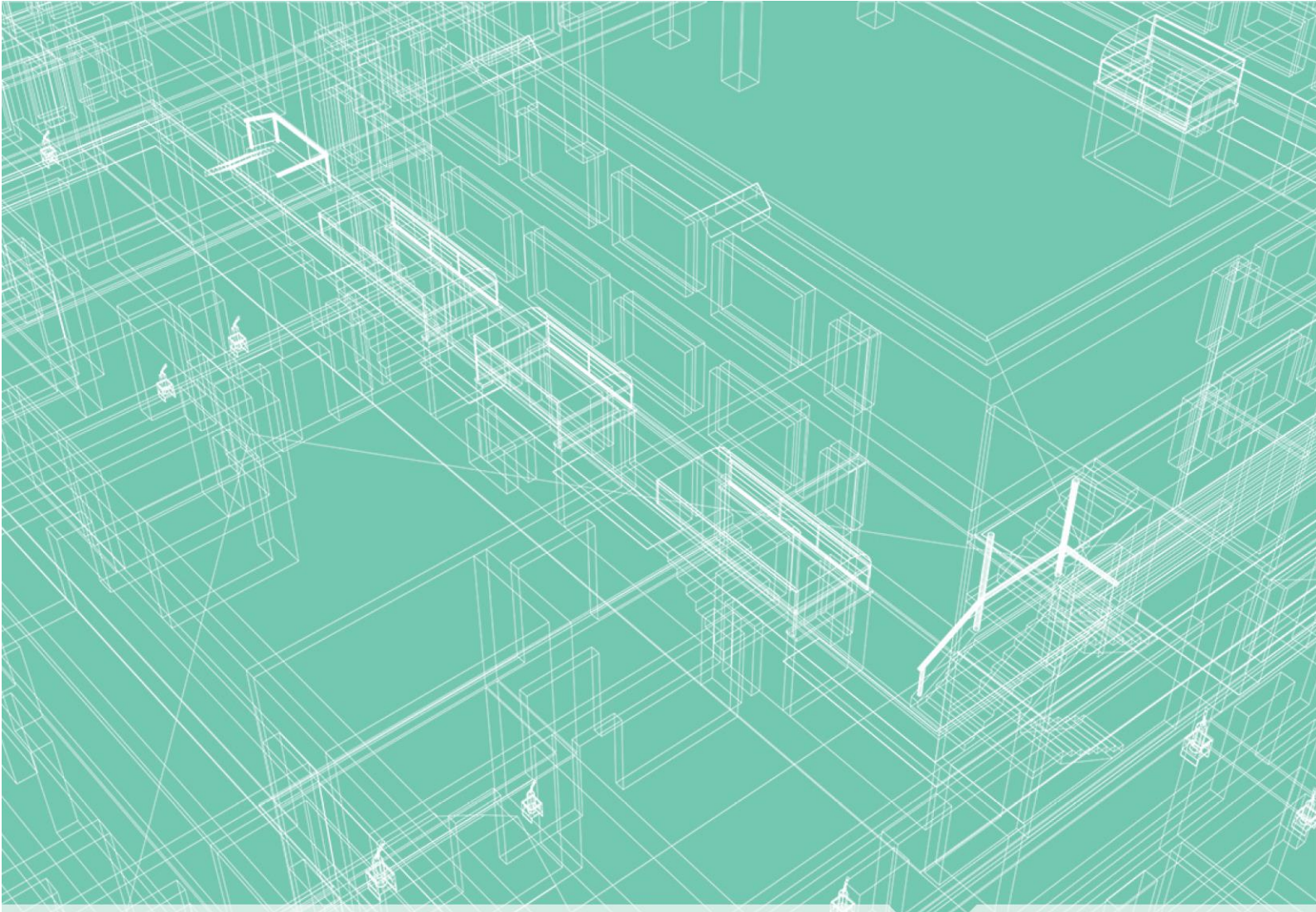

ACOUSTIC 70% DETAILED DESIGN REPORT

OXFORD FALLS GRAMMAR SCHOOL – FIELD OF DREAMS

ACOUSTIC SERVICES

JHA

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CONTENTS

1 INTRODUCTION

JHA Consulting Engineers has been engaged by EPM Projects to provide acoustic services for the Oxford Falls Grammar School Field of Dreams Development.

This Detailed Design Report outlines the acoustic performance requirements, minimum design standards applicable, and provides design recommendations for the following:

- Internal partitions, to control noise transfer between internal areas, including walls, internal glazing, operable walls and doors.
- Acoustic finishes, to meet the room acoustic performance and reverberation times for internal areas – where applicable.
- Roof construction acoustic treatment for rain noise control
- Building services, to control noise transfer from building services to internal areas, plus to control noise transfer from mechanical services to external areas and close properties / receivers.

The following documentation has been used for the preparation of this report:

- Architectural drawings provided by Allen Jack + Cottier Architects
- Australian Standard 2107:2016 "*Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors*".

This report should be read in conjunction with all other Contract Documents including the Architectural, Electrical, Hydraulic, Mechanical and Structural drawings, specifications and schedules.

This document complies with JHA Consulting Engineers accreditations ISO 9001:2015 Quality Management System and ISO 14001:2015 Environmental Management Systems.

2 ACOUSTIC CRITERIA

2.1 INTERNAL NOISE LEVELS

The internal noise criteria from mechanical services shall be designed in general accordance with the Australian Standard / New Zealand Standard 2107:2016 *"Acoustics- Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

The AS/NZS 2107:2016 recommends acoustic criteria to ensure the well-being of the occupants within buildings. The background noise levels apply to the sound level measured within the space which is fully furnished and unoccupied but ready for occupancy. The recommended background noise levels are defined as Design Sound Levels and are expressed as a range from satisfactory to maximum defined. The Design Sound Levels are given as overall A-weighted equivalent continuous sound pressure levels ($L_{Aeq,t}$) in decibels.

The recommended Design Sound Levels for the relevant spaces of the development are shown in Table 1.

Type of occupancy / activity	*Design Sound Level ($L_{Aeq,t}$) range, dB(A)*
First Aid	40 – 45
Libraries – General Areas	40 – 50
Office Areas	40 – 45
Corridors and Lobbies	< 50
Toilet / Change / Showers	< 55

Table 1: AS/NZS 2107:2016 design sound levels for areas relevant to the project.

2.2 ROOM ACOUSTICS

Refer to Table 2 for the recommended reverberation time targets for the spaces of the development based on Australian Standard / New Zealand Standard 2107:2016 *"Acoustics- Recommended Design Sound Levels and Reverberation Times for Building Interiors"* as a guideline.

Type of occupancy / activity	*Design Reverberation Time (RT) range, secs*
First Aid	0.60 – 0.80
Libraries – General Areas	0.60 – 0.80
Office Areas	0.40 – 0.70
Corridors and Lobbies	< 0.80
Toilet / Change / Showers	---

Table 2: AS/NZS 2107:2016 reverberation times for areas relevant to the project.

3 ARCHITECTURAL ACOUSTIC RECOMMENDATIONS

3.1 INTERNAL PARTITIONS

Based on the information obtained from the architectural drawings, Table 3 shows the proposed internal wall-types and their sound insulation rating (R_W) for full height partitions. All walls to be full height to the underside of the roof sheeting. Refer to the architectural documentation for walls not included. Where insulation is required, it shall be 75mm 11kg/m^3 at minimum.

ID	*Construction Detail*	*Sound Insulation Rating (R_W)*
D2d	2x 13mm Fyrchek plasterboard (10.5kg/m^2) / 150mm steel stud with 75mm Insulation (@11kg/m^3) / 1x 13mm Fyrchek plasterboard (10.5kg/m^2)	45
D1c	1x 9mm fibre cement(13.5kg/m^2) / 35mm Substrate / 150mm steel stud with 75mm Insulation (@11kg/m^3) / 1x 13mm standard plasterboard (8.4kg/m^2)	45
D2b	1x 13mm standard plasterboard (8.4kg/m^2) / 150mm steel stud with 75mm Insulation (@11kg/m^3) / 1x 13mm standard plasterboard (8.4kg/m^2)	40
D2c	2x 13mm Fyrchek plasterboard (10.5kg/m^2) / 35mm Top Hat / 150mm steel stud with 75mm Insulation (@11kg/m^3) / 35mm Top Hat / 1x 13mm standard plasterboard (8.4kg/m^2)	45

Table 3: Nominated internal partitions constructions.

Walls that are R_W40 or greater are to extend to the underside of the roof sheeting to achieve full height construction and the acoustic separation requirements. There should be no air gaps or flanking path over the partitions.

3.2 DOORS

Doors are generally the weakest component in a partition system, and the impact on the total acoustic performance of a partition is based on its acoustic performance and the amount of area the door takes up in relation to the partition. For developments with this type of spaces and arrangements, suitable doors are generally 5-10dB lower than the performance of the partition in which they are installed, resulting in a suitable level of sound insulation overall (a composite performance of about 5dB less than the partition rating). Situations where noise intrusion through doors is more critical would require proprietary high performance door systems that match the performance of the wall in order to maintain the composite performance.

Based on the sound insulation ratings provided in Appendix A, the recommended door constructions for glazed and non-glazed door sets are shown below in Table 4.

Door Sound Insulation	*Door Type*	*Acoustic Seals*
Rw30 (Glazed)	Single leaf, hinged, aluminium framed 8.38mm laminated glazing	Raven RP87Si perimeter seal Raven RP38Si drop/bottom seal
Rw35 (Glazed)	Single leaf, hinged, aluminium framed 10.38mm laminated glazing	Raven RP87Si perimeter seal Raven RP38Si drop/bottom seal
Rw35 (Glazed sliding)	Single leaf, aluminium framed. 10.38mm laminated glazing	2 x Schlegel Silent-Fin (PBSF) door seals (1 on each side of sliding door top channel) 2 x Raven RP74F door seals to the inside of sliding leaf bottom rail frame 2 x Schlegel Silent-Fin (PBSF) door seals on the side of the aluminium frame and 2 x Schlegel Silent-Fin (PBSF) door seals within the C-Channel in which the door slides
Rw30-35	Solid core, 35mm thick	Raven RP87Si perimeter seal Raven RP38Si drop/bottom seal
Rw40 (Glazed)	Optima Affinity or equivalent	Proprietary Seals
Rw40	Solid core, 45mm thick	Raven RP87Si perimeter seal Raven RP38Si drop/bottom seal

Table 4: Recommended doors and acoustic seals.

3.3 FAÇADE NOISE CONTROL

The building envelope (façade) of the proposed building shall be designed to control external noise break-in plus noise break-out generated within the spaces and affecting nearby noise sensitive receivers.

The main factors determining the sound insulation performance of the façade are the area surface of the glazing and any openings – usually, the latter are critical. For good sound insulation performance, the glazing should form airtight joints with the glazing frame when closed and the joints between frame and solid wall should be sealed.

The glazing has been designed to provide sound insulation against typical operational noise emissions within the school.

Based on the information obtained from the architectural drawings, the following table shows the description of the proposed external wall types plus the sound insulation rating achieved. Refer to the architectural documentation for other wall types and other requirements.

ID	*Composition*	*Acoustic performance*
D1c2 / E1e	External FC cladding / 6mm fibre cement / 150mm steel stud with 75mm 14kg/m^3 insulation / 20mm air gap / 92mm steel stud / 13mm plasterboard (8.4kg/m^2)	Rw50

Table 5: External wall types.

3.4 ROOM ACOUSTICS

The minimum required area and the NRC of the ceiling has been provided in order to achieve the reverberation time targets. Proposed acoustic ceilings which achieve the above NRC and the nominated minimum coverage of ceiling have been provided. Refer to the architectural documentation for floor finishes. All library spaces to be carpeted.

3.4.1 ACOUSTIC ABSORPTION REQUIREMENTS

The ceiling type and coverage required to achieve the reverberation time criteria for the different spaces are provided in Table 6.

Location	*Ceiling type*	*Min. Coverage (%)*	*Min. NRC*
First Aid	CL02 - Perforated plasterboard ceiling	100%	0.70
Library (All)	CL02 – Perforated plasterboard ceiling	80-90%	
Library Staff	CL02 – Perforated plasterboard ceiling	100%	
Foyer	CL10 – Timber batten	70-80% or as shown on architectural documentation	

Table 6: Nominated ceiling types and minimum ceiling coverage.

Refer to Table 7 for proposed products. Alternative products can be used at the approval of the acoustic engineer provided they achieve the required acoustic performance.

Material Type	*Description*	*Typical NRC Range*	*Example Products*
CL02 Perforated Panels	Minimum 18% open area and 12mm thickness of panel. Sound insulation above panel	0.70 - 0.85	Rigitone Maxtrix with acoustic backing
CL10 Timber batten	Timber batten with 50mm thick Martini Absorb HD backing	0.70 - 0.85	Refer to architectural documentation for timber batten system. Install 500mm thick Martini Absorb HD backing

Table 7: Sound Absorptive Panel Types

3.5 RAIN NOISE

The roofing shall be designed such that the noise generated by rain on roofing (particularly metal roofing) does not result in undue disturbance – particularly during storm events. The design is to assume a yearly storm event for a period of 1 hour as given by the Bureau of Meteorology to 30 mm/h of rain. It is recommended to implement a solid layer into the roof construction consisting of the following at minimum:

- Steel roof
- 100mm air cavity min. with 75mm 14kg/m^3 insulation
- Wavebar 4kg or 13mm plasterboard (8.4kg/m^2) or 17mm plywood
- Architectural ceiling

3.6 ACOUSTIC ACCESS PANELS

All access panels shown on the documentation to be acoustic type with a sound insulation performance of ≥Rw31.

3.7 SOUND INSULATION RECOMMENDATIONS

3.7.1 OPERABLE WALLS

The minimum sound insulation rating of operable walls shall achieve R_W45. In order to ensure that the overall performance of the wall is not compromised, ceiling void flanking shall be minimised. The recommended operable walls include Lotus (100 series), Hufcor (8000 series), or similar.

Above ceiling construction is required to the operable walls which extends from the top of the wall to the underside of the roof sheeting and acoustically sealed. The construction is to consist of 13mm plasterboard either side of a 64mm steel stud at minimum.

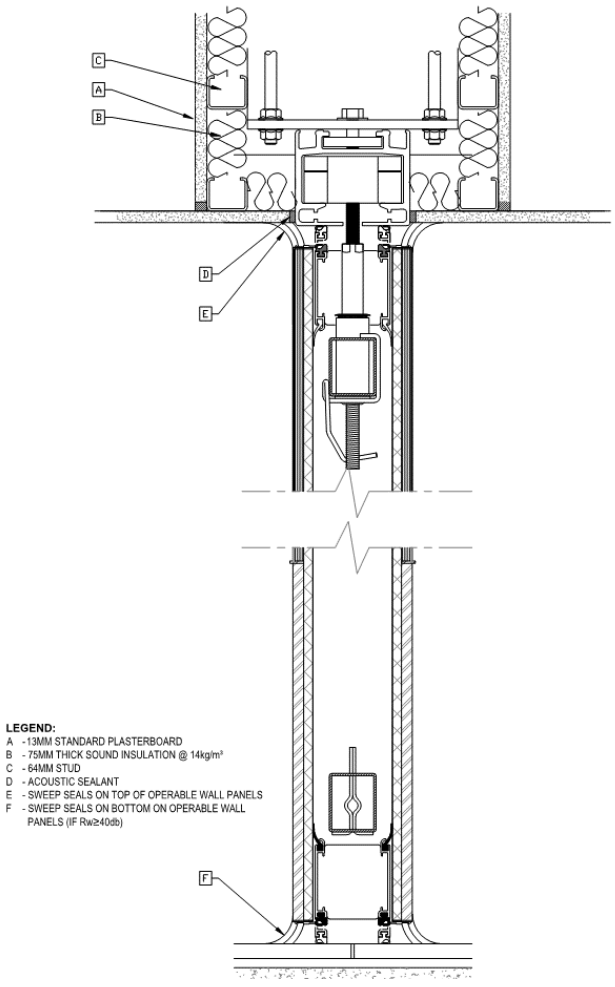


Figure 1: Acoustic treatment for operable wall.

3.7.2 INTERNAL GLAZING

Internal glazing partitions and vision panels in internal doors shall be specified in order to ensure that the overall performance of the partition / door is not degraded.

Where internal glazing partitions require a sound insulation rating of R_W40 or higher, double glazing will need to be selected and certified so that the whole system (including the framing construction) can achieve the partition performance requirements. This can have significant cost impacts and, for this reason, it is important to carefully consider where glazing is located and the feasibility / practicality when considering sound insulation performance. Single glazing has been provided based on expected levels of acoustic privacy.

Where internal partitions with glazing have an acoustic rating, the construction of the glazing and its frame are to achieve the sound insulation rating as shown. Table 8 shows typical glazing types in order to achieve the sound insulation ratings. Where full height is required, an above ceiling baffle is to be installed above the glazing as per the plasterboard construction details in Table 3 with the corresponding R_W rating.

Sound Insulation Rating R_w	*Construction Detail*	*Full Height Construction*
35	10.38mm laminated glass	No
40	12.5mm Viridian VLam Hush	Yes

Table 8: Recommended internal glazing types.

The following constructions for glazing frames are required for the corresponding level of sound insulation required:

- R_W35 glazed partition – Aluminium window framing, solid timber or steel.
- R_W40 glazed partition – Solid timber or steel framing.

3.7.3 EXTERNAL GLAZING

Refer to the markups in Appendix A for external glazing requirements. The acoustic requirement to the glazing has been based on a level of sound insulation that will reduce noise significantly, although some audibility is still expected to an extent depending on the level of external noise. The performance of the glass systems shall achieve the acoustic requirement based on the framing and glass combined.

Sound Insulation Rating R_w	*Construction Detail*
40	12.5mm Viridian VLam Hush

Table 9: Recommended external glazing types.

4 BUILDING SERVICES RECOMMENDATIONS

In order to achieve the recommended internal design sound levels within the spaces of the units plus the external noise emissions limits, this section provides recommendations for noise and vibration control for the building services of the development.

4.1 MECHANICAL SERVICES NOISE CONTROLS

4.1.1 GENERAL STRATEGY

Noise controls will need to be incorporated with the design of the mechanical plant and plantrooms to ensure that the cumulative noise levels to the nearest sensitive receivers meets the noise level criteria when assessed against the NSW EPA NPI and internal noise targets.

Design noise controls that may need to be implemented will typically include, but are not limited to:

- Wrapping of OAF with Soundlag 4525c.
- Install acoustic insulation into the base of all bulkheads for FCUs consisting of 50mm 11kg/m3 insulation.
- Acoustic louvres to the condenser plant on the roof
- Strategic location and selection of plant to ensure the cumulative noise levels at the spaces are met.
- Selection of appropriate quiet plant.
- Acoustic noise control measures to be put in place to minimise noise impacts such as:
  - In-duct attenuation.
  - Noise enclosures as required.
  - Sound absorptive panels as required.
- Sound absorptive duct lining will be installed internally to air ducts as required. Ductwork will be lined internally with 50 mm thick insulation.
- Vibration isolation will be incorporated to minimise any vibration transmission and / or structure-borne noise.

4.1.2 ACOUSTIC DUCT LINING

Sound absorptive duct lining shall be installed internally to air ducts in the locations indicated on the drawings. Ductwork shall be lined internally with 25mm, 50mm or 100mm thick insulation, as indicated on the mechanical services drawings.

The lining shall be faced with an appropriate material to ensure that the lining shall withstand an air passage velocity of at least 25m/s without surface erosion or other forms of material migration. This facing material shall 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 shall be inert, incombustible, non-hygroscopic, rot and vermin proof and, where required, fire rated.

The installed duct lining shall have minimum sound absorption coefficients measured according to AS ISO 354:2006 *'Acoustics – Measurement of sound absorption in a reverberation room'*, summarised in Table 10.

Thickness (mm)	Sound Absorption Coefficient							
	63	125	250	500	1k	2k	4k	8k
25	0.05	0.10	0.35	0.55	0.85	0.95	0.95	0.90
50	0.10	0.35	0.55	0.85	0.95	0.95	0.95	0.90
100	0.15	0.55	0.85	0.95	0.95	0.95	0.95	0.90

Table 10: Minimum sound absorption coefficients for duct lining.

4.1.3 FLEXIBLE DUCTWORK

All flexible duct shall have acoustically perforated inner sleeve with 10kg/m^3 insulation and shall not be restricted in any way. To minimise re-generated noise, air velocities in flexible ducts shall not exceed the recommended velocities in Section 4.1.4.

Flexible ducts shall be connected using standard sheet metal dove-tail or spin-in collars and mechanically attached either with plastic closure straps, metal clamp straps, or approved tape. Connections should be made without bends in excess of 90 degrees – preferable to use radii of at least 1.5 times the flexible duct diameter for bends, using the shortest possible lengths of flexible duct material.

Flexible ducts shall be supported at intervals not greater than 1.5m, with maximum permissible sag of 15mm per 300mm of spacing between support points.

Maximum length of flexible ductwork shall be 6m in any location, measured from the plenum box to the trunk duct. Flexible ductwork shall not pass through full-height walls or walls with vertical ceiling-void barriers. Where this is unavoidable, a flat, rectangular, internally-lined acoustic transfer duct shall be provided at the wall penetration as per Figure 2.

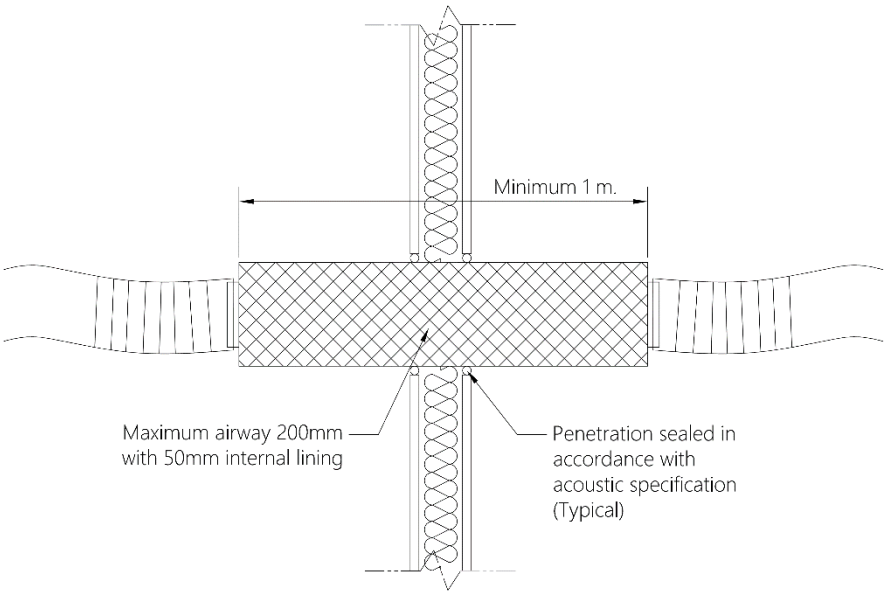


Figure 2: Flexible duct penetration detail.

Where acoustic lagging is required and located on both sides of a flexible ductwork coupling, the coupling shall also be lagged.

The acoustic performance of the flexible duct is shown in Table 11.

Diameter (mm)	*Insertion Loss (dB/m)*							
	63	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
150	3	5	7	14	18	20	12	10
200	3	5	8	14	16	17	9	7
250	2	4	8	14	13	14	7	6
300	2	3	7	13	11	12	5	5

Table 11: Acoustic performance specification for flexible ductwork.

4.1.4 AIR VELOCITIES

Mechanical duct design shall consider the geometry of duct branches, duct tees, transitions for smooth airflow and low duct regenerated noise levels.

To minimise duct turbulence, the separation between different fittings shall be kept to a minimum of three to one duct dimensions. Where this is unavoidable, external stiffeners shall be employed to minimise re-radiated noise due to air turbulences. Internal stiffeners shall not be used.

Table 12 shows the maximum airflow velocities within mechanical ductwork serving internal spaces upon the required noise level criteria.

Noise Criterion dB(A)	*Duct air velocity, in m/s*			
	Main Riser	*Primary Branch*	*Runout*	*Flexible*
30	5.0	3.0	2.5	1.0
35	6.0	4.0	3.0	1.5
40	7.5	5.5	3.5	2.0
45	9.0	6.0	4.5	2.5

Table 12: Maximum recommended in-duct airflow velocities

4.1.5 ACOUSTIC BARRIER

In order to mitigate any adverse noise impact from the rooftop condensers, an acoustic noise barrier will be required. Table 13 provides the minimum insertion loss required for the acoustic barrier around the roof top.

Brand	*Model*	*Insertion Loss*					
		125	*250*	*500*	*1k*	*2k*	*4k*
Acran	200	8	7	11	21	24	16

Table 13: Required Insertion Loss for Roof top Mechanical Plant

4.2 HYDRAULIC SERVICES

Hydraulic services will be provided with the following treatment as a minimum:

- External wrapping for all drainage pipework at high level in the ceiling space or in risers over/adjacent to occupied space. Wrapping to comprise Soundlag 4525C, or similar.
- Water velocities in all water supply pipework to be limited as required in order to avoid water-flow noise.
- All water supply pipework to be properly fixed to the building structure to prevent water-hammer.

The following pipework shall be externally lagged with Soundlag 4525C where it is located above, or travels vertically through, occupied acoustic-sensitive areas:

- 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.
- Hot water services.
- Gas services.

4.3 ELECTRICAL SERVICES

4.3.1 IN WALLS

The electrical outlets shall be located with an offset from each other on both sides of the wall not less than 100mm in masonry walls and not less than 300mm in timber or steel frame walls. Electrical outlets include general power and telecommunication outlets, MATV and data outlets, light switches and wall mounted lights.

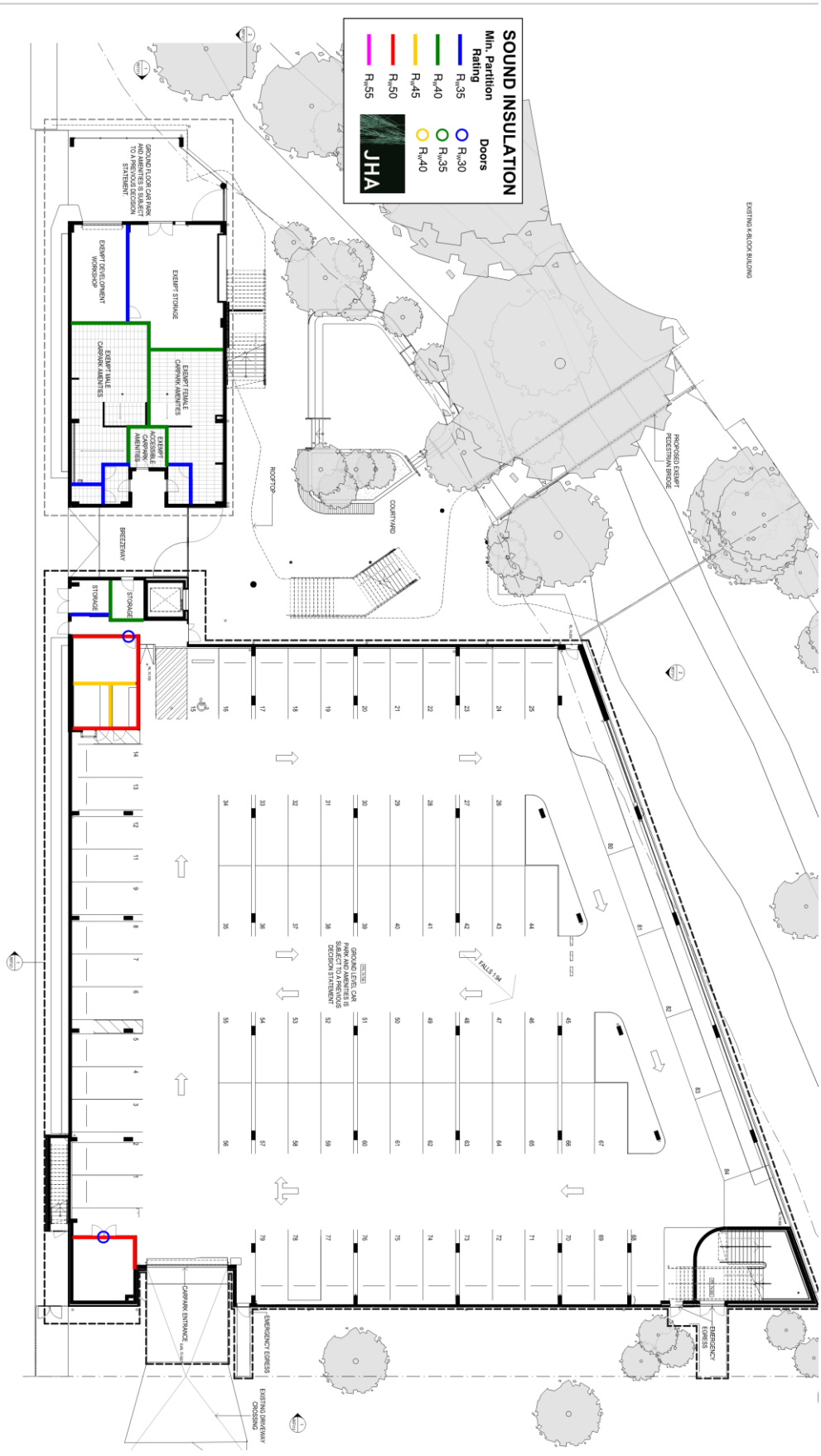
Acoustic rated fireboxes can be used for acoustic purposes to outlets, particularly when back to back electrical outlets can't be avoided within walls rated Rw45 and above. The fireboxes must achieve a minimum sound insulation rating of R_w50.

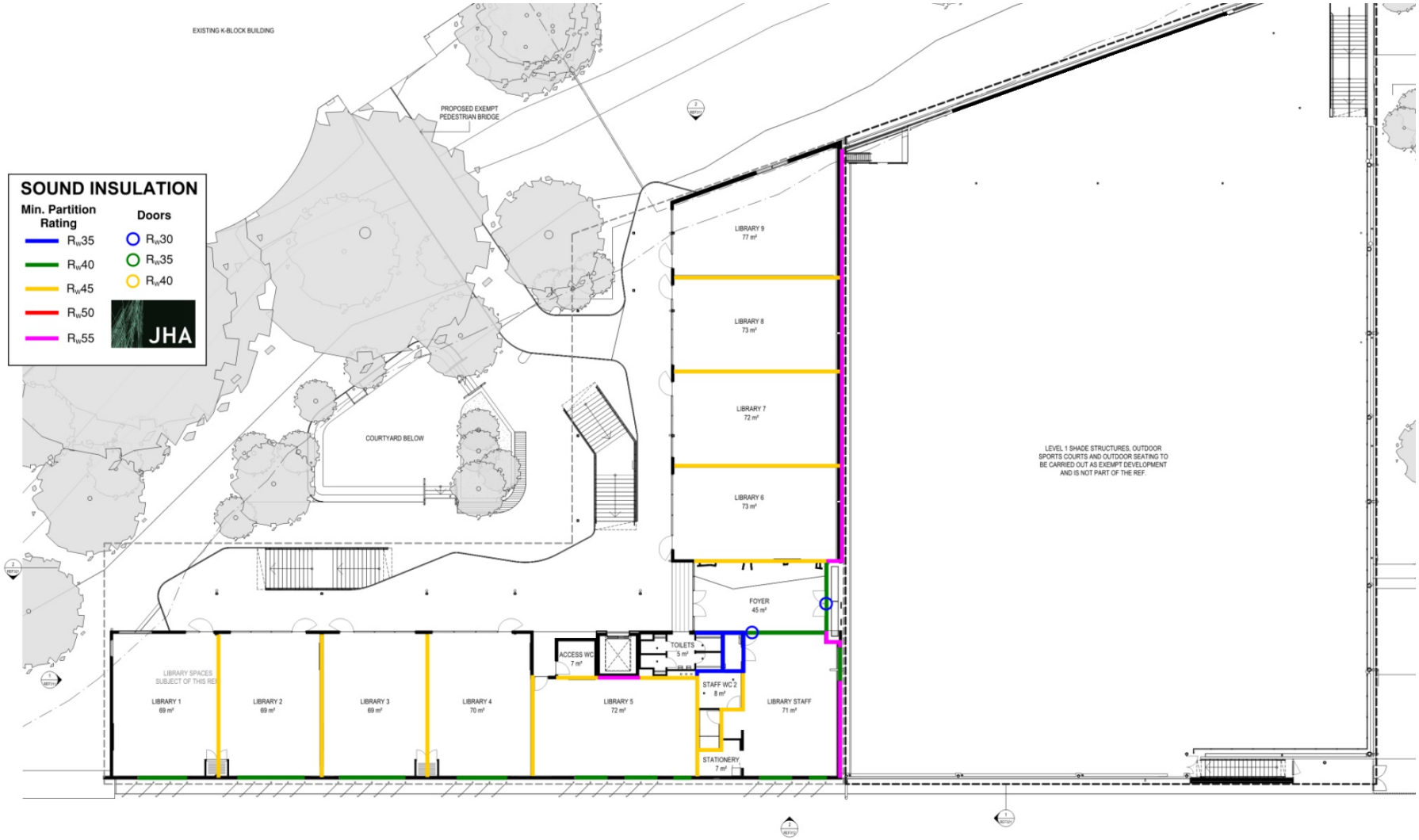
All electrical penetrations shall be sized for cables and conduits passing through building slabs, plasterboard or masonry walls to allow a uniform clearance of 10mm around the item and this gap shall be sealed using an approved acoustic sealant.

Any alternative sealing details utilised shall be designed to maintain the acoustic rating of the walls, ceilings and floors that they penetrate. Alternative details shall be submitted to the Acoustic Engineer for approval.

Any cable, conduit and the like shall be located within the furring channels wherever it is possible.

APPENDIX A: INTERNAL SOUND INSULATION DIAGRAMS




SOUND INSULATION
Min. Partition Rating
Rw35
Rw40
Rw45
Rw50
Rw55
Doors
Rw30
Rw35
Rw40
JHA
EXISTING K-BLOCK BUILDING
PROPOSED EXEMPT PEDESTRIAN BRIDGE
COURTYARD BELOW
LIBRARY 9
77 m²
LIBRARY 8
73 m²
LIBRARY 7
72 m²
LIBRARY 6
73 m²
LEVEL 1 SHADE STRUCTURES, OUTDOOR SPORTS COURTS AND OUTDOOR SEATING TO BE CARRIED OUT AS EXEMPT DEVELOPMENT AND IS NOT PART OF THE REF.
FOYER
45 m²
ACCESS WC
7 m²
TOILETS
5 m²
STAFF WC 2
8 m²
STATIONERY
7 m²
LIBRARY STAFF
71 m²
LIBRARY SPACES SUBJECT OF THIS REF
LIBRARY 1
69 m²
LIBRARY 2
69 m²
LIBRARY 3
69 m²
LIBRARY 4
70 m²
LIBRARY 5
72 m²

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