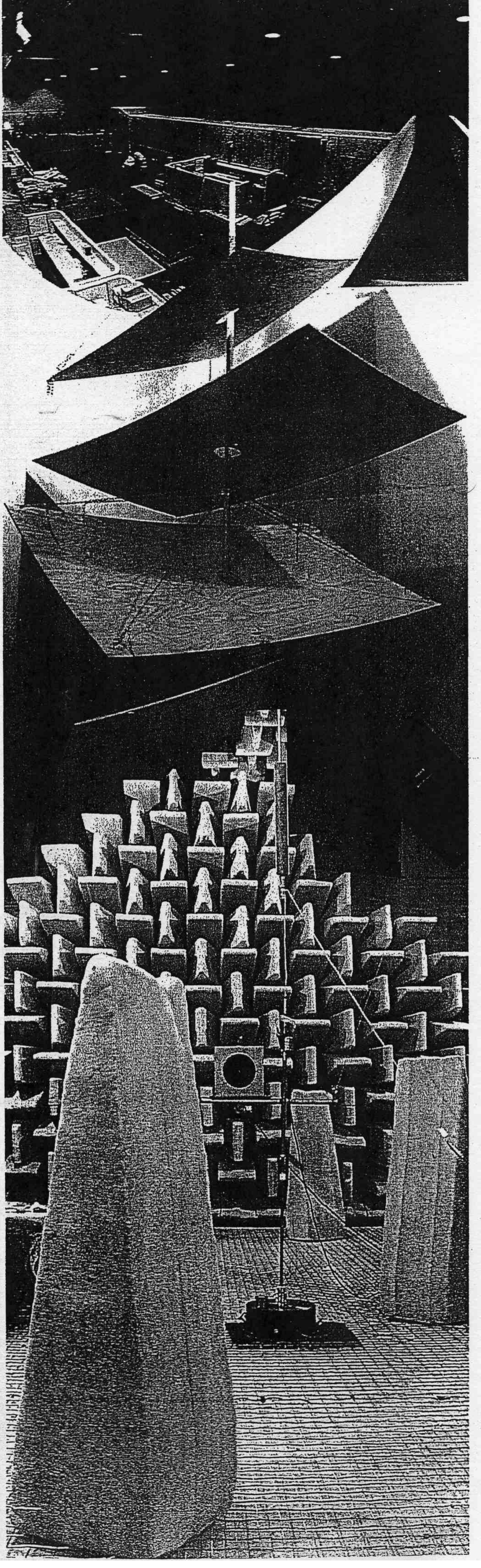

ATF Report 1549

Airborne Sound Transmission Test of a Tilt and Turn Window with 60mm PVC frame with steel reinforcing and 10.38mm glazing

Commissioned by
REHAU

Test Date: 10 August 2004

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ATF Report 1549

Airborne Sound Transmission Test of a Tilt and Turn Window with 60mm PVC frame with steel reinforcing and 10.38mm glazing

Commissioned by
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AS1191-1985, AS1045-1988
Accredited Lab No: 5472

Airborne Sound Transmission Test of a Tilt and Turn Window with 60mm PVC frame with steel reinforcing and 10.38mm glazing

1.0 Introduction and test results summary

The National Acoustic Laboratories were commissioned by REHAU to measure the acoustical transmission loss of a Tilt and Turn Window with 60mm PVC frame with steel reinforcing and 10.38mm glazing as described in item 2.0 'Test sample' details

The test sample achieved the following results :

Sound Transmission Class	STC 36
ISO-717 Sound Insulation Rating Rw (C; Ctr)	36 (-1 ; -2)
Outdoor Indoor Transmission Class	OITC 33
Unweighted average transmission loss value (100Hz - 5kHz)	35dB
A-Weighted average transmission loss value (100Hz - 5kHz)	30dB

2.0 Test sample details

Frame Type	Tilt and Turn window with fixed lite
Frame Material	PVC Frame with Steel reinforcing
Frame Dimensions	1150mm high x 1575mm wide
Glazing	10.38mm
Glazing Channels	EPDM Glazing seal
Lock/Latch Assembly	Tilt-turn gear set (ROTO)
Reveal Lining	20mm maple timber reveal
Installation	Sample screw fixed into a 1810mm wide x 1220mm high aperture with a 20mm thick maple timber reveal and sealed with silicone sealant. The PVC Secondary frame screw fixed and glued to the timber reveal with polyurethane sealant.
Drawing Number	LTB61 CM03
Test Date	10-Aug-2004
Notes	An extra wide timber reveal was fitted to the test window. This was because materials were not available at the time to manafacture a window of the correct size. Unfortunately this will have adversely affected the window's performance.

3.0 Testing rationale

The procedure for testing a small test sample building element such as a door or window requires the construction of a specially designed 'filler wall'. This filler wall is constructed in an aperture between two reverberation rooms and tested for acoustic transmission loss. After testing, an opening which is sufficiently large to accommodate the window or door is made in the filler wall (the size of the opening can be varied to suit a particular sample but normally it is 1850 x 1250mm (W x H) for windows and 1850 x 2150mm (W x H) for doors). The perimeter of this opening is lined with a layer of 16mm thick fire rated gypsum plasterboard, a layer of 12mm thick medium density fibreboard (m.d.f.) and a layer of Barium sulphate impregnated vinyl sheet. The small sample is then fitted into the opening and the acoustical integrity of the installation checked before testing.

The filler wall attenuation characteristics are designed to provide a minimum of 10dB greater attenuation than the test sample at all one-third octave frequencies between 80Hz and 5000Hz. This is to ensure an accurate measurement of the test sample according to standard acoustical practice, and to conform with the measurement requirements of AS1191-1985 *Acoustics - Method for laboratory measurement of airborne sound transmission loss of building partitions*. The transmission loss characteristics of this wall are presented in item 4.1 **Sound Transmission Class** of this report.

The second measurement taken is of the test sample fitted within the filler wall as presented in item 4.1 **Sound Transmission Class** of this report. The difference between the filler wall and filler wall and test sample measurements provide a means of calculating the Sound Transmission Class (STC) rating of the test sample as presented in item 4.1 **Sound Transmission Class** of this report. Other criteria presented in the report are derived from the two sets of measurements.

4.0 Results

4.1 Sound Transmission Class

A complete set of measurements and calculations for determination of the test sample acoustical transmission loss was calculated and is presented numerically and graphically on the appended spreadsheets. A summation of one-third octave transmission loss results, rounded to the nearest deciBel (as required by AS1191-1985), follows.

Transmission Loss Measurement					
1/3 Octave Band Centre Frequency (Hz)	Filler Wall STC 80	Filler Wall and Test Sample STC 44	Test Sample STC 36	STC Criterion Value STC 36	Difference (dB)
80	41	35	29	-	-
100	50	32	25	-	-
125	59	35	27	20	-
160	60	33	26	23	-
200	65	36	29	26	-
250	71	40	33	29	-
315	73	40	32	32	-
400	76	42	34	35	-1
500	78	42	35	36	-1
630	80	43	36	37	-1
800	83	44	36	38	-2
1000	86	43	36	39	-3
1250	89	41	34	40	-6
1600	90	41	34	40	-6
2000	90	44	36	40	-4
2500	86	46	39	40	-1
3150	86	47	40	40	-
4000	92	51	43	40	-
5000	95	55	48	-	-
				SUM	-25

Note 1. The two channel pulse analyser averaging time conforms with the AS1191-1985 requirement of (1/20 the reverberation time of each one-third octave band in the measurement frequency range).

Note 2. Determination of Sound Transmission Class for a test sample requires comparison of the measured sound transmission loss with the value for each transmission class rating listed in the STC tables for each one-third octave band centre frequency, 125Hz to 4000Hz. The STC value, which is expressed as a class rating only (not as deciBels) as determined by these tables, is reached when either or both of the following requirements are met:

(a) The test sample transmission loss at any frequency in the range 125Hz to 4000Hz must not lie more than 8dB below that of the STC reference graph value at the same frequency and

(b) The total sum obtained from the addition of unfavourable deficiencies (as defined in the "Rw determination" description), must not add to more than 32dB. They are listed in the STC table above.

Note 3. Refer to the spreadsheet summaries (attached) for deciBel precision at the 95% confidence level for each attenuation value. The uncertainties have been calculated on the basis of there being not more than five chances in one hundred that any value differs from the true value by more than the stated uncertainty.

Signatory: Peter Alway

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Date: 30.8.04

4.2 Outdoor-Indoor Transmission Class

The first column of the Summarised OITC RatingTable lists centre frequencies of the one-third octave bands measured.

The second column specifies levels of the A-weighted reference spectrum defined by ASTM E1332 which are required to determine OITC. This spectrum has been A-Weighted and then normalised so that its energy summation is 0dB as required by that Standard.

The third column contains transmission loss coefficients for each one-third octave band in the frequency range 80Hz to 4000Hz used to determine test sample OITC rating.

The fourth column represents the difference between column two and three converted to sound energy. The summation of this energy, converted back to deciBels is taken as the OITC value of the test sample.

OITC Rating			
1/3 Octave Band Centre Frequency (Hz)	Normalised A-Weighted Spectrum (dB)	Test Sample Transmission Loss (dB)	Transmitted Sound Energy (Watts)
80	-19.6	29	1.380E-05
100	-17.2	25	6.026E-05
125	-15.2	27	6.026E-05
160	-15.5	26	7.079E-05
200	-14	29	5.012E-05
250	-13.7	33	2.138E-05
315	-12.7	32	3.388E-05
400	-11.9	34	2.570E-05
500	-10.3	35	2.951E-05
630	-11	36	1.995E-05
800	-10.9	36	2.042E-05
1000	-11.1	36	1.950E-05
1250	-10.5	34	3.548E-05
1600	-11.1	34	3.090E-05
2000	-10.9	36	2.042E-05
2500	-11.8	39	8.318E-06
3150	-13.9	40	4.074E-06
4000	-15.1	43	1.549E-06
		Sum of total energy =	5.263E-04
		OITC = -10 * log (Sum of total energy) =	32.79
		OITC	33

4.3 ISO-717 Sound Insulation Rating

Rw Rating	
Rw	36
C_T	-1
C_{TR}	-2

Signatory...............
Peter Alway

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Date 30.8.104

5.0 Procedure for measuring test samples

The procedural detail requires reverberation room measurements of the following parameters for the filler wall and then for the filler wall with test sample fitted:

Reverberation time measured in the receive room
Sound pressure level in the send room and
Sound pressure level in the receive room

The receive room reverberation time is measured according to the requirements of AS 1045 - 1985 *"Acoustics - Measurement of Sound Absorption in a Reverberation Room"*. The procedures require twelve measurements of sound pressure levels in the send room and twelve in the receive room for each one-third octave band at different locations in the rooms.

Measurement of twenty four sets of sound decay data in the receive room requires the use of two sound sources, each positioned at a different location in the room and by moving the microphone through three positions, one for each measurement. A measurement is repeated four times for each combination of microphone and sound source location.

The total number of measurements required to evaluate sound pressure performance of the small test sample therefore comprises forty eight one-third octave sets of recordings in the send and receive rooms for the filler wall and forty eight sets for the filler wall with test sample installed. A set of recordings contains a measurement of the sound pressure level in each one-third octave frequency band between 100Hz and 5000Hz (eighteen in total), 80Hz is added to this for the calculation of OITC. These multiple measurements provide a means of calculating the sound field space-time variation within each room and establishes a basis for determining an estimation of the measurement precision to a confidence level of 95%.

Before testing commences, the measurement microphone in each reverberation room is acoustically calibrated and the acoustical noise floor measured. Acoustical calibration of each microphone is repeated at completion of the testing programme to ensure accuracy of results.

AS1191-1985 and the equivalent standards ISO140-1 and ISO140-3 describe procedures which allow measurement of transmission loss of 10 square metre samples or of smaller size samples such as windows, doors, partitions etc. The procedure for 10 square metre test samples is straightforward and requires only the aforementioned three sets of measurements. The procedure for measurement of smaller test samples, which is discussed in appendix A of AS1191-1985, requires construction and transmission loss measurement of a 10 square metre test wall which has at least 5dB and preferably 10dB more attenuation at each one-third octave band centre frequency in the frequency range to be measured than that of the smaller test sample to be evaluated and a calculation based on relative sizes of the 10 square metre test wall and the small test sample.

OITC is then calculated as required by ASTM E1332-90 by assuming the previously specified spectra and using the transmission loss coefficients obtained in the calculation procedure (refer spreadsheets) and Rw (C; Ctr) calculated according to requirements of ISO 717-1:1996 "Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne Sound Insulation".

6.0 Test sample performance assessment

Several criteria are presented in this report to evaluate the acoustical transmission loss of the test sample to satisfy building industry requirements in Australia. Each evaluation is made on an analysis of the calculated difference between the filler wall and the filler wall with test sample fitted.

a. The Internationally used rating of Sound Transmission Class as required by Australian Standard AS1191-1985.

b. The Weighted Sound Reduction Index, Rw rating with spectral corrections C and Ctr as discussed in International Standards Organisation document ISO717-1:1996 *"Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne Sound Insulation"*. The ISO Rw rating is relevant where the spectra has low frequency energy content and is similar in application to the American OITC criteria. They differ however in the frequency range of application. Each compares a standardised reference curve with the measured data over one-third octave bands. The Rw evaluation is carried out using the one-third octave band with centre frequencies ranging from 100Hz to 3150Hz, and the OITC evaluation is carried out using the one-third octave bands in the frequency range 80Hz to 4000Hz. The Rw criteria is now largely favoured as a replacement for STC. The OITC evaluation is included in our reports for clients who wish to market their products overseas.

c. Other ratings presented are an evaluation of linear and A-weighted sound transmission loss averaged over the frequency range 100Hz to 5kHz. These are often required for marketing in New Zealand.

7.0 Sound Transmission Class (STC) rating

The first criterion presented, Sound Transmission Class (STC), has been an internationally standardised criterion for many years for evaluating noise reducing characteristics of building elements. The test procedure provides a single number which has been considered sufficient to determine transmission loss of building elements such as walls, windows, doors and other small test samples fitted into the walls of buildings.

This STC rating criterion was originally developed for acoustical performance evaluation of internal walls and doors in buildings and is based on noise spectra with an energy distribution typical of music and speech. It is now considered to be unsuitable for use where the building element under evaluation is likely to be exposed to low frequency components of noise generated by transportation movement.

Determination of Sound Transmission Class for a test sample requires comparison of the measured sound transmission loss with the value for each transmission class rating listed in the STC tables for each one-third octave band centre frequency, 125Hz to 4000Hz. The STC value, which is expressed as a class rating only (not as deciBels) as determined by these tables, is reached when either or both of the following requirements are met:

(a) The test sample transmission loss at any frequency in the range 125Hz to 4000Hz must not lie more than 8dB below that of the STC reference graph value at the same frequency and

(b) The total sum obtained from the addition of unfavourable deficiencies (as defined in the "Rw determination" description), must not add to more than 32dB.

8.0 Outdoor - Indoor Transmission Class (OITC), and Rw (C; Ctr) Weighted Sound Reduction Ratings

Alternative single number criterion, the American Outdoor - Indoor Transmission Class (OITC) rating and the European International Organisation for Standardisation Document ISO 717-1:1996, specification for the Weighted Sound Reduction Index (Rw) associated with relevant spectrum corrections C and Ctr, have been developed in order to more closely rank transmission loss performance of building elements with a listener's subjective reaction to transportation and living activity type noise spectra. Each criterion is intended for use in situations where the relevant spectra can be transmitted through the element.

The OITC and Rw (C; Ctr) criterion are not considered to be suitable for use where the noise has a predominantly low frequency component such as produced by some industrial activities. More information on the OITC test procedure can be obtained in ASTM Standard Test Procedure E1332, *"Standard Classification for Determination of Outdoor-Indoor Transmission Class"* and the Weighted Sound Reduction Index, C and Ctr criteria are fully explained in ISO 717-1:1996, *"Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne Sound Insulation"*.

8.1 OITC determination

The OITC value for a test sample, as detailed in ASTM E 1332, is obtained by A-Weighting a noise spectrum which was obtained as an average of multiple measurements of aircraft take-off, freeway and railroad passby activities. This standardised noise spectrum is assumed to be in the send room during measurement of transmission loss.

The noise energy from this assumed noise spectra is (theoretically) transmitted through the small test sample, reduced by the transmission loss of the test sample at each one-third octave centre frequency (each transmission loss obtained from the STC measurement) and then summed as the total energy in the receive room.

The total energy is then determined as sound power (deciBels re 1 pW) and the resulting numerical value expressed as the OITC value of the sample under test. It should be noted that the OITC rating is considered as a class evaluation and stated numerically in a similar way to the STC value which is also a class evaluation (that is, stated numerically and not as deciBels as is sometimes found in literature).

8.2 Rw determination

The Rw criterion is obtained by comparing the set of test sample transmission loss against a set of reference data specified on table 3 on page 4 of ISO 717-1: 1996 (the comparison is made between values specified for each set at each one-third octave band centre frequency over the frequency range 100Hz to 3150Hz).

The reference data must then be amplitude shifted by the same amount (in single deciBel steps) until the sum of unfavourable readings, determined from the data difference at each frequency, is as large as possible but not more than 32dB. The 500Hz value of the reference data minus the number of deciBels the reference data set has been shifted is then referred to as the Rw value for the test sample.

Note 1. An unfavourable difference (deficiency) at any frequency occurs when the test sample transmission loss is less than the value specified for the shifted reference data at the same frequency.

Note 2. The STC rating determination criterion has failure modes of -8dB at any one frequency and/or a deficiency sum of -32dB, whereas Rw has only a single failure mode, this being a -32dB deficiency summation over the pass band consisting of 100Hz to 3150Hz one-third octave bands. As a result of this, the Rw rating usually has the same numerical value as the STC rating unless the STC evaluation is a consequence of one or more -8dB deficiencies and any deficiency at 100Hz does not contribute to the Rw failure or at 4kHz to the STC failure.

8.3 C and Ctr determination

Rw corrections are accommodated in ISO 717-1:1996 to account for the type of spectra incident on the high noise side of a test sample. The correction C is applied to Rw spectra which is generated by sources such as transportation which are located close to the building element under test. Such noise sources have a wide energy distribution in their noise spectra. The correction Ctr is applied to pink noise or to spectra which is generated by sources such as transportation, located at a distance. This correction is applied to Rw where spectral energy is mostly concentrated in the low frequency end of the measurement frequency range.

Relevant Spectrum "correction" for different types of noise source
(table A.1 of ISO717-1:1996)

Type of Noise Source	Relevant Spectrum "Correction" Term
Living activities (talking, music, radio, TV) Children playing Railway traffic at medium and high speed Highway road traffic > 80km/hour Jet aircraft, short distance Factories emitting mainly medium and high frequency noise	C
Urban road traffic Railway traffic at low speeds Aircraft, propeller driven Jet aircraft, large distance Disco music Factories emitting mainly low and medium frequency noise	Ctr

9.0 Test environment

Transmission loss measurement according to the requirements of AS1191 requires the use of two reverberation rooms which conform to the acoustical performance requirements of Annex D, guidelines for the design of reverberation rooms, ISO 3741-1975 "*Acoustics - Determination of sound power levels of noise sources - Precision methods for broad-band sources in reverberation rooms*".

Each test room, designated Reverberation (send) Room and Diffuse Field (receive) Room has a volume of approximately 200 cubic metres and is individually air conditioned by a special purpose acoustically attenuated air conditioning system. During testing, the supply and return air ducts are closed off via both pneumatically and manually operated dampers. The floors have different dimensions and are pentagonally shaped. The ceilings are inclined to the plane of the floor, opposite wall surfaces are different dimensions and inclined at an angle to each other to avoid acoustical coupling between rooms and to minimise the possibility of resonance in each room.

Additional sound diffusion within each of the rooms, to meet diffusivity requirements of ISO 354 - 1985 "*Acoustics - Measurement of sound absorption in a reverberation room*" is achieved by non-parallel room surfaces together with careful placing of eight 2400mm x 1200mm randomly oriented, freely suspended panels (19mm thick plywood sheets) with a total surface area of 40 square metres. These surfaces are heavily coated with epoxy resin to minimise acoustical absorption. The panels in each room are suspended in accordance with the tuning detail of ISO 354-1985 and therefore fully comply with the requirements of Australian Standard AS1045-1988.

Acoustical absorption coefficients in each octave band for each room and its diffusers do not exceed the maximum AS1191 requirement of 0.06 and are as follows:

Acoustical Absorption Coefficients						
Frequency	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
Reverberation Room	0.02	0.01	0.02	0.03	0.04	0.06
Diffuse Field Room	0.02	0.02	0.02	0.03	0.04	0.06

Both reverberation rooms are inside separate isolating rooms, which serve as plenum chambers. This construction ensures freedom from flanking noise transmission problems even when very high acoustical sound pressure levels are generated inside either reverberation room.

The 300mm thick walls, floor and ceiling of all three rooms and plenum chambers are made from a heavily reinforced, high density concrete. The reverberation rooms are vibrationally suspended on damped, high tensile springs resting on neoprene rubber. The entire suspension assembly forms a two pole resonant suspension system, which is tuned below 5Hz.

The complete mounting system of springs, dampers and high compliance acoustical seals around the test aperture ensures negligible vibrational coupling between the reverberation rooms or interference from outside vibrational sources for all frequencies within the operating range of the two reverberation rooms. Entry to both reverberation rooms and plenum chambers is by means of double doors.

Each room size, geometry and suspended diffusers ensures that the acoustical performance characteristics fully meet requirements of Australian Standard AS1191-1985.

A sample testing space of approximately 10 square metres is located within an opening in the common wall between the plenum chambers. This wall is part of the external sound shell construction, it is not a component of either test room and effectively isolates the sample from any vibrational energy, which may be generated inside either reverberation test room.

Exposure of either side of any test sample in this test space to a sound field is achieved via apertures in each reverberation room wall which align with the opening in the common wall of the plenum chambers. Acoustical sealing at the location of the openings between the reverberation rooms and the wall holding the test sample is achieved by means of compliant, high transmission loss and vibration isolation gaskets installed between the reverberation rooms and the common wall between the plenum chambers.

When testing small samples a filler wall is constructed in the 10 square metre opening in the testing space. An aperture is made in the filler wall, the test sample is then fitted and sealed in the opening. The acoustical integrity of the fitting is then tested.

10.0 Formulae

(A) **Receive room acoustical absorption**

Sound absorption coefficients at each frequency band for the test specimen alpha (A) is determined from the reverberation time measurements according to the following equation:

$$A = \frac{0.16V}{T_{60}} \qquad \text{........(1)}$$

Where

A	=	the equivalent absorption area in the receiving room
V	=	the receive room volume (in m^3)
T_{60}	=	the receive room reverberation time (RT60)

(B) **Average sound pressure level**

Average sound pressure level (Lp) is determined for each frequency band as follows:

$$L_p = 10 Log\left[\frac{p_1^{\,2} + p_2^{\,2} + p_3^{\,2} .... + p_n^{\,2}}{np_o^{\,2}}\right] \qquad \text{........(2)}$$

Where

L_p	=	Average sound pressure level (dB)
p_n	=	sound pressure of the n^{th} measurement (Pascals)
p_o	=	reference sound pressure (Pascals)
n	=	number of measurements

(C) **Transmission Loss**

Since the sound fields in both rooms are diffuse and the environment is free of flanking transmission, sound transmission loss (R) of a test sample for each frequency band is calculated according to the following equation:

$$R = L_{ps} - L_{pr} + 10 Log\left[\frac{S}{A}\right] \qquad \text{........(3)}$$

Where

R	=	the sound transmission loss of the test sample
L_{ps}	=	the average SPL in the source room
L_{pr}	=	the average SPL in the receiving room
S	=	the area of the specimen under test
A	=	the equivalent absorption area in the receiving room

(D) Small Test Samples

Test objects comprising a small size test sample mounted in a filler wall are measured according to the small sample method discussed in standard AS1191-1985. The equations used to calculate results are as follows:

Transmission loss coefficients for the small test sample (τ_s) are determined from the difference between the filler wall transmission loss (τ_f) and the composite wall transmission loss (τ_c) according to the following equations:

$$\tau_f = 10^{-\frac{R_f}{10}} \qquad \text{.........(4)}$$

$$\tau_c = 10^{-\frac{R_c}{10}} \qquad \text{.........(5)}$$

Rearranging the equations produces the transmission loss coefficient for each frequency band as follows:

$$\tau_s = \frac{\tau_c S_c - \tau_f S_f}{S_s} \qquad \text{.........(6)}$$

Transmission loss for each frequency band (R_s) is determined from this result according to the following equation:

$$R_s = 10Log\left[\frac{1}{\tau_s}\right] \qquad \text{.........(7)}$$

Where

τ_c	=	the transmission loss coefficient of the filler wall and the small test sample
τ_f	=	the transmission loss coefficient of the filler wall
τ_s	=	the transmission loss coefficient of the small test sample for each frequency band
R_c	=	the transmission loss of the filler wall and the small test sample
R_f	=	the transmission loss of the filler wall
R_s	=	the transmission loss of the small test sample for each frequency band
S_c	=	the surface area of the composite wall
S_f	=	the surface area of the filler wall
S_s	=	the surface area of the wall mounted small test sample

(E) Errors

Errors (95% confidence level) are determined for each frequency band by means of the following equation:

$$Error(95\%confidence) = \frac{t.sd}{\sqrt{n}} \qquad \text{.........(8)}$$

Where

n	=	the number of microphone positions sampled
t	=	the students t factor
sd	=	the standard deviation obtained from the measurement spreadsheet

11.0 Instrumentation

The following instrumentation is used for acoustical transmission loss measurements. Instrumentation calibration where appropriate has been calibrated according to NATA requirements.

Brüel and Kjaer two channel pulse analyser (assembly 2825, 7521, 2 x 3015), S/N 2005502
Brüel and Kjaer Cathode Follower type 2639, S/N 1448239 & S/N 1391974
Brüel and Kjaer Cathode Follower type 2660, S/N 1337994 & S/N 1338051
Brüel and Kjaer Cathode Follower type 2669, S/N 1888716 & S/N 1834203
Brüel and Kjaer Microphone type 4144, S/N 563123, S/N 1138528, S/N 439142 & S/N 2118354
Brüel and Kjaer Microphone type 4179, S/N 2245299, S/N 2245300 & S/N 2245154
Brüel and Kjaer Sound Level Calibrator type 4231, S/N 2095393
Yamaha Professional Sound Sources type S500, S/N 1068 and S/N 1069
Murray 100 Watt Amplifier type MA534, S/N 15
Vaisala Digital Barometer type PTB201AD, S/N R3330001
Testo Temperature/Humidity Logger, type 177-H1, S/N 00886924

ATF Report 1547

Client Name: REHAU

Test Conditions:

Date Of Test 9-Aug-2004

Total Area Under Test (Sq m):	9.97	Barometric Air Pressure (hPa)	1016
Temperature (C):	18.8	Relative Humidity SR (%)	65.4
Receive Room Volume (Cu m):	200	Relative Humidity RR (%)	65.4
Speed of Sound (m/s):	342.16		

Testing Officer: Peter Alway

FILLER WALL ONLY

Frequency	Mean SEND Room SPL (dB)	Std Dev	Mean RECEIVE Room SPL (dB)	Std Dev	Difference with Mic Response Corrections	Mean Receive Room Reverb RT_{60} (seconds)	Receive Room Absorption	10*log (S/A)	Std Dev	Frequency	Calculated 1/3 Octave Transmission Loss (dB)	Precision 95% Confidence Interval (dB)	Frequency	Calculated 1/1 Octave Transmission Loss (dB)
50 Hz	80.50	1.90	51.45	5.87	29.06	3.42	9.35	0.28	0.87	50 Hz	29.336	3.82		
63 Hz	80.61	3.45	44.80	3.22	35.80	2.84	11.28	-0.54	0.73	63 Hz	35.288	3.04	63 Hz	33.048
80 Hz	80.47	2.04	39.69	2.10	40.78	3.19	10.04	-0.03	0.77	80 Hz	40.747	1.82		
100 Hz	87.15	1.51	38.25	2.36	48.90	4.52	7.08	1.49	0.41	100 Hz	50.390	1.74		
125 Hz	88.00	1.84	31.36	1.16	56.63	5.12	6.25	2.03	0.43	125 Hz	58.656	1.30	125 Hz	55.416
160 Hz	87.17	1.29	30.24	0.91	56.94	6.09	5.28	2.78	0.30	160 Hz	59.715	1.01		
200 Hz	87.95	0.97	26.17	1.20	61.78	6.88	4.65	3.31	0.42	200 Hz	65.092	1.02		
250 Hz	88.54	0.63	21.09	0.36	67.45	7.36	4.35	3.60	0.31	250 Hz	71.056	0.81	250 Hz	69.214
315 Hz	88.83	0.56	19.99	0.62	68.84	8.18	3.91	4.06	0.27	315 Hz	72.903	0.56		
400 Hz	91.65	0.43	19.88	0.30	71.77	7.71	4.15	3.80	0.17	400 Hz	75.572	0.35		
500 Hz	92.88	0.33	19.09	0.31	73.79	7.66	4.18	3.78	0.09	500 Hz	77.569	0.30	500 Hz	77.402
630 Hz	91.50	0.32	15.05	0.81	76.45	7.08	4.52	3.44	0.19	630 Hz	79.887	0.45		
800 Hz	91.94	0.35	11.54	0.39	80.40	6.47	4.95	3.04	0.13	800 Hz	83.444	0.34		
1000 Hz	95.27	0.36	12.48	0.41	82.79	6.30	5.08	2.93	0.14	1000 Hz	85.720	0.40	1000 Hz	87.043
1250 Hz	98.56	0.36	12.12	0.21	86.24	5.74	5.58	2.52	0.14	1250 Hz	88.759	0.31		
1600 Hz	100.63	0.35	11.61	0.38	88.54	4.80	6.66	1.75	0.09	1600 Hz	90.289	0.37		
2000 Hz	99.40	0.39	9.67	0.37	89.10	3.98	8.04	0.93	0.10	2000 Hz	90.029	0.39	2000 Hz	90.451
2500 Hz	98.32	0.35	11.05	0.16	85.91	3.17	10.11	-0.08	0.09	2500 Hz	85.850	0.35		
3150 Hz	97.55	0.41	8.58	0.30	87.13	2.55	12.56	-1.00	0.12	3150 Hz	86.122	0.36		
4000 Hz	98.03	0.46	2.03	0.31	93.24	2.18	14.70	-1.69	0.05	4000 Hz	91.559	0.42	4000 Hz	91.891
5000 Hz	97.69	0.47	-4.02	0.26	97.81	1.85	17.32	-2.40	0.10	5000 Hz	95.410	0.44		
6300 Hz	96.00	0.42	-5.22	0.82	96.10	1.77	18.07	-2.58	0.08	6300 Hz	93.515	0.72		
8000 Hz	96.00	0.36	-8.40	0.04	98.71	1.87	17.08	-2.34	0.09	8000 Hz	96.376	0.55	8000 Hz	99.251
10000 Hz	90.30	0.69	-7.36	0.10	93.52	1.88	17.01	-2.32	0.41	10000 Hz	91.199	0.79		

Material Under Test:
Filler wall for window test program August 2004

Arithmetic Average of Transmission Loss From 100hz to 5kHz

Unweighted Average	A-Weighted Average
78	74

Results (Incorporating AS1191-1985 Compliant Measurements)

Frequency		Rounded 1/3 octave Transmission Loss Values (dB)	STC 80 Curve	Transmission Loss to STC Difference
50		29		
63		35		
80		41		
100	(AS1191)	50		
125	(AS1191)	59	64	-5
160	(AS1191)	60	67	-7
200	(AS1191)	65	70	-5
250	(AS1191)	71	73	-2
315	(AS1191)	73	76	-3
400	(AS1191)	76	79	-3
500	(AS1191)	78	80	-2
630	(AS1191)	80	81	-1
800	(AS1191)	83	82	-
1000	(AS1191)	86	83	-
1250	(AS1191)	89	84	-
1600	(AS1191)	90	84	-
2000	(AS1191)	90	84	-
2500	(AS1191)	86	84	-
3150	(AS1191)	86	84	-
4000	(AS1191)	92	84	-
5000	(AS1191)	95		Sum -28
6300		94		
8000		96		
10000		91		

The Sound Transmission Class Of This Sample Is:

STC 80

OITC Rating

Frequency	Normalised A-Weighted Reference Noise Spectrum (dB)	Sound Energy (W/m2)
80 Hz	-19.6	8.710E-07
100 Hz	-17.2	1.905E-07
125 Hz	-15.2	3.802E-08
160 Hz	-15.5	2.818E-08
200 Hz	-14	1.259E-08
250 Hz	-13.7	3.388E-09
315 Hz	-12.7	2.692E-09
400 Hz	-11.9	1.622E-09
500 Hz	-10.3	1.479E-09
630 Hz	-11	7.943E-10
800 Hz	-10.9	4.074E-10
1000 Hz	-11.1	1.950E-10
1250 Hz	-10.5	1.122E-10
1600 Hz	-11.1	7.762E-11
2000 Hz	-10.9	8.128E-11
2500 Hz	-11.8	1.660E-10
3150 Hz	-13.9	1.023E-10
4000 Hz	-15.1	1.950E-11
	Sum	1.151E-06
	-10*LOG(Sum)	59.39

The Outdoor Indoor Transmission Class Is:

OITC 59

1/1 Octave

Frequency	Rounded 1/1 octave Transmission Loss Values (dB)
63 Hz	33
125 Hz	55
250 Hz	69
500 Hz	77
1000 Hz	87
2000 Hz	91
4000 Hz	92
8000 Hz	99

R_w Rating

R_W = 79

C_T = -4

C_{TR} = -10

$C_{T(50-5000)}$ = -12

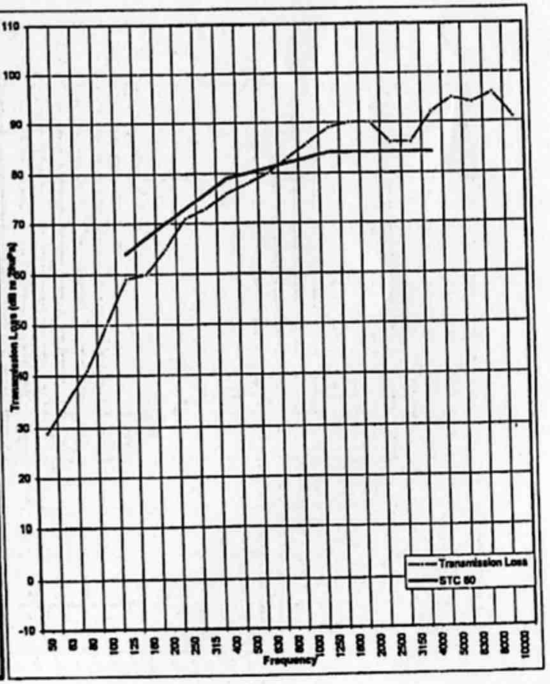
$C_{TR(50-5000)}$ = -27

$R_w(C_T; C_{TR})$ is:

79 (-4 ; -10)

$R_w(C_T; C_{TR}; C_{50-5000}; C_{TR,50-5000})$ is:

79 (-4 ; -10 ; -12 ; -27)



Signatory: ....

Peter Alway.

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Date: 30/8/04

ATF Report 1549

Client Name: REHAU

Test Conditions:

Date Of Test	10-Aug-2004
Total Area Under Test (Sq m):	9.97
Temperature (C):	18.6
Receive Room Volume (Cu m):	200
Speed of Sound (m/s):	342.16
Barometric Air Pressure (hPa)	1010
Relative Humidity SR (%)	48.8
Relative Humidity RR (%)	48.8

Testing Officer: Peter Alway

FILLER WALL + SAMPLE

Frequency	Mean SEND Room SPL (dB)	Std Dev	Mean RECEIVE Room SPL (dB)	Std Dev	Difference with Mic Response Corrections	Mean Receive Room Reverb RT_{60} (seconds)	Receive Room Absorption	10*log (S/A)	Std Dev	Frequency	Calculated 1/3 Octave Transmission Loss (dB)	Precision 95% Confidence Interval (dB)	Frequency	Calculated 1/1 Octave Transmission Loss (dB)
50 Hz	83.72	1.82	49.11	3.59	34.61	2.75	11.64	-0.67	0.97	50 Hz	33.835	2.84		
63 Hz	82.79	3.52	43.03	3.54	39.76	2.58	12.38	-0.94	0.75	63 Hz	38.820	3.20	63 Hz	35.602
80 Hz	81.26	2.10	45.78	2.95	35.48	2.91	11.01	-0.43	0.77	80 Hz	35.046	2.35		
100 Hz	86.91	1.85	55.39	3.25	31.52	3.49	9.17	0.36	0.41	100 Hz	31.885	1.79		
125 Hz	88.05	1.06	54.47	2.18	33.58	4.14	7.73	1.10	0.43	125 Hz	34.679	1.65	125 Hz	34.149
160 Hz	85.73	1.31	54.38	2.04	31.35	5.00	6.40	1.92	0.30	160 Hz	33.271	1.55		
200 Hz	85.10	1.25	51.29	1.09	33.81	5.94	5.38	2.66	0.42	200 Hz	36.483	1.06		
250 Hz	85.35	0.70	48.42	0.89	36.93	7.15	4.48	3.48	0.31	250 Hz	40.408	0.75	250 Hz	38.950
315 Hz	84.36	0.44	48.00	0.34	36.36	7.17	4.46	3.49	0.27	315 Hz	39.852	0.39		
400 Hz	86.20	0.33	48.18	0.83	38.02	7.42	4.31	3.64	0.17	400 Hz	41.657	0.41		
500 Hz	86.45	0.44	47.98	0.25	38.47	7.60	4.21	3.74	0.06	500 Hz	42.216	0.36	500 Hz	42.288
630 Hz	84.25	0.48	44.57	0.32	39.67	6.97	4.59	3.36	0.18	630 Hz	43.039	0.38		
800 Hz	83.48	0.38	42.72	0.22	40.76	6.30	5.08	2.93	0.13	800 Hz	43.688	0.29		
1000 Hz	85.35	0.50	45.09	0.29	40.26	5.97	5.36	2.69	0.14	1000 Hz	42.953	0.42	1000 Hz	42.785
1250 Hz	87.67	0.40	48.32	0.23	39.14	5.52	5.80	2.35	0.14	1250 Hz	41.492	0.33		
1600 Hz	88.72	0.43	48.36	0.23	39.87	4.56	7.01	1.53	0.09	1600 Hz	41.402	0.35		
2000 Hz	86.60	0.36	42.95	0.27	43.02	3.85	8.31	0.79	0.10	2000 Hz	43.809	0.35	2000 Hz	43.657
2500 Hz	85.27	0.29	37.66	0.37	46.25	3.24	9.88	0.04	0.08	2500 Hz	46.293	0.38		
3150 Hz	84.03	0.43	34.26	0.42	47.93	2.78	11.51	-0.63	0.12	3150 Hz	47.303	0.43		
4000 Hz	83.32	0.65	28.32	0.40	52.25	2.30	13.94	-1.45	0.05	4000 Hz	50.798	0.54	4000 Hz	51.935
5000 Hz	81.91	0.61	20.56	0.98	57.45	1.87	17.08	-2.34	0.10	5000 Hz	55.114	0.80		
6300 Hz	79.25	0.75	12.54	0.53	61.58	1.45	22.03	-3.44	0.09	6300 Hz	58.139	0.66		
8000 Hz	79.05	0.76	9.05	0.68	64.31	1.09	29.26	-4.68	0.06	8000 Hz	59.637	0.82	8000 Hz	64.255
10000 Hz	71.71	1.05	6.47	0.06	61.10	0.87	36.73	-5.66	0.41	10000 Hz	55.438	0.94		

Material Under Test:
60mm tilt and turn window with steel reinforcing
10.38mm glass

Arithmetic Average of Transmission Loss From 100hz to 5kHz

Unweighted Average	A-Weighted Average
42	38

Results (Incorporating AS1191-1985 Compliant Measurements)

Frequency		Rounded 1/3 octave Transmission Loss Values (dB)	STC 44 Curve	Transmission Loss to STC Difference
50		34		
63		39		
80		35		
100	(AS1191)	32		
125	(AS1191)	35	28	-
160	(AS1191)	33	31	-
200	(AS1191)	36	34	-
250	(AS1191)	40	37	-
315	(AS1191)	40	40	-
400	(AS1191)	42	43	-1
500	(AS1191)	42	44	-2
630	(AS1191)	43	45	-2
800	(AS1191)	44	46	-2
1000	(AS1191)	43	47	-4
1250	(AS1191)	41	48	-7
1600	(AS1191)	41	48	-7
2000	(AS1191)	44	48	-4
2500	(AS1191)	46	48	-2
3150	(AS1191)	47	48	-1
4000	(AS1191)	51	48	-
5000	(AS1191)	65		Sum
6300		58		-32
8000		60		
10000		55		

The Sound Transmission Class Of This Sample Is:

STC 44

OITC Rating

Frequency	Normalised A-Weighted Reference Noise Spectrum (dB)	Sound Energy (W/m2)
80 Hz	-19.6	3.467E-06
100 Hz	-17.2	1.202E-05
125 Hz	-15.2	9.550E-06
160 Hz	-15.5	1.413E-05
200 Hz	-14	1.000E-05
250 Hz	-13.7	4.266E-06
315 Hz	-12.7	5.370E-06
400 Hz	-11.9	4.074E-06
500 Hz	-10.3	5.888E-06
630 Hz	-11	3.981E-06
800 Hz	-10.9	3.236E-06
1000 Hz	-11.1	3.890E-06
1250 Hz	-10.5	7.079E-06
1600 Hz	-11.1	6.166E-06
2000 Hz	-10.9	3.236E-06
2500 Hz	-11.8	1.660E-06
3150 Hz	-13.9	8.128E-07
4000 Hz	-15.1	2.455E-07
	Sum	9.907E-05
	-10*LOG(Sum)	40.04

The Outdoor Indoor Transmission Class Is:

OITC 40

1/1 Octave

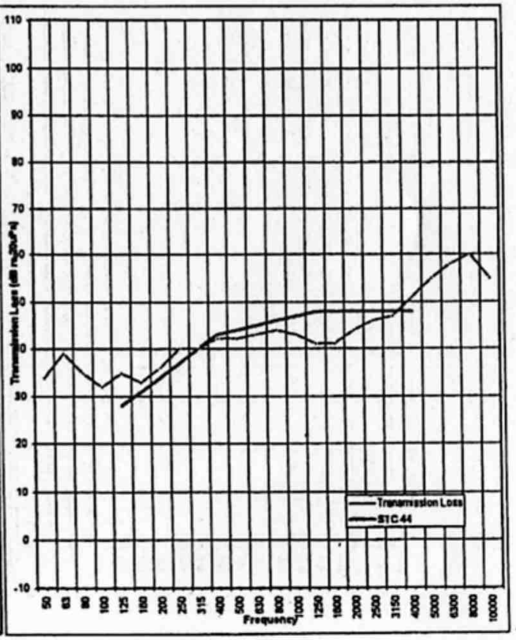
Frequency	Rounded 1/1 octave Transmission Loss Values (dB)
63 Hz	36
125 Hz	34
250 Hz	39
500 Hz	42
1000 Hz	43
2000 Hz	44
4000 Hz	52
8000 Hz	64

R_w Rating

R_W =	44
C_T =	-1
C_{TR} =	-3
$C_{T\,(50-5000)}$ =	0
$C_{TR\,(50-5000)}$ =	-3

$R_W(C_T; C_{TR})$ is:
44 (-1 ; -3)

$R_W(C_T; C_{TR}; C_{T(50-5000)}; C_{TR(50-5000)})$ is:
44 (-1 ; -3 ; 0 ; -3)



Signatory: ....
Peter Alway.

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Date: 30.8.04

ATF Report 1549

SAMPLE ONLY

Client Name: REHAU

Test Conditions:

Date Of Test
10-Aug-2004

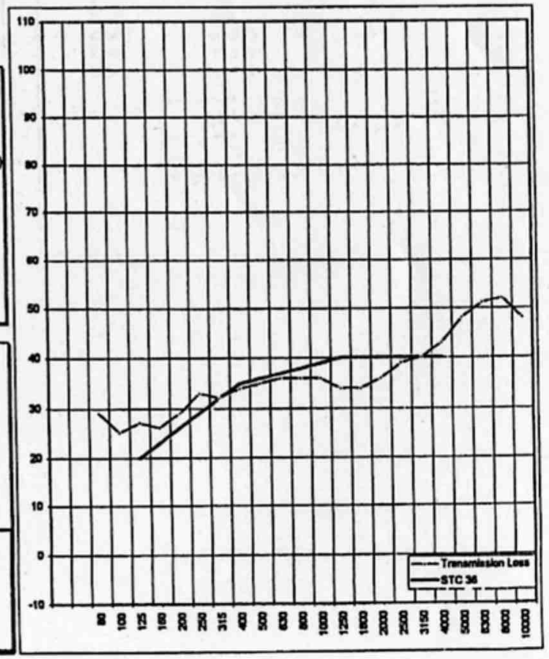
Surface Area Of Test Sample (Sq m): 1.811
Surface Area Of Remaining Filler Wall: 8.159
Total Surface Area Of Test Aperture: 9.97

Sample Under Test:
60mm tilt and turn window with steel reinforcing
10.38mm glass

Frequency	Filler Wall Transmission Loss (dB)	Std Dev	Filler Wall + Sample Transmission Loss	Std Dev	Transmission Coefficient of Filler Wall (τ_f)	Transmission Coefficient of Filler Wall + Sample (τ_c)	Transmission Coefficient of Sample (τ_s)	$1/\tau_s$	Frequency	Calculated 1/3 Octave Transmission Loss (dB)	Precision 95% Confidence Interval (dB)	Frequency	Calculated 1/1 Octave Transmission Loss (dB)
80 Hz	40.75	1.82	35.05	2.35	8.41893E-05	0.000312906	0.001343331	744.42	80 Hz	28.718	3.04		
100 Hz	50.39	1.74	31.89	1.76	9.14024E-06	0.000647839	0.003525333	283.66	100 Hz	24.528	2.48		
125 Hz	56.66	1.30	34.68	1.30	1.36256E-06	0.000340451	0.001868126	535.30	125 Hz	27.286	2.03	125 Hz	26.767
160 Hz	59.71	1.01	33.27	1.55	1.06785E-06	0.000470864	0.002587411	386.49	160 Hz	25.871	1.85		
200 Hz	65.09	1.02	36.48	1.06	3.0963E-07	0.000224742	0.001235665	809.15	200 Hz	29.080	1.46		
250 Hz	71.06	0.51	40.41	0.75	7.84211E-08	9.10253E-05	0.000500764	1996.95	250 Hz	33.004	0.91	250 Hz	31.545
315 Hz	72.90	0.56	39.85	0.39	5.12551E-08	0.000103484	0.000569363	1756.35	315 Hz	32.446	0.66		
400 Hz	75.57	0.35	41.66	0.41	2.7719E-08	6.82851E-05	0.000375802	2660.98	400 Hz	34.250	0.54		
500 Hz	77.57	0.30	42.22	0.36	1.75038E-08	6.00389E-05	0.00033045	3026.18	500 Hz	34.809	0.47	500 Hz	34.880
630 Hz	79.89	0.43	43.04	0.36	1.0264E-08	4.96884E-05	0.000273391	3657.77	630 Hz	35.632	0.59		
800 Hz	83.44	0.34	43.69	0.29	4.52514E-09	4.27762E-05	0.000235473	4246.77	800 Hz	36.281	0.45		
1000 Hz	85.72	0.40	42.95	0.42	2.67936E-09	5.06675E-05	0.000278925	3585.19	1000 Hz	35.545	0.58	1000 Hz	35.377
1250 Hz	88.76	0.31	41.49	0.33	1.33081E-09	7.09263E-05	0.000390472	2561.00	1250 Hz	34.084	0.48		
1600 Hz	90.29	0.37	41.40	0.33	9.35542E-10	7.24159E-05	0.000398663	2508.38	1600 Hz	33.994	0.51		
2000 Hz	90.03	0.39	43.81	0.35	9.93281E-10	4.16046E-05	0.000229039	4366.07	2000 Hz	36.401	0.52	2000 Hz	36.250
2500 Hz	85.85	0.35	46.29	0.36	2.60011E-09	2.34793E-05	0.000129248	7737.08	2500 Hz	38.886	0.52		
3150 Hz	86.12	0.38	47.30	0.43	2.44234E-09	1.86064E-05	0.000102422	9763.54	3150 Hz	39.896	0.57		
4000 Hz	91.56	0.42	50.80	0.54	6.98391E-10	8.32523E-06	4.58293E-05	21820.10	4000 Hz	43.389	0.88	4000 Hz	44.528
5000 Hz	95.41	0.44	55.11	0.60	2.87732E-10	3.08018E-06	1.69558E-05	58976.75	5000 Hz	47.707	0.75		
6300 Hz	93.52	0.72	58.14	0.86	4.45093E-10	1.53498E-06	8.44846E-06	118364.81	6300 Hz	50.732	0.96		
8000 Hz	96.38	0.65	59.64	0.82	2.30338E-10	1.08711E-06	5.96375E-06	167119.29	8000 Hz	52.230	0.99	8000 Hz	56.849
10000 Hz	91.20	0.79	55.44	0.94	7.58718E-10	2.8588E-06	1.5735E-05	63552.70	10000 Hz	48.031	1.22		

Arithmetic Average of Transmission Loss From 100hz to 5kHz

Unweighted Average	A-Weighted Average
35	30



Results (Incorporating AS1191-1985 Compliant Measurements)

Frequency		Rounded 1/3 octave Transmission Loss Values (dB)	STC 36 Curve	Transmission Loss to STC Difference
80		29		
100	(AS1191)	25		
125	(AS1191)	27	20	-
160	(AS1191)	26	23	-
200	(AS1191)	29	26	-
250	(AS1191)	33	29	-
315	(AS1191)	32	32	-
400	(AS1191)	34	35	-1
500	(AS1191)	35	36	-1
630	(AS1191)	36	37	-1
800	(AS1191)	36	38	-2
1000	(AS1191)	36	39	-3
1250	(AS1191)	34	40	-6
1600	(AS1191)	34	40	-6
2000	(AS1191)	36	40	-4
2500	(AS1191)	39	40	-1
3150	(AS1191)	40	40	-
4000	(AS1191)	43	40	-
5000	(AS1191)	48		Sum -25
6300		51		
8000		52		
10000		48		

The Sound Transmission Class Of This Sample is:

STC 36

OITC Rating

Frequency	Normalised A-Weighted Reference Noise Spectrum (dB)	Sound Energy (W/m2)
80 Hz	-19.6	1.380E-05
100 Hz	-17.2	6.026E-05
125 Hz	-15.2	6.026E-05
160 Hz	-15.5	7.079E-05
200 Hz	-14	5.012E-05
250 Hz	-13.7	2.138E-05
315 Hz	-12.7	3.388E-05
400 Hz	-11.9	2.570E-05
500 Hz	-10.3	2.951E-05
630 Hz	-11	1.995E-05
800 Hz	-10.9	2.042E-05
1000 Hz	-11.1	1.950E-05
1250 Hz	-10.5	3.548E-05
1600 Hz	-11.1	3.090E-05
2000 Hz	-10.9	2.042E-05
2500 Hz	-11.6	8.318E-06
3150 Hz	-13.9	4.074E-06
4000 Hz	-15.1	1.549E-06
	Sum	5.263E-04
	-10*LOG(Sum)	32.79

The Outdoor Indoor Transmission Class Is:

OITC 33

1/1 Octave

Frequency	Rounded 1/1 octave Transmission Loss Values (dB)
125 Hz	27
250 Hz	32
500 Hz	35
1000 Hz	35
2000 Hz	36
4000 Hz	45
8000 Hz	57

R_w Rating

R_W = 36

C_T = -1

C_{TR} = -2

R_w(C_T ; C_{TR}) is

36 (-1 ; -2)

ATF 1549 Window Transmission Loss August 2004.xls/Sample Results

Signatory: [signature]

Peter Alway.

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Date: 30, 8, 04

ATF Report 1549	Date Of Test 10-Aug-2004

R_W Calculation Spreadsheet

R_W = 36

Frequency (Hz)	Transmission Loss R_i (Rounded down to 1 significant figure)	Rw 36 Curve	Transmission Loss to R_W Difference
100	24.5	17	-
125	27.3	20	-
160	25.9	23	-
200	29.1	26	-
250	33	29	-
315	32.4	32	-
400	34.3	35	-0.7
500	34.8	36	-1.2
630	35.6	37	-1.4
800	36.3	38	-1.7
1000	35.5	39	-3.5
1250	34.1	40	-5.9
1600	34	40	-6
2000	36.4	40	-3.6
2500	38.9	40	-1.1
3150	39.9	40	-0.1
		SUM	-25.2

Determination Of Correction C

C spectrum (ISO 717-P7) L_{i1}	L_{i1}-R_i	10^((L_{i1}-R_i)/10)
-29	-53.50	4.467E-06
-26	-53.30	4.677E-06
-23	-48.90	1.288E-05
-21	-50.10	9.772E-06
-19	-52.00	6.310E-06
-17	-49.40	1.148E-05
-15	-49.30	1.175E-05
-13	-47.80	1.660E-05
-12	-47.60	1.738E-05
-11	-47.30	1.862E-05
-10	-45.50	2.818E-05
-9	-43.10	4.898E-05
-9	-43.00	5.012E-05
-9	-45.40	2.884E-05
-9	-47.90	1.622E-05
-9	-48.90	1.288E-05
	SUM	2.992E-04
	10*Log (SUM)	35.24
	C =	-1

Determination Of Correction CTR

C_{tr} spectrum (ISO717-P7) L_{i2}	L_{i2}-R_i	10^((L_{i2}-R_i)/10)
-20	-44.50	3.548E-05
-20	-47.30	1.862E-05
-18	-43.90	4.074E-05
-16	-45.10	3.090E-05
-15	-48.00	1.585E-05
-14	-46.40	2.291E-05
-13	-47.30	1.862E-05
-12	-46.80	2.089E-05
-11	-46.60	2.188E-05
-9	-45.30	2.951E-05
-8	-43.50	4.467E-05
-9	-43.10	4.898E-05
-10	-44.00	3.981E-05
-11	-47.40	1.820E-05
-13	-51.90	6.457E-06
-15	-54.90	3.236E-06
	SUM	4.168E-04
	10*Log (SUM)	33.80
	C_{TR}=	-2

Determination Of Arithmetic Average Of Transmission Loss

Frequency (Hz)	Calculated Transmission Loss	A-Weighting Correction	A-weighted Transmission Loss
100	24.528	-19.1	5.428
125	27.286	-16.1	11.186
160	25.871	-13.4	12.471
200	29.080	-10.9	18.180
250	33.004	-8.6	24.404
315	32.446	-6.6	25.846
400	34.250	-4.8	29.450
500	34.809	-3.2	31.609
630	35.632	-1.9	33.732
800	36.281	-0.8	35.481
1000	35.545	0	35.545
1250	34.084	0.6	34.684
1600	33.994	1	34.994
2000	36.401	1.2	37.601
2500	38.886	1.3	40.186
3150	39.896	1.2	41.096
4000	43.389	1	44.389
5000	47.707	0.5	48.207
Average =	34.616	A-weighted Average =	30.249
Rounded	35	Rounded	30

Signatory.......................................

Peter Alway.

Date: 30 / 8 / 04

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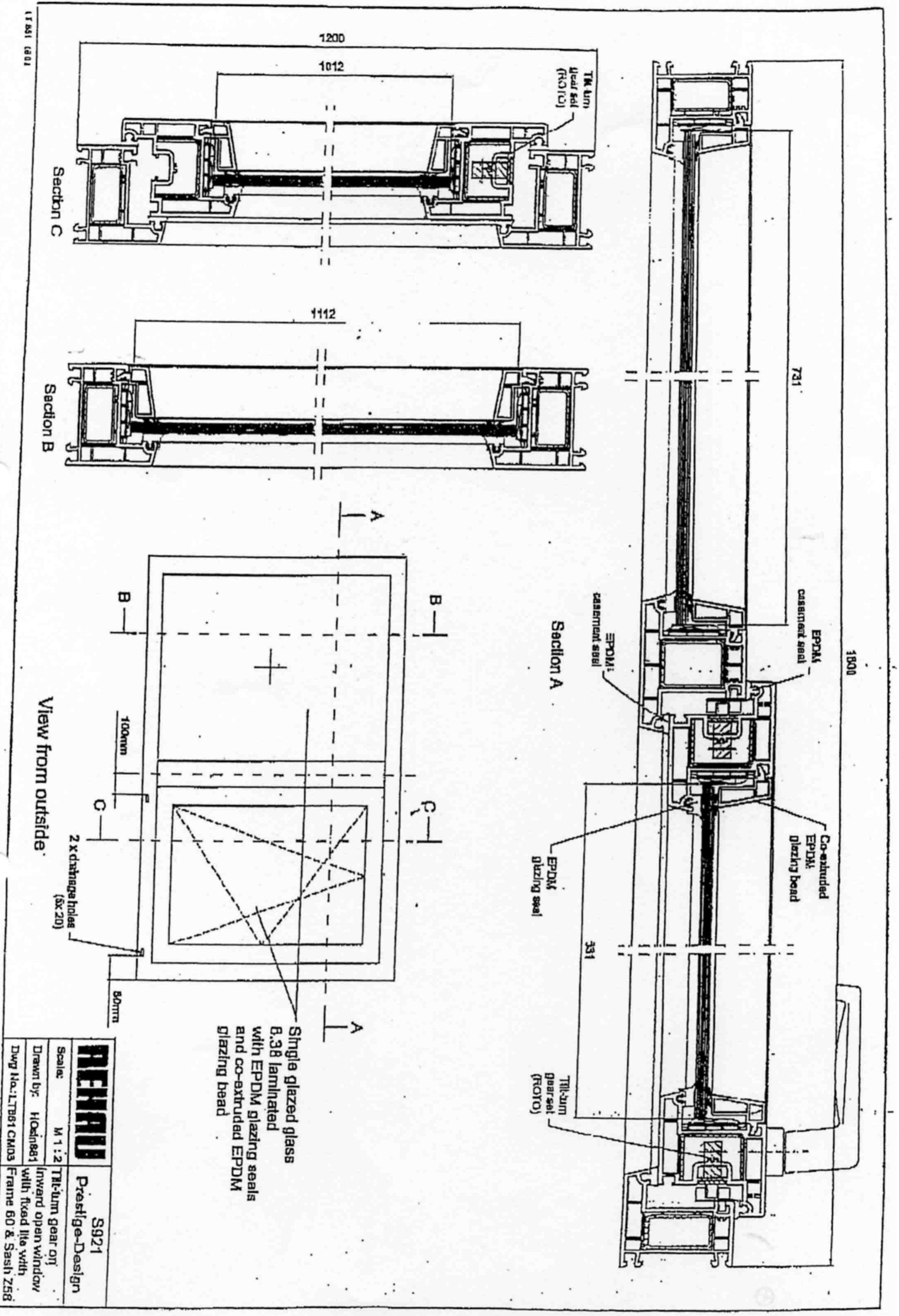

Signatory: [signature]

Peter Alway

Appendix: Rehau

Date: 30/8/04