Sound insulation

1 Introduction

This report provides the procedure and results of the acoustic tests carried out by Arup Acoustics at the above development on 24/3/11.

The purpose of these tests was to determine the acoustic performance of a selection of existing constructions, to help inform the acoustic design of the proposed new hotel and spa. The building was in a poor state of repair at the time of the tests, and so the scope of the tests was limited (ie tests can only be carried out between complete rooms). However, a number of suitable areas were found and it was possible to test the following:

- Airborne sound insulation of a section of the following floors: 3rd floor (rear), 2nd floor (front), 2nd floor (rear), 1st floor (front). It was not possible to test the 4th floor as it was in a very poor condition.
- Airborne sound insulation of one wall on the 2nd floor and one wall on the 1st floor (both at the front of the building).
- Impact sound insulation of a section of floor on the 2nd floor (front).

The results of these tests have been considered and initial advice on remedial/upgrading works has been provided.

2 Acoustic tests

2.1 Airborne sound insulation (walls and floors)

The measurements were carried out in general accordance with BS EN ISO 140-4:1998, Part 4: “Field measurements of airborne sound insulation between rooms”.

'Pink' noise was played on a loudspeaker in the ‘source’ room and the 1/3 octave band sound levels (centre frequencies 50 Hz to 5000 Hz) were measured in the ‘source’ and ‘receiver’ rooms. This process was carried out with the loudspeaker located in two positions in the source room. The measurements in the source room were taken using the moving microphone technique, and were taken in the receiver room at six fixed microphone positions (for each loudspeaker location).

The background noise levels (minimum of two positions) and reverberation times (minimum of six positions) were also measured in the receiver rooms.

The results of the measurements were post-processed to determine the R'_w values, in accordance with BS EN ISO 717-1:1997, Part 1: “Airborne sound insulation”.

2.2 Impact sound insulation (floors)

Measurements were carried out in accordance with BS EN ISO 140-7:1998, Part 7: "Field measurements of impact sound insulation of floors".

A standard Tapping Machine was placed on the floor of the ‘source’ room, and the resultant impact sound pressure level was measured in the ‘receiver’ room in third octave bands with centre frequencies from 50Hz to 5000Hz. A total of four tapping machine positions and six measurement positions were used, the mean of these was computed for each 1/3 octave frequency band.

The background noise level and reverberation times were measured in the ‘receiver’ room as discussed in Section 1.1.1 above.

The weighted standardised impact sound pressure level $L'_{nT,w}$ was then computed in accordance with BS EN ISO 717-2:1997, Part 2:”Impact sound insulation”.

2.3 Equipment

The main items of equipment were as follows:

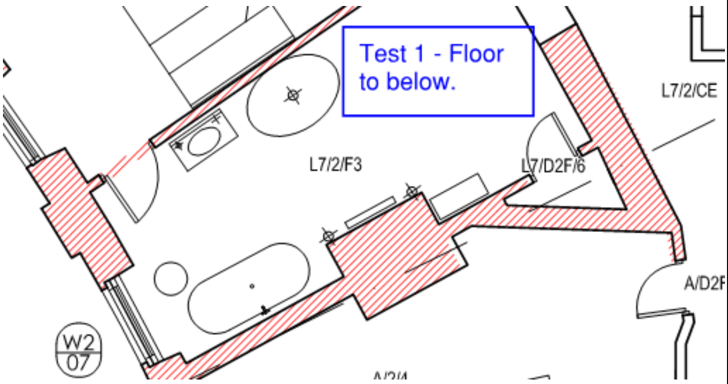
- Brüel & Kjær 2260 Investigator
- Brüel & Kjær 4231 Calibrator
- JBL EON 15 G2 Active Loudspeaker
- Neutrik MR1 noise source
- Norsonics Nor221A Tapping Machine

2.4 Constructions, test locations and criteria

The test locations and constructions are summarised in Table 1. The floor constructions are from AECOM drawings 60029979: sk 632, sk 634, sk 633 and sk 630. We understand that these drawings are based on an inspection of a small number of floors at the Old Hall Hotel end of the crescent (ie the opposite end of the crescent to the location of the acoustic tests) and so should only be treated for guidance, as the actual floors tested could vary significantly.

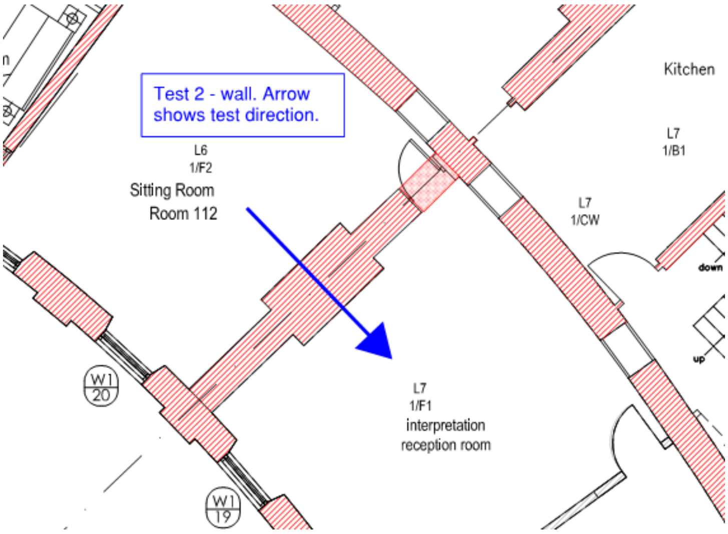
Test 1 (floor) - 2nd floor (front)

Office-type carpet (approx 4mm thick), 22mm floor boards on joists, approx 25mm of plaster pugging between the joists on 10mm timber boards. Cavity of around 350mm and a lath and plaster ceiling (approx 25mm thick) supported on separate joists.



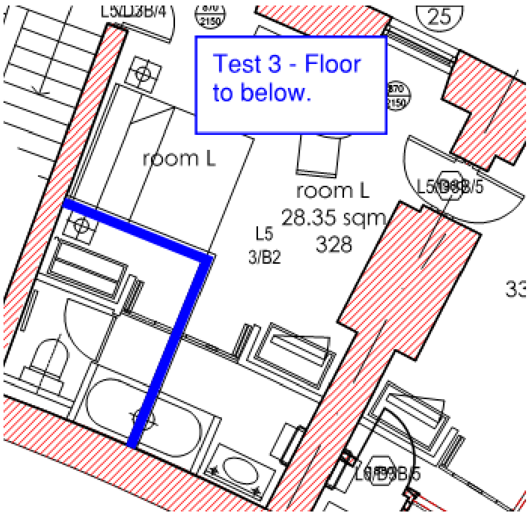
Test 2 (wall) - 2nd floor (front)

This wall appeared to be solid brickwork (approximately 600mm thick), plastered on both sides. It had back to back fireplaces, the fireplace on the 'source' room side of the wall was open and the fireplace on the 'receiver' room side of the wall had been enclosed.



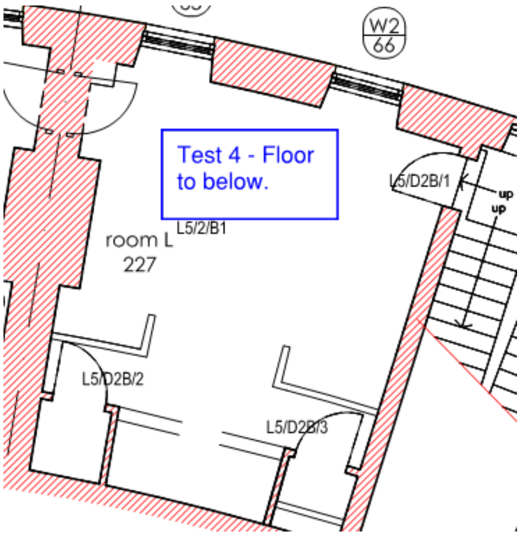
Test 3 (floor) - 3rd floor (rear)

Office-type carpet (approx 4mm thick), 22mm floor boards on joists. Cavity of around 300mm and a lath and plaster ceiling (approx 25mm thick) supported on separate joists.



Test 4 (floor) - 2nd floor (rear)

Office-type carpet (approx 4mm thick), 22mm floor boards on joists. Cavity of around 190mm and a lath and plaster ceiling (approx 25mm thick) supported on separate joists.



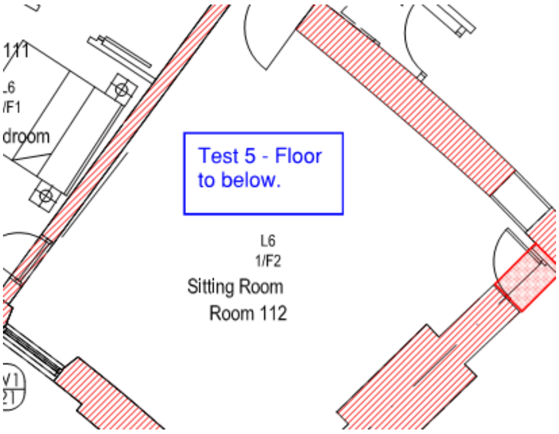
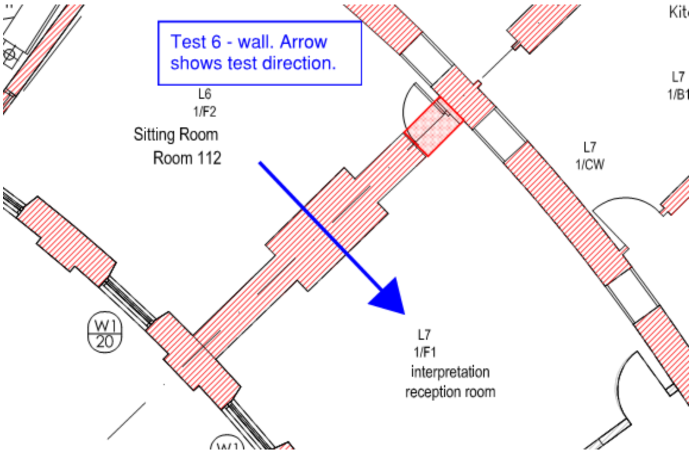
Test 5 (floor) - 1st floor (front) Office-type carpet (approx 4mm thick), 22mm floor boards on joists, approx 25mm of plaster pugging between the joists on 10mm timber boards. Cavity in excess of 1m and a lath and plaster ceiling (approx 25mm thick) supported on separate joists.	
Test 6 (wall) – 1st floor (front) This wall appeared to be solid brickwork (approximately 600mm thick), plastered on both sides. It had back to back fireplaces, the fireplace on the 'receiver' room side of the wall was open and the fireplace on the 'source' room side of the wall had been enclosed.	

Table 1 – Test locations and likely constructions

The proposed sound insulation criteria are discussed in our report of 25/2/11, and the relevant airborne sound insulation criteria for floors have been marked on Figure 1 below. Generally the proposed standard is $\geq R'_{w}55$ & $\leq 50dBL'_{nT,w}$ between Guestrooms, and $\geq R'_{w}60$ & $\leq 55dBL'_{nT,w}$ between Guestrooms and other areas (restaurant, retail units etc).

2.5 Results

2.5.1 Airborne sound insulation

The detailed results of the airborne sound insulation tests have been plotted on the graphs attached. The following table summarises the test results and compares them to the proposed standards. Also, any subjective observations made whilst carrying out the tests have been included.

Test	Test element	Result R'_w	Proposed standard R'_w	Comments
1	Floor 2nd floor (front)	54dB	55dB (Guestroom to Guestroom) 60dB (Guestroom to other area)	Marginally fails to achieve the 55dB requirement, but significantly fails to achieve the 60dB requirement. Sound leakage noted via radiator pipework (which appeared to be common to rooms above and below the floor), and a small amount of flanking was noted via the wall to the Grand Staircase.
2	Wall 2nd floor (front)	55dB	55dB	Just achieves the requirement. Sound leakage noted via radiator pipework (which appeared to be common to rooms on both sides of the wall).
3	Floor 3rd floor (rear)	48dB	55dB	Significantly fails to achieve the requirement. The floor subjectively appeared to be the weakest element. Some leakage was noted via radiator pipework (as Test 1), and the doors (it was not possible to fully close the door to the receiver room).
4	Floor 2nd floor (rear)	54dB	55dB	Marginally fails to achieve the 55dB requirement. Some sound leakage was noted via radiator pipework (as Test 1) and the doors. Also a small degree of flanking was noted via the corridor wall.
5	Floor 1st floor (front)	55dB	55dB (Guestroom to Guestroom) 60dB (Guestroom to other area)	Achieves the 55dB requirement, but significantly fails to achieve the 60dB requirement. Some leakage was noted via the doors and window (it was not possible to close the window to the receiver room). Also a small degree of flanking was noted via the wall with the fireplace.
6	Wall 1st floor (front)	53dB	55dB	Marginally fails to achieve the requirement. Sound leakage noted via radiator pipework (as Test 2).

Table 2: Summary of the airborne sound insulation tests

2.5.2 Impact sound insulation

The impact sound insulation of the Test 1 floor (2nd floor front) was measured and the result was 50dB$L'_{n,Tw}$, which just achieves the proposed standard of 50dB$L'_{n,Tw}$. This floor was carpeted with a thin office-type carpet (approx 4mm thick). Providing a good quality carpet with underlay would most likely further improve the performance of the floor in this regard.

3 Discussion

The results of the tests are discussed as follows, together with our initial advice on remedial/upgrading works.

As can be seen from Table 2, the radiator pipework was frequently noted to be a path for sound leakage. It will be important to re-route this pipework to ensure that it does not pass directly through the separating walls and floors, and its routing needs to be considered further with the building services engineers.

3.1 Walls

Both walls tested appear to have a general construction of around 600mm plastered brickwork, with back to back fireplaces. The results of the tests suggest that this basic construction is capable of achieving the proposed standards, and so no specific upgrading measures are likely to be required. However, it will be important to maintain the integrity of these and the other walls by making sure that any holes/cavities are filled with brickwork and mortar to the full depth of the wall and any surface cracks are filled plaster etc.

The floor plans show a number of walls between guestrooms that are significantly thinner than the above 600mm construction and so these are likely to require an independent plasterboard lining to achieve the requirement. These walls should initially be made good as discussed above, and then the independent lining should be added. This would consist of 2 sheets of 12.5mm plasterboard on an independent framework (ie not touching the existing wall) with a sheet of 50mm mineral wool in the cavity; a typical proprietary system would be British-Gypsum-IWL .

Interconnecting doors are a common source of weakness in the sound insulation of separating walls and so should be avoided wherever possible. We will advise further if they are absolutely necessary, although at this stage we recommend that a high performance R_w40 acoustic doorset is allowed for each leaf of the interconnecting door. Please refer to our report of 25/2/11 for further advice on acoustic doors.

3.2 Floors

The results of the tests, together with the relevant criteria, have been marked on Figure 1 below. As can be seen from this figure, some of the floors tested achieve or are very close to achieving the proposed standards. Some of the results are roughly what we would expect for our understanding of the construction, and some are not. For example, the 2nd floor (rear) test achieved a significantly higher sound insulation than the 3rd floor (rear) construction, but the drawings suggest that their constructions are very similar.

As discussed in Section 2.4, the actual construction of the floors tested is not known, and so it is possible that they are significantly different to our understanding (eg key elements such as pugging could have been removed etc) which is the most likely explanation for any unexpected results. It will therefore be important to establish the actual constructions of the floors we tested, to ensure that accurate comparisons can be made with the other floors in the building, and better inform the extent of any remedial/upgrading works required.

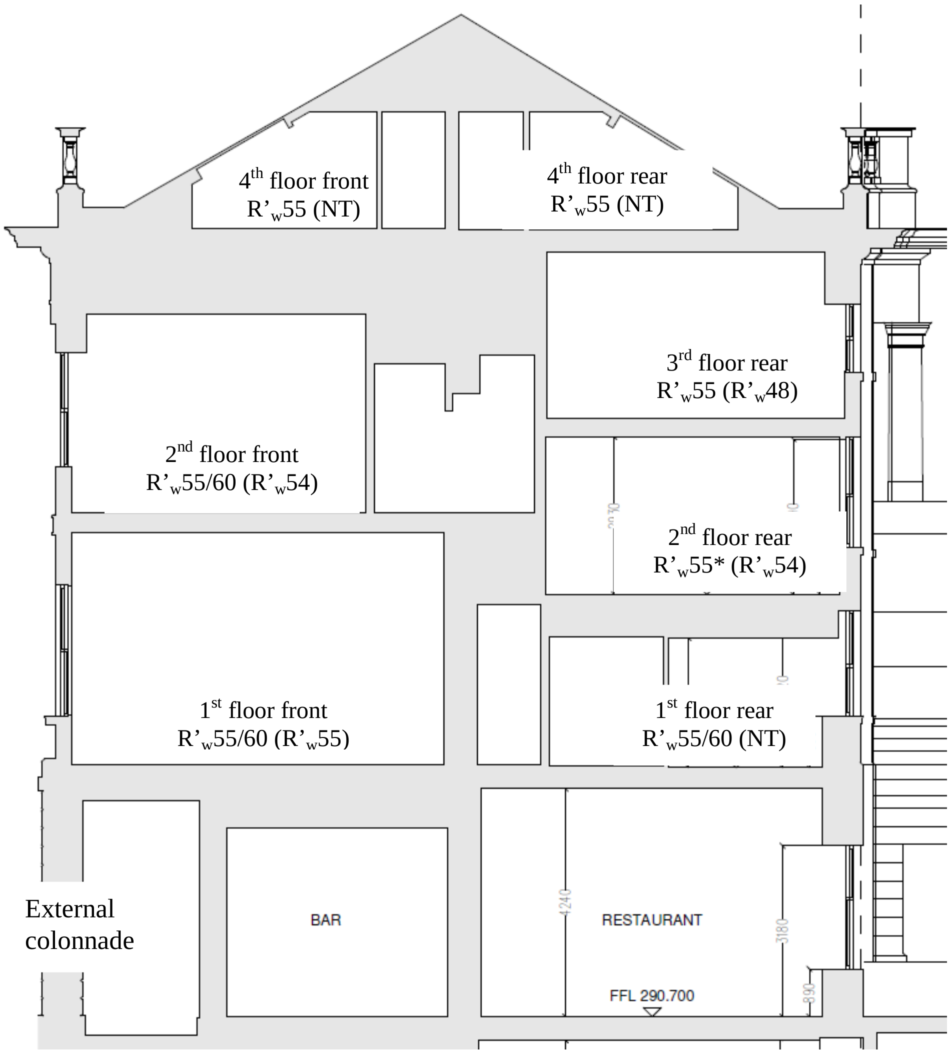


Figure 1 – Sound insulation criteria and test results (shown in brackets), NT= not possible to test

*We recommended in our report of 25/2/11 that the use of the room directly above the 1st floor kitchen is changed to a non-noise sensitive use (a store, maid's room, heritage bedroom etc), and assume that this advice has been adopted.

3.2.1 4th floor (front and rear)

It was not possible to test this floor due its poor condition, and it will not be possible to carry out these tests until remedial works have been carried out to reinstate the floor and the rooms/constructions around it. Based on the information currently available, we understand that the construction of the front section of this floor is likely to be: 30mm lime/ash on 4mm timber laths, a large cavity of around 1.5m and an independent ceiling of approx. 25mm lath and plaster. The construction of the rear section is not known, although we assume it will be similar with a significantly reduced cavity (possibly around 300mm). In good conditions these constructions may be able to achieve the proposed standard of R'_w55, although this should be confirmed by a test onsite.

If these floors do not achieve the requirements, then typical upgrading measures might be as follows:

- Front section of floor – increase the mass of the upper and lower layers. This might involve increasing the thickness of the lime/ash layer (or changing this material for one with a higher density), adding sheets of plasterboard to the ceiling etc.
- Rear section of floor – add an independent plasterboard ceiling. This would consist of at least two sheets of 12.5mm plasterboard overlaid with 50mm of mineral fibre. It is important that this independent ceiling is separated from the existing ceiling by a cavity of at least 100mm (although the greater the cavity, the higher the sound insulation) and that its supports span from the walls and do not touch the existing ceiling (this support framework may be located within the 100mm cavity).

In both cases, adding a layer of 50mm mineral wool quilt (density 10–33kg/m^3) can provide a small increase in the overall sound insulation of these floors, and this might also be achieved by blowing the mineral fibre into the cavity.

3.2.2 3rd floor (rear)

This section of floor significantly failed to achieve the proposed standard, although its performance is roughly what we would expect for our understanding of its construction. This suggests that the floor's basic construction is not capable of achieving the proposed standards and so will need to be upgraded. The two key options for this are to either add an independent plasterboard ceiling (as discussed above) or perhaps adding a layer of pugging on boards may be sufficient. The latter option would bring the construction of this floor more in line with the construction of the 1st / 2nd floor (front) floors, which appear to be achieving the requirements.

3.2.3 2nd floor (front)

This section of floor only marginally failed to achieve the standard required between Guestrooms (ie R'_w55) and so specific upgrading works may not be necessary. It would however be necessary to determine the actual construction of this floor and ensure that the construction in other areas is similar (or reinstated accordingly).

There are a number of Guestrooms on the 2nd floor that are located directly above the Conference rooms, and a higher standard of R'_w60 has been proposed for these floors. Based on the above test result we very much doubt whether the basic floor construction will be sufficient to achieve this higher standard. Adding independent plasterboard ceilings to the Conference rooms would be the best method of increasing the sound insulation of these floors, although we doubt whether this would be possible for aesthetic/historic reasons.

The options to practically increase the sound insulation of this floor (without altering the ceilings) are therefore very limited and may involve increasing the thickness of the pugging, adding mineral wool insulation to the cavity (as discussed in Section 3.2.1), adding a proprietary overlay flooring system on top of the existing floor (eg Refurb Deck , Reduc Strata Extra etc) or a combination of a number of these measures. It is not possible to predict the improvement that such measures will achieve with any degree of accuracy and so we would recommend that options are tested on site.

3.2.4 2nd floor (rear)

This section of floor only marginally failed to achieve the proposed standard (ie R'_w55) and so specific upgrading works may not be necessary. It will however be necessary to determine the actual construction of this floor to set a benchmark for works to the other areas of 2nd floor (rear).

3.2.5 1st floor (front & rear)

The front section of this floor achieves the standard proposed between Guestrooms (ie R'_w55), but does not achieve the standard required between Guestrooms and other areas such as the bar, restaurant, retail units etc (ie R'_w60). In ideal conditions we would expect this floor construction to achieve a higher sound insulation than we measured (ie it is a double construction with a cavity in excess of 1m), and so in the first instance we recommend that it is inspected to determine whether any of its key elements have been removed (ie the pugging). If this is the case, then these need to be replaced and the floor retested.

However, if the floor is found to be intact, then the best method to increase its performance would be to add an independent ceiling (refer to Section 3.2.1). If this is not possible then the measures discussed in Section 3.2.3 would need to be considered.

It was not possible to test the rear section of floor. We understand that its construction is likely to be similar to the front section, but with a significantly reduced cavity (possibly to around 300mm). It is therefore very unlikely that this floor will achieve the R'_w60 requirement and so upgrading measures similar to those discussed above will most likely be required.

3.3 Sound flanking transmission

As discussed in Section 3.2.1 of our report of 25/2/11, sound flanking transmission is an important consideration, particularly where standards of airborne sound insulation up to R'_w60 are required. The most effective method to control flanking transmission would be to provide the flanking elements with plasterboard linings (independent wall linings etc). Based on our observations during these tests our initial thoughts are that the existing constructions will provide sufficient control of flanking and that plasterboard linings will not be required. However, the need for these linings cannot be completely ruled-out until further tests have been carried out onsite with the uprated constructions discussed above.

4 Summary

Arup Acoustics has carried out acoustic tests at the Crescent building to assess whether the existing constructions are capable of achieving the proposed acoustic standards, and advise on measures to upgrade them if necessary.

Generally, the results of the above tests are encouraging and suggest that the building is already achieving the proposed standards in some cases. The results are summarised as follows:

- Wall airborne sound insulation – the 2nd floor (front) wall achieved the requirement and the 1st floor (front) wall only marginally failed to achieve the requirement (ie by 2dB).
- Floor impact sound insulation – the 2nd floor (front) floor achieved the requirement.

- Floor airborne sound insulation – some of the floors tested achieve or are very close to achieving the requirements. However, there are a number of floors that significantly failed to achieve the requirements and will require upgrading.

The actual construction of the floors we tested is not known, and so it will be important to establish these constructions before more detailed advice on remedial/upgrading works can be provided. Based on the information currently available we have provided initial guidance on such measures, which is summarised as follows (please refer to Section 3.0 for further details).

Test element	**Comments**
4th Floor (front & rear)	Not possible to test due to poor condition. Remedial works are required to reinstate this floor and surrounding constructions to enable tests to be carried out. If these floors do not achieve the requirements, then typical upgrading measures might involve increasing the mass of their upper and lower layers, or adding independent plasterboard ceilings to the spaces below.
3rd Floor (rear)	Significantly failed to achieve the proposed standard. The two key options for upgrading this floor are either to add an independent plasterboard ceiling or adding a layer of pugging on boards may be sufficient.
2nd Floor (front)	Marginally failed to achieve the standard required between Guestrooms, but significantly failed to achieve the standard for the Conference rooms. It is not likely to be possible to add an independent ceiling to the Conference rooms. Other options for improvement might involve increasing the pugging thickness, adding mineral wool to the cavity, adding an overlay flooring system on top of the existing floor (or a combination of such measures).
2nd Floor (rear)	Marginally failed to achieve the proposed standard and so specific upgrading works are not likely to be required.
1st Floor (front & rear)	The front section of floor achieves the standard proposed between Guestrooms, but not the standard required to other areas (bar, restaurant, retail units etc). A higher test result was expected and so an inspection is required to determine whether any key elements are missing. If necessary, an independent ceiling would be the best method to improve its performance. Other options would be as 2nd Floor (front).
Separating walls	Any walls that are less than around 600mm thick brickwork are likely to require independent plasterboard linings.
Radiator pipework	This was frequently noted to be a path for sound leakage during our tests. It is important to re-route this pipework to avoid it passing directly through the separating walls and floors.

Table 3 – Summary of initial proposals for upgrading measures

Apparent sound reduction index according to ISO 140-4
Field measurements of airborne sound insulation between rooms

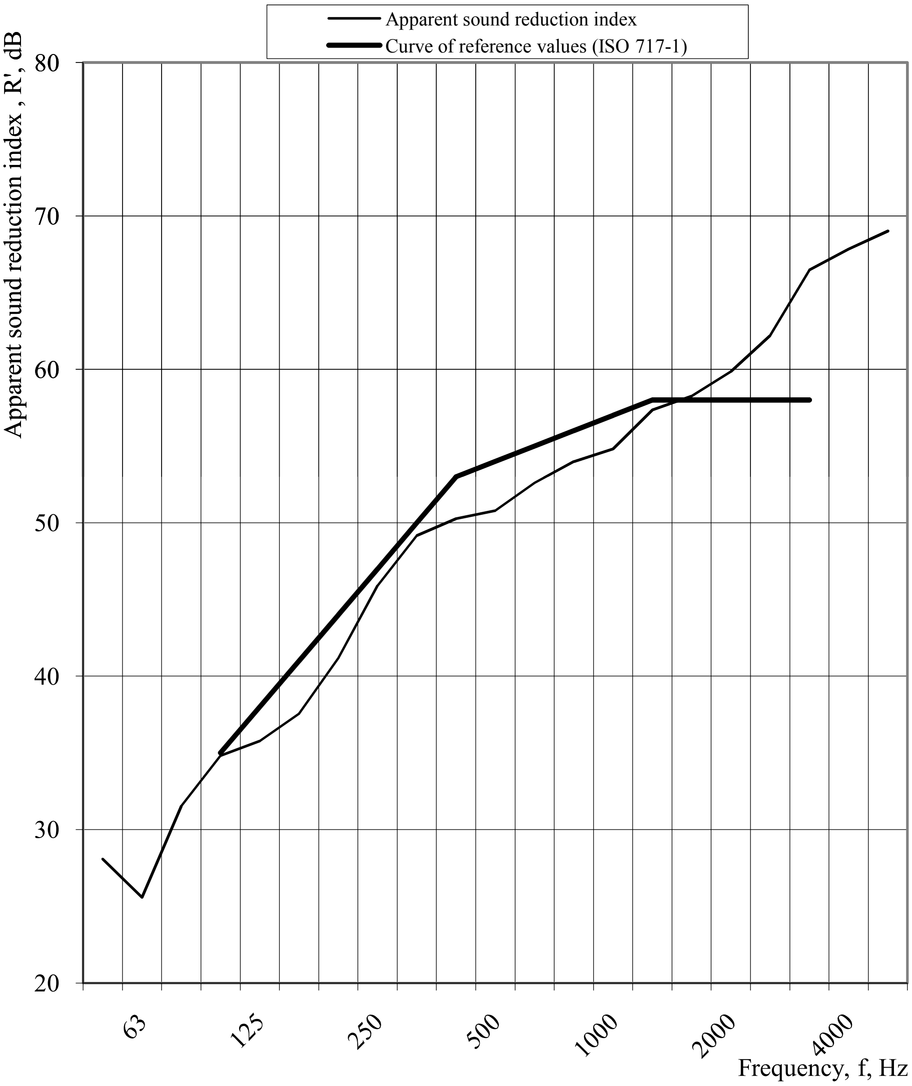
Client: Trevor Osborne Property Group   Date of test: 24/03/2011

Test 1 - Floor, 2nd floor (front)

Partition area: 21 m^2

Receiving room vol: 104 m^3

Frequency *f* Hz	R' (one-third octave) dB
50	28.1
63	25.6
80	31.5
100	34.8
125	35.8
160	37.5
200	41.2
250	45.9
315	49.2
400	50.3
500	50.8
630	52.6
800	54.0
1000	54.8
1250	57.4
1600	58.3
2000	59.9
2500	62.2
3150	66.5
4000	67.8
5000	69.0



Rating according to ISO 717-1

R'_w ($C;C_{tr}$) = 54 (-1;-6) dB $C_{50-3150}$ = -2 dB; $C_{50-5000}$ = -1 dB; $C_{100-5000}$ = 0 dB

Evaluation based on field measurement results obtained by an engineering method $C_{tr,50-3150}$ = -10 dB; $C_{tr,50-5000}$ = -10 dB; $C_{tr,100-5000}$ = -6 dB

No. of test report: 1   Name of test organisation: Arup Acoustics

Date: 28/03/2011

Apparent sound reduction index according to ISO 140-4
Field measurements of airborne sound insulation between rooms

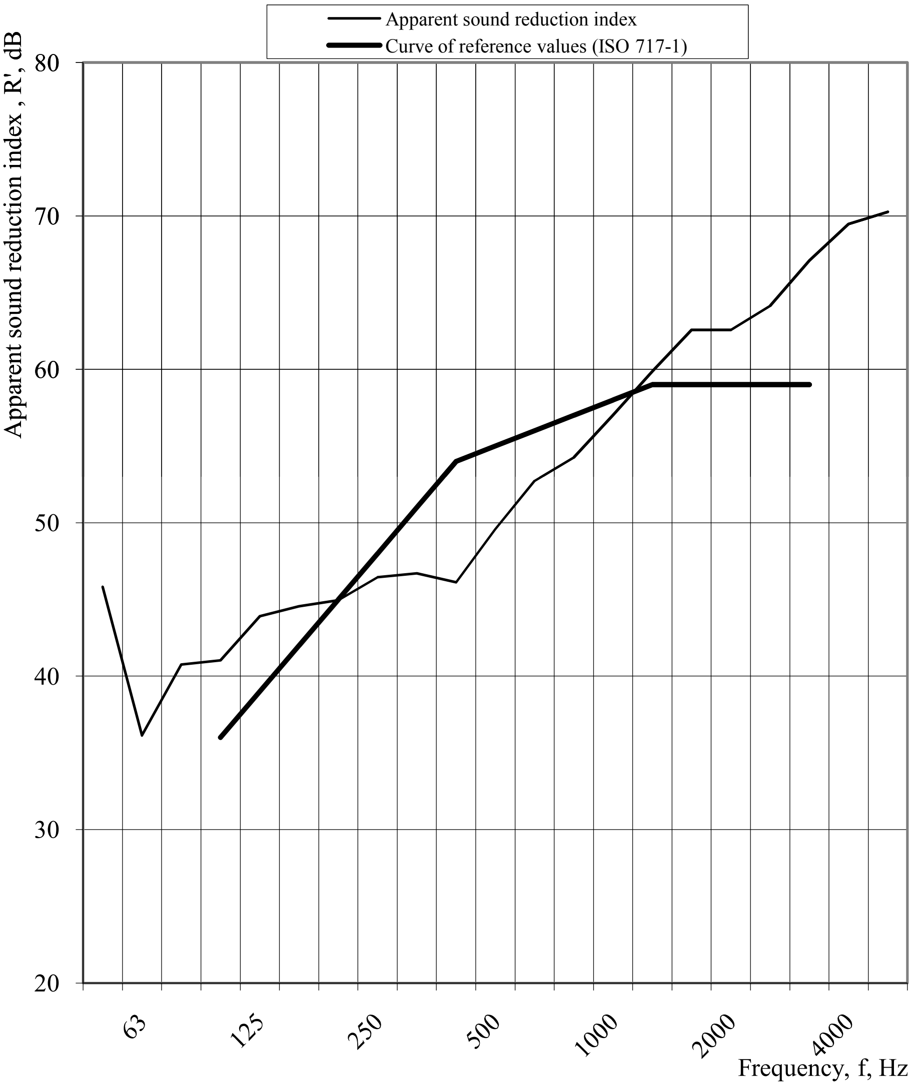
Client: Trevor Osborne Property Group   Date of test: 24/03/2011

Test 2 - Wall, 2nd floor (front)

Partition area: 22 m^2

Receiving room vol: 70 m^3

Frequency *f* Hz	R' (one-third octave) dB
50	45.8
63	36.1
80	40.8
100	41.0
125	43.9
160	44.6
200	45.0
250	46.5
315	46.7
400	46.1
500	49.6
630	52.7
800	54.2
1000	57.0
1250	59.9
1600	62.6
2000	62.6
2500	64.1
3150	67.1
4000	69.5
5000	70.3



Rating according to ISO 717-1

R'_w $(C;C_{tr})$ = 55 (-1;-4) dB $C_{50\text{-}3150}$ = -1 dB; $C_{50\text{-}5000}$ = 0 dB; $C_{100\text{-}5000}$ = 0 dB

Evaluation based on field measurement results obtained by an engineering method $C_{tr,50\text{-}3150}$ = -5 dB; $C_{tr,50\text{-}5000}$ = -5 dB; $C_{tr,100\text{-}5000}$ = -4 dB

No. of test report: 2   Name of test organisation: Arup Acoustics

Date: 28/03/2011

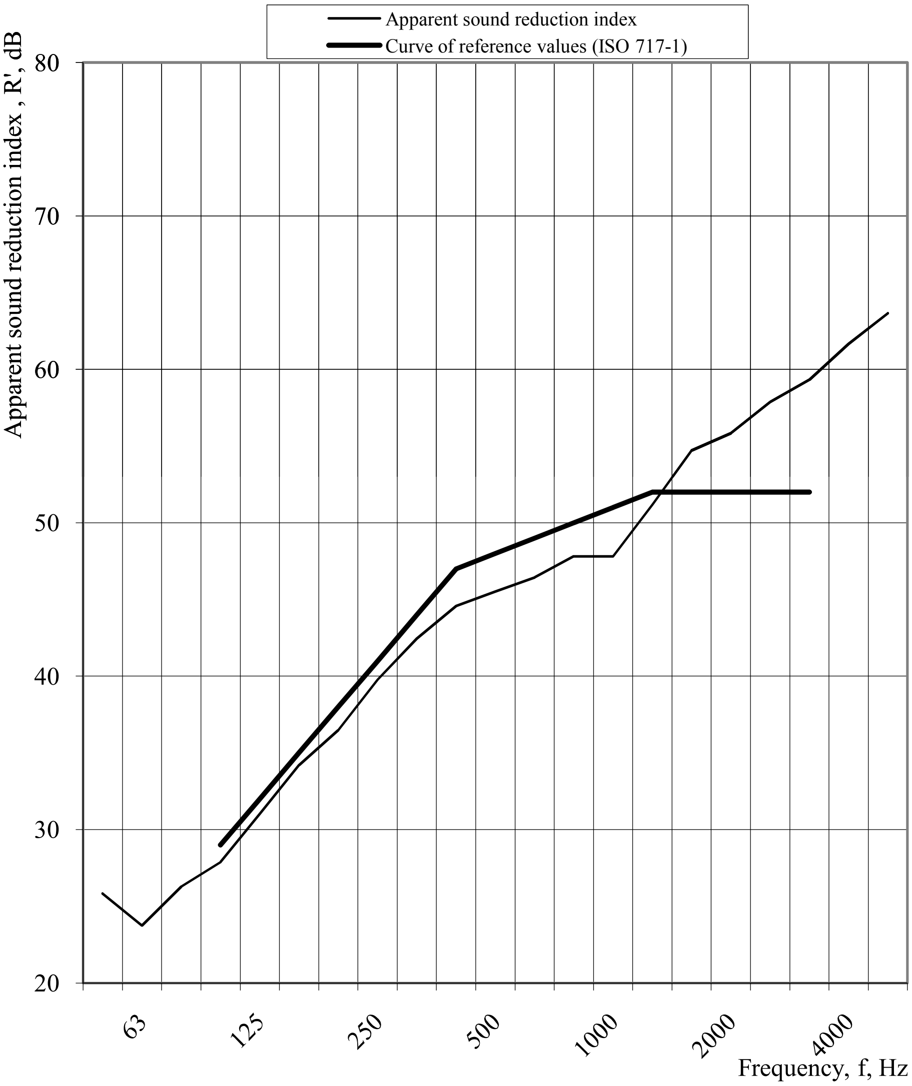
Apparent sound reduction index according to ISO 140-4
Field measurements of airborne sound insulation between rooms

Client: Trevor Osborne Property Group   Date of test: 24/03/2011

Test 3 - Floor, 3rd floor (rear)

Partition area: 23 m^2
Receiving room vol: 68 m^3

Frequency f Hz	R' (one-third octave) dB
50	25.8
63	23.7
80	26.3
100	27.9
125	31.0
160	34.2
200	36.5
250	39.8
315	42.4
400	44.6
500	45.5
630	46.4
800	47.8
1000	47.8
1250	51.2
1600	54.7
2000	55.8
2500	57.9
3150	59.3
4000	61.7
5000	63.7



Rating according to ISO 717-1

$R'_w (C;C_{tr})$ = 48 (-1;-5) dB $C_{50-3150}$ = -1 dB; $C_{50-5000}$ = 0 dB; $C_{100-5000}$ = 0 dB

Evaluation based on field measurement results obtained by an engineering method $C_{tr,50-3150}$ = -8 dB; $C_{tr,50-5000}$ = -8 dB; $C_{tr,100-5000}$ = -5 dB

No. of test report: 3   Name of test organisation: Arup Acoustics

Date: 28/03/2011

Apparent sound reduction index according to ISO 140-4
Field measurements of airborne sound insulation between rooms

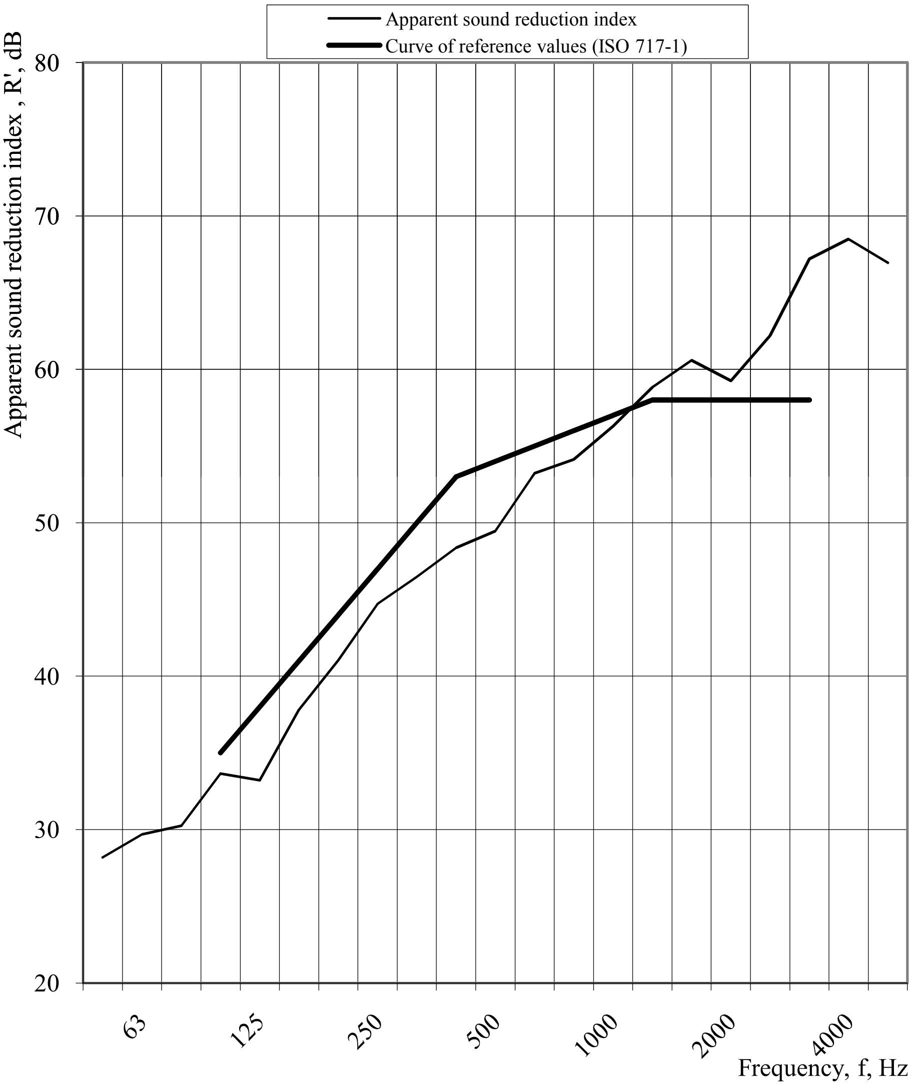
Client: Trevor Osborne Property Group Date of test: 24/03/2011

Test 4 - Floor, 2nd floor (rear)

Partition area: 13 m^2

Receiving room vol: 30 m^3

Frequency *f* Hz	R' (one-third octave) dB
50	28.2
63	29.7
80	30.3
100	33.6
125	33.2
160	37.8
200	41.0
250	44.7
315	46.5
400	48.4
500	49.5
630	53.2
800	54.1
1000	56.3
1250	58.8
1600	60.6
2000	59.3
2500	62.2
3150	67.2
4000	68.5
5000	67.0



Rating according to ISO 717-1

$R'_w (C;C_{tr})$ = 54 (-2;-7) dB $C_{50-3150}$ = -3 dB; $C_{50-5000}$ = -2 dB; $C_{100-5000}$ = -1 dB

Evaluation based on field measurement results obtained by an engineering method $C_{tr,50-3150}$ = -10 dB; $C_{tr,50-5000}$ = -10 dB; $C_{tr,100-5000}$ = -7 dB

No. of test report: 4 Name of test organisation: Arup Acoustics

Date: 28/03/2011

Apparent sound reduction index according to ISO 140-4
Field measurements of airborne sound insulation between rooms

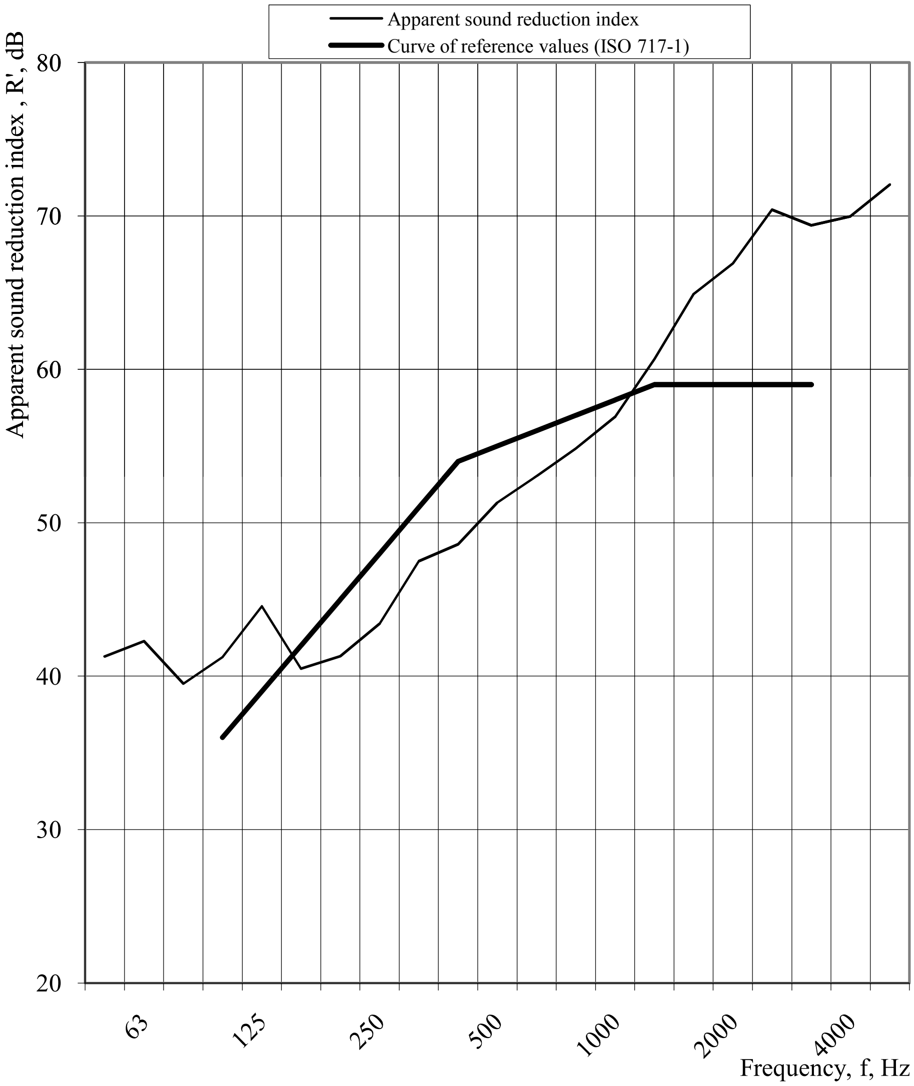
Client: Trevor Osborne Property Group   Date of test: 24/03/2011

Test 5 - Floor, 1st floor (front)

Partition area: 19 m^2

Receiving room vol: 66 m^3

Frequency *f* Hz	R' (one-third octave) dB
50	41.3
63	42.3
80	39.5
100	41.2
125	44.5
160	40.5
200	41.3
250	43.4
315	47.5
400	48.6
500	51.3
630	53.0
800	54.8
1000	56.9
1250	60.7
1600	64.9
2000	66.9
2500	70.4
3150	69.4
4000	70.0
5000	72.0



Rating according to ISO 717-1

R'_w (C;C_{tr}) = 55 (-1;-5) dB $C_{50-3150}$ = -1 dB; $C_{50-5000}$ = 0 dB; $C_{100-5000}$ = 0 dB

Evaluation based on field measurement results obtained by an engineering method $C_{tr,50-3150}$ = -5 dB; $C_{tr,50-5000}$ = -5 dB; $C_{tr,100-5000}$ = -5 dB

No. of test report: 5   Name of test organisation: Arup Acoustics

Date: 28/03/2011

Apparent sound reduction index according to ISO 140-4
Field measurements of airborne sound insulation between rooms

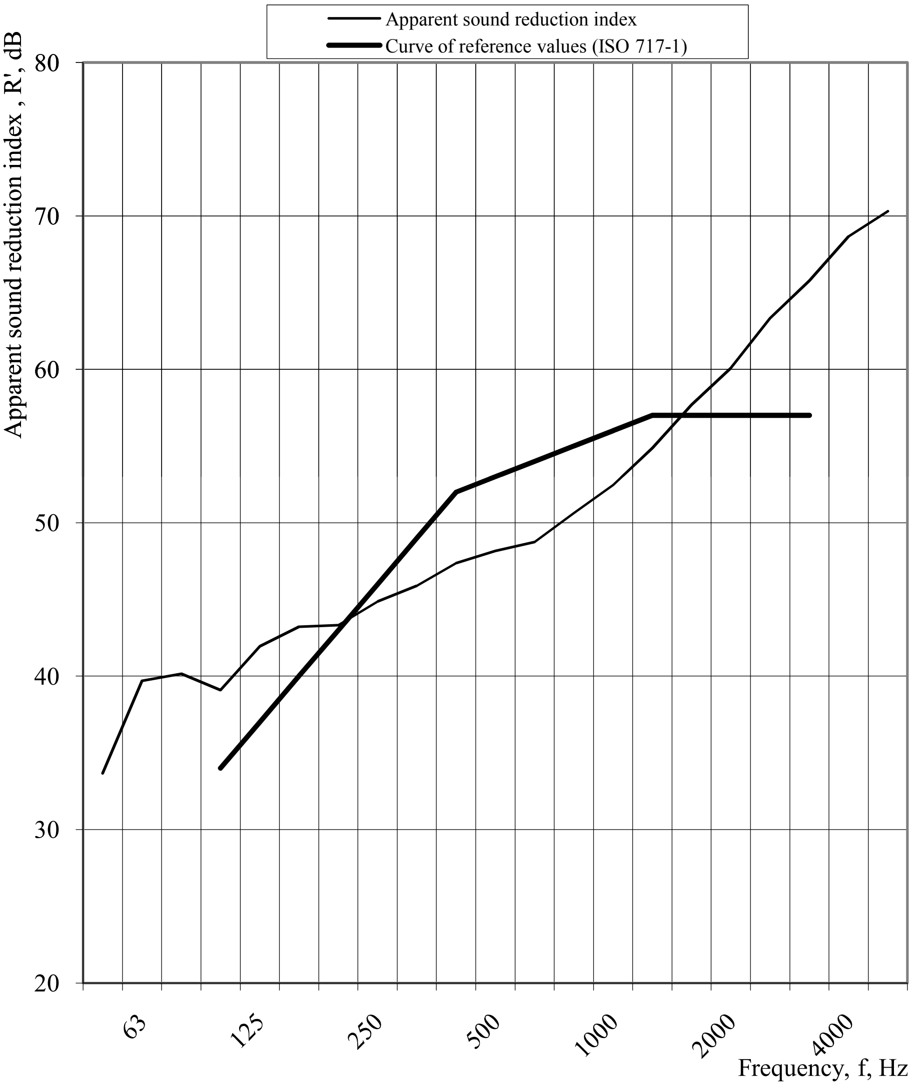
Client: Trevor Osborne Property Group   Date of test: 24/03/2011

Test 6 - Wall, 1st floor (front)

Partition area: 29 m^2

Receiving room vol: 161 m^3

Frequency *f* Hz	R' (one-third octave) dB
50	33.7
63	39.7
80	40.2
100	39.1
125	42.0
160	43.2
200	43.3
250	44.9
315	45.9
400	47.4
500	48.2
630	48.7
800	50.6
1000	52.4
1250	54.9
1600	57.7
2000	60.1
2500	63.3
3150	65.8
4000	68.7
5000	70.3



Rating according to ISO 717-1

R'_w (C;C_{tr}) = 53 (-1;-4) dB $C_{50-3150}$ = -1 dB; $C_{50-5000}$ = 0 dB; $C_{100-5000}$ = 0 dB

Evaluation based on field measurement results obtained by an engineering method $C_{tr,50-3150}$ = -5 dB; $C_{tr,50-5000}$ = -5 dB; $C_{tr,100-5000}$ = -4 dB

No. of test report: 6   Name of test organisation: Arup Acoustics

Date: 28/03/2011