**DAY DESIGN PTY LTD**

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# AIRBORNE SOUND TRANSMISSION LOSS

# SOUND PROOF WINDOWS

# SECONDARY GLAZING SYSTEM
# ULTRA SLIM WINDOW & TIMBER AWNING WINDOW

**REPORT NUMBER:** **4954-3**

**PREPARED FOR:** Sound Proof Windows
PO Box 460
Lilydale VIC 3140

Attention: Mr Paul Mason
Telephone: 1300 127 173

**DATE ISSUED:** 8 November 2012

| **Report Status** | **Prepared by:** Alex Li | **Approved by:** Stephen Gauld |
|---|---|---|
| Draft | | |

Document R\4954-r1.doc,11 pages plus attachments

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## 1.0 INTRODUCTION

Day Design was commissioned by Sound Proof Windows to measure the airborne sound transmission loss of a secondary glazing system consisting of their 507/508 Ultra Slim Sliding Window fitted with 6.38 mm laminated glass and pile seals, installed as a secondary sliding window with a typical timber awning window fitted with 3 mm float glass as the primary window. The measurements were conducted in the twin reverberation rooms at the National Acoustic Laboratories in accordance with Australian Standard AS 1191-2002: *"Acoustics – Method for Laboratory Measurement of Airborne Sound Insulation of Building Elements"*.

The test specimen was rated in accordance with AS/NZS ISO 717.1:2004 *"Acoustics – Rating of Sound Insulation in buildings and of building elements"*.

## 2.0 INSTRUMENTATION

Measurements and analysis were made with instrumentation as follows in Table 2.1:

**Table 2.1 Instrumentation**

| Description | Serial No. |
|---|---|
| Brüel and Kjær "PULSE" Data Acquisition Unit type 3560C | 2336733 |
| Brüel and Kjær Cathode Follower type 2669 | 1888716 |
| Brüel and Kjær Cathode Follower type 2660 | 1097420 |
| Brüel and Kjær Microphone type 4144 | 1304942 |
| Brüel and Kjær Microphone type 4179 | 1052016 |
| Brüel and Kjær Measuring Amplifier 2636 | 1193776 |
| Brüel and Kjær Sound Level Calibrator type 4231 | 2095393 |
| Yamaha Professional Sound Sources type S500 (1x unit) | 1069 |
| Yamaha Professional Sound Sources type S215IV (1x unit) | 09218269 |
| Murray 100 Watt Amplifier type MA534 | 15 |
| Vaisala Digital Barometer type PTB201AD | R3330001 |
| Testo Temperature/Humidity Logger, type 177-H1 | 00886924 |

All acoustic instrument systems have been laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The acoustic measurement system was also calibrated prior to and after the noise level measurements. Calibration drift was found to be less than 0.5 dB during the measurements. No adjustments for instrument drift during the measurement period were warranted.

## 3.0 ACOUSTIC TEST LABORATORY

| | |
|---|---|
| Location: | National Acoustic Laboratories<br>126 Greville Street, Chatswood, NSW. |
| Room Construction: | The twin Reverberation Rooms were used for the acoustical measurements with the test specimen installed in the aperture. The rooms are of concrete and masonry construction, each having an internal volume of approximately 200 cubic metres. The floors are pentagonally shaped and the ceilings are inclined so that no two surfaces are parallel. The rooms are vibration and sound isolated from the enclosing building, being floated on steel springs and rubber dampers below the concrete floor.<br>Large panels of 19 mm thick plywood, heavily coated with an epoxy resin are suspended inside the test room in random orientation to aid in the diffusion of the sound field. |
| Room Surface Area: | 231 $m^2$ |
| Atmospheric Conditions: | The relative humidity inside the reverberation room throughout the testing was between the ranges of 60 to 80 %. The temperature was between the ranges of 15 to 25 °C. |
| $R_w$ 70 Filler Wall: | A double timber stud wall was constructed in the 10 $m^2$ aperture between the Reverberation Room (source room) and the Diffuse Room (receive room). From the source room to receive room, the wall consisted of:<br>- 16 mm Fire Rated Plasterboard (density 12.3 kg/$m^2$)<br>- 3 x 10 mm Standard Plasterboard (density 3 x 6.4 kg/$m^2$)<br>- 70 mm timber studs<br>- 38 mm air gap between studs with 150 mm glasswool insulation<br>- 70 mm timber studs<br>- 10 mm Standard Plasterboard (density 6.5 kg/$m^2$)<br>- 2 x 13 mm Standard Plasterboard (density 2 x 8.1 kg/$m^2$)<br>- 16 mm Fire Rated Plasterboard (density 12.3 kg/$m^2$) |
| Test Specimen: | Manufacturer: Sound Proof Windows<br>Primary Window: Typical Timber Awning Window<br>Primary Glazing Spec: 3 mm float glass with compression seals<br>Secondary Window: 507/508 Ultra Slim Sliding Window<br>Secondary Glazing Spec: 6.38 mm laminated glass with pile seals<br>Dimensions: 1200 mm (H) x 1800 mm (W), 100 mm gap glass-to-glass |
| Date of Test: | Monday 29th October, 2012 |

## 4.0 MEASUREMENT PROCEDURE

Before testing commenced, the reverberation room temperature, relative humidity and barometric air pressure were noted. The measurement microphones were acoustically calibrated and the acoustical noise floor of the room checked.

All reverberation rooms have small space variations of the sound field distribution and time variations in sound field decay (of reverberation time) during the measurement period. The gathering of meaningful results therefore requires multiple measurements to determine the extent of these variations. The testing procedure uses 48 sets of data to determine the spread of results around the estimate of the mean, each set containing 18 measurements of one-third octave reverberation times.

The two reverberation rooms are identified as the Reverberation Room and the Diffuse Field Room; the Reverberation Room being the room where noise is generated, and the Diffuse Field Room is the room on the other side of the test specimen measuring the transmitted noise levels.

The suite of data is divided into two sets of 24 measurements. The first set consists of sound pressure level measurements in the Reverberation Room and Diffuse Field Room measured simultaneously as noise is generated in the Reverberation Room and is transmitted into the Diffuse Field Room. Sound pressure levels are measured at 12 different locations in each of the two rooms to obtain a spatial average of the sound pressure levels in the rooms. Measurements of sound transmission loss were carried out in accordance to AS 1191-2002: *"Acoustics – Method for Laboratory Measurements of Airborne Sound Insulation of Building Elements"*.

The second set of measurements is of the reverberation times in the Diffuse Field Room, which determines the absorption characteristics of the Diffuse Field Room. The measurements consist of a spatial average of six different combinations of two loudspeakers and three microphone positions, and four measurements taken at each combination for a time average to obtain an estimate of the reverberation time precision.

This space-time measurement data was computer processed on a pre-configured Excel spreadsheet to obtain a final average and standard deviation for the test specimen results. The calculations provide sound absorption coefficients and precision level of the measurements to a 95% confidence level.

## 4.1 Reverberation Time ($T_{60}$)

The reverberation time, $T_{60}$, is the time it takes for a noise source to decay by 60 dB. A "live" room, such as a reverberation room, which consist of only hard surfaces will typically have a long reverberation time. A "dead" room, such as an anechoic chamber, which consist of highly absorptive surfaces, will have a much shorter reverberation time.

Measurement of the reverberation time in the Receiving Room allows us to adjust the measured sound reduction to account for the sound energy absorption by the room.

## 4.2 Equivalent Absorption Area (A)

The equivalent absorption area, *A*, of the receiving room is obtained from the measured reverberation time, *T*, at each one-third octave centre frequency by use of the following equation:

$$A = \frac{0.16V}{T}$$

where $V$ = volume of receiving room ($m^3$)

$T$ = space-averaged reverberation time of receiving room (seconds)

## 4.3 Sound Reduction Index (R)

The Sound Reduction Index, R, is the ratio of the incident sound power to the transmitted sound power through a building element. It is expressed as:

$$R = \frac{W_1}{W_2}$$

where $W_1$ = sound power incident on the element under test (watts)

$W_2$ = sound power transmitted through and radiated by the element under test (watts)

However, as sound powers cannot be measured directly, the Sound Reduction Index has been redefined in AS 1191-2002 in terms of sound pressure levels. The Sound Reduction Index is derived from the following equation:

$$R = L_{p1} - L_{p2} + 10\log(S/A)$$

where $L_{p1}$ = average sound pressure level in the source room (dB)

$L_{p2}$ = average sound pressure level in the receiving room (dB)

$S$ = area of building element specimen under test ($m^2$)

$A$ = equivalent absorption area in receiving room ($m^2$)

### 4.4 Weighted Sound Reduction Index ($R_w$) & Correction Factor ($C_{tr}$)

The weighted sound reduction index ($R_w$) as described in Australian Standard AS/NZS ISO 717.1:2004 provides an acoustic rating for the sound insulation of walls and partitions subject to airborne sounds having a spectrum similar to that of the human voice, which is typically of a mid-to-high frequency character.

Sound insulation varies with frequency and is dependant on the type of material and construction. However, the $R_w$ provides a convenient method of rating sound insulation using a single number. The higher the $R_w$ rating the better the sound insulation provided by the partition.

The $R_w$ rating is determined by comparing the measured sound reduction indices against a set of reference values between one-third-octave band centre frequency range of 100 Hz to 3150 Hz, as specified in AS/NSZ ISO 717.1:2004.

The reference data is then amplitude shifted in 1 dB increments across the spectrum until the sum of the unfavourable deviations is as large as possible without exceeding 32 dB. (The unfavourable deviation is the difference between the measured data and the reference data where the measured data is less than the reference data).

The spectrum adaptation terms C and $C_{tr}$ are applied to the sound reduction index to account for the different spectra of noise sources that the specimen can be exposed to. The adaptation term C is used for sources such as children playing and highway road traffic noise, which have a wide energy distribution in their noise spectra. The adaptation term $C_{tr}$ is used for noise sources such as aircraft noise (at long distance), slow railway traffic, and disco music, which has a high concentration of energy in the low frequency range of the measurement spectrum.

## 5.0 TEST SPECIMEN DESCRIPTION AND RESULTS

The test specimen windows were installed into a 1205 mm (H) x 1810 mm (W) aperture within the filler wall. The timber awning window was installed in the aperture to replicate a typical timber frame window that is found in residential homes. Gaps around the perimeter were sealed using silicone. The window was second-hand and had signs of wear-and-tear from previous use.

The 507/508 Ultra Slim Sliding Window was then installed behind the timber awning window on the inside as a secondary window. The secondary window is an independent window consisting of its own frames and sash components, and was set back 100 mm (glass-to-glass) from the primary timber window. Gaps around the secondary window perimeter were seals using silicone. The test specimen setup is shown in Figures 1 to 3 below.


**Figure 1. Installation of combined Secondary Window System (Receive Room Side)**


**Figure 2. Installation of combined Secondary Window System with 507/508 Ultra Slim Sliding Window open**

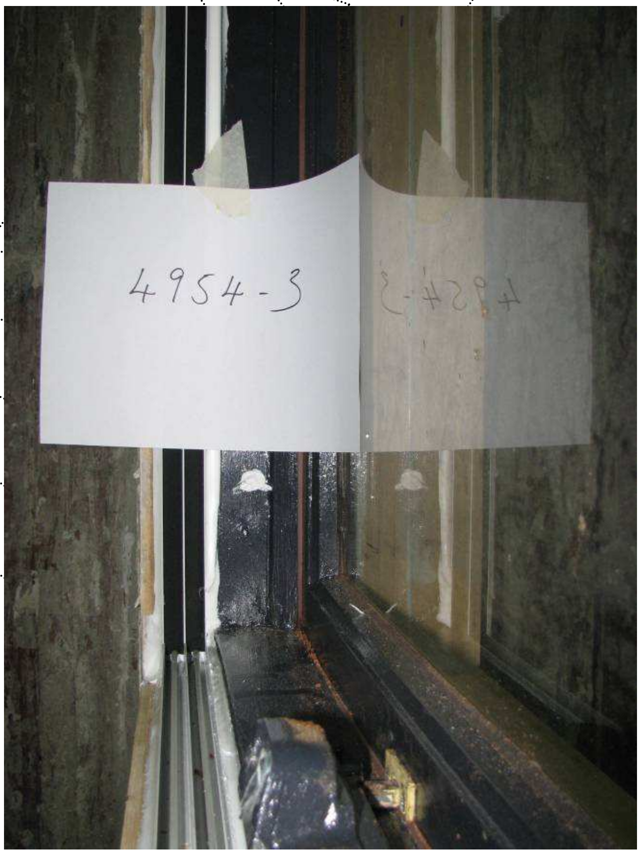



**Figure 3. Side profile showing air gap between the primary and secondary window**

Sound reduction indices (rounded to the nearest one-tenth decibel) are tabulated for each one-third-octave band tested and presented in Table 1. Formulae used in deriving results are presented in the attached Appendix A.

**Table 1 Measured Sound Reduction Index**

| 1/3 Octave Band Centre Frequency (Hz) | Sound Reduction Index (dB) |
|---|---|
| 100 | 21.2 |
| 125 | 29.4 |
| 160 | 34.3 |
| 200 | 32.2 |
| 250 | 35.0 |
| 315 | 37.1 |
| 400 | 40.9 |
| 500 | 42.2 |
| 630 | 43.7 |
| 800 | 46.8 |
| 1000 | 47.0 |
| 1250 | 49.0 |
| 1600 | 50.2 |
| 2000 | 50.6 |
| 2500 | 53.8 |
| 3150 | 55.4 |
| 4000 | 52.4 |
| 5000 | 50.8 |
| **$R_w$ (C;Ctr)** | **45 (-1;-7)** |

The combined secondary window system incorporating the timber awning window fitted with 3 mm float glass and compression seals, and 507/508 Ultra Slim Sliding Window fitted with 6.38 mm laminated glass and pile seals, separated by 100 mm air gap glass-to-glass achieved a weighted sound reduction index of $R_w$ (C; $C_{tr}$) = 45 (-1;-7).

Test measurements and calculations were conducted by the undersigned.

**Alex Li**, BE (Mech) Hons, MAAS

Consulting Acoustical Engineer

for and on behalf of Day Design Pty Ltd.

## AAAC MEMBERSHIP

Day Design Pty Ltd is a member company of the Association of Australian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

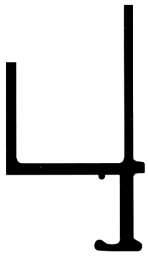
**Attachments:**

- Design Section Drawings – Sound Proof Windows
- Test Certificate 4870-3 – Combined Secondary Window System incorporating the Primary Timber Awning Window fitted with 3 mm float glass, and the Secondary 507/508 Ultra Slim Sliding Window fitted with 6.38 mm laminated glass and pile seals
- Appendix A: Method of Calculation of Sound Reduction Index of Composite Walls

| DAY DESIGN | SOUND PROOF WINDOWS DESIGN CROSS SECTIONS | 4954 |
|---|---|---|

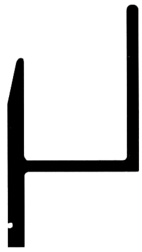
## LIFT OUT FRAMES

719



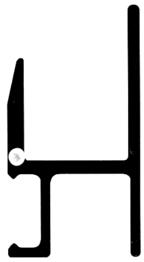
L/O OUTER HEAD/SILL
(FACE FIXING)

319



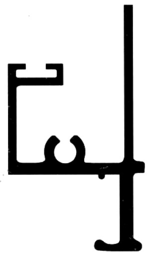
L/O OUTER HEAD/SILL
(REVERSE FIXED)

519



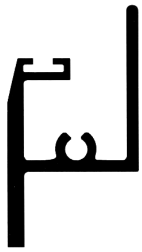
L/O OUTER HEAD/SILL
(EQUAL LEG)

720



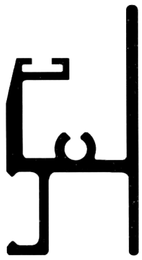
L/O OUTER SIDE FRAME
(FACE FIXING)

320



L/O OUTER SIDE FRAME
(REVERSE FIXED)

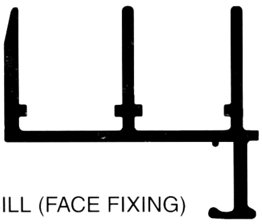
520



L/O OUTER SIDE FRAME
(EQUAL LEG)

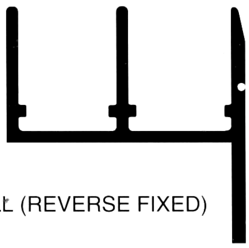
## SLIDE UNIT TRACK

707



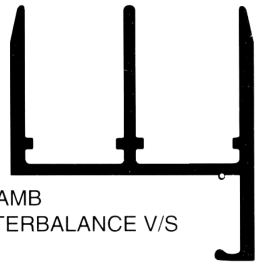
HEAD/SILL (FACE FIXING)

307



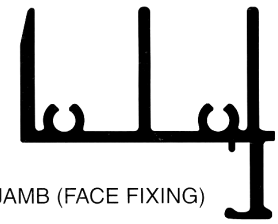
HEAD/SILL (REVERSE FIXED)

807



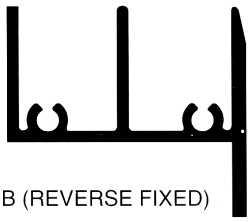
SIDE JAMB
COUNTERBALANCE V/S

708



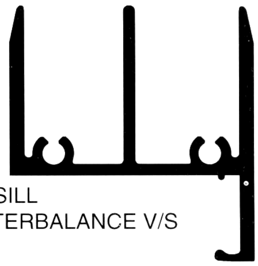
SIDE JAMB (FACE FIXING)

308



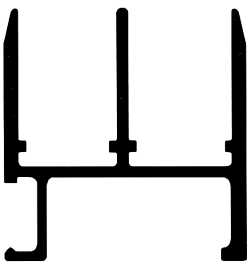
SIDE JAMB (REVERSE FIXED)

808



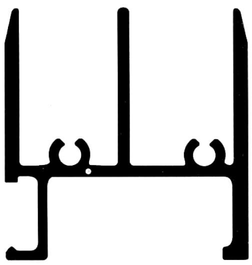
HEAD/SILL
COUNTERBALANCE V/S

507



HEAD/SILL
UNIVERSAL

508

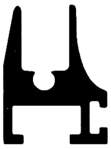


SIDE JAMB
UNIVERSAL

| DAY DESIGN | SOUND PROOF WINDOWS<br>DESIGN CROSS SECTIONS | 4954 |
|---|---|---|

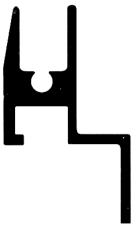
## HINGED AND FIXED UNITS

301



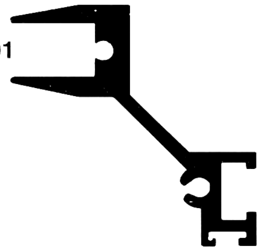
HINGED/FIXED FRAME

310



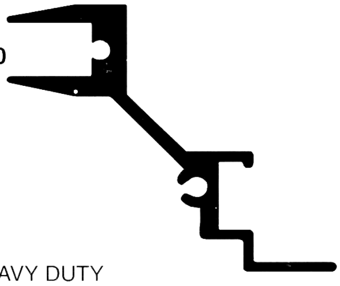
HINGED MEETING STILE

701



HEAVY DUTY
HINGED/FIXED FRAME

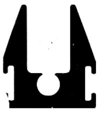
710



HEAVY DUTY
HINGED/FIXED MEETING STILE

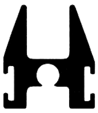
## HORIZONTAL/COUNTER BALANCED V/S SLIDE AND LIFT OUT UNITS

202



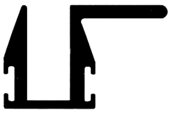
HEAD/SILL, V/S SIDES

302



SILL (ROLLER FITTING)

203



HANDLE (FRONT PANEL)

205

EXTENDED HANDLE (REAR PANEL)

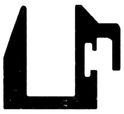
204

MEETING STILE

206

HEAVY DUTY
MEETING STILE

209

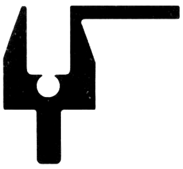


REVERSE MEETING STILE

213

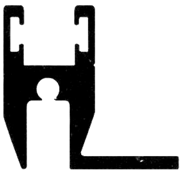
HEAVY DUTY
REVERSE MEETING STILE

211



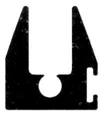
BI PART MEETING STILE (MALE)

212



BI PART MEETING STILE (FEMALE)

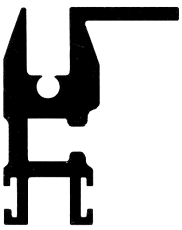
218



L/O INNER SIDE FRAME

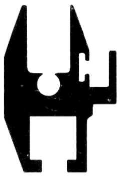
## GUILLOTINE VERTICAL SLIDE UNITS

214



LOWER TRANSOM

215



CENTRE TRANSOM

## UNIVERSAL MIDRAIL

303

4000MM

| DAY DESIGN | SECONDARY WINDOW SYSTEM<br>SOUND TRANSMISSION LOSS<br>TEST CERTIFICATE | 4954-3 |
|---|---|---|

**Client:**

## Sound Proof Windows

| Frequency - Hz | Sound Reduction Index - dB | |
|---|---|---|
| | 1/3 Octave | 1/1 Octave |
| 100 | 21.2 | |
| 125 | 29.4 | 25.2 |
| 160 | 34.3 | |
| 200 | 32.2 | |
| 250 | 35.0 | 34.3 |
| 315 | 37.1 | |
| 400 | 40.9 | |
| 500 | 42.2 | 42.1 |
| 630 | 43.7 | |
| 800 | 46.8 | |
| 1000 | 47.0 | 47.5 |
| 1250 | 49.0 | |
| 1600 | 50.2 | |
| 2000 | 50.6 | 51.3 |
| 2500 | 53.8 | |
| 3150 | 55.4 | |
| 4000 | 52.4 | 52.5 |
| 5000 | 50.8 | |
| $R_w$ ($C$;$C_{tr}$) | 45 ( -1 ; -7 ) | |

**Test Specimen:**

## 507/508 Ultra Slim Sliding Window

**(fitted with 6.38 mm laminated glass and pile seals)**

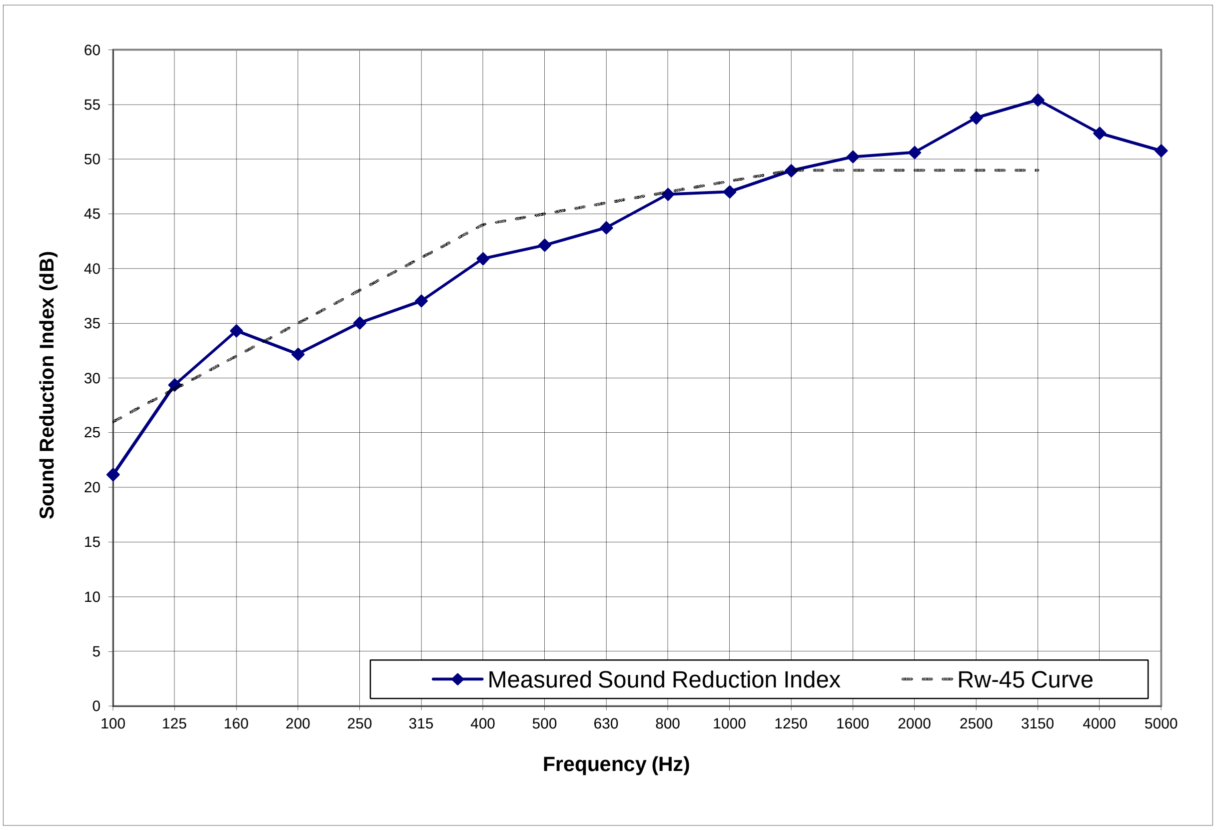
installed behind typical timber awning window (3 mm float glass & foam seals) set back 100 mm glass-to-glass

**Australian Standards:**
Measured according to AS 1191-2002
Rated to AS/NZS ISO 717.1:2004

**Test Specimen Dimensions:**
1.2 m (H) x 1.8 m (W)

**Test Location:**
Twin Reverberation Rooms
National Acoustic Laboratories
126 Greville Street, Chatswood NSW

**Instrumentation:**
Brüel and Kjær Pulse Analyser type 3560C
Brüel and Kjær Cathode Follower type 2660
Brüel and Kjær Cathode Follower type 2669
Brüel and Kjær Microphone type 4144
Brüel and Kjær Microphone type 4179
Brüel and Kjær Measuring Amplifier 2636
Brüel and Kjær Sound Level Calibrator type 4231
Yamaha Professional Sound Sources type S500 (1 x unit)
Yamaha Professional Sound Sources type S245IV (1 x unit)




**Date of Test:** Monday, 29 October 2012
**Project Number:** 4954-3

**Test Engineer:** ..................................................................
**Alex Li,** BE(Mech) Hons, MAAS
For and on behalf of Day Design Pty Ltd

The proportion of sound energy transmitted by the way of a filler wall should be determined where it is necessary to reduce the aperture opening to accommodate a small test specimen. The standard theory for composite walls (see below) can be applied to determine whether the transmission through the filler wall will significantly affect the results obtained for the specimen by measurement of the sound reduction index of the composite of the specimen and its surrounding filler wall. The sound reduction index of the construction used for the filler wall is required to be known; if it is not known it may need to be determined by separate measurements with that construction as the specimen.

The sound transmission coefficient $\tau_c$ and $\tau_f$ for the composite and filler walls respectively are calculated from the corresponding sound reduction indices, $R_c$ and $R_f$, by the following equations:

$$\tau_c = 10^{-0.1R_c}$$

and

$$\tau_f = 10^{-0.1R_c}$$

$R_c$ is derived from the measurements on the composite of specimen and filler walls by the following equation:

$$R_c = D_c + 10\log_{10}(S_c / A)$$

where

$S_c$ = area of the composite wall, in square metres

$A$ = receiving room equivalent absorption area, in square metres

$D_c$ = average sound pressure level difference for the composite wall, in decibels

$\tau_c$ and $\tau_c$ may then be substituted in the following equation to obtain $\tau_c$, the transmission coefficient for the specimen:

$$\tau_c = \frac{\tau_c S_c - \tau_f S_f}{S_s}$$

where $S_f$ and $S_s$ are the areas of the filler wall and the test specimen, respectively. The sound reduction index of the specimen is then given by the following equation:

$$R_s = 10\log_{10}\left(\frac{1}{\tau_s}\right)$$

NOTE: It is assumed in the above derivation that the two parts of the composite wall react to the sound field independently of each other, and that the sound reduction index of a complete filler wall is the same as that of that portion surrounding the test specimen. These simplifications are acceptable so long as $\tau_f S_f$ is small compared with $\tau_c S_c$.