ROYAL PRINCE ALFRED HOSPITAL

NORTH WEST PRECINCT REDEVELOPMENT

ACOUSTIC DESIGN REPORT

Issued

October 2012

acoustic studio

abn	76 106 325 982
address	Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel	(+61) 2 9557 6421
fax	(+61) 2 9557 6423
email	mail@acousticstudio.com.au

Contact for this Report
Peter Griffiths
peter.griffiths@acousticstudio.com.au

acoustic studio

abn	76 106 325 982
address	Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel	(+61) 2 9557 6421
fax	(+61) 2 9557 6423
email	mail@acousticstudio.com.au

Proj & Code	Royal Prince Alfred Hospital North West Precinct Redevelopment		SAV2052
Doc Title	Acoustic Design Report		
Ref	SAV2052.0006.Rep.revA.120904.doc		
Date	October 2012		**Revision: A**
Author(s)	Peter Griffiths		
Circulation	**Organisation**	**Location**	**Delivered Via**
Paul Edmiston	Savills Australia	Sydney	email
Attachment(s)	Appendices as listed in the Table of Contents		

acoustic studio is a member of the
Association of Australian Acoustical Consultants

This report takes into account the particular instructions and requirements of our Client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Table of Contents

1 Introduction

This report presents the acoustic recommendations for the new building proposed as the redevelopment of the Northwest Precinct of the Royal Prince Alfred Hospital, Camperdown. The building will accommodate mental health and ambulatory health care services.

These recommendations cover the following four general acoustic aspects of the building's technical performance:

- Control of external noise.
- Building services noise and vibration.
- Internal sound insulation.
- Room acoustics.

2 The Building

The new building will provide a range of mental health and ambulatory care services.

It will consist of a six occupied levels plus a basement car park, a ground level parking area at the eastern end of the site, and roof top plant, located on Missenden Road, Camperdown in the North West Precinct of the Hospital campus.

The proposed facility will accommodate a range of spaces including bedrooms, consulting rooms and associated clinical support areas, office areas including private and open plan offices and administrative support areas.

The buildings will be fully air-conditioned.

2.1 Location & description of surrounding area

The site is located on the western side of Missenden Road and is part of the overall western part of the hospital complex. It is close to the following buildings considered as being particularly noise and vibration sensitive due to the activities that occur within them:

- St John's College (student residential accommodation)
- Building 12 (RPA Hospital building – no wards).
- Cyclotron Building (offices and sensitive equipment).
- Chinese Consulate (offices).
- QE II (RPA Hospital building – including wards).

The building immediately to the west of the site is a hospital building and is currently unoccupied. It is understood it will remain unoccupied for the duration of the project.

Further to the west of the unoccupied building is a Child Care facility.

To the south west of the project site is the Queen Mary Building that was once residential accommodation for nurses training at the hospital. This building is currently unoccupied, and it understood that a DA has been approved to refurbish the building for residential use. Whilst it is not anticipated that the building will be occupied during the early works and main works of this project, it is necessary to consider operational noise impact at this location.

The site is shown below in Figure 2, together with the noise and vibration sensitive receivers.

Figure 2: Project site, including noise and vibration sensitive adjacent buildings

3 Existing Noise Environment

The existing noise environment is dominated by:

- Road traffic noise from Missenden Road.
- Existing plant from adjacent buildings.

3.1 General survey information

Surveys of the existing noise environment around the project site were carried out on 7 and 8 June 2012, and 19 October 2012.

Operator attended short term monitoring was carried out between 11.30 am and 1.00 pm on 7 June, between midday and 1:00 pm on 8 June 2012, and between 3 am and 4 am on 19 October 2012 in order to establish the typical daytime and night time noise levels on the site and the octave band spectra of the levels.

Short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 2446899). The calibration of the analyser was checked before and after the surveys and no variation in level occurred.

A windshield was used to protect the microphone of the analyser.

Weather conditions were calm and dry during the attended noise surveys.

Matthew Shriffer of Acoustic Studio Pty Ltd carried out the surveys.

The noise monitoring locations are shown in Figure 3.

Figure 3: Ambient noise survey locations ●

3.2 Ambient noise monitoring results

The results of the background and ambient noise monitoring are shown below in Table 1.

Location	Date	Time	Measured sound level, dB	
			Ambient sound level, $L_{Aeq,\ 15\ minutes}$	Background sound level, $L_{A90,\ 15\ minutes}$
St John's College	7 June 2012	12:08 pm	63	56
	8 June 2012	12:05 pm	63	55
	19 October 2012	3.00 am	55	48
RPA Building 12	7 June 2012	1:03 pm	58	53
	8 June 2012	1:20 pm	54	51
	19 October 2012	4:00 am	53	47
Cyclotron Building	7 June 2012	12:44 pm	55*	54*
	8 June 2012	11:47 am	54*	52*
	19 October 2012	3:45 am	54*	53*
Chinese Consulate	7 June 2012	12:25 pm	54	49
	8 June 2012	11:30 am	58	48
	19 October 2012	3:30 am	50	49
QE II	7 June 2012	1:20 pm	57	52
	8 June 2012	11:13 am	60	52
	19 October 2012	3:15 am	49	47

* Sound levels dominated by air conditioning grille in upper level façade of Cyclotron Building

Table 1: Results of ambient and background sound level surveys.

The existing ambient noise levels were dominated by noise from general campus activities and particularly traffic on Missenden Road.

The existing background noise level of the area is dominated by distant traffic on Parramatta and Missenden Roads, and external air conditioning plant from the nearby hospital

It is necessary to use a number of different noise indices to describe particular types of noise relevant to the differing issues described above. These indices are:

- The A-weighted equivalent continuous noise level (L_{Aeq}). An L_{Aeq} level can be considered as the subjective "average" noise level perceived at the measurement location over the measurement period. This index is used to describe the ambient noise levels affecting the site.

- The A-weighted background noise level (L_{A90}). The background noise level can be considered as the perceived "noise floor" of the noise environment on site. It is precisely defined as the L_{A90}, a statistically based index which describes the noise level exceeded 90% of the sample time. This index is used to assess the impact of noise from the development on the surrounding neighbourhood.

The so-called "A-weighting" is used to relate the measured noise to the sensitivity of the human ear. This is necessary because the sensitivity of the human ear varies with frequency.

4 External Noise Control - Criteria and Approach

4.1 Noise criteria – road traffic

Internal traffic noise criteria are based on the following Australian standards:

- Australian Standard AS 3671:1989 *Acoustics – Road traffic noise intrusion - Building Site and Construction*
- Australian Standard AS/NZS 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors.*

For Health Buildings, the relevant traffic noise criteria for this project are listed below in Table 2.

Type of occupancy	**Recommended design sound level, L_{Aeq}, dB(A)**	
	Satisfactory	**Maximum**
Corridors and lobby spaces	40	50
Consulting rooms	40	45
Office areas	40	45
Wards (Bedrooms)	35	40
Waiting rooms, reception areas	40	50

Table 2: Traffic noise criteria

4.2 Required building façade noise reductions

Table 4 shows the highest external traffic noise level affecting each façade of the proposed building, and the façade noise reductions required to achieve the recommended internal design sound level (L_{eq}) of 35 dB(A) within the Bedrooms and 40 dB(A) in the remaining areas (refer Table 2 of this report).

Façade	Highest external traffic noise level, dBL_{Aeq}	Required façade noise reduction, dB	
		Bedrooms	All other areas
North	60	25	20
East	63	28	23
South	58	23	18
West	58	23	18

Table 3: Building façade noise reductions

5 External Noise Control - Recommendations

5.1 Recommended facade construction - glazing

To Bedrooms (for both accessible and inaccessible windows)

Fixed double glazing consisting of:

- Minimum 14 mm laminated glazing internal.
- Minimum 25 mm airgap.
- Minimum 6 mm glazing external.

Double glazing rated at minimum R_w 40

To all other areas

Fixed double glazed unit (DGU) consisting of:

- 6 mm glazing
- 12 mm airgap
- 6 mm glazing

DGU rated at minimum R_w 32.

To Entrance Hall

Fixed single glazing consisting of:

- 8 mm laminated glazing (minimum to meet acoustic requirements)

Single laminated glazing rated at minimum R_w 35.

5.2 Recommended facade construction – walls

The following proposed façade construction meets the acoustic requirements.

Precast façade elements

- The proposed 200 mm thick precast concrete panels meet the acoustic requirements.
- Cavity with insulation (not critical to acoustic performance).
- Internal lining of minimum 13 mm thick Powerscape is acoustically acceptable.

Overall minimum acoustic rating R_w 55.

Lightweight façade elements

- Alucabond composite aluminium cladding external.
- Minimum 150 mm cavity, with minimum 50 mm thick insulation (Bradford Gold wall batts, R2.5 or equivalent sound absorption performance).
- Internal lining consisting of 13 mm Powerscape to all patient care areas, and 13 mm plasterboard to all non-patient care areas.

Overall minimum acoustic rating R_w 45.

5.3 Recommended roof/ceiling construction (Level 5)

The following proposed roof/ceiling construction meets the acoustic requirements.

- External metal deck roof sheeting.
- Thermal insulation.
- Concrete slab (minimum thickness to meet acoustic requirements: 150 mm)
- Services void of varying depth.
- 13 mm plasterboard ceiling (or Powerscape if required for non-acoustic reasons).

Overall minimum acoustic rating R_w 50.

6 Mechanical Services Noise Control

6.1 Noise and vibration criteria

Building services noise

The limits for noise from building services are set out in Table 5 (refer AS 2107:2000). This applies to the sum of contributions from all sources (i.e. lighting, air-conditioning and ventilation systems, electrical services, etc).

Type of occupancy	Recommended design sound level, L_{Aeq}, dB(A)	
	Satisfactory	Maximum
Corridors and lobby spaces	40	50
Consulting rooms	40	45
Office areas	40	45
Wards (Bedrooms)	35	40
Waiting rooms, reception areas	40	50

Table 4: Building services noise criteria

In all spaces, the criteria should apply at any location within 1.5m above the finished floor level, and no closer than 1m from any sound reflecting surface, with all services operating normally and together.

Vibration

Vibration levels in occupied spaces arising from the operations of the building services are to be limited to ensure that consequent re-radiated noise does not cause the limits in Table 5 to be exceeded.

Vibration from building services plant is to be limited to a surface velocity not greater than 0.2 mm/s rms on the surfaces of all occupied spaces (excluding plantrooms).

Environmental Noise Limits

The emission of noise associated with the use of the proposed premises including the operation of any mechanical plant and equipment shall comply with the following criteria. These criteria are in accordance with the conditions of consent set by the Council of the City of Sydney.

- The $L_{Aeq,\ 15minute}$ noise level emitted from the use must not exceed the background noise level $L_{A90,\ 15minute}$ by more than 5dB when assessed at the boundary of any affected residence (St Johns College).
- The background noise level shall be measured in the absence of noise emitted from the use in accordance with Australian Standard AS 1055.1- 1997-Description and measurement of environmental noise.
- The $L_{Aeq,15minute}$ noise level shall be adjusted to account for any applicable modifying factors in accordance with Part 4 of the EPA NSW Industrial Noise Policy.
- In this context, the term “noise level emitted from the use” means the contributing noise level from the use in isolation to any other ambient noise and account must therefore be taken of the $L_{Aeq,\ 15minute}$ when the use is not in operation.

6.2 Acoustic duct lining - internal

Sound absorptive duct lining is to be installed internally to air ducts in the locations indicated on the mechanical drawings. Ductwork should be lined internally with 38 mm or 50 mm thick insulation, as indicated on the mechanical drawings.

In summary the internal duct linings are to be:

- 50 mm thick to all ductwork and plenums located in the plant room
- 38 mm thick to all supply air ductwork on all floors from the main floor branch to the first take off.

The lining should be faced with an appropriate material to ensure that the lining should withstand an air passage velocity of at least 25 m/s without surface erosion or other forms of material migration. This facing material should be a thin, acoustically transparent membrane (such as a woven glass fibre tissue) to provide a tough surface that will present a smooth face to the airstream.

Absorptive materials should be inert, incombustible, non-hygroscopic, rot and vermin proof and, where required, fire rated.

The duct lining as installed should have the following minimum sound absorption coefficients measured according to AS 1045. No airspace should be included behind the material, and the facing material should be included in all tests.

Acoustic lining	**Octave Band Centre Frequency, Hz**							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
38 mm thick	0.10	0.10	0.30	0.65	0.75	0.85	0.80	0.80
50 mm thick	0.10	0.20	0.55	0.80	0.85	0.85	0.80	0.80

Table 5: Sound absorption coefficients for 38 mm and 50 mm acoustic lining, including facing as required

6.3 Vibration Isolation of mechanical plant

Vibration isolation should be incorporated to comply with the requirements of Section 6.1 of this report. Where a vibration isolator type is not specified, the method of mounting machinery and the size, type and active material of the mountings should be agreed between the machinery and isolator manufacturers and should comply with this specification.

Noise and vibration isolation systems should be selected to suit the environment in which the equipment is to be located. Components of the system located in the open air should be weatherproofed, non-rusting and be resistant to or protected from rodent and insect attack by choice of materials and design of components.

All equipment with moving parts should have flexible pipe connectors located between the equipment and the pipe work or ductwork.

6.4 Vibration isolation - general

Vibration isolators should be sized and selected with the proper loading to meet the requirements of Section 6.1 of this specification.

Levelling and height adjustment

Vibration isolators should be adjustable, to allow for unevenness in base level. The amount of adjustment for floor-mounted isolators should not be less than twice the permitted tolerance in the levelling of the floor. Levelling bolts or studs should be provided with lock nuts.

Alternatively, the deflection adjustment mechanism may be located between the supported machine and the isolators, or between the isolators and the basic supporting structure.

Lateral stiffness of isolators

The lateral stiffness of vibration isolators should be selected to suit the lateral isolation efficiency required without causing instability. For rotating machines with horizontal shafts, the horizontal stiffness perpendicular to the shaft should not be less than the vertical, if ‘floor’ mounted, and vice versa if ‘side’ mounted.

Asymmetrical loading of anti-vibration mounts

The vibration isolation system should allow the deflection of each mounting to be adjusted to the design value at the operating condition of the supported equipment.

The maximum difference between static deflection of any two mountings of a set when the supported equipment is operating should not be more than 15%. Inertia bases should be incorporated where necessary to ensure even loading of the mounts.

Flexible connections to fans and pumps

Vibration isolation systems for fans and pumps should allow for forces and movement due to pressure differences at flexible connections. Mountings should be laid out and sized for their loadings at all operating speeds. ‘Inertia’ bases may be used to reduce the percentage variations in mounting loads at varying speeds to amount specified.

Isolated sway braces, buffers and similar devices may be used to prevent movement in directions perpendicular to the vibration.

Prevention of overloading

Vibration isolation systems whose mountings can be overloaded by excessive deflections, should be provided with ‘bottoming’ or similar restraints. The restraints may be part of the mountings, machinery or bases. The maximum additional travel allowed by the restraints should be 50% of the rated deflection.

Vibration isolation systems fitted beneath boilers, chillers, condensing units or other equipment in which the weight of the liquid contents acts through the mountings and forms a significant part of the load, should be provided with restraints which limit the movement of the equipment on draining down to distances which do not strain service connections or adjacent runs.

Spring vibration isolators

Spring type vibration isolators should be housed, freestanding and laterally stable, preferably be constructed from suitably treated and finished steel or steel alloys. They should be manufactured with rubber, neoprene or glass fibre 'noise stop' pads, minimum static deflection 8 mm, to prevent transmission of high frequencies. The material of the pad should be selected to suit the location. Holes should be provided for fixing both to the supported machine and to the supporting structure.

The criterion of spring stability under compression should be:

(lateral stiffness : vertical stiffness) $\geq 1.2 \times$ (static deflection : working height).

Spring type isolators with (a) static deflection more than 50 mm or (b) fitted to reciprocating machinery or (c) fitted to rotating machines with long rundown times, should have ancillary dampers or adjustable 'snubber' type restraints which prevent excessive movement as the machine speed passes through the resonant frequency of the mounting system.

Rubber, neoprene, glass fibre in shear

The active element of the isolator should be bonded to mild steel or steel alloy plates, sleeves, pressings or forgings. Both element and bonding agent should be resistant to lubricating oil and water.

Holes should be provided for fixing both to the supporting machine and to the supporting structure. The holes should be located and formed in such a way that making the fixing does not stress the active element.

The dynamic stiffness and damping coefficients of the active material, at the operating speed of the supported equipment, should be used in calculation of isolation efficiencies. Alternatively certified isolation efficiency charts may be used.

Mountings whose stiffness varies with direction of deflection, should be mounted with orientation marks for use during maintenance and installation.

'Pad' or 'mat' mountings

The material used for 'pad' or 'mat' type mountings may be cellular, ribbed, or studded. Pads and mats should normally be bonded both to supported and to supporting surfaces.

Material and bonding agents should be resistant to lubricating oil and water.

'Pads' or 'mats' of vibration isolation material, used to obtain acoustic isolation in installations that do not require vibration isolators, should be selected and loaded to avoid resonance. The resonant frequency of the assembly should not lie between 2/3 and 4/3 of the disturbing frequencies of the supported equipment.

Pads or mats of vibration isolation material used in 'cast-in-situ' concrete sandwich construction machine bases, should be separated from the concrete, to ensure exclusion of grout and fine aggregate from internal voids, with materials recommended by the manufacturer.

Pipe and duct hangers

Hangers used for vibration control should consist of a mild steel welded cage containing a helical spring, or neoprene/rubber/glass fibre isolator, (or both) and be suitable for suspension from drop rods. Where both types of isolating elements are used together, the spring should be at the pipe or duct end of the hanger. The spring or active materials should be used in compression.

Steel springs should be stable at all loadings up to full compression and full compression should not occur before 150% of the rated maximum loading. No permanent deformation should be caused by full compression. The load should be transmitted to the spring through a neoprene washer bushed into the moving end to prevent metal to metal contact.

Neoprene/rubber/glass fibre isolators should be protected from overloading by metal to metal restraints or lateral containment.

The hanger cage should be capable of carrying five times the maximum rated normal service load without permanent distortion. The drop rod arrangements should allow the rod to swing through a 30 degree angle about the vertical before metal to metal contact.

Neoprene, rubber or glass fibre pipe clamp inserts should be fitted between the pipe and clamp such that the two are completely separated. The maximum compression of the insert should be at least 150% of the compression under normal load.

Inertia bases

Where specified or where otherwise required to achieve the specified static deflection or control out-of-balance forces, inertia bases should be constructed from reinforced concrete and should be designed for the loading due to the supported machine, the vibration isolation equipment and its own weight. The surface should be steel float finished or equivalent and levelled to the machine manufacturer's requirements.

Machinery should be fixed to the base with 'grouted in' holding down bolts located in reverse tapered cast sockets. Inertia base depth should be at least 1/12 the longest dimension of the inertia base but not less than 150 mm. The base footprint should be large enough to provide stability for supporting equipment.

Where the inertia base will be supported on spring or rubber in shear mountings, the base should be formed with a prefabricated mild steel continuous edge frame, to which the necessary cross members and reinforcing should be fixed. The mountings should be fixed to brackets that are welded to the sides of the edge frame.

Reinforced flexible pipe connectors

Flexible pipe connectors made from corrugated metal, rubber, neoprene or other flexible liner with braided metal or other similar internal or external reinforcing, and intended for use without tie rods, should have the following minimum live lengths when used for anti-vibration purposes.

Pipe Nominal Bore (mm)	Live Length (mm)
0 – 28	230
32 – 80	340
90 - 133	455
150 - 200	570
250 – 300	690

Table 6: Minimum live lengths of flexible pipe for anti-vibration purposes

The minimum internal bore should not be less than the actual pipe internal diameter.

The axis of the connectors should be perpendicular to the direction of vibration. Alternatively, where the design allows, the connectors should be formed into 90° bends.

Expansion joints in pipe work

The tie rod systems on expansion joints used for vibration isolation should be designed to achieve the isolation required across the joint. The tie rod fixings should use rubber or neoprene bushed washers to prevent metal-to-metal contact throughout the normal range of movement of the joint.

6.5 Pumps

All pumps should be selected with the highest efficiency consistent with the specified duty and pump and impeller diameter should not exceed 0.9 of the maximum impeller diameter capability of the pump housing to reduce the possibility of tonal effects.

Pump impellers, shafts and drive couplings should be statically and dynamically balanced to the best commercial standards and in accordance with ISO 2372-1974. Maximum vibration velocity amplitude should not exceed 2.5 mm/sec RMS vibration velocity when measured on the machine structure with the pumps/motors mounted on the inertia blocks as specified.

The pump and motor assembly should be mounted on a concrete filled inertia block and completely isolated. Pump inertia blocks should be sized to support the weight of elbows, bellows and other fittings without creating undue stress on the pump assembly. The weight of water in the pump and connected pipe work should be taken into account in selecting the final size of the required inertia blocks.

The pump and motor assembly should be bolted directly onto the concrete inertia block.

The inertia bases should be sufficiently large to provide support for all parts of the pumps, including any components that protrude over the equipment base, such as suction and discharge elbows on centrifugal pumps.

The construction and installation of all inertia bases should be in full compliance with the details provided in this specification.

Electrical connections to the equipment motors should be made with a long looped length of flexible cable and all piping should be resiliently supported.

T-shaped inertia bases should be used as support for pump elbows where applicable.

Inlet and discharge pipe work to pumps should incorporate flexible pipe connections of the twin sphere type. Tie rods should not bridge across the flexible connectors and if fitted should be loosened. Care should be taken to ensure the alignment between the pipe work and the pump system is in accordance with the flexible pipe connection manufacturers' recommendations.

6.6 Air handling units (AHUs) and extract fans

All AHUs and fans should be provided with double skin casings. The required construction is an outer casing of 1 mm (minimum thickness) steel with 50 mm mineral/ glass fibre insulation, internally faced with 0.6 mm (minimum thickness) perforated galvanised steel. The glass fibre should be suitably retained to prevent fibre erosion.

AHUs and extract fans should be supported on steel springs and/or neoprene/rubber pads to comply with the requirements of this specification.

Access doors should be sealed with neoprene gaskets to provide an airtight seal.

All connections between AHU/fans and ductwork should be properly aligned and executed using flexible material (rubberised canvas, lead impregnated PVC or an approved equivalent).

All pipe and conduit penetrations of AHU and fan casings should be acoustically sealed.

All pipes connected to AHUs or fans should have flexible union pipe connectors.

Noise levels generated by air handling units and fans should be limited to the octave band sound power levels in Tables 7 and 8 of this report. Test data should be provided to demonstrate conformity with the specified noise levels.

6.7 Chillers

The Works Sub-contractor should ensure that the chillers meet the noise levels specified in the equipment schedules. The Works Sub-contractor should provide test data for approval by the Acoustic Engineer.

The Works Sub-contractor should provide noise enclosures as required to ensure these limits are met.

Chillers should be supported on steel springs to comply with the requirements of this specification.

All pipes connected to chillers should have flexible union pipe connectors.

Noise radiated from the chiller plantroom to the surrounding premises shall not exceed the criteria set in Section 6.1 of this report. Noise controls such as acoustic barriers and acoustic louvres shall be included if necessary.

6.8 Volume Control Dampers

All control dampers are to be selected to maintain smooth air-flow and minimum regenerated noise. In balancing the systems, pressure drops across dampers nearest to terminal should be kept to a minimum practical value and proportional balance should be used to achieve minimum overall noise from dampers.

6.9 Ductwork

All duct access panels e.g. access panels adjacent to fire dampers, should be constructed with double skin casings. The required construction will be an outer casing of 1 mm minimum thickness steel with 12 mm mineral glass fibre insulation, internally faces with 0.6 mm (minimum thickness) galvanised steel.

Velocities in all ductwork should be limited according to Table 7.

dB(A) limit	Duct Velocity, m/s		
	Main	Branch	Run-out
35	6.5	5.5	3.0
40	7.5	6.0	3.5
45	9.0	7.0	4.5

Table 7: Maximum air velocities in ductwork (m/s)

Transitions in duct geometry are to be as gradual as possible (not exceeding 15%) and it is preferred that one pair of sides remains parallel.

Where duct aspect ratios exceeding 3:1 are unavoidable external stiffeners should be employed. Internal stiffeners should not be used.

6.10Pipework lagging

The following pipework shall be externally lagged with Soundlag 8025C:

- All sewer drainage pipework.
- All syphonic drainage.
- All general stormwater drainage.

No acoustic lagging is required for the following:

- Cold water services.
- Fire services.
- Fire hydrant pump room.
- Hot water services.
- Gas services.

Alternatively, it is acoustically acceptable that all waste pipework be Rehau Raupiano pipework, including the Rehau proprietary fittings.

6.11Emergency back-up generator

The following noise controls are specified for the emergency diesel generator installation and room.

These controls are based on the following sound power level output of a Cummins C450 D5e generator.

Load	Sound Power Level, dB re 10 $^{-12}$ watts							
	Octave Band Centre Frequency, Hz							
	63	125	250	500	1k	2k	4k	8k
75%	119.5	117.5	114.5	112.5	113.5	112.5	107.5	103.5
100%	120.2	118.2	115.2	113.2	114.2	113.2	108.2	104.2
110%	120.5	118.5	115.5	113.5	114.5	113.5	108.5	104.5

Table 8: Sound power output of nominated generator.

The noise controls will need to be reviewed should the selection of the generator differ from that nominated above.

Intake attenuator

The acoustic requirements of the intake attenuator are:

3m long, 33% airway (NAP H33/300 or equivalent).

Minimum insertion loss required, dB:

Octave Band Centre Frequency, Hz							
63	125	250	500	1k	2k	4k	8k
18	29	52	59	60	56	44	31

Discharge attenuator

The acoustic requirements of the intake attenuator are:

3m long, 33% airway (NAP H33/300 or equivalent).

Minimum insertion loss required, dB:

Octave Band Centre Frequency, Hz							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
18	29	52	59	60	56	44	31

Exhaust silencers

Residential grade, with one silencer located in the flue within the diesel generator room, and one within the flue downstream of the flue exiting the room.

The limiting noise level 1 m from the discharge of the engine exhaust is 72 dB(A).

Internal acoustic room lining

All walls and the soffit of the slab shall be lined with 100 mm thick insulation with the following minimum sound absorption coefficients:

Octave Band Centre Frequency, Hz							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
0.2	0.6	0.9	0.9	0.9	0.9	0.9	0.9

Mineral wool, glass fibre and polyester insulation are all acoustically acceptable materials.

It is acoustically acceptable for the internal lining to be faced with perforated foil or metal with a minimum 50% open area.

Doors

The doors of the diesel generator room shall be specialist acoustic door sets (door plus frame) rated at minimum R_w 40.

7 Internal Sound Insulation & Room Acoustics

The following constructions have been recommended and agreed with the architect during design development.

7.1 Recommendations – partitions

Partition types

There are two types of acoustic partitions recommended as follows:

- Type 1: Full height (slab to slab) partition consisting of 1 layer of 13 mm Powerscape both sides of 92 mm thick studs. Insulation (Tasman insulation, 75 mm thick, R2.0, or equivalent sound absorption performance) to be installed between studs. It is acceptable for 13 mm thick plasterboard to be used as the partition lining above the ceiling line. This construction system is rated at R_w 48.
- Type 2: As above, but with the partition running 150 mm above the ceiling. This construction system is rated at R_w 41.

Partition locations

Type 1 partitions:

- All bedroom partitions and attached ensuite bathrooms, except partitions to corridor.
- All consulting room partitions, including partitions to corridors.
- All treatment room partitions, including partitions to corridors.
- Quiet Rooms (all partitions).
- Group Meeting Rooms (all partitions).
- Seclusion Rooms, except partitions to corridor.
- Secure Access Room, including partition to corridor.
- Family Room (all partitions).
- Magistrate's Room (all partitions).

•

Type 2 partitions:

- Bedrooms to adjacent corridors
- Bedroom ensuites to adjacent corridors
- All office partitions
- Media Room (all partitions).
- Multifunction Room.

7.2 Recommendations – doors

Doors to all Consulting Rooms and Treatment Rooms are to be fitted with Raven RP 10 (or equivalent) and Raven RP 8 (or equivalent) acoustic seals.

All acoustic seals are to be correctly fitted and adjusted to provide an airtight seal as shown below in Figure 7.

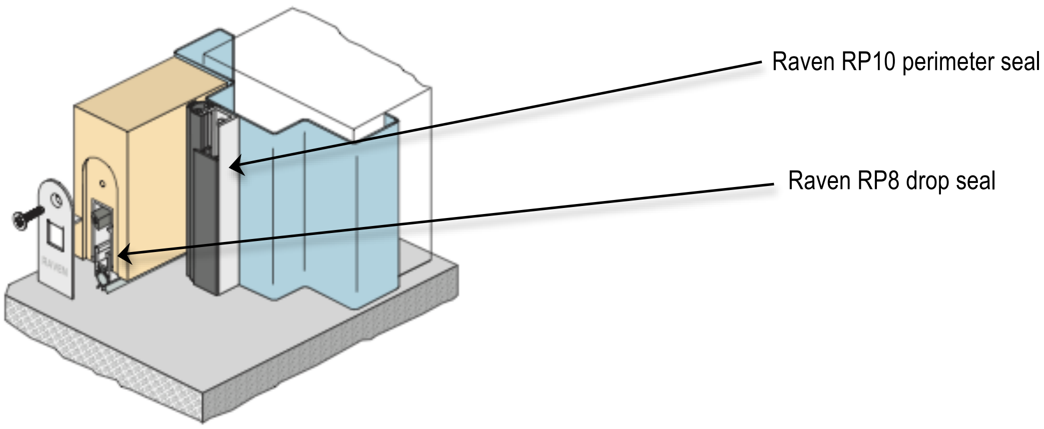

Figure 7: Acoustic doors seals for Consulting and Treatment Rooms.

It is noted that the architectural design includes RP8 and RP10 seals on all smoke and fire doors in this project.

7.3 Internal Room Acoustics

The ceilings within the office areas are to be suspended mineral fibre ceiling tiles rated at minimum NRC 0.70 (Armstrong Ultima ceiling tiles, fine fissured medium textured, with a square edge detail, or equivalent sound absorption performance) or equivalent acoustic performance.

8 Conclusion

A noise assessment has been carried out on the new building proposed as the redevelopment of the Northwest Precinct of the Royal Prince Alfred Hospital, Camperdown.

This report presents the acoustic recommendations and requirements for the project. Acoustic Studio Pty Ltd has provided these recommendations during design development and documentation.

These recommendations cover the following four general acoustic aspects of the building's technical performance:

- Control of external noise.
- Building services noise and vibration.
- Internal sound insulation.
- Room acoustics.

The acoustic performance requirements of the building envelope are driven by the need to control traffic noise levels from Missenden Road. Recommendations have been given for the Roof/ceiling construction, external wall construction and glazing configuration.

Building services noise and vibration controls have been specified.

Acoustic requirements for partitions have been provided such that the highest sound insulation will be achieved between patient bedrooms, and around consulting and treatment rooms. Similarly, we have recommended acoustic door seals for all consulting and treatment rooms.

Internal room acoustic control will be provided with a sound absorptive ceiling installed in the office areas. The minimum sound absorption requirements have been specified.