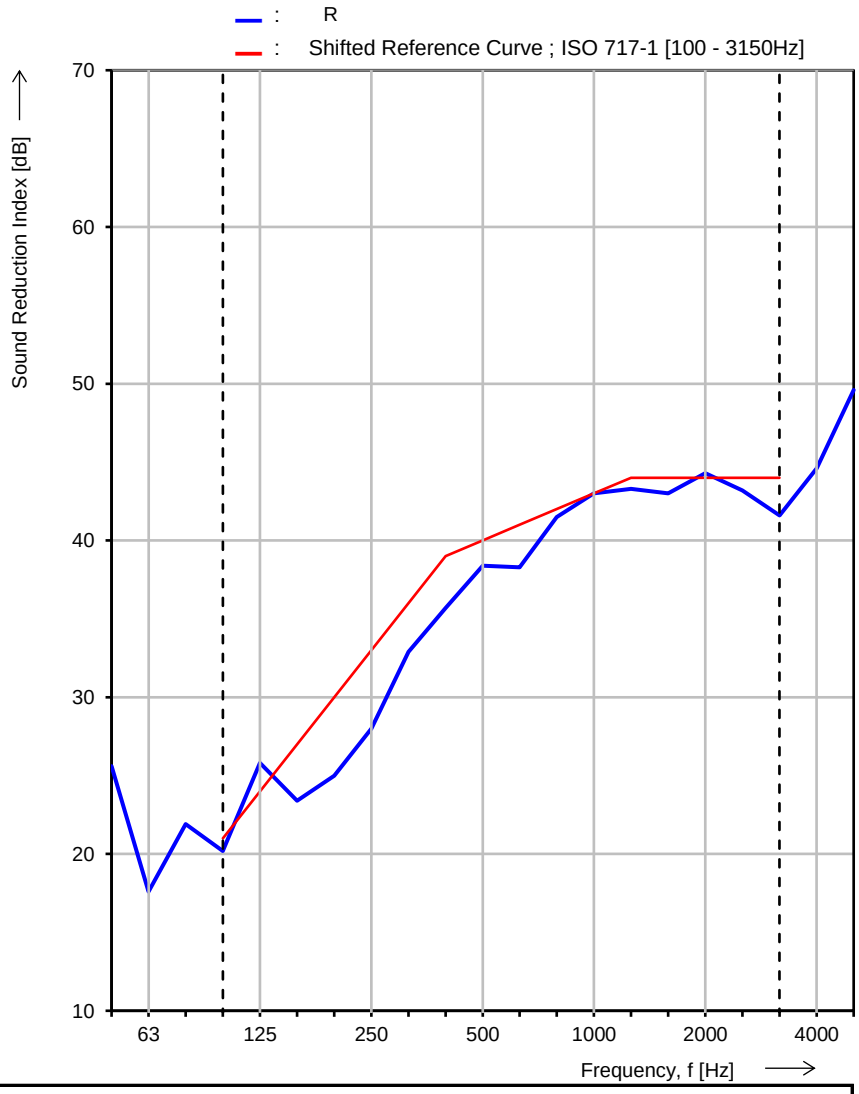
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & Slimline *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing *Unit on Staff Bead		

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.9 °C	Calculated Mass per unit area:	48.5 kg/m^2
Source Room Relative Humidity:	61.3 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.1 °C		
Receiving Room Relative Humidity:	65.7 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	25.6
63	17.6
80	21.9
100	20.2
125	25.8
160	23.4
200	25.0
250	28.0
315	32.9
400	35.7
500	38.4
630	38.3
800	41.5
1000	43.0
1250	43.3
1600	43.0
2000	44.3
2500	43.2
3150	41.6
4000	44.6
5000	49.6



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 40 (-2 ; -6) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -1 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -7 dB ; $C_{tr,50\text{-}5000}$ = -7 dB ; $C_{tr,100\text{-}5000}$ = -6 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3992	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

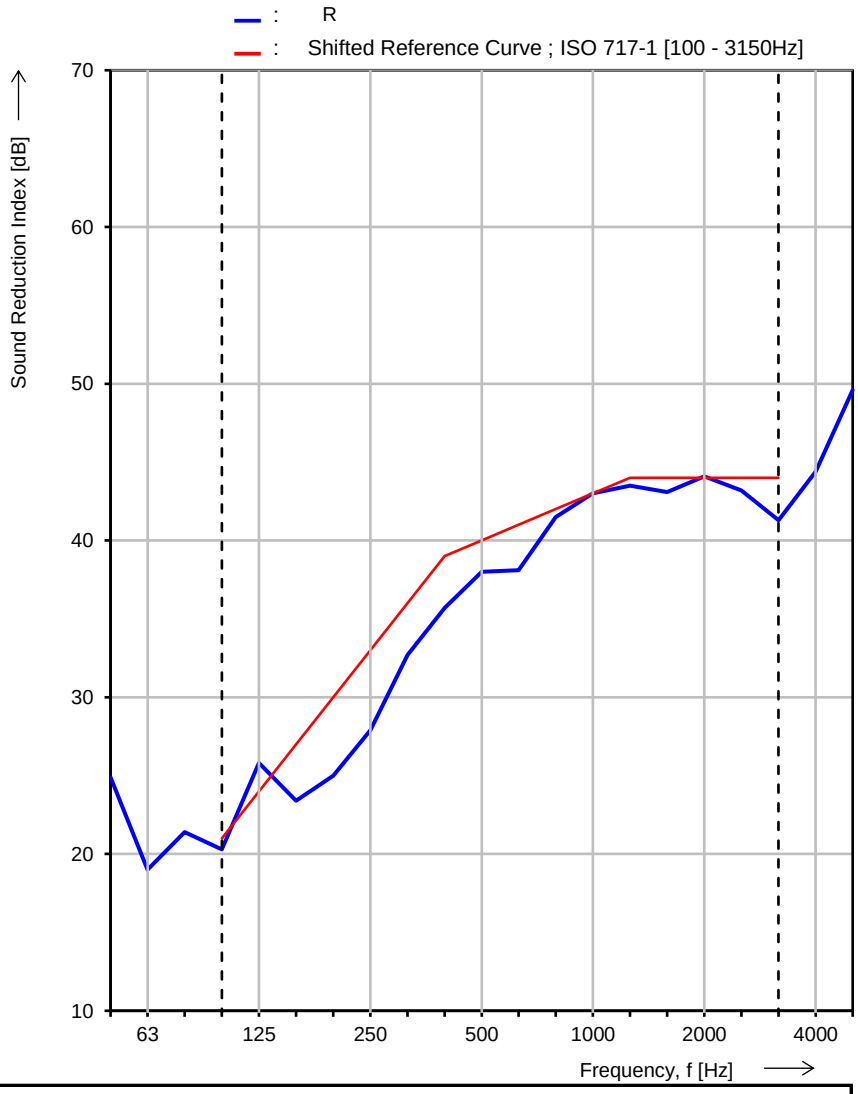
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & Slimline *
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*Unit on Staff Bead	

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.9 °C	Calculated Mass per unit area:	48.5 kg/m^2
Source Room Relative Humidity:	61.2 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.1 °C		
Receiving Room Relative Humidity:	66.1 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	24.9
63	19.0
80	21.4
100	20.3
125	25.8
160	23.4
200	25.0
250	27.9
315	32.7
400	35.7
500	38.0
630	38.1
800	41.5
1000	43.0
1250	43.5
1600	43.1
2000	44.1
2500	43.2
3150	41.3
4000	44.4
5000	49.6



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 40 (-2 ; -6) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -2 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -7 dB ; $C_{tr,50\text{-}5000}$ = -7 dB ; $C_{tr,100\text{-}5000}$ = -6 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3993	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

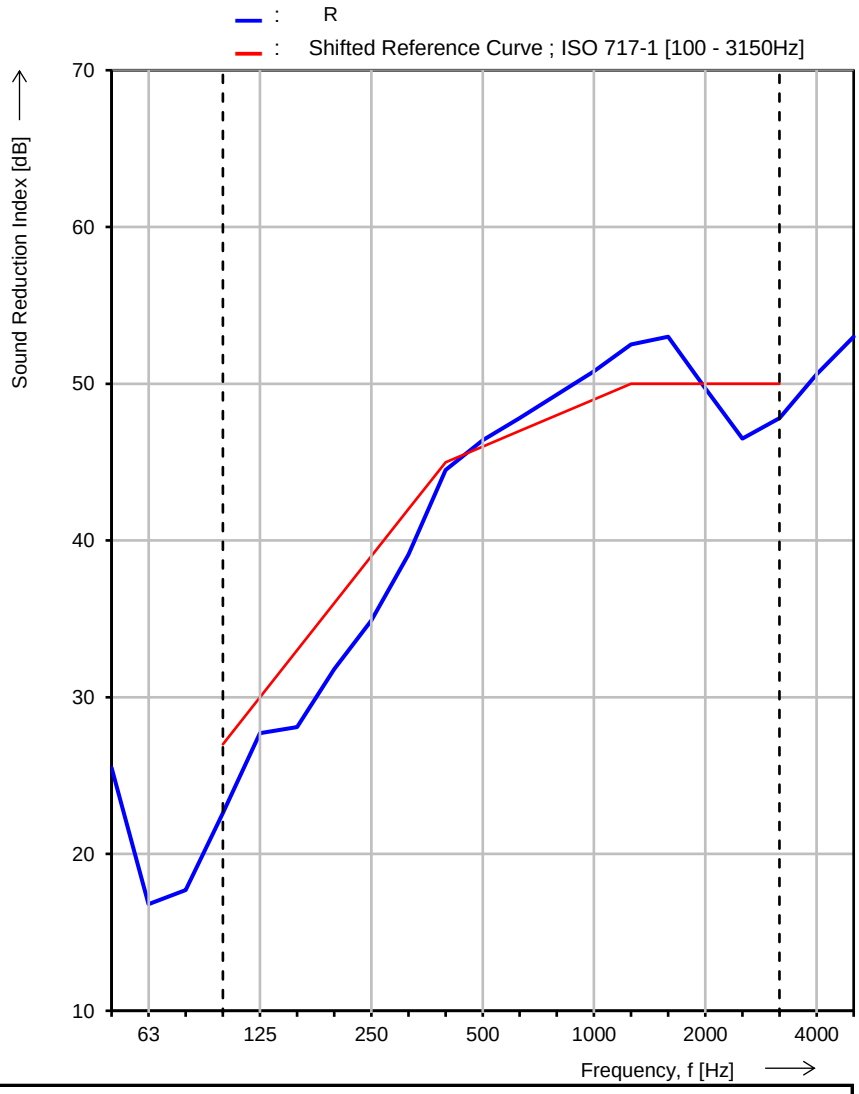
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & Slimline ×2
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary and Tertiary Glazing		

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	20.9 °C	Calculated Mass per unit area:	59.1 kg/m^2
Source Room Relative Humidity:	61.1 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.1 °C		
Receiving Room Relative Humidity:	66.7 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	25.5
63	16.8
80	17.7
100	22.6
125	27.7
160	28.1
200	31.8
250	34.9
315	39.1
400	44.5
500	46.4
630	47.8
800	49.3
1000	50.8
1250	52.5
1600	53.0
2000	49.7
2500	46.5
3150	47.8
4000	50.6
5000	53.0



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 46 (-2 ; -7) dB

$C_{50\text{-}3150}$ = -3 dB ; $C_{50\text{-}5000}$ = -3 dB ; $C_{100\text{-}5000}$ = -2 dB

$C_{tr,50\text{-}3150}$ = -12 dB ; $C_{tr,50\text{-}5000}$ = -12 dB ; $C_{tr,100\text{-}5000}$ = -7 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3994	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

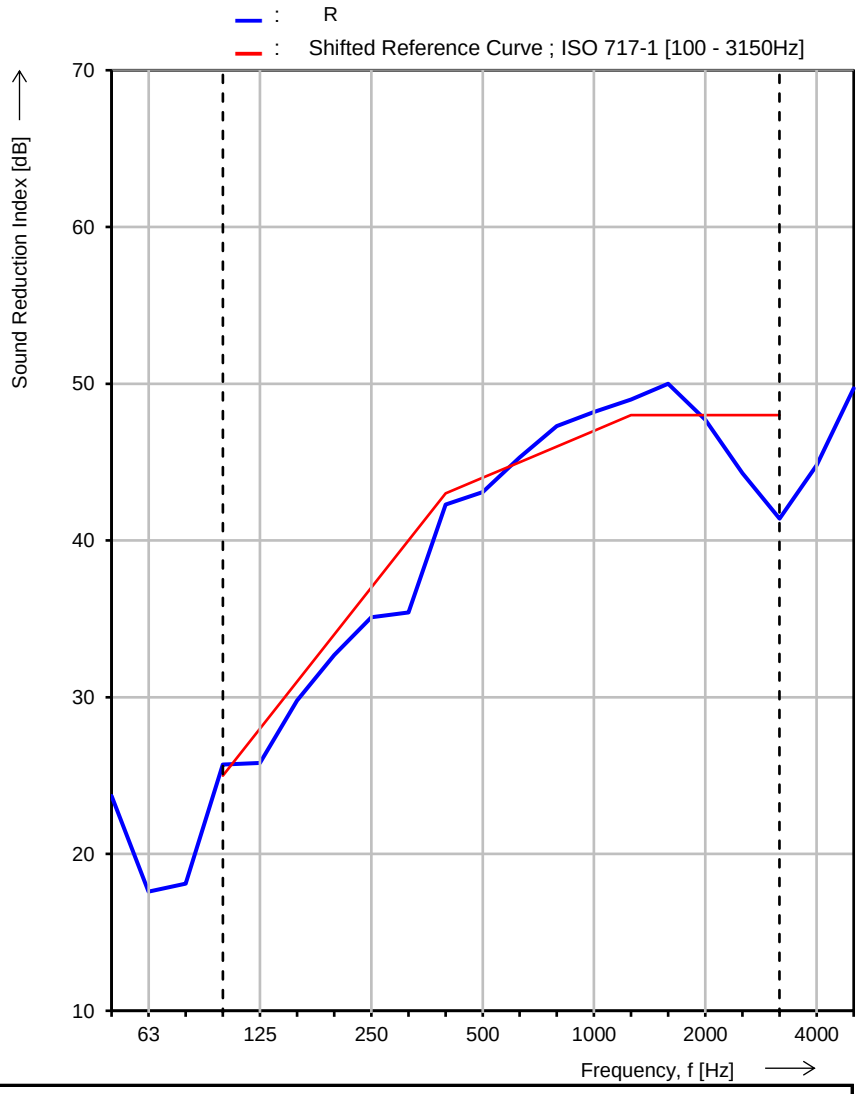
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & Slimline*
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*on Reveal	

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	21.0 °C	Calculated Mass per unit area:	49.0 kg/m^2
Source Room Relative Humidity:	61.9 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.1 °C		
Receiving Room Relative Humidity:	67.4 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	23.7
63	17.6
80	18.1
100	25.7
125	25.8
160	29.8
200	32.7
250	35.1
315	35.4
400	42.3
500	43.1
630	45.3
800	47.3
1000	48.2
1250	49.0
1600	50.0
2000	47.7
2500	44.3
3150	41.4
4000	44.8
5000	49.7



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 44 (-2 ; -5) dB

$C_{50\text{-}3150}$ = -1 dB ; $C_{50\text{-}5000}$ = -2 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -9 dB ; $C_{tr,50\text{-}5000}$ = -9 dB ; $C_{tr,100\text{-}5000}$ = -5 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3995	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney

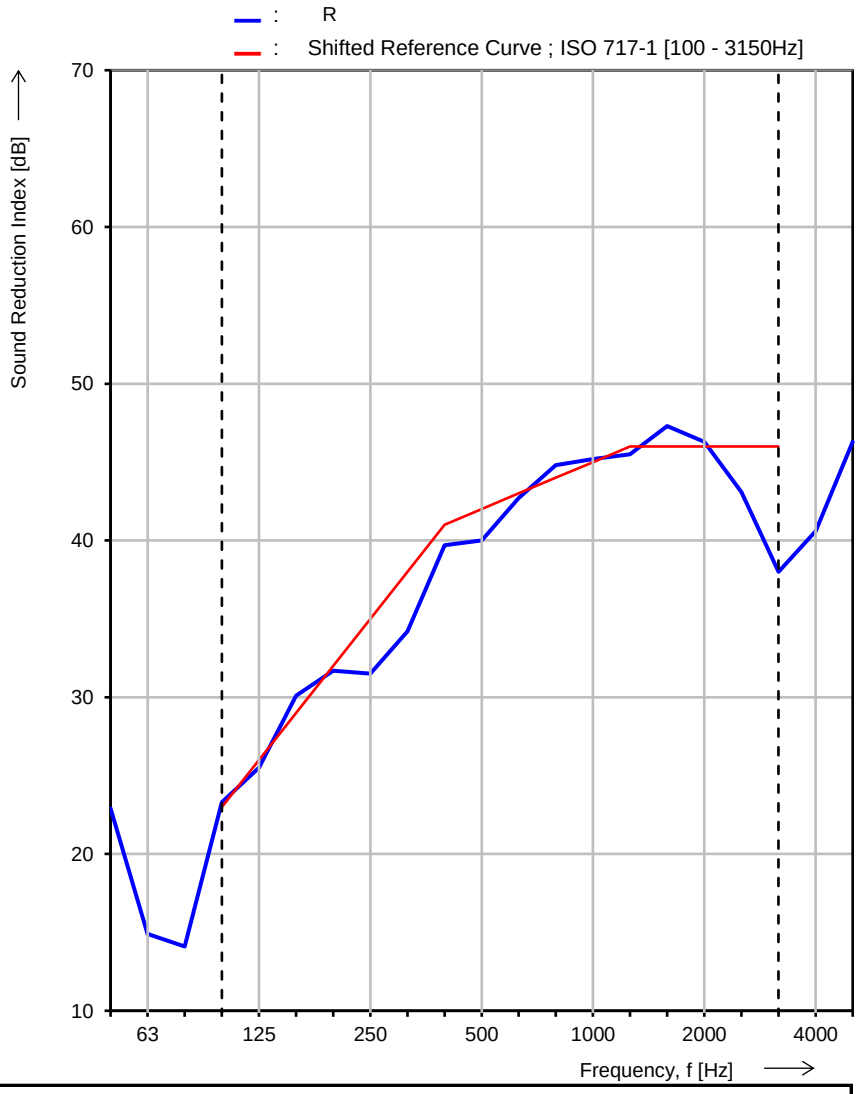
BS EN ISO 10140-2 : 2010, Sound Reduction Index

Laboratory measurement of sound insulation of building elements

Client:	Storm Windows	Product Identification:	Sash Box Window & Slimline*
Mounted by:	Client	Test Room Identification:	Acoustic Transmission Suite
Sample Size:	2.21 m²	Date of Test:	22 August 2019
Manufacturer:	Client		
Description:	Window & Secondary Glazing	*on Reveal, latch open	

Source Room Volume:	136 m^3	Ambient Pressure:	101.5 kPa
Source Room Temperature:	21.0 °C	Calculated Mass per unit area:	49.0 kg/m^2
Source Room Relative Humidity:	61.8 %	Curing Time:	Not Applicable
Receiving Room Volume:	220 m^3		
Receiving Room Temperature:	21.0 °C		
Receiving Room Relative Humidity:	67.3 %		

Frequency f [Hz]	R ⅓ octave [dB]
50	22.9
63	14.9
80	14.1
100	23.3
125	25.5
160	30.1
200	31.7
250	31.5
315	34.2
400	39.7
500	40.0
630	42.7
800	44.8
1000	45.2
1250	45.5
1600	47.3
2000	46.3
2500	43.1
3150	38.0
4000	40.6
5000	46.3



Rating according to BS EN ISO 717-1

R_w (C;Ctr) = 42 (-2 ; -5) dB

$C_{50\text{-}3150}$ = -2 dB ; $C_{50\text{-}5000}$ = -2 dB ; $C_{100\text{-}5000}$ = -1 dB

$C_{tr,50\text{-}3150}$ = -10 dB ; $C_{tr,50\text{-}5000}$ = -10 dB ; $C_{tr,100\text{-}5000}$ = -5 dB

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

Name of test institute:	The University of Salford, Acoustic Test Laboratory		
No. of test report:	4217-3996	Signature:	
Date: 22 August 2019		Operator:	D. Wong-McSweeney