ENGINEERING SPECIFICATION FOR ACOUSTIC SERVICES

NEW PRIMARY SCHOOL IN EDMONDSON PARK

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A	DETAILED DESIGN	23/09/2021	J REVERTER	210104
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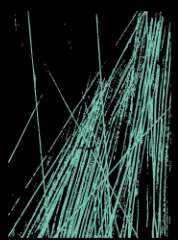

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DOCUMENT CONTROL SHEET

Project Number	210104
Project Name	New Primary School in Edmondson Park
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CONTENTS

1 INTRODUCTION

1.1 CONDITION OF CONTRACT – GENERAL

Refer to the contract preliminaries prepared by the Client's representative for general condition of tendering and contract.

1.2 PROJECT AND BUILDINGS DESCRIPTION

NSW Department of Education is proposing to build a new Primary School located on the corner of Buchan Avenue and Faulkner Way in Edmondson Park, NSW. The proposed location is surrounded by residential and passive recreational receivers and is approximately 0.5km west of Edmondson Park Railway Station

The project will involve site preparation and the construction of new buildings for the Primary School:

- Three new buildings including:
  - A three storey building on the western portion of the site primarily addressing Faulkner Way comprising of 36 homebases, 4 special support unit teaching spaces, staff room, administration office on the ground floor and library on the first floor addressing the corner of Buchan Avenue and Faulkner Way, and student amenities.
  - A single storey preschool for educational programs for children the year before they commence kindergarten, accommodating 40 places, connected at the southern end of the three storey building to be operated by Liverpool City Council.
  - A single storey building on the eastern portion of the site comprising of a communal hall, out of school hours care, 8 homebases and covered outdoor learning area.
- A sports court and various assembly, play and learning zones.
- A drop-off and pick-up zone, and bus zone on Buchan Avenue;
- An at-grade staff carpark at the south of the site with ingress and egress provided off Faulkner Way at the south-west corner of the site;
- Primary pedestrian entrance from Buchan Avenue and an additional entrance on Faulkner Way for the ground floor support unit; and
- Other ancillary infrastructure and utilities works and digital signage.

1.3 DESIGNATIONS

The Project Architect is Tanner Kibble Denton (TKD) Architects, the Acoustic Consultant is JHA Consulting Engineers, Mechanical, Electrical, Hydraulic Engineering Services are provided by JHA Consulting Engineers, and the Contractor is Richard Crookes Constructions.

1.4 SCOPE OF SPECIFICATION

This acoustic specification outlines the acoustic requirements and installation quality controls applicable for the following:

- Internal walls and doors, to control noise transfer between internal areas.
- Building envelope to control noise break-in and break-out.
- Acoustic finishes, to meet the required room acoustic performance and reverberation times for internal areas.

- 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.

This document shall be read in conjunction with all other Contract Documents including the architectural drawings, specification and schedules by TKD Architects; the mechanical services drawings, specification and schedules by JHA Engineers, the hydraulics drawings, specification and schedules by JHA Engineers, plus electrical drawings, specification and schedules by JHA Engineers.

This acoustic specification and related work has been prepared following JHA Consulting Engineers Quality and Environmental Management Systems, which are based on AS/NZS ISO 9001:2015 and ISO 14001:2015 respectively.

1.5 WORKS BY OTHERS

The main Contractor is responsible for ensuring that all of the acoustic performance requirements specified, noise and vibration criteria in this document are satisfied. Notwithstanding the acoustic performance requirements given in this specification, the Contractor must ensure full compliance with this specification with respect to construction materials, installation and workmanship.

This acoustic specification has been developed to efficiently indicate to the Contractor the minimum acceptable requirements of the Principal.

Any deficiencies in performance shall be rectified by the Contractor in accordance with this specification document. All costs associated with rectification works are assumed by the Contractor, and rectification work shall not conclude until the specification is satisfied.

All works completed shall be in accordance with the current Australian Standards, Educational Facilities Standards and Guidelines (ESFG) DG11, Building Code of Australia and the Development Consent Conditions.

1.6 RESPONSIBILITIES

This specification is intended to represent the nature of the works to be undertaken. The Contractor is responsible for the provision of all aspects of the acoustic services in order to provide architectural elements plus noise and vibration control measures for the building services which meet the requirements established in Section 2.

Where the Contractor provides design (alternative solutions), this shall be carried out by a suitably qualified Acoustic Engineer, being a member of either the AAAC or AAS. Proposed design shall be accompanied by technical specification and supporting evidence of their acoustic performance complies with the documented acoustic design.

If discrepancies between documentation and this specification will be found, the Contractor shall action with a Request for Information (RFI) to the Acoustic Engineer and related services. The Acoustic Engineer will review the request to ensure that acoustic performance will be achieved and will confirm approval.

2 PROJECT CRITERIA

2.1 EDUCATIONAL FACILITIES STANDARDS AND GUIDELINES DG11

2.1.1 INTERNAL BACKGROUND NOISE LEVELS

Internal background noise levels within each of the spaces in the development shall meet background noise levels as per ESFG-DG11.

The background noise levels apply to the sound level measured within the space unoccupied but ready for occupancy. The background noise levels are given as overall A-weighted equivalent continuous sound pressure levels ($L_{Aeq,t}$) in decibels.

Mechanical services noise levels in occupied spaces shall be 5dB(A) below the background noise level for each space. This will allow the total noise level from other building services and external noise to be within the recommended range for each area.

The noise generated by mechanical, hydraulics and electrical services plant shall not exceed the values in background noise levels when operating under normal conditions. The noise criteria for internal areas apply at any expected occupancy position(s) in the space.

The noise measurements shall be taken with the space unoccupied but ready for occupancy. The parameter to be measured shall be $L_{Aeq,t}$, where 't' is the duration of a normal operating cycle and the plant is operating throughout the measurement.

The recommended internal background noise levels as per ESFG-DG11 are shown in Table 1.

2.1.2 REVERBERATION TIMES

Each space should have a room acoustic that suits the function of the space and shall meet reverberation time as per ESFG-DG11.

The reverberation time (RT) is the most reliable descriptor of room acoustic performance. The reverberation times apply to spaces unoccupied but ready for occupancy. The reverberation times are given as RT_{mid} (arithmetic average of the reverberation times of the octave bands at 500Hz and 1,000Hz), in seconds.

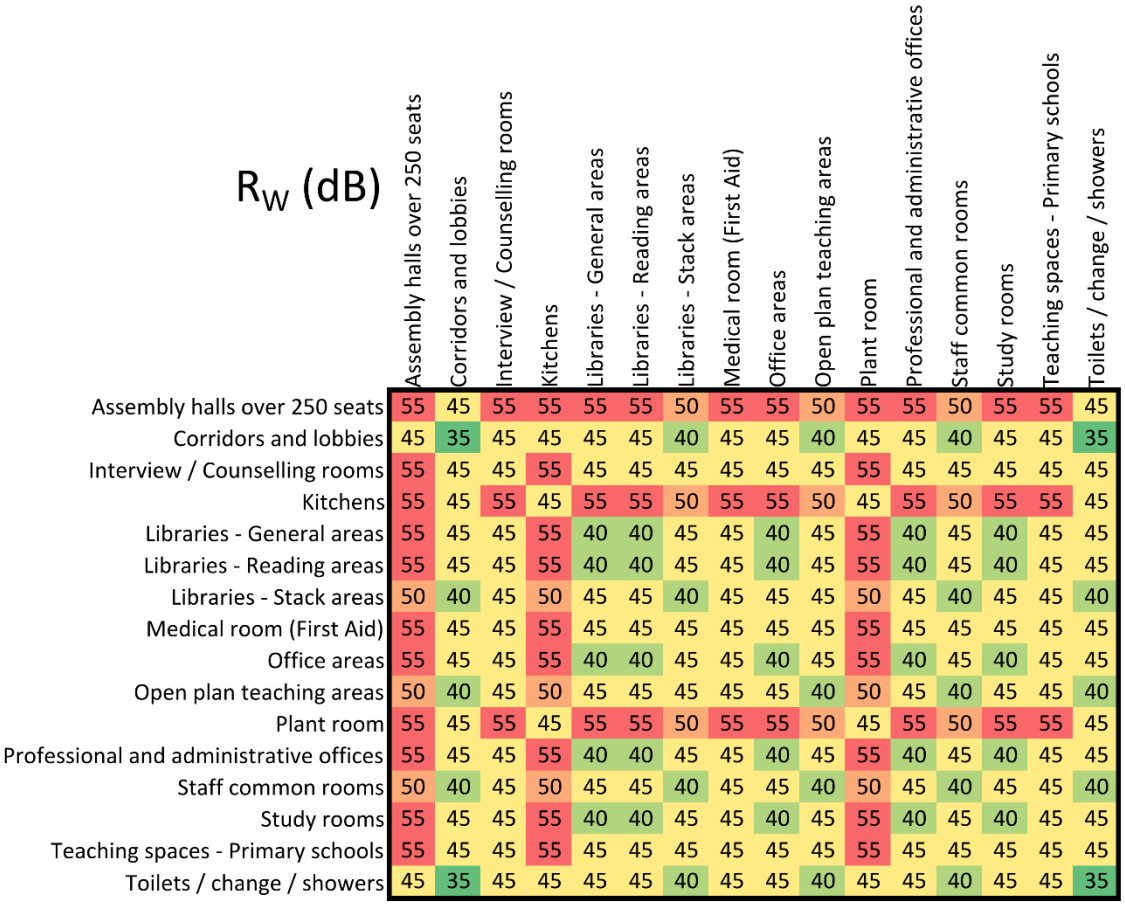
The recommended reverberation times as per ESFG-DG11 are shown in Table 1.

2.1.3 INTERNAL SOUND INSULATION PERFORMANCE

ESFG-DG11 sets the sound insulation performance for internal walls / partitions based on the speech privacy level within the spaces, the adjacent noise source level and the vocal effort. Based on the functionality of noise sensitive spaces, ESFG-DG11 has been reviewed to establish the acoustic requirements for each room.

The sound insulation requirement is assessed between a pair of rooms in each direction (room A to room B and room B to room A) using the speech privacy requirement for the source room, the noise generation of the source room and the noise sensitivity of the receiving room. The more stringent requirement determines the sound insulation rating (R_W) required for each partition.

Based on the above, a minimum sound insulation rating chart has been prepared in Figure 1. This chart shows the minimum sound insulation rating requirements depending on the sensitivity to noise of the receiving space and the noise activity generated in the adjacent, source space.



R_W (dB)	Assembly halls over 250 seats	Corridors and lobbies	Interview / Counselling rooms	Kitchens	Libraries - General areas	Libraries - Reading areas	Libraries - Stack areas	Medical room (First Aid)	Office areas	Open plan teaching areas	Plant room	Professional and administrative offices	Staff common rooms	Study rooms	Teaching spaces - Primary schools	Toilets / change / showers
Assembly halls over 250 seats	55	45	55	55	55	55	50	55	55	50	55	55	50	55	55	45
Corridors and lobbies	45	35	45	45	45	45	40	45	45	40	45	45	40	45	45	35
Interview / Counselling rooms	55	45	45	55	45	45	45	45	45	45	55	45	45	45	45	45
Kitchens	55	45	55	45	55	55	50	55	55	50	45	55	50	55	55	45
Libraries - General areas	55	45	45	55	40	40	45	45	40	45	55	40	45	40	45	45
Libraries - Reading areas	55	45	45	55	40	40	45	45	40	45	55	40	45	40	45	45
Libraries - Stack areas	50	40	45	50	45	45	40	45	45	45	50	45	40	45	45	40
Medical room (First Aid)	55	45	45	55	45	45	45	45	45	45	55	45	45	45	45	45
Office areas	55	45	45	55	40	40	45	45	40	45	55	40	45	40	45	45
Open plan teaching areas	50	40	45	50	45	45	45	45	45	40	50	45	40	45	45	40
Plant room	55	45	55	45	55	55	50	55	55	50	45	55	50	55	55	45
Professional and administrative offices	55	45	45	55	40	40	45	45	40	45	55	40	45	40	45	45
Staff common rooms	50	40	45	50	45	45	40	45	45	40	50	45	40	45	45	40
Study rooms	55	45	45	55	40	40	45	45	40	45	55	40	45	40	45	45
Teaching spaces - Primary schools	55	45	45	55	45	45	45	45	45	45	55	45	45	45	45	45
Toilets / change / showers	45	35	45	45	45	45	40	45	45	40	45	45	40	45	45	35

Figure 1: Chart of the required Sound Insulation Rating for a range of space adjacencies.

These sound insulation requirements are for adjacent rooms without operable walls, entry doors or glazed panels.

2.1.4 DOORS

EFSG-DG11 sets that entry doors to teaching, music, drama and sports spaces shall be solid core, minimum 35mm thick with acoustic seals on all rebated closing faces, being the gap at floor minimised. Sound insulation rating of the described prescriptive construction door is up to R_W30. It is understood that this requirement applies to doors between circulation areas and the teaching, music, drama and sport spaces only.

For doors with a sound insulation rating above R_W30, only hinged, solid core timber doors fitted with acoustic door seals should be considered for these doors. Sliding doors and / or pivot doors should be avoided where any degree of acoustic separation is required.

2.1.5 IMPACT SOUND INSULATION PERFORMANCE

Impact sound via the floor and / or other flanking transmission paths are to be controlled as set out by ESFG-DG11. The required impact sound insulation levels as required by ESFG-DG11 are shown in Table 1.

2.1.6 SUMMARY OF ESFG-DG11 CRITERIA

Table 1 shows the summary of the acoustic criteria described in the previous sections as per EFSG-DG11 requirements.

DG 11 Room	*Reverberation time, RT_{mid} in seconds, unoccupied*	*Internal Ambient Noise Level, L_{Aeq} dB(A) unoccupied*	*Source Room Activity Noise*	*Receiving Room Noise Tolerance*	*Impact Sound Insulation Rating, $L'_{nT,w}$ dB*
Assembly halls over 250 seats	1.1 – 1.3[1]	35	High	Low	60
Corridors and lobbies	Minimise	45	Average	High	60
Interview / Counselling Rooms	< 0.6	35	Average	Low	55
Kitchens	---	50	High	High	---
Libraries – General areas	< 0.6	45[2]	Low	Low	55
Libraries – Reading areas	< 0.6	45[2]	Low	Low	55
Libraries – Stack areas	< 0.6	45	Average	Medium	55
Medical room (First Aid)	< 0.8	40	Average	Low	60
Office areas	< 0.7	40	Low	Low	55
Open plan teaching areas	< 0.8	40	Average	Medium	55
Professional and administrative offices	< 0.8	35	Low	Low	60
Staff common rooms	< 0.6	40	Average	Medium	60
Study rooms	< 0.6	45[2]	Low	Low	55
Teaching spaces – Primary school	< 0.5	40[2]	Average	Low	55
Toilets / change / showers	---	50	Average	High	---

Table 1: Summary of the acoustic criteria as per EFSG DG11 requirements.

[1] Note: The appropriate reverberation time as per AS/NZS 2107:2016 Figure A1.
[2] Note: values as per EFSG – DG55 if spaces are air conditioned.

2.2 OPERATIONAL NOISE

The design shall ensure that noise emissions associated with operation of the Primary School and mechanical plant are controlled to achieve appropriate levels at neighbouring noise sensitive receivers.

Noise controls will need to be incorporated with the design of the mechanical plant room to ensure that the cumulative noise levels from plant to the nearest sensitive receivers meets the noise level criteria when assessed against the NSW Environment Protection Authority (EPA) Noise Policy for Industry (NPI).

A noise monitoring has been carried out in the surroundings of the proposed development in order to establish the Project Noise Trigger Levels (PNTL's) which were obtained in accordance with the requirements of the NSW NPI. The PNTL's are shown in Table 2.

Indicative Noise Amenity Area	*Period*	*Intrusiveness Criterion dB(A)*	*Amenity Criterion dB(A)*
General Residential (R1)	Day	46	58
	Evening	46	48
	Night	43	43
Public Recreation (RE1)	When In Use	---	53
School Classroom	When in use	---	35 (internal)

Table 2: Determination of PNTL's (grey highlight) for noise sensitive receivers.

2.3 GREEN STAR DESIGN

The project is targeting a *"Formal"* 5 Star rating under Green Star Design & As Built v1.3. The Project registration with GBCA is complete. The specification herein and the JHA ESD specification – refer to the project ESD specification – details Green Star initiatives for the project.

The project has targeted Green Star *'credit'* for Acoustic Comfort – IEQ10. The aim of the Acoustic Comfort credit is to reward projects that provide appropriate and comfortable acoustic conditions for the occupants.

The points relevant to the Acoustic Engineering are shown in the table below with a general description of the credit requirements.

Rating System	*Concept and Features*	*Credit Requirements*	*Points / To be claimed?*
Green Star	10.1 Internal Noise Levels	Internal noise levels in the nominated area are suitable and relevant to the activity type in the room. This includes all sound generated by the building systems and the external noise ingress.	1 / Yes
	10.2 Reverberation	The nominated area has been built to reduce the persistence of sound to a level suitable to the activities in the space	1 / Yes
	10.3 Acoustic Separation	The nominated enclosed spaces have been built to minimise crosstalk between rooms and between rooms and open areas	1 / Yes

Table 3: Green Star requirements and points to be claimed.

Refer to the relevant Green Star requirements of this specification for further information relating the aspirations of the project and design / delivery requirements for the acoustic. The Contractor will be responsible to ensure full compliance and delivery of all Green Star initiatives allocated to the acoustic discipline.

2.3.1 INTERNAL NOISE LEVELS

One (1) point is awarded where it can be demonstrated that internal ambient noise levels in the nominated area are no more than 5dB(A) above the lower figure in the range recommended in Table 1 of AS/NZS 2107:2016 *'Acoustics – Recommended design sound levels and reverberation times for building interiors'*.

The noise measurement and documentation must be provided by a qualified acoustic consultant and in accordance with AS/NZS 2107:2016. Noise measurement must account for all internal and external noise including noise arising from building services equipment, noise emission from outdoor sources such as traffic, and (where known) noise from industrial process. Occupancy noise is excluded.

Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified within the Submission Template and must consider how the spaces are considered to be the most conservative with respect to both internal, and external noise sources.

The range of measurement locations shall be representative of all spaces available within the nominated area. All relevant building systems must be in operation at the time of measurement. Projects less than 500m^2 Gross Floor Area (GFA) must account for measurements conducted in at least 95% of spaces within the nominated area.

2.3.2 REVERBERATION TIMES

One (1) point is awarded where the reverberation time in the nominated area is below the maximum stated in the 'Recommended Reverberation Time' provided in Table 1 of AS/NZ 2107:2016 *'Acoustics – Recommended design sound levels and reverberation times for building interiors'*.

Reverberation refers to the persistent prolonged reflections of sound in a space. A technical definition is provided in AS/NZS 2107:2016.

Where note 1 of Table 1 AS/NZ 2107:2016 applies and requires that reverberation times be minimised as far as practical, acoustic absorption should be installed in the noise sensitive space. Acoustic absorption should be applied in locations appropriate to the function of the space, and located to maximise the acoustic performance of materials selected.

The resulting performance of the installed acoustic absorption, irrespective of quantity or location installed, must result in a reverberation time equivalent to or lower than the reverberation time predicted for treating at least 50% of the combined floor and ceiling area with a material having a noise reduction coefficient (NRC) of at least 0.50.

Alternatively, compliance may be demonstrated by treating 50% of the combined floor and ceiling area with a material having a NRC of at least 0.50.

Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified within the Submission Template and must consider how the spaces are considered to be the most conservative.

The range of measurement locations shall be representative of all spaces available within the nominated area. All relevant buildings systems must be in operation at the time of measurement. Projects less than 500m^2 Gross Floor Area (GFA) must account for measurements conducted in at least 95% of spaces within the nominated area.

2.3.3 SOUND INSULATION

One (1) point is awarded where the project addresses noise transmission in enclosed spaces within the nominated area. Enclosed space is defined as meeting rooms, private offices, classrooms, residential apartments (bounding apartment construction), and any other similar space where it is expected that noise should not carry over from one space to the next. For this specific criterion, where the delivery method of the project is core and shell, then the criteria may be considered 'Not Applicable'.

There are two methods for demonstrating compliance with this criterion for this project.

10.3A: Sound Reduction. The partition between the spaces should be constructed to achieve a weighted sound reduction index (R_W) of:

- At least 45; for all partitions which are:
  - Fixed without a door; and/or
  - Glazed partitions without a door*.
- At least 35; for all partition types that contain a door.

*The Acoustic Consultant can use their discretion to determine whether an R_W of 35 or 45 is more applicable when using glazed partitions. The selected Weighted Sound Reduction index must be justified in terms of adjoining space use, required levels of noise sensitivity between spaces and any other aspects which would help to achieve acoustic separation.

10.3B: Sound Insulation. The sound insulation between enclosed spaces complies with:

$$D_W + L_{Aeq,T} \geq 75$$

Where:

- D_W: Weighted sound level difference measured between two spaces; and
- $L_{Aeq,T}$: Indoor ambient noise level in the space adjacent to the enclosed space.

The sound tests from which D_W is derived must be measured in accordance with ISO 140-4:1998[3]. Measurements must be based on finished rooms, accounting for any carpets and acoustically absorbent ceilings specified. The measurements can be conducted in either furnished or unfurnished spaces.

Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified within the Submission Template and must consider how the spaces are considered to be the most conservative with respect to both internal, and external noise sources.

[3] This International standard has been superseded and AS ISO 140.4:2006 shall be employed.

3 ARCHITECTURAL ELEMENTS

3.1 BUILDING ENVELOPE

Building envelope constructions have been developed and specified to control the break-in of external ambient noise (e.g. road traffic noise) to avoid disturbance and to control the break-out of internal operational noise (e.g. mechanical plant noise) to meet the acceptable external noise emissions criteria.

3.1.1 GENERAL

The building envelope (walls, external glazing, ventilation openings and roof) shall be built-up as per the architectural drawings and schedules, and shall be located in the positions indicated on the architectural drawings. Minimum sound insulation performance of the whole façade – including ventilation openings – shall enable to achieve the internal noise levels established in Section 2.

Where acoustic insulation is to replace thermal insulation, it must be adapted to meet the requirements of the thermal insulation specification by, if necessary, introducing additional layers of insulation material and adopting a similar protective outer layer as specified.

Notwithstanding the acoustic ratings given in this specification, the Contractor must ensure full compliance with this specification with respect to construction materials, installation and workmanship.

The Contractor shall rectify any deficiencies in performance with respect to the requirements of this specification. The Contractor shall be responsible for all costs associated with the rectification works until the specification is satisfied. Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the Sound Reduction Indices given in the specification.

Any alternative material and construction to those outlined in this specification shall be reviewed by the Architect and Acoustic Engineer to ensure that the design sound insulation performance is achieved.

3.1.2 DRY WALLS / CLADDING

All dry wall / cladding components in external wall constructions shall meet the following acoustic requirements:

- Metal stud framing or furring channels shall be installed at maximum 600mm centres.
- Proprietary cladding systems shall be installed as per manufacturer's instructions.
- For multiple layers, all joints shall be staggered and sealed.
- Where specified, polyester or mineral fibre sound absorptive insulation shall be installed in the wall cavity being inert, incombustible, non-hygroscopic and rot and vermin proof. Unless noted otherwise on the architectural drawings or in this specification, the cavity insulation material shall be minimum 50mm thick with density of 11kg/m^3.

As per architectural drawing AR-DD-SW-2430[P2], Table 4 shows the composition and minimum sound insulation ratings of the external stud walls.

ID	Composition	Sound Insulation Rating, dB
EWP1	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 30mm airgap / 150mm steel stud with 75mm sound insulation @14kg/m^3) / 6mm fibre cement (@9kg/m^2) / 20mm top hat / 35mm top hat / 9mm compressed fibre cement (@16.9kg/m^2)	R_W55
EWP2	6mm fibre cement (@9kg/m^2) / 20mm top hat / 35mm top hat / 9mm compressed fibre cement (@16.9kg/m^2)	R_W40
EWP3	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 30mm airgap / 2x16mm fire rated plasterboard (@12.5kg/m^2 each) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 2x16mm fire rated plasterboard (@12.5kg/m^2 each) / 20mm top hat / 35mm top hat / 9mm compressed fibre cement (@16.9kg/m^2)	R_W70
EWP4	2x16mm fire rated plasterboard (@12.5kg/m^2 each) / 150mm steel stud with 75mm sound insulation (@14kg/m^3) / 2x16mm fire rated plasterboard (@12.5kg/m^2 each) / 20mm top hat / 35mm top hat / 9mm compressed fibre cement (@16.9kg/m^2)	R_W60
EWP5	6mm XMS / 150mm steel stud with 100mm sound insulation (@14kg/m^3) / 6mm fibre cement (@9kg/m^2) / 20mm top hat / 35mm top hat / 9mm compressed fibre cement (@16.9kg/m^2)	R_W55

Table 4: External wall-types.

3.1.3 EXTERNAL GLAZING

Glazing shall be provided as shown on the architectural drawings and schedules with the nominated type and thickness.

External glazing shall meet a minimum sound reduction performance in order to control noise break-in via the building fabric and shall not exceed the noise levels specified in Section 2.1.

Refer to Table 5 for the nominated glazing thickness. The sound insulation performance of the glazing and frame combined must achieve the stated sound insulation rating.

Sound Reduction Index	Fixed Single Glazing System	Location
R_W35	6mm float / 12mm airgap / 6mm float	Fixed windows
R_W35	10.38mm laminated	Communal Hall
R_W32	6.38mm laminated	Glazed louvres

Table 5: Recommended External glazing.

The Contractor shall be fully responsible for ensuring that each glazing specification is satisfied, including the design, construction, and installation of each glazing type. Any deficiencies in performance, with respect to the requirements of this specification, shall be rectified by the Contractor. The Contractor shall be responsible for all costs associated with the testing and re-testing of the glazing systems until the specification is satisfied.

Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the sound insulation performance given in the specification.

All framing and ancillary elements shall perform similarly such that the whole assembly when completed and in position. The construction of all glazing, framing, ironmongery, seals, surrounds, packing and fixings shall be such as to maintain the full performance of the sealed units.

Seals shall be formed from materials capable of maintaining their elastic qualities and dimensions, and shall be resistant to physical or chemical attack, sufficient to maintain the full acoustic performance of the glazing system during its design life.

The Contractor shall be responsible for ensuring that the glazing framework is effectively sealed to the building structure to achieve the acoustic performance requirements. Any variations in materials and / or constructions used shall only be accepted if approved by the Acoustic Engineer and Architect.

The Contractor shall be responsible for ensuring that the installation tolerances and gaps specified are maintained at all times, and never exceeded. The completed installations shall be capable of accommodating the specified building tolerances and expected building movement without reduction in the specified maximum gaps and tolerances.

3.1.4 ROOF

Roof shall be constructed as shown on the architectural drawings and described in this specification. The Contractor shall be fully responsible for ensuring that the roof construction specification is satisfied, including the design, construction materials, installation and workmanship. Any variations in material and / or constructions used shall only be accepted if approved by the Acoustic Engineer and Architect.

Any deficiencies in performance, with respect to the requirements of this specification shall be rectified by the Contractor. The Contractor shall be responsible for all costs associated with the testing and re-testing of the roof system until the specification is satisfied. Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the sound insulation performance.

The nominated roofing of School is a light metal roofing. The sound insulation performance of a lightweight roof / ceiling construction depends upon the mass of the roof and ceiling layers and the presence of sound absorption in the ceiling cavity. The impact noise from rain on the roof can significantly increase the internal noise levels which must be considered in the design to minimise disruption / disturbance within the teaching spaces.

EFSG-DG11 provides rain noise assessment assumptions but does not establish a rain noise level criteria. Typical acoustic practice is to increase above internal noise level criteria of 5 to 10dB(A). This aligns with previous experiences in schools and typical school constructions plus other design guidelines for educational spaces.

A solid lining barrier between the metal roof / thermal insulation and the perforated ceilings in the teaching spaces shall be included to minimise rain noise. This solid lining barrier can be plasterboard, fibre cement, plywood, etc. Therefore, the proposed roofing / ceiling is:

- Metal roofing;
- Thermal insulation – recommended minimum 11kg/m^3;
- Solid lining barrier – plasterboard, fibre cement, plywood, etc, with minimum 9kg/m^2;
- 50mm thick sound insulation – medium density 32kg/m^3;
- Nominated ceiling.

3.2 INTERNAL ELEMENTS

3.2.1 WALLS AND PARTITIONS

All acoustic partitions are required to be full height / slab-to-slab unless specifically noted in this specification and architectural documentation. There shall be appropriate coordination with the services sub-contractors to ensure that undue penetrations are avoided.

The thickness and density of the sound insulation within the cavity shall be as per this specification – typically 75mm thick with a minimum density of 14kg/m^3. Sound absorptive material shall be inert, incombustible, non-hygroscopic plus rot and vermin proof. Insulation installed into partition cavities shall be installed so voids are not present due to settling and shall fill all partition cavity.

The sound insulation rating of the architectural elements shall not be less than those indicated in Appendix A and the architectural drawings, schedules and this specification. The complete constructions, including all construction materials, associated framing and support systems and seals, when tested in accordance with Section 7.2.1, shall provide the minimum weighted airborne sound reduction indexes (R_W) nominated in the architectural documents (where applicable) and this specification. Any alternative material and construction to those outlined in this specification shall be reviewed by the Acoustic Engineer to ensure that the design sound insulation performance is achieved.

The sound insulation ratings are based on laboratory tests. This performance is unlikely to be met on site due to flanking transmissions, construction quality, penetration details and workmanship. To obtain the best sound insulation performance on site, sealing flanking sound transmission paths during installation including, but not necessarily limited to, junctions between partitions and other building surfaces, air gaps around door-sets, cut-outs for services and the like. All services penetrations to be acoustically sealed to the satisfaction of the Principal and Acoustic Consultant.

All acoustic materials including adhesives and surface materials shall be non-combustible and, under conditions of fire or intense heat, shall not give off toxic emissions. Where required they will comply with all applicable requirements of the current Building Codes.

All acoustic architectural elements shall be adequately protected during delivery, storage and installation.

Masonry wall constructions shall meet the following requirements:

- Concrete walls and core filled concrete block walls shall be minimum density 2,200kg/m^3. Hollow concrete block walls and brick work walls shall be minimum density of 1,800kg/m^3.
- Blocks and bricks shall be of nominated thickness, non-porous and undamaged.
- When masonry walls are adjacent to acoustic rated constructions, airgaps shall be free of mortar or other debris to avoid any mechanical bridge. All joints shall be fully filled with mortar to the full depth of the wall – including between walls and structure. Any depression or irregularity in the walls shall be fully filled with mortar.
- Mechanical connection between masonry / concrete leaves shall be avoided.
- All joints must be filled solid with mortar to the full depth of the wall and services must not be chased into concrete or masonry elements.
- Where joints cannot be filled with mortar, or where walls are non-load bearing and constructed to the underside of slab soffit, the maximum gap between the top of wall and the slab soffit shall be 15mm. The gap shall be filled with mineral wool (minimum density 45kg/m^3) packed tight and covered with a steel angle (minimum 3mm thick steel) bedded in mastic.

- Cracks occurring in a mortar joint shall be surface-sealed with a non-setting mastic compound.
- Control joints shall not be more than 15mm wide and shall be packed with mineral wool (minimum density 45kg/m^3) to the full depth of the wall. Control joints shall be backed with mesh (or similar to retain mineral wool) being surface sealed with a non-setting mastic compound.
- Where walls adjoin a column or other structure and no movement joint is required, the joint shall be filled with dry pack mortar or non-shrink grout to the full depth of the wall and shall be surface sealed with a non-setting mastic compound.
- Where walls adjoin a column and a movement joint is required, the joint shall be formed as described for control joints above.

It is the responsibility of the Sub-Contractor to ensure that the architectural elements meet the required sound insulation ratings. The Contractor shall rectify any deficiencies in performance with respect to the requirements of this specification. The Contractor shall be responsible for all costs associated with the rectification works until the specification is satisfied. Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the Sound Reduction Ratings given in Appendix A.

Figure 2 shows a design sketch of the recommended lightweight wall / partition junction detail to minimise flanking path noise transmission and maintain the sound insulation performance of wall / partitions achieving a sound insulation rating $R_W \geq 50$. This design sketch is for design purposes intent only, and is not prepared to a level where it can be relied upon for installation.

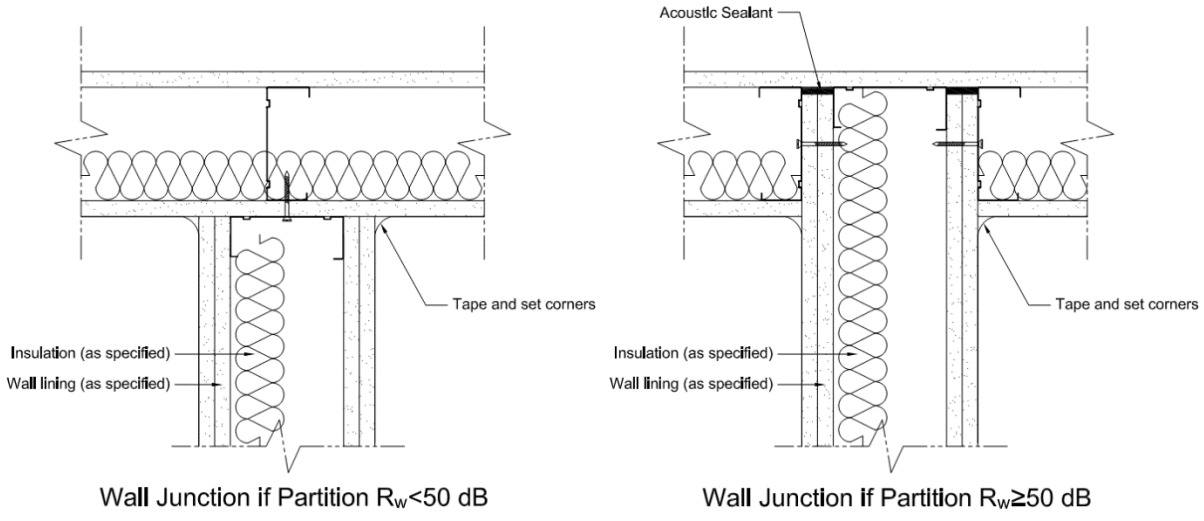


Figure 2: Wall / partition junction detail to minimise flanking path via walls.

Plasterboard / dry wall constructions shall be installed with the fixings, joint seals and other ancillary material in accordance with the manufacturer instructions. Joints between plasterboard layers and between a plaster and slab shall be acoustically sealed.

If one layer is required on both sides of a wall, it must be fastened to the studs with joints staggered on opposite sides; and if two layers are required, the second layer must be fastened over the first layer so that the joints do not coincide with those of the first layer. Joints between sheets, or between sheets and any adjoining construction, must be taped and filled solid.

Edge joints to masonry wall or columns shall be close fitting, with a gap of maximum width 10mm. The gaps shall be filled with non-hardening mastic or sealant.

Metal stud framing or furring channels shall be installed at minimum 600mm centres. Head and foot channels shall be mechanically fixed to the ceiling slab and floor slab, and be fully sealed with a bead of non-hardening mastic or sealant between the channel and the slab. In partitions with blockwork, a 10mm minimum gap shall be between blockwork and steel studs.

The perimeter of the timber or metal stud framing members must be securely fixed to the adjoining structure, bedded in resilient compound; and joints must be caulked so that there are no voids between the framing members and the adjoining structure.

Based on the information obtained from the architectural drawing AR-DD-SW-2431[P2] and specification, Table 6 shows the proposed internal wall-types and their sound insulation rating (R_W) for full height partitions.

ID	*Composition*	*Sound Insulation Rating, dB*
IWP1	2x13mm plasterboard (@8.4kg/m^2 each) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 13mm soundcheck plasterboard (@12.5kg/m^2)	R_W50
IWP2	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 13mm soundcheck plasterboard (@12.5kg/m^2)	R_W45
IWP3	13mm plasterboard (@8.4kg/m^2) / 150mm steel stud with 75mm sound insulation (@14kg/m^3) / 13mm plasterboard (@8.4kg/m^2)	R_W45
IWP4	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 13mm plasterboard (@8.4kg/m^2)	R_W40
IWP5	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud / 13mm plasterboard (@8.4kg/m^2)	R_W35
IWP6	9mm fibre cement (@13.5kg/m^2) / 92mm staggered steel stud with 75mm sound insulation (@14kg/m^3) / 9mm fibre cement (@13.5kg/m^2)	R_W50
IWP7	9mm fibre cement (@13.5kg/m^2) / 92mm staggered steel stud with 75mm sound insulation (@14kg/m^3) / 13mm plasterboard (@8.4kg/m^2)	R_W50
IWP8	13mm fire rated plasterboard (@10.5kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 13mm fire rated plasterboard (@10.5kg/m^2)	R_W45
IWP9	2x16mm fire rated plasterboard (@12.5kg/m^2 each) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 2x16mm fire rated plasterboard (@12.5kg/m^2 each)	R_W55
IWP10	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 155mm airgap / 250mm concrete wall (@2,200kg/m^3) / 16mm top hat / 9mm fibre cement (@13.5kg/m^2)	R_W70
IWP11	13mm plasterboard (@8.4kg/m^2) / 92mm steel stud with 75mm sound insulation (@14kg/m^3) / 30mm airgap / 150mm steel stud / 9mm fibre cement (@13.5kg/m^2)	R_W60

Table 6: Internal wall-types.

3.2.2 PARTITION AND WALL PENETRATIONS

Ductwork and other building service penetrations must not reduce the sound insulation performance of partitions. The best principle is to avoid holes being cut through critical separating walls altogether and ensure that all services enter the room via a corridor and do not pass directly from room to room.

Where the sound insulation rating of any partition is greater than or equal to R_W50, a 13mm plasterboard close fitting cover plate is required. It shall be sealed airtight with a non-hardening mastic or sealant and fitted round the penetration on one side. Holes and gaps bigger than 10mm shall be sealed as close as possible

with plasterboard. The remaining gap shall be tightly packed with medium density (≥45kg/m^3) mineral wool or polyester and sealed airtight with a non-hardening mastic or sealant. Gaps smaller than 10mm shall be tightly packed with medium density mineral wool or polyester and sealed airtight with a non-hardening mastic or sealant.

All ducting and pipework penetrations shall be completely sealed such that the sound insulation and fire performance of the penetrated construction alone is not downgraded.

Where services pass through fire-rated walls or enclosures, the Contractor shall ensure that the penetration sealing detail is sufficiently fire-rated to maintain the fire-rated performance of the wall or enclosure.

Where penetrations are constructed in ceiling structures, the surfaces of the penetration shall be smooth and even (to within 5mm). The penetrations shall not be oversized. If oversized, the penetrations shall be made good to the required size.

Appendix B contains penetration sketches for design purposes intent only, and are not prepared to a level where they can be relied upon for installation purposes. Installation drawings are required by this Contract for the purpose of installing the services. Installation should not proceed without installation drawings having been prepared by the responsible Contractor and returned with comments by the Acoustic Engineer.

3.2.3 INTERNAL GLAZING

Glazed partitions and glazing must be provided in the locations as shown on the Architect's drawings. All framing and ancillary elements must not reduce the sound insulation performance of the partition when completed and installed.

If there is no laboratory sound insulation test evidence for the whole assembly, aluminium framing must be packed with medium density mineral wool (45kg/m^3) and compressed to 80%.

Internal glazed partitions and vision panels shall be specified in order to ensure that the overall performance of the partition / door is not degraded. Table 7 shows the nominated glazing arrangements for the partition types and their nominated sound insulation ratings.

Sound Insulation Rating	*Typical arrangement*	*Nominated glazing*
R_W35	Single	10.38mm laminated

Table 7: Internal glazing composition and sound insulation ratings.

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 – Aluminium framing filled with 30kg/m^3 insulation (minimum density), solid timber or steel.

3.2.4 DOORS

3.2.4.1 General

Acoustic doors shall be provided as shown on the Architect's drawings and schedules (wherever an R_W rating is nominated for a door, or the door is nominated as an acoustic doorset) and / or described in the specifications, with the material properties described in this specification. Appendix A shows the location of the acoustic doorsets and their sound insulation rating.

For rooms where doors with an acoustic rating are required, the following doorsets presented in Table 8 are nominated to achieve the proposed acoustic privacy requirements.

ID	*Weighted Sound Reduction (R_W)*	*Composition*	*Acoustic Seals*	
			Frame	*Bottom*
SL	R_W30	10.38mm laminated	Raven RP74F	Raven RP129F
GD / SL	R_W30	10.38mm laminated	Raven RP74F	Raven RP129F
TD	R_W35	40mm solid core Rebated frame	Raven RP120	Raven RP99Si

Table 8: Acoustic door types.

For proprietary acoustic doorsets, the Contractor shall provide an acoustic laboratory test report of the proposed proprietary acoustic doorset – with the acoustic door frame, leaf and seals as provided by the acoustic door supplier – to demonstrate compliance with the acoustic performance requirements. The test report shall be submitted for the Acoustic Engineer's approval prior to ordering. An inspection by a supplier representative is recommended to be carried out in order to check that proprietary acoustic doorsets have been installed in accordance with the manufacturer's recommendations.

The Contractor shall be fully responsible for ensuring that each Acoustic Door specification is satisfied, including construction materials, installation and workmanship, and the R_W rating shown in the Architect's door schedule.

The Contractor shall rectify any deficiencies in performance with respect to the requirements of this specification. The Contractor shall be responsible for all costs associated with the rectification works until the specification is satisfied.

The door supplier shall be fully responsible for ensuring that each door specification is satisfied, including the design, construction, installation, commissioning and testing of each acoustic doorset. The supplier shall rectify any deficiencies in performance, with respect to the requirements of this specification. The supplier shall be responsible for all costs associated with the testing and re-testing of the doors until the specification is satisfied.

Notwithstanding the guidance on materials and fixings, the Contractor must ensure full compliance with the R_W ratings given in the door schedules and specification.

All acoustic door leaves shall be solid (not hollow construction) and composite door leaves shall not be used without Acoustic Engineer approval.

There shall be no open key holes or a transfer grille in acoustically rated door leaves. Fixing for facing, brackets to hold door open, handles or other items attached to the doors shall not decrease the sound insulation performance.

As per the Disability Discrimination Act (DDA) the maximum opening and closing force is 20N for non-powered doors. In order to meet the required closing force of the door, the doorset manufacturer shall supply the complete door set of frame, door and hardware to achieve the acoustic rating and closing force requirement.

Where vision panels can be installed in doors, the size and performance of the glazing must be such that it has an equal performance to that of the door.

Door frames shall be sealed airtight into the adjoining wall in order to maintain the sound insulation performance.

Where frames are installed in lightweight walls, each layer of the lightweight wall shall be separately sealed to the framing or shall be continued across the door jamb and head to close the wall cavity. Cement or mortar shall be used where frames are installed in masonry walls and gaps shall be filled to the full depth of the wall and shall be installed such that the frame is not wedged.

Framing gaps not exceeding 10mm width may be sealed with non-hardening sealant.

The Contractor shall provide full shop drawings of the acoustic doors for the Architect and Acoustic Engineer's approval prior to fabrication.

3.2.4.2 Seals

Effective, continuous, acoustic seals shall be provided around the perimeters of all Acoustic Doors, including the threshold. The form and material of the seals shall be such that normal operation of the doors shall not result in seal degradation, loss of acoustic performance or visible uneven sealing lines.

All seals shall be designed to be protected from impacts during operation. Exposed seals shall be protected using steel or other impact resistant material.

Sealing mechanisms shall allow for the accommodation, without loss of acoustic performance, of building tolerances and of floor level variations. The threshold sealing mechanism shall be adjustable to allow for the accommodation of door movement and normal building tolerances without loss of performance. Seals shall not be used to take up tolerances greater than ±30% of the design dimension.

Seals and sealing mechanisms shall be adequately protected against damage during transit and installation. The protection shall remain effective until the doors are commissioned. Seals shall not be stretched. Site cutting of seals shall be limited to an absolute minimum, and shall be approved by the Architect and Acoustic Engineer.

The seals and sealing mechanism shall be guaranteed to maintain the acoustic performance, given fair wear and tear, for a minimum period of 10 years. The design shall allow for simple replacement or adjustment of any elements necessary to restore the acoustic performance to the design value thereafter, at any time during the design life of the Acoustic doorset as a whole, should any degradation of performance occur after 10 years.

The Contractor shall grout the recesses in the concrete at the door thresholds as necessary to a minimum density of 2,200kg/m^3. Compression seals shall be fitted to the frames of the each Acoustic Door to form continuous seals around the jambs and heads.

Fire seals shall be provided in addition if required as specified by the Architect.

3.2.5 CEILING CONSTRUCTIONS

Ceilings shall be provided in the locations as shown on the Architect's drawings and schedules and / or described in the specifications, with the material properties described in the specification.

Edge joints to masonry wall or columns shall be close fitting, with a gap of maximum width 10mm. The gaps shall be filled with non-hardening mastic or sealant.

Metal stud framing or furring channels shall be installed at minimum 600mm centres. Where specified, sound-absorptive insulation shall be installed in the ceiling cavity. Absorbent materials shall be inert, incombustible, non-hygroscopic and rot and vermin proof. Unless noted otherwise on the architectural drawings, all ceiling cavity sound insulation shall be 75mm thick with a minimum density of 32kg/m^3.

Ceilings shall not contact any mechanical or hydraulics services in the ceiling cavity. A minimum clearance of at least 10mm shall be provided between the top of the ceiling lining and the underside of the external dimension of the services.

Any service openings or other penetrations through any solid ceiling shall be fully sealed in order to maintain the acoustic integrity of the ceiling. All ceiling access panels in acoustic rated ceilings are required to be acoustic rated access panels. Proprietary acoustic access panel with a minimum rating of R_W30 are required for room ceilings. The acoustic access panel will be formed by a steel-encased plasterboard panel with perimeter acoustic seals.

3.3 INTERNAL FINISHES

Acoustic finishes shall be provided as shown on the architectural drawings and described in this specification. The Contractor shall be responsible for constructing the finishes / panels from the materials shown in these documents. Any variations in materials and / or constructions used shall only be accepted if approved by the Acoustic Engineer and Architect.

The acoustic criterion for the acoustic finishes is expressed in terms of the random incidence sound absorption coefficient, as defined in AS ISO 354:2006 *'Acoustics – Measurement of sound absorption in a reverberation room'*. Octave band and one-third octave band values of sound absorption shall be measured directly and provided in the test report.

Acoustic ceiling finishes shall be provided in the locations shown on the architectural drawings. The Contractor shall be responsible for carrying out measurements on site prior to fabrication / installation of the finishes, as required, in order to ensure that the sizes shown can be accommodated on site. If panels / finishes need to be modified, or new panels fabricated, because they do not fit or clash with other fixtures, fittings or services, the Contractor shall bear the cost of the modifications or re-fabrication.

Sound-absorbent materials within acoustic ceiling panels or above acoustic ceilings shall be inert, incombustible, non-hygroscopic and rot and vermin proof with a minimum density of 32kg/m^3.

For all insulation used in acoustic ceiling panelling or above acoustic ceilings, test data shall be provided for the acoustic insulation products used, for each thickness, prior to installation of the panels / finishes to demonstrate compliance with the performance requirements indicated in the specification. Test data shall show that the performance requirements are achieved using any facing material as specified by the Architect.

The minimum sound absorption coefficients for the acoustic insulation used in acoustic ceiling panelling or above acoustic ceilings shall be:

Thickness (mm)	Sound absorption coefficient (α),							
	63	125	250	500	1k	2k	4k	8k
50mm	0.15	0.20	0.62	0.95	0.95	0.95	0.95	0.90
75mm	0.30	0.45	0.80	0.95	0.95	0.95	0.95	0.90

Table 9: Minimum Sound Absorption Coefficients for acoustic insulation used in room acoustic finishes.

In addition to the specified acoustic performance, all insulation used in acoustic ceiling panelling or above acoustic ceilings shall be a mineral fibre (glasswool or rockwool) or polyester insulation manufactured using high quality fibres. Loose or fibrous materials shall be packaged under not less than 5% compression to eliminate voids due to settling. The material shall be fixed to the backing so as to not sag or drop.

All acoustic materials including adhesives and surface materials shall be non-combustible and under conditions of fire or intense heat shall not give off toxic emissions. Where required they will comply with all applicable requirements of the current Building Codes.

Nominated acoustic products and their minimum NRC are shown in Table 10, as per Architect's schedule TKD-SCH-AR-DD-07[P1] and set of RPC drawings.

ID	Description	Minimum NRC
CA	Carpet with acoustic backing.	0.30
LIN	Acoustic wall panel / pinboard. Autex Quietspace panel 25mm with Vertiface finish.	0.70
PBD	Plasterboard ceiling. Gyprock 13mm.	0.10
PBD/PER	Perforated Plasterboard Ceiling. Gyprock Rigitone Galaxy 8mm, 15mm, 20mm with 50mm thick sound insulation (@32kg/m^3)	0.60
ACT	Acoustic ceiling tile. Armstrong Fine Fissured Plank.	0.60
ACP1	Acoustic ceiling panel. Décor System DécorSlat.	0.60

Table 10: Nominated interior acoustic internal finishes.

Ceiling coverage and types for the different spaces are provided in Table 11.

Location	Ceiling type	Coverage (%)
PAA	PBD/P – Perforated plasterboard	< 40
	ACT – Acoustic ceiling tile	> 60
Homebase / Withdrawal	PBD/P – Perforated plasterboard	100
Library	PBD/P – Perforated plasterboard	100
Communal Hall	ACP1 – Acoustic ceiling panel	100
Administrative Offices / Interview / Professional Offices / Staff Rooms	PBD/P – Perforated plasterboard	100
Clerical	PBD/P – Perforated plasterboard	> 50
	ACT – Acoustic ceiling tile	< 50
Special Programs	PBD/P – Perforated plasterboard	100

Table 11: Nominated ceiling types and ceiling coverage.

4 MECHANICAL SERVICES

This section outlines the requirements specific to mechanical services equipment. It is recommended to incorporate these into the mechanical design drawings and specification.

4.1 MECHANICAL PLANT – GENERAL

Noise levels generated by all mechanical plant shall be limited to the in-duct and case radiated octave band sound power levels, and sound pressure levels as given in the mechanical documents, schedules and Appendix C of this specification. These noise levels are limiting noise levels and noisier plant items will not be considered.

No measurable tonal sound characteristics shall exist in the tested sound levels. If tonality is considered to be present, the Contractor shall make every effort to eliminate it. Failure to achieve this will require attenuation of the pure tones by the amounts below the permitted corresponding octave band sound pressure level.

If an alternate mechanical equipment is nominated to replace any plant in this specification, the alternative plant shall have sound power levels lower than those of the plant that it replaces. The Contractor's mechanical plant selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

4.2 PRELIMINARY PROJECT SPECIFIC NOISE CONTROLS

Preliminary specific noise controls for mechanical services are provided below. These shall be reviewed and confirmed before final documentation. Acoustic treatment to the mechanical services shall be installed in accordance with the mechanical documentation and as detailed below, in order to achieve the project specific acoustic requirements:

- All ductwork for Outside Air Fans (OAFs) serving Fan Coil Units (FCUs) shall be 50mm internally lined.
- The minimum length of flexible ductwork from the take-off / return plenum shall be 2m.
- FCUs located above acoustically perforated ceilings will require an acoustic noise controls to minimise the noise break-out from the units as per Section 4.4.5.
- All flexible ductwork is to be internally insulated and shall meet the insertion loss values as stated in this report as per Section 4.4.2.
- Install vibration isolation to all mechanical services in accordance with the requirements of this specification, the manufacturers' instructions and the mechanical services specification.
- Install transfer ducts in accordance with the requirement of this report as per Section 4.4.4. All transfer ducts within acoustically rated partitions be 50mm internally lined.
- Select supply and return diffusers such that the regenerated noise does not contribute to the overall noise level, and such that the resulting noise level in the spaces meets the internal noise requirements. Refer to Section 4.5.
- Acoustic barriers / screens shall be provide to the external mechanical plants serving the Building A and facing Faulkner Way. Refer to Section 4.6.

4.3 FAN COIL UNITS (FCUS) AND FANS

FCUs and fans shall be supported on steel springs and / or neoprene / rubber pads to comply with the requirements of this specification and minimise vibration transmission into the building structure. Access doors shall be sealed with neoprene gaskets to provide an airtight seal.

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

All pipe and conduit penetrations of FCUs / fan casings shall be acoustically sealed.

All pipes connected to FCUs / fans shall have flexible union pipe connectors. The works Sub-Contractor shall ensure that all fan casing / enclosures are adequate so that noise in occupied rooms due to break-out does not exceed the background noise level criteria specified in the NSW Police Force Building Code.

Noise levels generated by FCUs / fans shall be limited to the octave band sound power levels as given in the mechanical schedules. Test data shall be provided to demonstrate conformity with the specified noise levels. Where test data cannot be provided for the actual units to be installed on site, at their operating duties, the Tenderer shall provide representative sound level data for approval by Acoustic Engineer.

The Contractor's selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

4.4 ACOUSTIC DUCTWORK

4.4.1 INTERNAL

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 or 50mm 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 duct lining as installed shall have minimum sound absorption coefficients as measured according to AS ISO 354:2006 *'Acoustics – Measurement of sound absorption in a reverberation room'*. Table 12 shows the minimum sound absorption coefficients for linings of various thicknesses

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

Table 12: Minimum sound absorption coefficient for duct lining.

4.4.2 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 regenerated noise, air velocities in flexible ducts shall not exceed the recommended velocities in Section 4.4.3.

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 – it is 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.

Where the flexible duct is connected to a spigot or collar, the inner section of the duct shall overlap with the spigot or collar by at least 100mm. A hose clamp or heavy duty cable tie with mechanical tensioning shall be used to clamp the flexible duct securely to the spigot. Duct tape shall be used to provide the final seal of the insulation and outer sleeve of the flexible duct to the spigot or collar.

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.

The 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 shown in Figure 3.

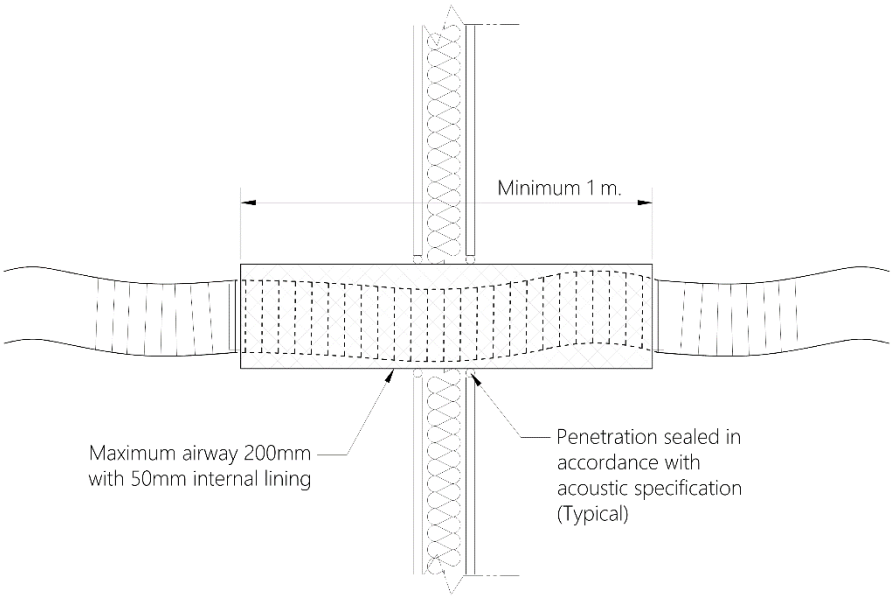


Figure 3: Flexible duct penetration detail.

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 13.

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 13: Acoustic performance specification for flexible ductwork.

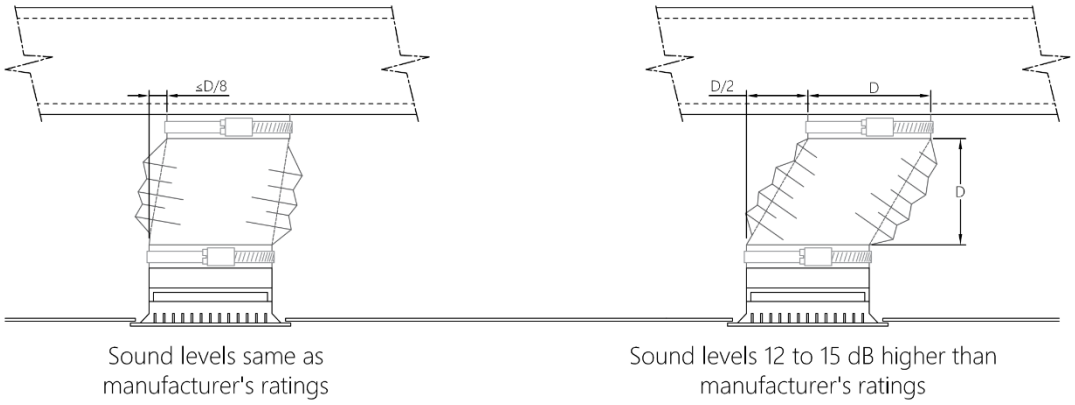


Figure 4: Effect of proper (left) and improper (right) alignment for flexible ductwork connection.

4.4.3 AIR VELOCITIES

Mechanical duct design shall consider the geometry of duct branches, duct tees and 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 14 shows the maximum airflow velocities within mechanical ductwork serving internal spaces with the required noise level criteria.

NR Curve / Noise Criterion dB(A)	*Duct air velocity, in m/s*			
	Main	*Branch*	*Runout*	*Flexible*
20 / 30	4.5	3.5	2.0	1.6
25 / 35	5.0	4.5	2.5	2.0
30 / 39	6.5	5.5	3.2	2.5
35 / 44	7.5	6.0	4.0	3.0
40 / 48	9.0	7.0	5.0	3.5

Table 14: Maximum recommended in-duct airflow velocities.

4.4.4 TRANSFER DUCTS

Transfer ducts shall be located in the positions indicated on the mechanical drawings and above doors – whenever is possible. Transfer ducts shall achieve the performance provided in the Mechanical Engineer's documentation plus an insertion loss that minimises reduction of sound insulation performance of the partition where is located.

All transfer ducts shall be at least 50mm thick internally lined – either mineral fibre or polyester with a minimum sound absorption coefficient as per Table 12 – and their construction shall be as follows:

R_W of partition	*Ceiling type*	*Transfer Duct Construction*		
		Straight duct length (m)	*Maximum airway (mm)*	*Number of bends*
35 – 40	Solid	1.0	200	---
	No solid	1.5	200	1
40 – 45	Solid	1.5	200	---
	No solid	1.5	200	2
45 – 50	Solid	1.0	200	1
	No solid	2.0	200	2

Table 15: Transfer ducts constructions.

The Contractor's selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

4.4.5 ACOUSTIC LAGGING / ENCLOSURE OF MECHANICAL PLANT

Where additional noise control measures are necessary to control noise break-out of mechanical plant, acoustic cladding / wrapping shall be provided as per mechanical drawings and schedules plus this specification.

Acoustic lagging and enclosure of mechanical plant shall be as follows:

- Unless otherwise specified, acoustic enclosure shall be constructed using a minimum of 50mm medium density (32kg/m^3) sound insulation covered by one continuous solid layer with a minimum surface mass of 12kg/m^2. The enclosure shall be completely isolated from the duct or fan to form a completely sealed envelope around the mechanical plant – no gaps are permitted. The enclosure shall extend at least 1 meter either side of the mechanical plant casing covering the flexible joints. Acoustic rated access panels shall be provided with a minimum R_W30.
- Acoustic lagging with 50mm thick sound insulation (32kg/m^3) and loaded vinyl (8kg/m^2) with joints overlapped at least 50mm.

An indicative diagram - for design intent only - showing an acoustic enclosure for mechanical plant is shown in Figure 5.

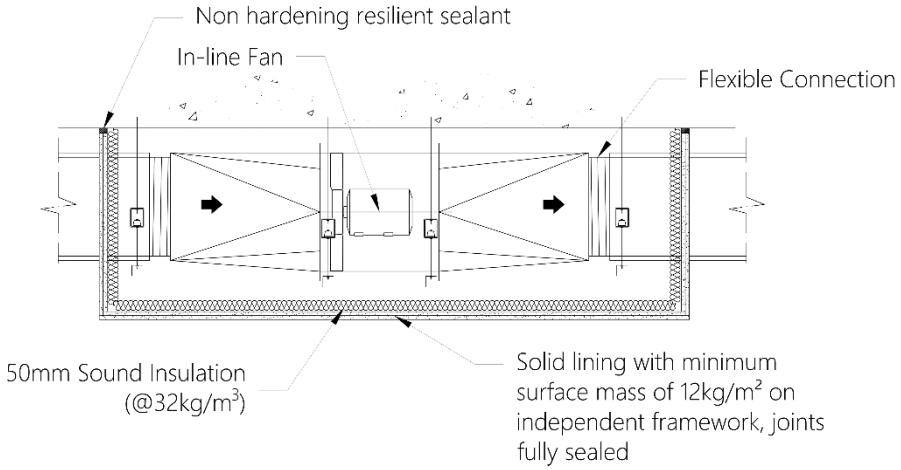


Figure 5: Acoustic enclosure for mechanical plant.

4.5 DIFFUSERS / GRILLES

Terminals shall be selected in accordance with the air velocities within the range deemed acceptable by the manufacturer. Notwithstanding with this, terminals shall be quiet in operation and shall not produce tones or hissing noise.

Sound power level data shall be measured in accordance with ISO 5135:1997 *'Acoustics – Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room'*.

The terminals shall be selected to ensure that their self-generated noise, together with the noise from the main distribution system, do not exceed the noise level criteria specified in Section 2.1.1 for the spaces being served. Terminals shall be selected so that the manufacturer noise level is at least 8 to 10dB lower than the internal noise level criteria for the room it serves.

Ceiling grilles shall be located away from transfer ducts. All linear supply air and return slot diffusers shall not be located above a partition line.

Table 16 shows the maximum air velocities for grilles and diffusers serving internal spaces with the required noise level criteria.

NR Curve / Noise Criterion dB(A)	*Maximum neck velocity, in m/s*		
	Egg-Crate Grille	*Half Chevron Grille*	*Supply Register*
35 / 44	3.0	1.8	2.1
40 / 48	4.0	2.2	2.6
45 / 53	4.5	3.0	3.2
50 / 58	5.5	3.5	3.9

Table 16: Maximum air velocities for grilles and diffusers.

4.6 ACOUSTIC BARRIER / SCREEN

The external mechanical plant will comprise of external condenser units spread across three locations on the eastern side of Block A along Faulkner Way.

Acoustic barriers / screens must be provided to the external mechanical plant to minimise any noise impact to the nearest residential receivers on Faulkner Way. Acoustic screens / barriers shall be provided around the external mechanical plantrooms as indicated in the architectural drawings.

Figure 6 shows the external mechanical units adjacent to Block A and the proposed acoustic screen location.

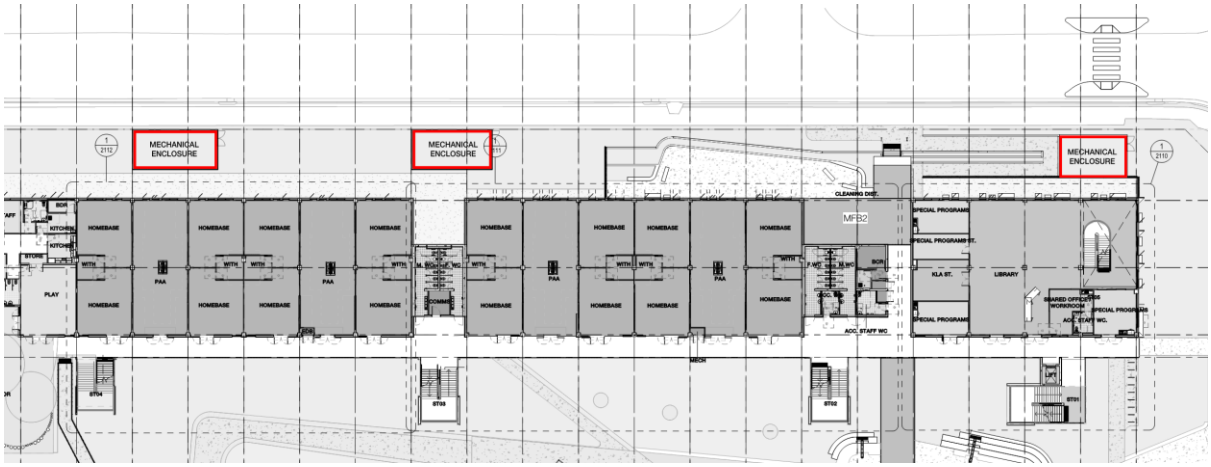


Figure 6: Acoustic barriers / screens for the condenser units on the eastern side of Block A.

The acoustic barrier / screen for the external mechanical plant shall have solid walls with a minimum height of 300mm above the tallest element of the mechanical plant. Acoustic barrier / screen to be lined with sound absorptive acoustic material on the side facing the mechanical plant. The solid sections of the screen shall be constructed from a material with a total surface weight of not less than 12kg/m^2 (being 6 mm CSR Wallboard, compressed fibre cement, or similar) and shall be continuous with no gaps. Any doors shall be of a similar material and weight, and shall have acoustic seals on all sides, to the approval of the Acoustic Consultant.

The acoustic barrier / screen shall be designed for external use and be provided with all bracing and structural support required to comply with loadings and building regulations. The fixing of the components and the sound absorptive assembly as a whole shall allow for ease of inspection and replacement of the sound absorptive material. Details of the screen construction, performance and installation shall be subject to the approval of the Structural Engineer, Architect and Acoustic Consultant.

The nominated sound absorptive material to be applied to the internal side of the solid screen is Pyrotek Reapor, or equal and approved alternative complying with this specification. The material is suitable for use in outdoor environments and shall be facing the mechanical plant. The sound absorptive material shall be manufactured consistently and shall remain dimensionally stable under the defined range of environmental conditions to which it will be exposed. Sunlight or daylight shall not cause sufficient damage to the material to affect its sound absorptive properties and durability. The material shall be non-hygroscopic, insect, rot and vermin-proof and shall drain naturally and successfully when wet.

4.7 PUMPS

All pumps shall be selected with the highest efficiency consistent with the specified duty. To minimise the possibility of tonal effects, the pump impeller diameter shall not exceed 0.9 of the maximum impeller diameter capability of the pump housing.

Pump impellers, shafts and drive couplings shall be statically and dynamically balanced to the best commercial standards. Maximum vibration velocity amplitude shall not exceed 2.5mm/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 shall be mounted on a concrete filled inertia block and completely isolated as specified. Pump inertia blocks shall 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 when selecting the final size of the required inertia blocks.

Where inertia bases are recommended, the pump and motor assembly shall be bolted directly onto the concrete inertia block. The inertia base 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 shall be in full compliance with the details provided in this specification. T-shaped inertia bases shall be used as support for pump elbows where applicable.

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

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

4.8 VIBRATION CONTROL

The Contractor is responsible for the vibration isolation of the mechanical services in order to minimise noise and vibration transmissions to the building structure. Vibration isolation will be required for all mechanical services plant and equipment. Vibration isolation systems are to be selected to meet the noise and vibration criteria set in this specification.

It is the responsibility of Services Contractors, particularly the Mechanical Service Contractor, to select appropriate vibration isolation for each plant item. Note that it may be necessary for the Contractor to engage the services of an appropriately qualified vibration consultant or vibration isolation manufacturer to assist in the selection of appropriate vibration isolation.

Where a vibration isolator type is not specified, the type, active material, size and mounting shall be agreed between the machinery and vibration isolator manufacturers and shall comply with this specification.

Vibration isolation components of mechanical systems 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.

Vibration isolation systems for mechanical plant shall be selected accordingly to the weight loads of plant. Vibration isolation shall be incorporated to minimise vibration impacts and shall be sized and selected with the proper deflection. This will allow no perceptible structural vibration in noise sensitive spaces plus no

audible re-radiated noise. The Contractor's selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

Generic recommendations for vibration isolation are shown in Table 17 and vibration isolators are to be Embelton, Manson or similar approved by Acoustic Engineer.

Plant Type	*Vibration Isolator Type*	*Minimum Static Deflection (mm)*
In-line Centrifugal Fans	Neoprene mounts or hangers	10
Axial Fans (Ø<450mm)	Neoprene mounts or hangers	10
Axial Fans (Ø>450mm)	Springs or neoprene mounts	25
Fan Coil Units	Waffle pad mounts or neoprene hangers	6
Condenser Units	Waffle pad mounts or rubber mounts	6

Table 17: Vibration isolation recommendations.

In addition to the vibration measures above, the following is also recommended to be implemented:

- Statically and dynamically balancing rotating plant and equipment to comply with ISO 21940.11:2016.
- Providing inertia blocks where required.
- Providing flexible connections where ducts and piping are connected to vibrating plant and machinery.

5 HYDRAULIC SERVICES

This section outlines the requirements specific to hydraulic services equipment. It is recommended to incorporate these into the hydraulic design drawings and specification.

Pumps and motor assembly shall be mounted on a concrete filled inertia block and vibration isolated. Pump inertia block shall be designed to support the weight of elbows and other fittings plus the weight of water in the pump and connected pipe work.

Vibration isolate shall be supplied and installed to all pumps in accordance with the manufacturers' data. Vibration isolation data shall be provided to the Acoustic Engineer for review and approval.

Piping to vibration-generating equipment must be supported by vibration isolated hangers. Vibration isolation shall be selected to achieve at least 98% efficiency, with at least 10-20mm static deflection.

There must be a minimum of 10mm clearance between any walls, ceilings or risers supporting structure and any hydraulic pipes.

All soil, waste, storm water pipes and downpipes shall be manufactured from PVC material or equivalent, unless where acoustically rated pipes are used as shown on Hydraulic drawings. Where possible, waste pipes shall not be fixed to the walls of the riser shaft but shall be fixed to slab edges.

All storm water pipes shall be externally wrapped with a layer of Pyrotek Soundlag 4525C, or similar. All downpipes located in the cavity of external walls and internal walls should be installed using appropriate acoustic measures.

Bends within the pipe work should also be gradual as possible, as sudden 90° angles will create additional unwanted noise.

Hydraulic services must be boxed using 1 layer of 13mm plasterboard and filled with sound insulation. To avoid noise flanking through the services, the gaps around the pipe should be sealed prior to the boxing. This may be done using a fire collar as required by other disciplines.

All access panels shall achieve a minimum acoustic performance of $R_W + C_{tr} \geq 25$.

Penetrations made through slabs should be sealed for the full depth of the penetration with a cement grout to achieve an airtight seal around the hydraulic services. Reticulation water pipes shall not be chased into sound rated walls.

Supply and install supporting vibration isolation hangers for all hydraulic piping located above sensitive noise sensitive spaces with a diameter greater than 40mm.

Water hammer should be eliminated by lowering operating pressures – not exceeding 350kPa – or providing pressure regulators. Fluid velocity should be designed to minimise noise in the pipes and have a maximum velocity of approximately 2.5m/s.

6 ELECTRICAL SERVICES

This section outlines the requirements specific to electrical services equipment, communications and AV cabling for critical spaces. It is recommended to incorporate these into the electrical design drawings and specification.

6.1 IN WALLS

Electrical outlets include general power and telecommunication outlets, MATV and data outlets and light switches. Unless noted in this specification and / or in the architectural documentation, 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 one stud spacing in timber or steel frame walls.

Acoustic rated fireboxes can be used for acoustic purposes to outlets, particularly when back to back electrical outlet cannot be avoided. 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. Services must not be chased into concrete or masonry elements of sound rated walls.

6.2 IN CEILINGS

Cable penetrations through plasterboard ceiling from surface mounted lights, smoke detectors, etc. shall be sealed using an approved acoustic sealant.

The maximum diameter of penetrations for down lights shall not exceed 95mm and down lights penetrations shall be located at least 600mm from waste pipes.

If higher concentrations of lights are required or will be in an acoustic rated ceiling, all down lights shall be acoustically treated. Acoustic down light treatment will consist of either down lights purchased with an acoustic can fitted or custom made galvanised box around the down lights.

7 INSPECTION AND COMMISSIONING

7.1 INSPECTIONS

Should inspection be required by the client, JHA will provide options for periodic inspections of work during the construction phase to ensure compliance with the specifications. This will be at the cost of the Contractor.

Acoustic checks will primarily inspect the following:

- Partition construction.
- Partition to column.
- Partition to mullion.
- Noise controls in ceiling voids.
- Acoustic ceilings and internal finishes.
- Penetrations.
- Doors.
- Electrical services.
- Hydraulic services.
- Mechanical services.

The Contractor shall provide documentary evidence to support that the form of construction / material or design being used complies with the performance requirements. Refer to Section 1.5.

Sign-off inspections shall be carried out after the completion of major acoustic milestones. The Contractor shall identify, in the programme of construction works, dates when each major layer of construction will be completed and made ready for sign-off inspections.

If each major milestone has been inspected and found to be constructed in accordance with the requirements for workmanship and materials specified in the contract documents, it shall be approved by the Acoustic Engineer and the construction of subsequent constructions shall proceed without on-site compliance testing.

If, in the opinion of the Acoustic Engineer, requirements for workmanship and materials specified in the contract documents have not been satisfied, the Contractor shall carry out all remedial works necessary to satisfy the specification before subsequent constructions proceed.

Where wall and ceiling components are separated by an acoustic cavity, effective precautions shall be employed to ensure that cavities and joints remain clear of mortar droppings, broken blocks / bricks or any other debris liable to bridge or close the cavity or joint, for example, using temporary cavity closing boards or sheets.

Any debris entering the wall / ceiling cavities as a result of the Contractor's operations shall be removed at the Contractor's expense.

Where penetrations are constructed in walls and ceilings, the surfaces of the penetration shall be smooth and even (to within 5mm). The penetrations shall not be oversized. If oversized, the penetrations shall be made good to the required size.

All measures shall be taken to minimise shrinkage and subsequent cracking in sealants.

7.2 ACOUSTIC TESTING AND COMMISSIONING

Commissioning testing shall be carried out after completion of the building but before occupation. In order to not interfere with the commissioning testing, no noisy works shall take place during the testing.

Before commencement of commissioning, the Contractor shall submit a program itemising the systems and the proposed dates for conducting acceptance tests in accordance with the program.

One week prior to the proposed testing date, the Acoustic Engineer shall be notified regarding the testing to carry out and if witnessing is required.

Commissioning procedures and testing methods which are not approved or not in accordance with methods detailed in this specification will not be accepted as evidence that the systems have been correctly commissioned.

The Contractor should demonstrate compliance by acoustic testing according to nominated standards in this document and report results when fully completed prior to handover. If acoustic or compliance testing are not received, the Contractor will be liable for any rectification works associated with achieving the acoustic requirements.

Measurements shall be conducted with Sound Level Meters Type 1, in third octave band frequency ranging from 50Hz to 10,000Hz and "Fast" time-weighted response.

7.2.1 LABORATORY-TESTED PERFORMANCE

The Contractor shall provide evidence, in the form of laboratory results, to prove that the construction, material selection and design being used complies with the performance requirement outlined by this specification. This will be at the cost to the Contractor.

Compliance with this specification document shall be verified by the laboratory tests and determined in accordance with:

- AS 1191:2002 (R2016) *'Acoustics – Method for laboratory measurement of airborne sound transmission insulation of building elements'*, OR
- ISO 10140.2:2010 (R2016) *'Acoustics – Laboratory measurement of sound insulation of building elements. Measurement of airborne sound insulation'*, OR
- ISO 10140.3:2010 (R2016) *'Acoustics – Laboratory measurement of sound insulation of building elements. Measurement of impact sound insulation'*.

And rated in accordance with:

- AS/NZS ISO 717.1:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements – Airborne sound insulation'*, OR
- AS ISO 717.2:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements – Impact sound insulation'*.

The sound absorption performance of materials will be verified under:

- AS ISO 354:2006 (R2016) *'Acoustics – Measurement of sound absorption in a reverberation room'*, OR
- AS/NZS 1935.1:1998 (R2016) *'Acoustics – Determination of sound absorption coefficient and impedance in impedance tubes – Method using standing wave ratio'*.

Mechanical ducted silencers performance shall be in accordance with:

- ISO 7235:2003 (R2018) *'Acoustics – Laboratory measurement procedures for ducted silencers and air-terminal units – Insertion loss, flow noise and total pressure loss'*.

The Tenderer will provide test reports that show compliance with the acoustic requirements. The reports shall be written in English and as a minimum will contain:

- Results presented in tabular and graphic form over the third octave band centre frequency range from 100Hz to 5000Hz.
- A full written and drawn description giving details of materials, dimensions, thicknesses and weights of the principal components, including seals and furniture (where applicable), together with details of any sealants used at the interface between the frame and test aperture.

Any deviations shall be noted in the test reports. Test certificates shall be obtained from an independent accredited test laboratory approved by the Acoustic Engineer. The test reports shall be submitted to the Acoustic Engineer for approval prior to ordering or construction.

7.2.2 IN-SITU TESTED PERFORMANCE

In-situ acoustic performance testing shall be undertaken by a suitably qualified Acoustic Engineer, being a member of either the AAAC or AAS, on a representative sample of the relevant forms of construction / material or design agreed with the Contractor. The Contractor shall rectify all non-compliances, and the cost of any retesting shall be borne by the Contractor.

Compliance with the performance requirements will be verified when the in-situ-tested performance of the forms of construction / materials comply with the performance requirements in this document when determined under:

- AS/NZS ISO 140.4:2006 *'Acoustics – Measurement of sound insulation in buildings and of building elements, Part 4: Field measurements of airborne sound insulation between rooms'*.
- AS/NZS ISO 140.7:2006 *'Acoustics – Measurement of sound insulation in buildings and of building elements, Part 7: Field measurements of impact sound insulation of floors'*.

And rated in accordance with:

- AS/NZS ISO 717.1:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements - Airborne sound insulation'*.
- AS ISO 717.2:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements – Impact sound insulation'*.

Compliance with the performance requirements for internal noise levels, environmental noise levels and internal room acoustic performance will be verified when the in-situ-tested performances comply with the performance requirements in this document when determined under:

- AS 2107:2016 *'Acoustics – Recommended design sound levels and reverberation times for building interiors'*.
- AS 1055:2018 *'Acoustics – Description and measurement of environmental noise'*.
- AS/NZS 2460:2002 (R2106) *'Acoustics – Measurement of the reverberation time in rooms'* OR
- ISO 3382:2012 *'Acoustics – Measurement of room acoustic parameters'*.

8 EXTENT OF WORKS

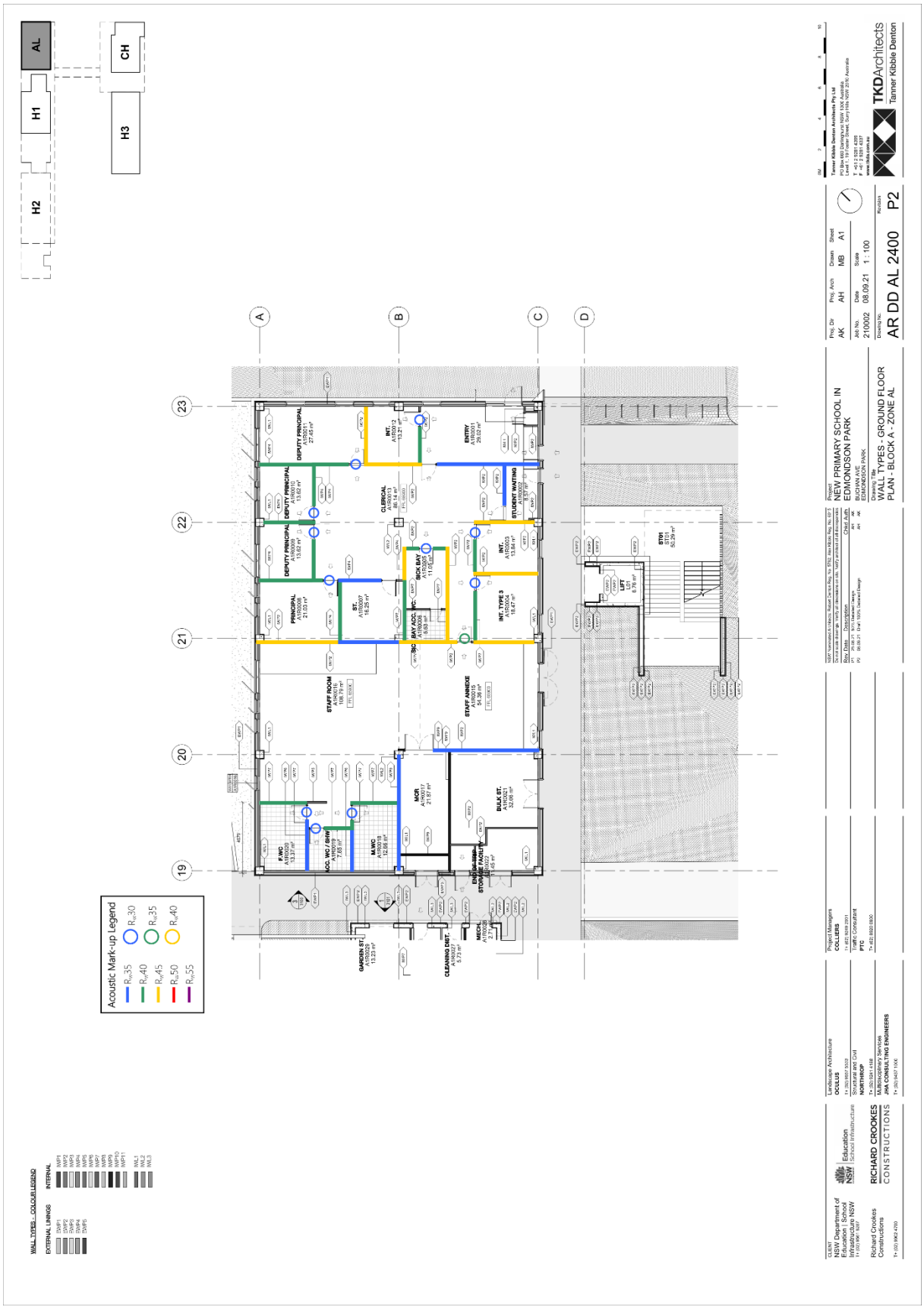
The extent of work covered by this document includes the co-ordination of works by a number of trades affecting the acoustic performance of the completed works.

The following list identifies the work to be undertaken by the Contractor. The listed items are not intended to limit or exclude any items required by the contract documents.

The contract acoustic co-ordination work shall comprise the provision of the following major items:

- Supply and install acoustically rated walls and partitions in accordance with the specifications.
- Supply and install acoustic treatment to mechanical equipment as required to comply with specified internal noise levels.
- Acoustically seal all service penetrations passing through full height and sound rated partitions.
- Re-align, and acoustically treat, ductwork where ductwork conflicts with sound rated partitions.
- Externally insulate ductwork, pipe work and equipment as specified and / or shown on the drawings.
- Vibration isolate equipment and systems as required.
- Ensure all thermal or acoustic insulation materials, other than those that are fully enclosed within partition linings, are physically secured so as not to be dislodged during normal use and maintenance of the building.
- Install all partition and ceiling constructions so as to ensure that audible sound leakage through building discontinuities is minimal. In particular, ensure that gaps between a partition head and ceiling system are acoustically sealed. Obtain approval for the proposed seal method before proceeding with the works.
- Seal sound rated partitions at the building façade junction so as to maintain the acoustical performance of the partitions. Obtain approval for the proposed seal method before proceeding with the works.
- Select and install electrical lighting equipment so as the overall acoustic performance of the floor / ceiling system complies with the performance requirements nominated within.
- Select mechanical services equipment so as to comply with the specified internal noise levels in areas of occupancy.
- Supply and install acoustic attenuators to mechanical services systems where specified.
- Supply and install acoustically insulated ductwork as shown on the mechanical drawings and as required.
- Supply and install vibration isolation mounts to all mechanical and rotating equipment.
- Commission and test building services systems. This includes the following:
  - Air balancing of all outlets where necessary to conform specified noise levels.
  - Optimise operating duty for air handling plant and equipment.

APPENDIX A: DIAGRAMS SHOWING SOUND INSULATION RATINGS FOR PARTITIONS AND DOORS



WALL TYPES - COLOUR LEGEND

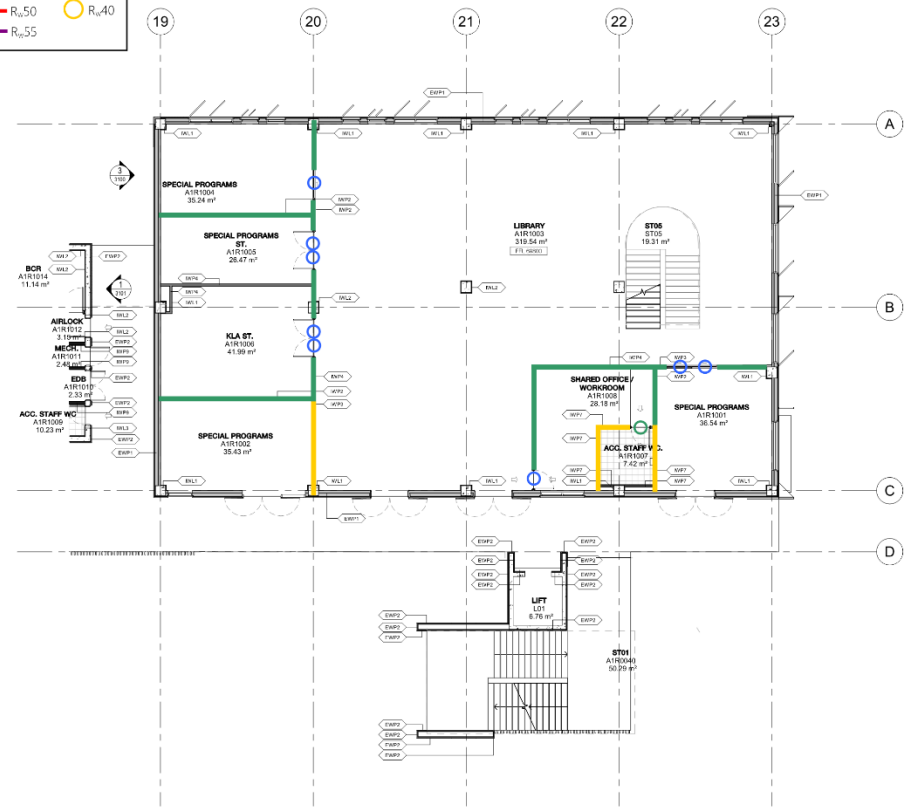
EXTERNAL LININGS
EWP1
EWP2
EWP3
EWP4
EWP5

INTERNAL
IWP1
IWP2
IWP3
IWP4
IWP5
IWP6
IWP7
IWP8
IWP9
IWP10
IWP11

IWL1
IWL2
IWL3

Acoustic Mark-up Legend
R_w35
R_w40
R_w45
R_w50
R_w55
R_w30
R_w35
R_w40

PS | H2 | H1 | AL
H3 | CH



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Rev	Date	Description	Chkd	Auth
P1	25.08.21	50% Detailed Design	AH	AK
P2	08.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - LEVEL 01 FLOOR PLAN - BLOCK A - ZONE AL

Proj. Dir	Proj. Arch	Drawn	Sheet
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Job No.	Date	Scale
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Drawing No.
AR DD AL 2410

Revision
P2

0M 2 4 6 8 10

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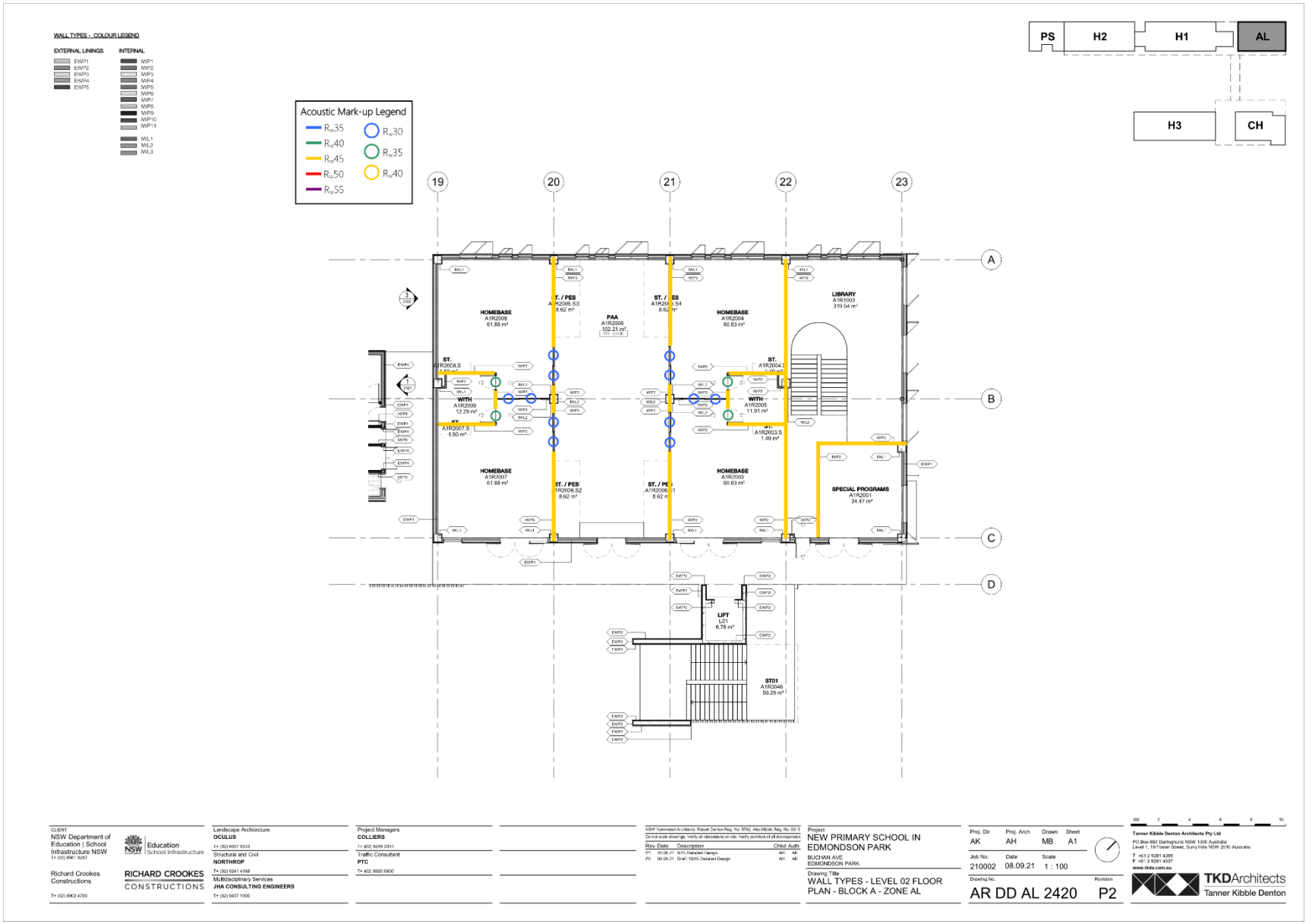

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Project
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Drawing Title
WALL TYPES - LEVEL 02 FLOOR PLAN - BLOCK A - ZONE AL

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Job No.	Date	Scale
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Drawing No.
AR DD AL 2420

Revision
P2

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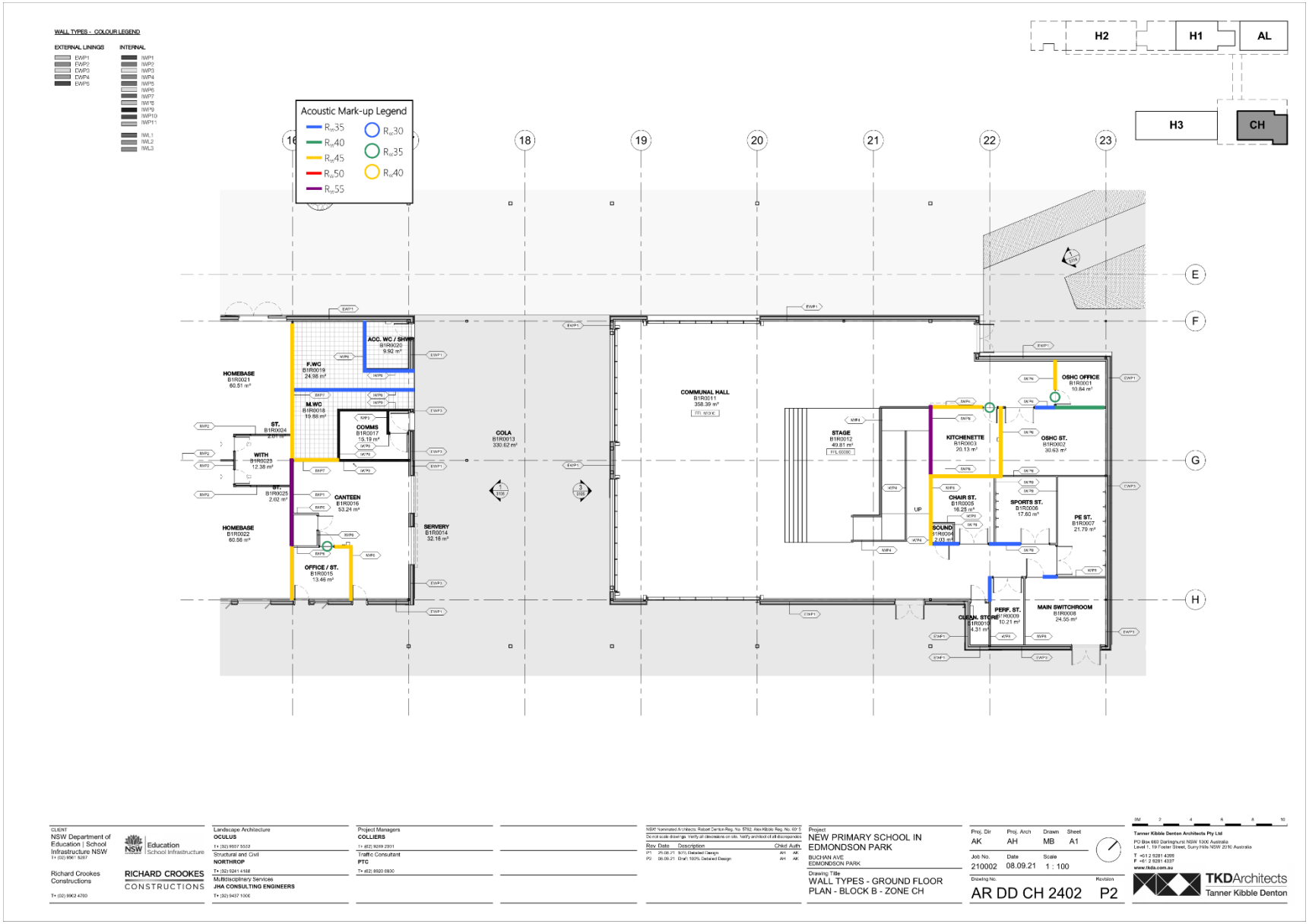

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P2	08.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - GROUND FLOOR PLAN - BLOCK B - ZONE CH

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD CH 2402

Revision
P2

0M 2 4 6 8 10

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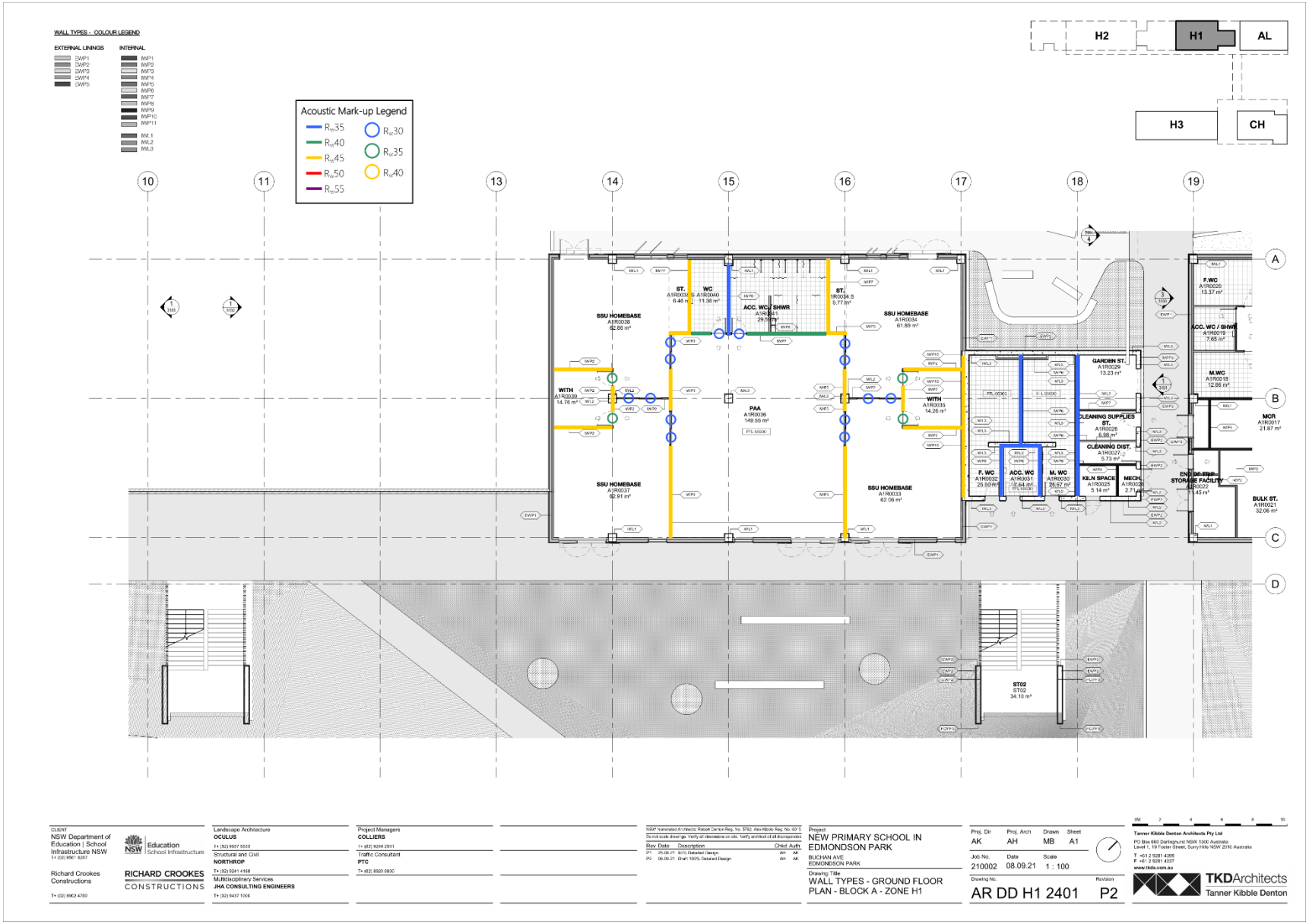

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P2	06.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - GROUND FLOOR PLAN - BLOCK A - ZONE H1

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD H1 2401

Revision
P2

0M 2 4 6 8 10

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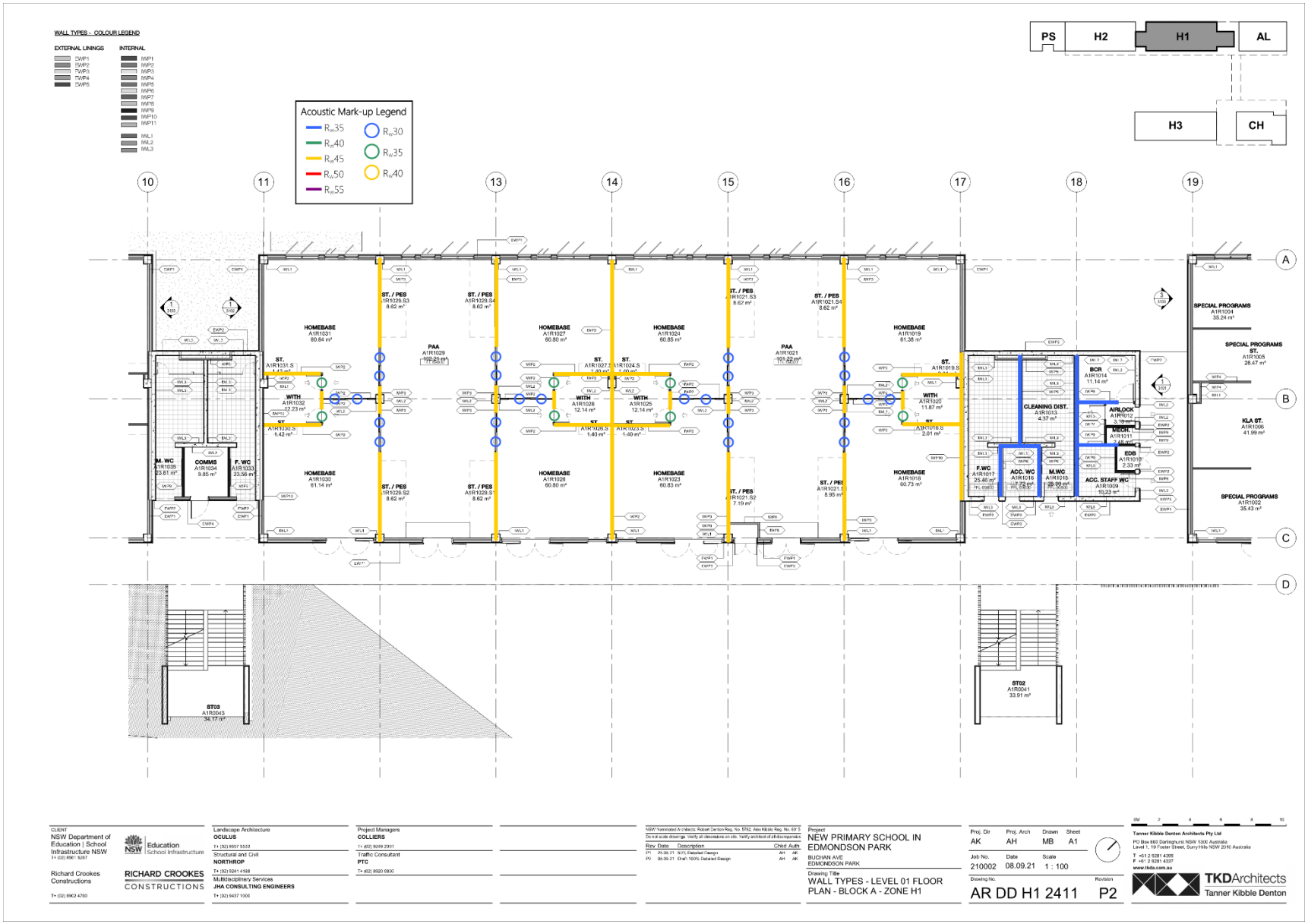

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NSW Nominated Architects: Robert Denton Reg. No. 5752, Alex Kibble Reg. No. 6975
Do not scale drawings. Verify all dimensions on site. Notify architect of all discrepancies

Rev	Date	Description	Chkd	Auth
P1	25.08.21	50% Detailed Design	AH	AK
P2	06.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - LEVEL 01 FLOOR PLAN - BLOCK A - ZONE H1

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD H1 2411

Revision
P2

0M 2 4 6 8 10

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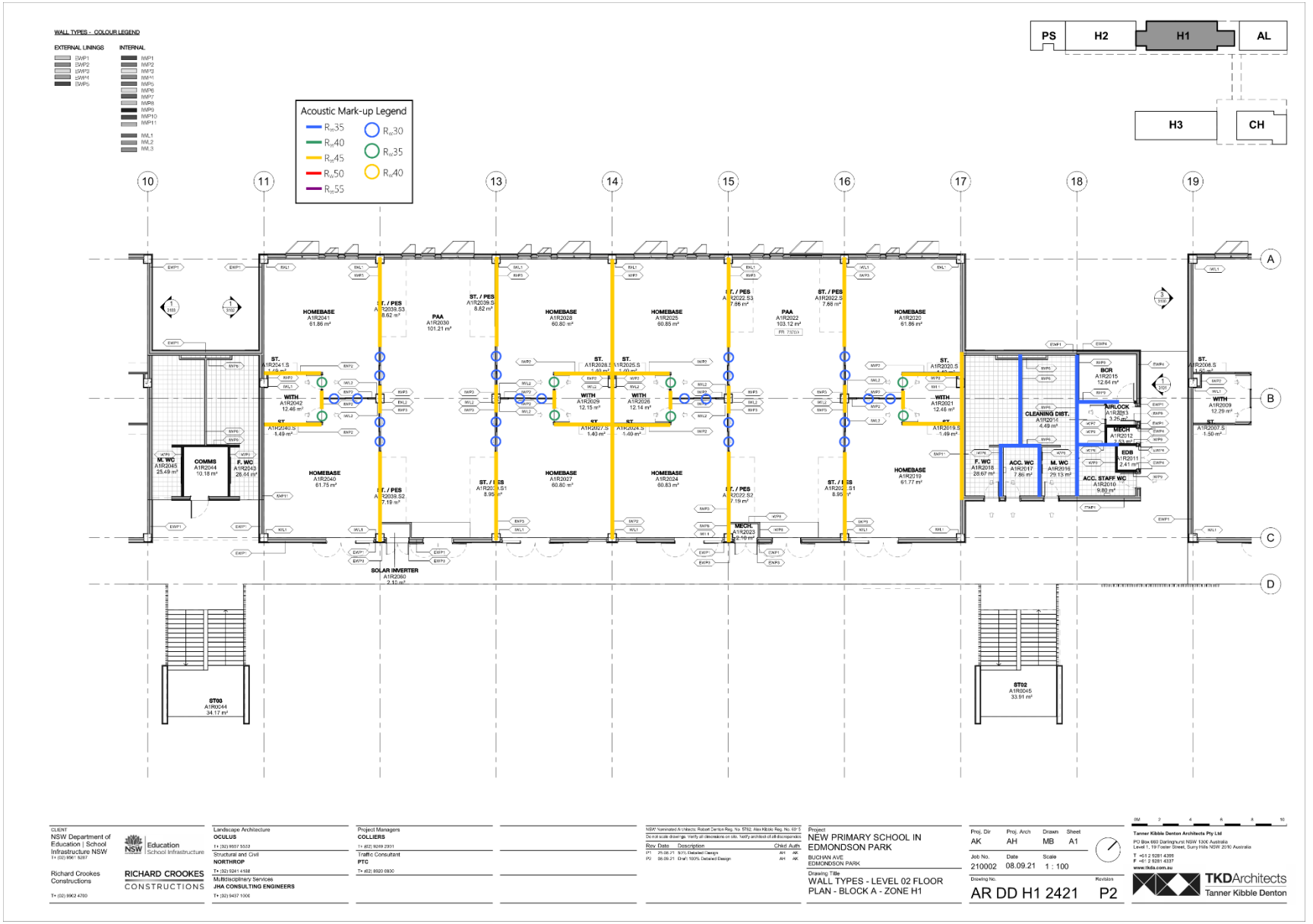

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Rev	Date	Description	Chkd	Auth
P1	25.08.21	SUTC Detailed Design	AH	AK
P2	06.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - LEVEL 02 FLOOR PLAN - BLOCK A - ZONE H1

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1
Job No.	Date	Scale	
210002	08.09.21	1 : 100	

Drawing No.
AR DD H1 2421
Revision
P2

0M 2 4 6 8 10

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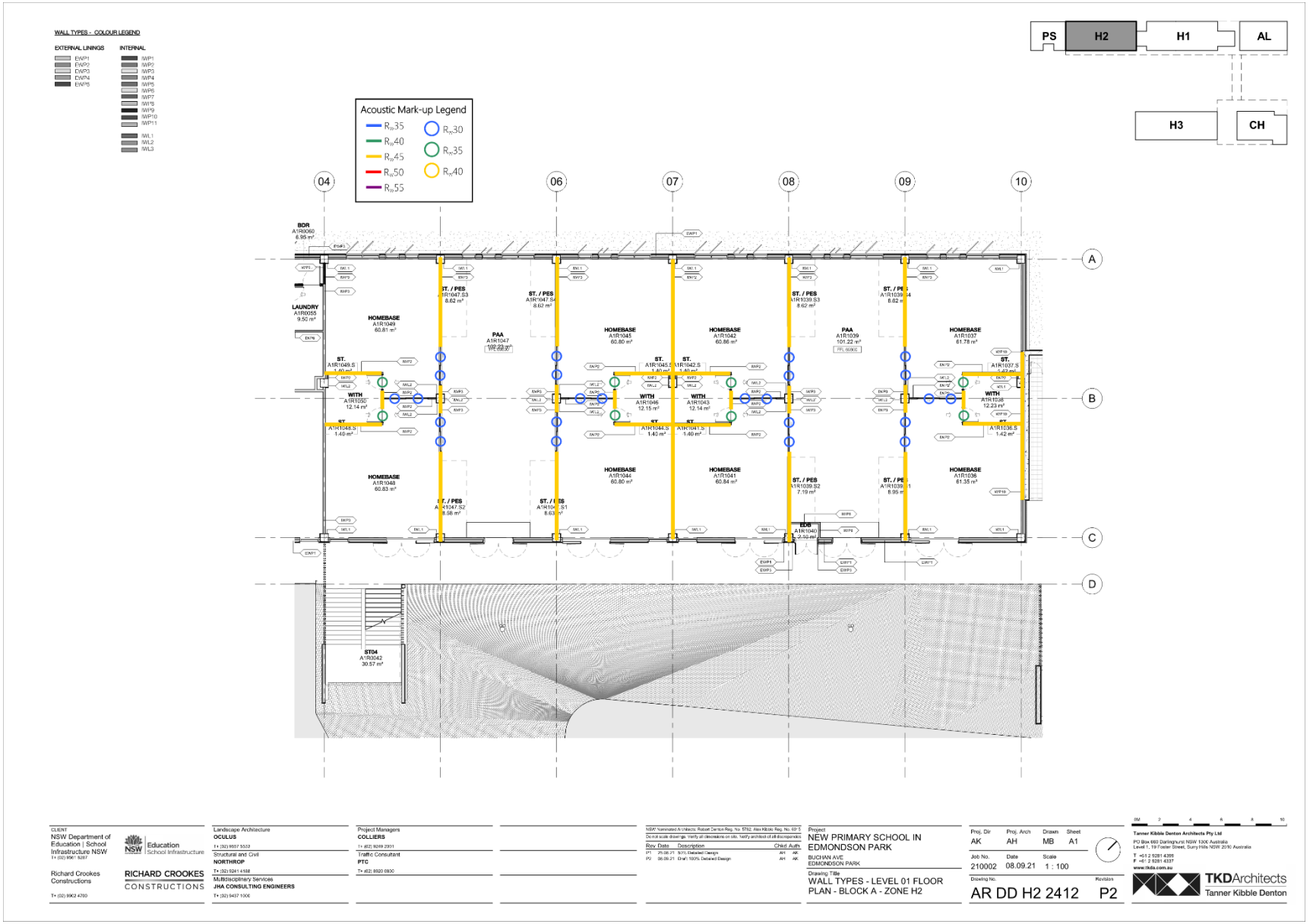

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Rev	Date	Description	Chkd	Auth.
P1	25.08.21	50% Detailed Design	AH	AK
P2	08.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - LEVEL 01 FLOOR PLAN - BLOCK A - ZONE H2

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD H2 2412

Revision
P2

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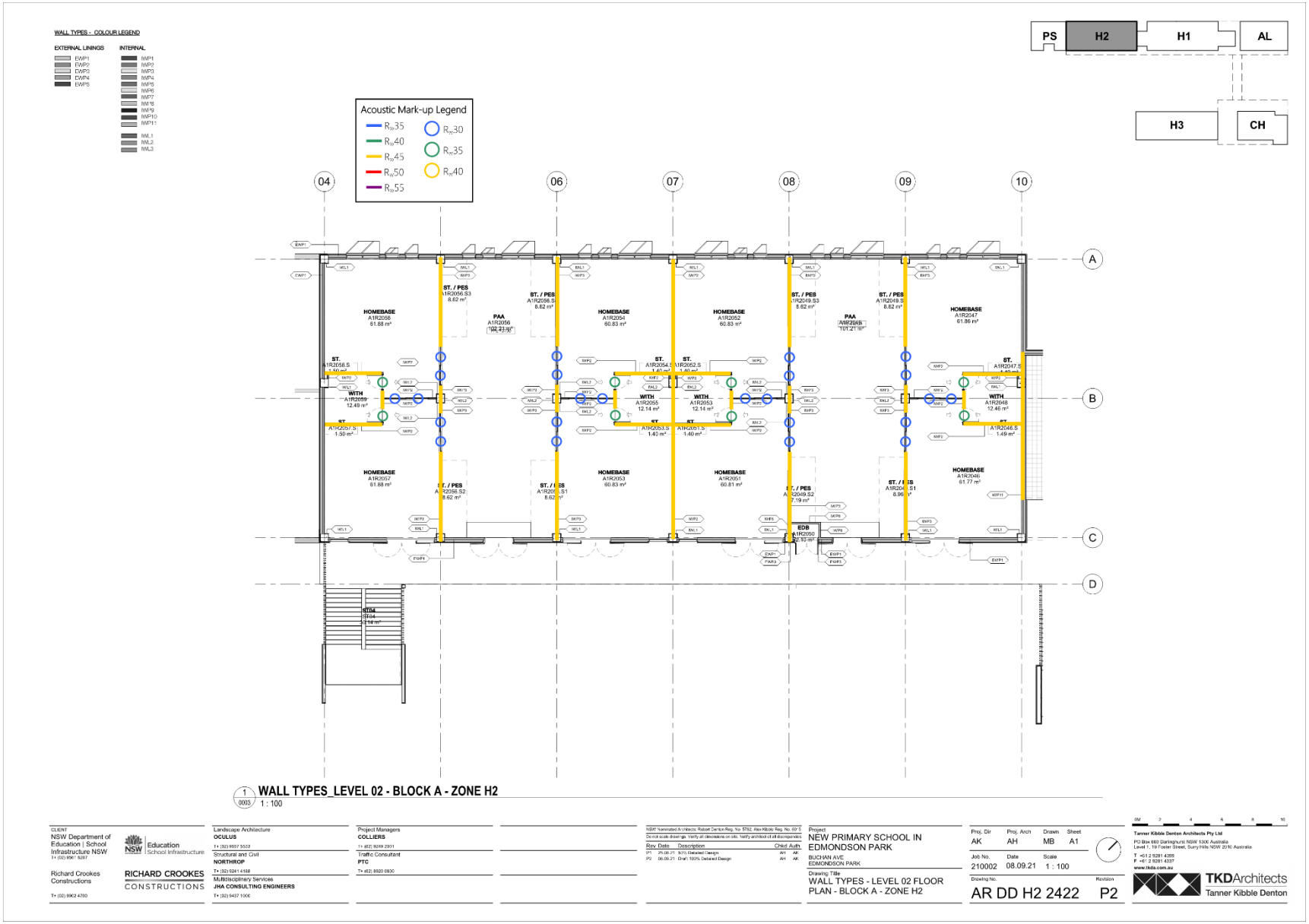

1 / 0003 WALL TYPES_LEVEL 02 - BLOCK A - ZONE H2
1 : 100

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Rev	Date	Description	Chkd	Auth
P1	25.08.21	50% Detailed Design	AH	AK
P2	08.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - LEVEL 02 FLOOR PLAN - BLOCK A - ZONE H2

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD H2 2422
Revision
P2

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WALL TYPES - COLOUR LEGEND

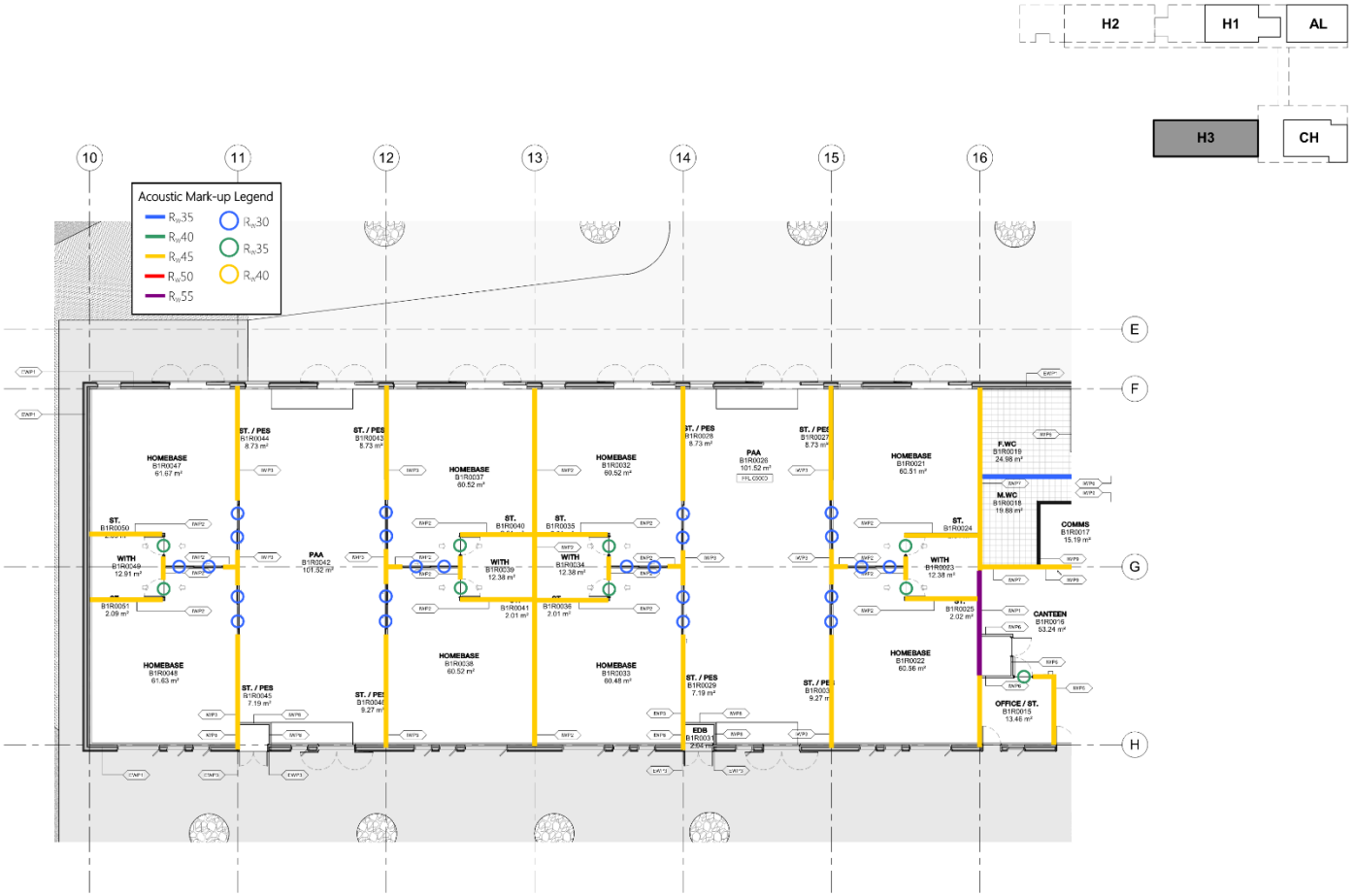
EXTERNAL LININGS

EWP1
EWP2
EWP3
EWP4
EWP5

INTERNAL

IWP1
IWP2
IWP3
IWP4
IWP5
IWP6
IWP7
IWP8
IWP9
IWP10
IWP11

IWL1
IWL2
IWL3



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Rev	Date	Description	Chkd	Auth.
P1	25.08.21	50% Detailed Design	AH	AK
P2	08.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - GROUND FLOOR PLAN - BLOCK B - ZONE H3

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD H3 2403

Revision
P2

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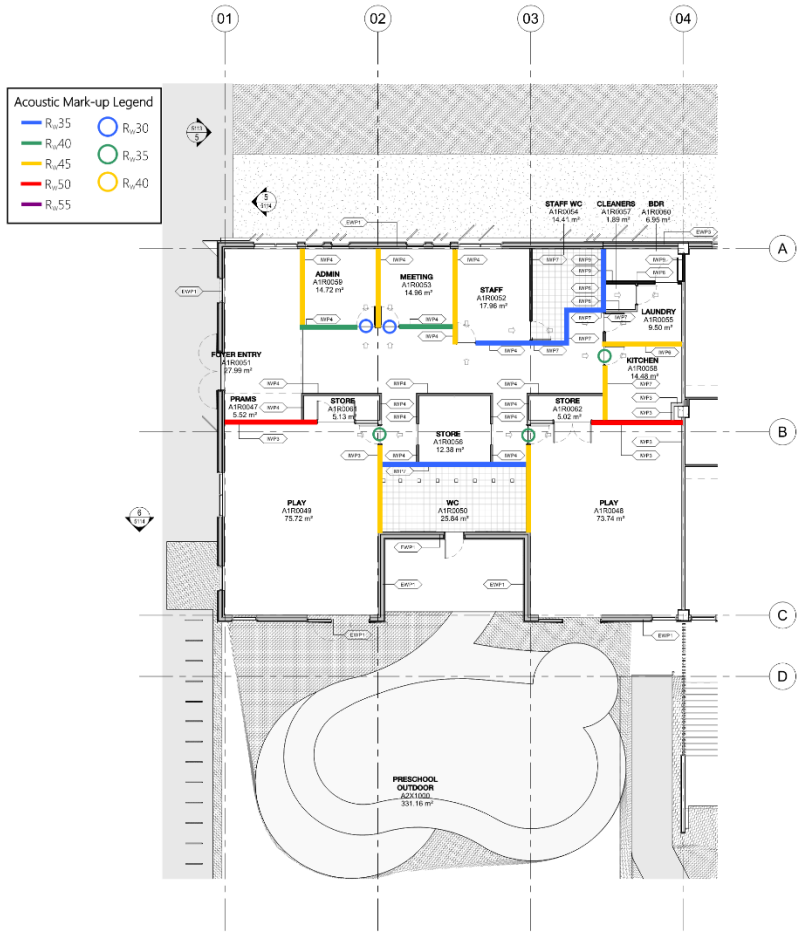

1 / 0003 **WALL TYPES_LEVEL 01 - BLOCK A - ZONE PS**
1 : 100

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NSW Nominated Architects: Robert Denton Reg. No. 5752, Alex Kibble Reg. No. 6975
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Rev	Date	Description	Chkd	Auth
P1	08.09.21	Draft 100% Detailed Design	AH	AK

Project
NEW PRIMARY SCHOOL IN EDMONDSON PARK
BUCHAN AVE
EDMONDSON PARK

Drawing Title
WALL TYPES - LEVEL 01 FLOOR PLAN - BLOCK A - ZONE PS

Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH	MB	A1

Job No.	Date	Scale
210002	08.09.21	1 : 100

Drawing No.
AR DD PS 2413

Revision
P1

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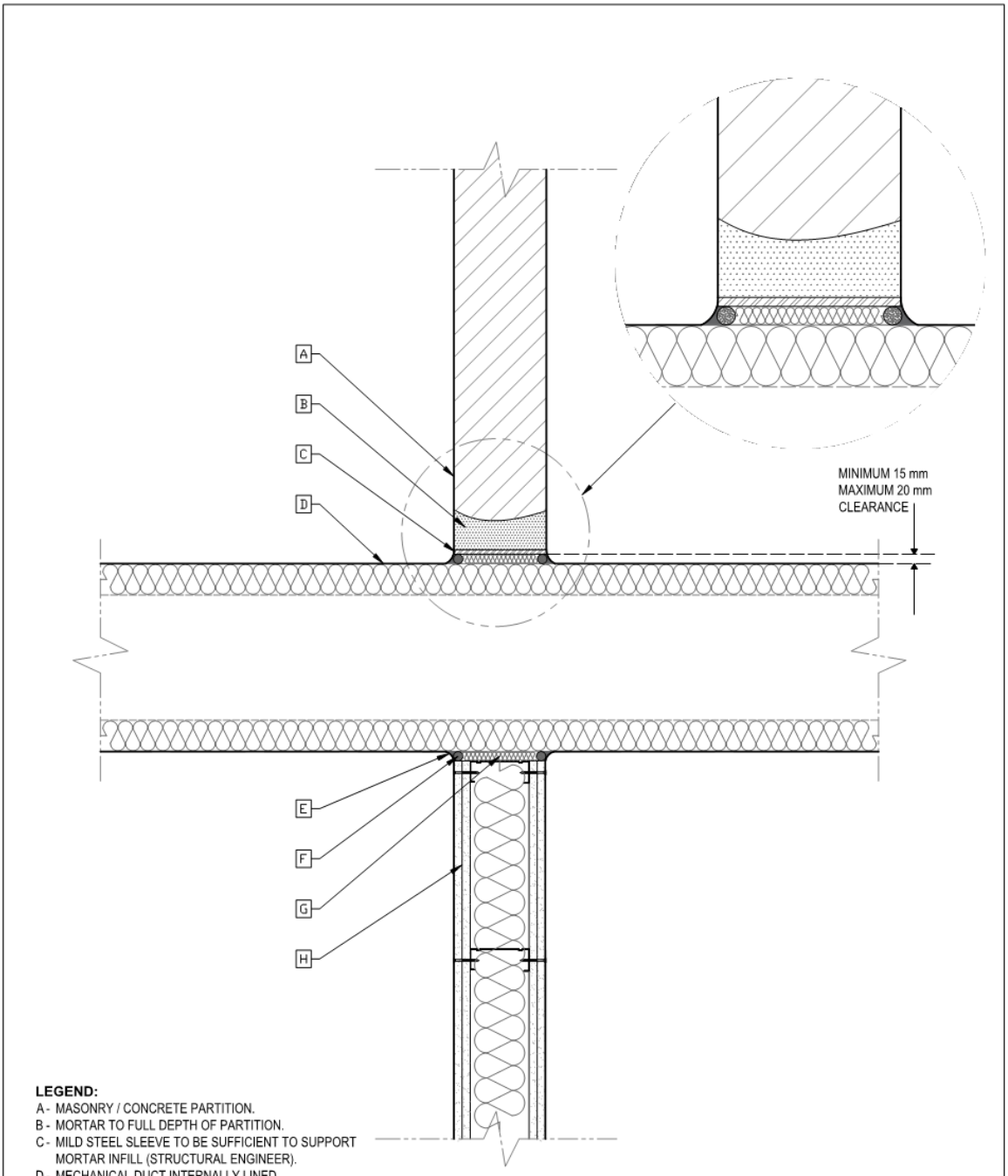
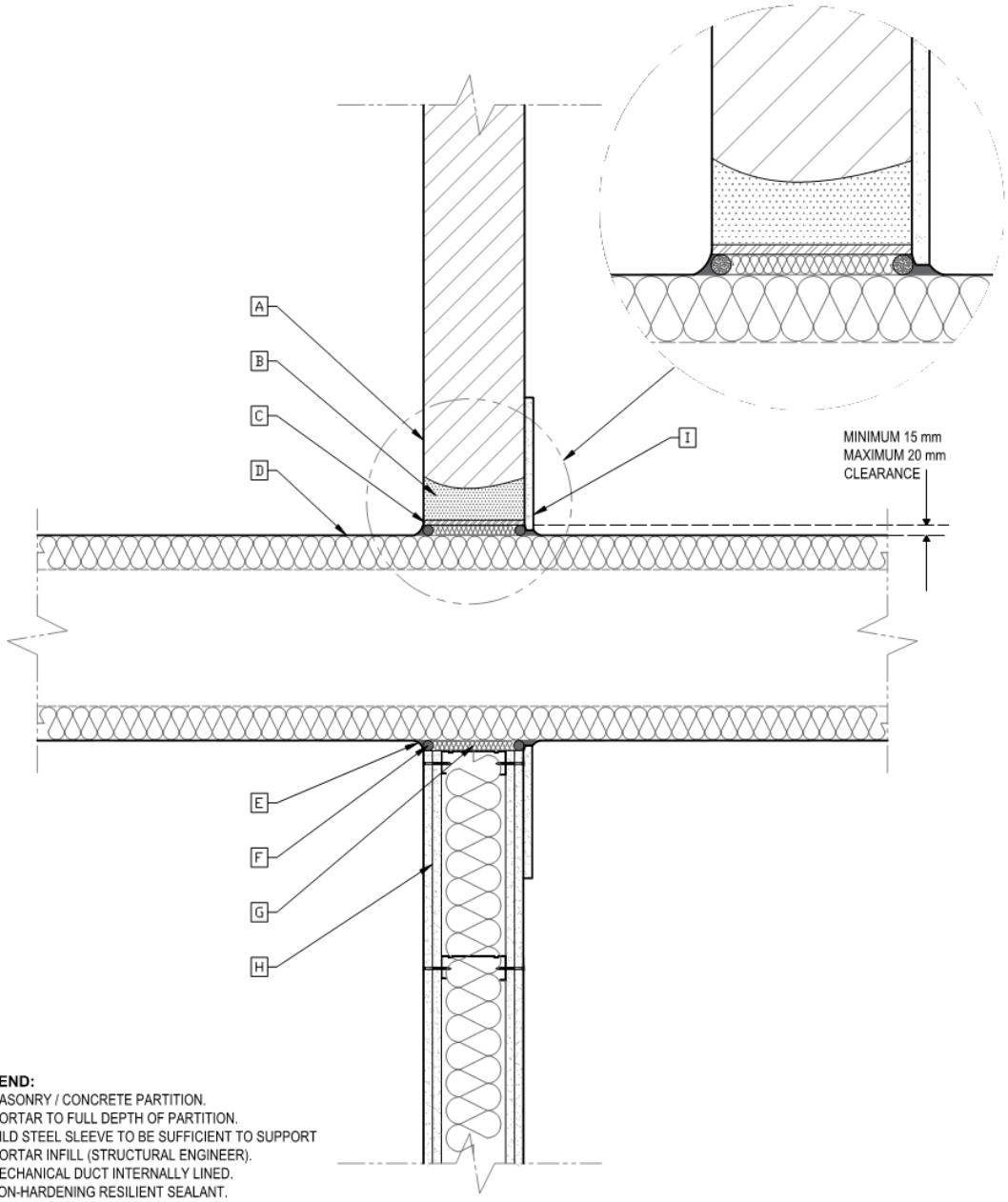
APPENDIX B: TYPICAL DETAILS FOR ACOUSTIC SEALING OF SERVICE PENETRATIONS



LEGEND:
A - MASONRY / CONCRETE PARTITION.
B - MORTAR TO FULL DEPTH OF PARTITION.
C - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
D - MECHANICAL DUCT INTERNALLY LINED.
E - NON-HARDENING RESILIENT SEALANT.
F - COMPRESSIBLE FOAM BACKING ROD.
G - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
H - LIGHTWEIGHT PARTITION.

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR INTERNALLY LINED MECHANICAL DUCTWORK - STANDARD SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035	DRAWING No. AC1101			REV P1

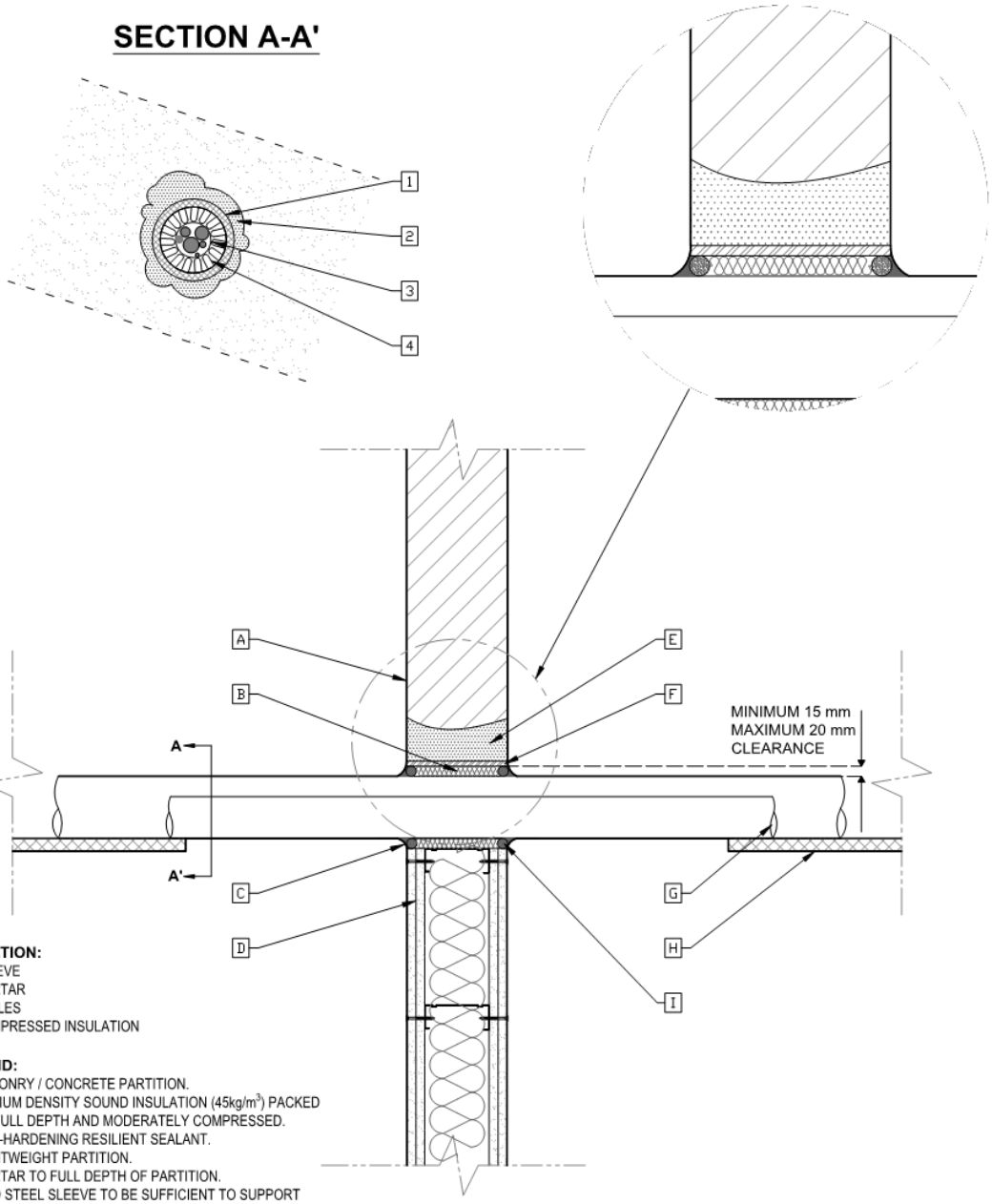


LEGEND:

A - MASONRY / CONCRETE PARTITION.
B - MORTAR TO FULL DEPTH OF PARTITION.
C - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
D - MECHANICAL DUCT INTERNALLY LINED.
E - NON-HARDENING RESILIENT SEALANT.
F - COMPRESSIBLE FOAM BACKING ROD.
G - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
H - LIGHTWEIGHT PARTITION.
I - SOLID BOARD COVER PLATE (MINIMUM SURFACE MASS 10kg/m^2) PLATE BEDDED IN RESILIENT SEALANT.

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR INTERNALLY LINED MECHANICAL DUCTWORK - CRITICAL SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035		DRAWING No. AC1102		REV P1

SECTION A-A'

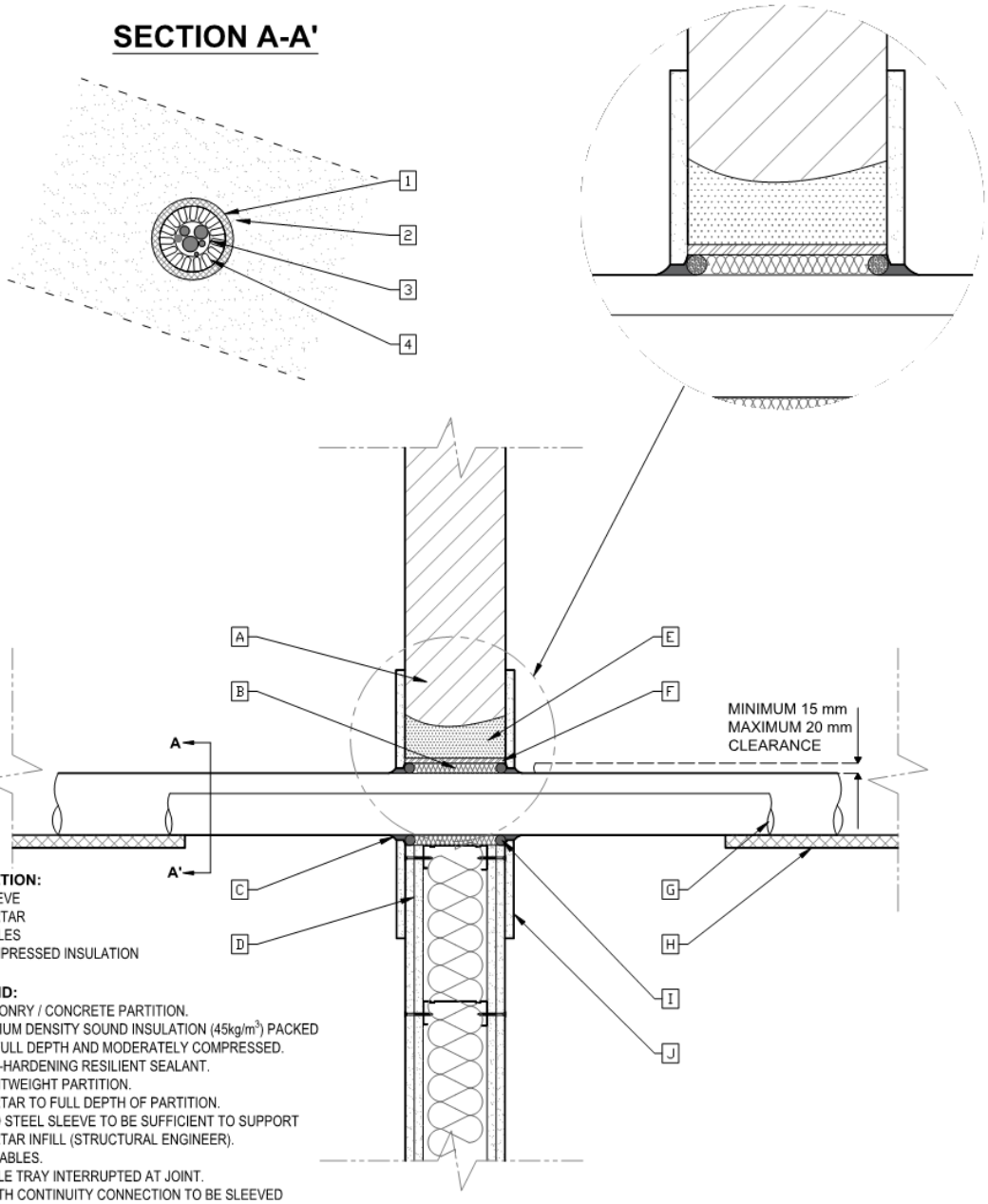


ELEVATION:
1 - SLEEVE
2 - MORTAR
3 - CABLES
4 - COMPRESSED INSULATION

LEGEND:
A - MASONRY / CONCRETE PARTITION.
B - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
C - NON-HARDENING RESILIENT SEALANT.
D - LIGHTWEIGHT PARTITION.
E - MORTAR TO FULL DEPTH OF PARTITION.
F - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
G - LV CABLES.
H - CABLE TRAY INTERRUPTED AT JOINT. EARTH CONTINUITY CONNECTION TO BE SLEEVED WITH OTHER CABLES ON THE TRAY.
I - COMPRESSIBLE FOAM BACKING ROD.

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR ELECTRICAL CABLES - STANDARD SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035	DRAWING No. AC1103			REV P1

SECTION A-A'



ELEVATION:

1 - SLEEVE
2 - MORTAR
3 - CABLES
4 - COMPRESSED INSULATION

LEGEND:

A - MASONRY / CONCRETE PARTITION.
B - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
C - NON-HARDENING RESILIENT SEALANT.
D - LIGHTWEIGHT PARTITION.
E - MORTAR TO FULL DEPTH OF PARTITION.
F - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
G - LV CABLES.
H - CABLE TRAY INTERRUPTED AT JOINT. EARTH CONTINUITY CONNECTION TO BE SLEEVED WITH OTHER CABLES ON THE TRAY.
I - COMPRESSIBLE FOAM BACKING ROD.
J - 13 mm PLASTERBOARD COVER PLATE OR OTHER APPROVED BUILDING BOARD (MINIMUM SURFACE MASS 10 kg/m^2) BEDDED IN RESILIENT SEALANT (COVER PLATE SEPARATED FROM CABLE BY 2-3 mm)

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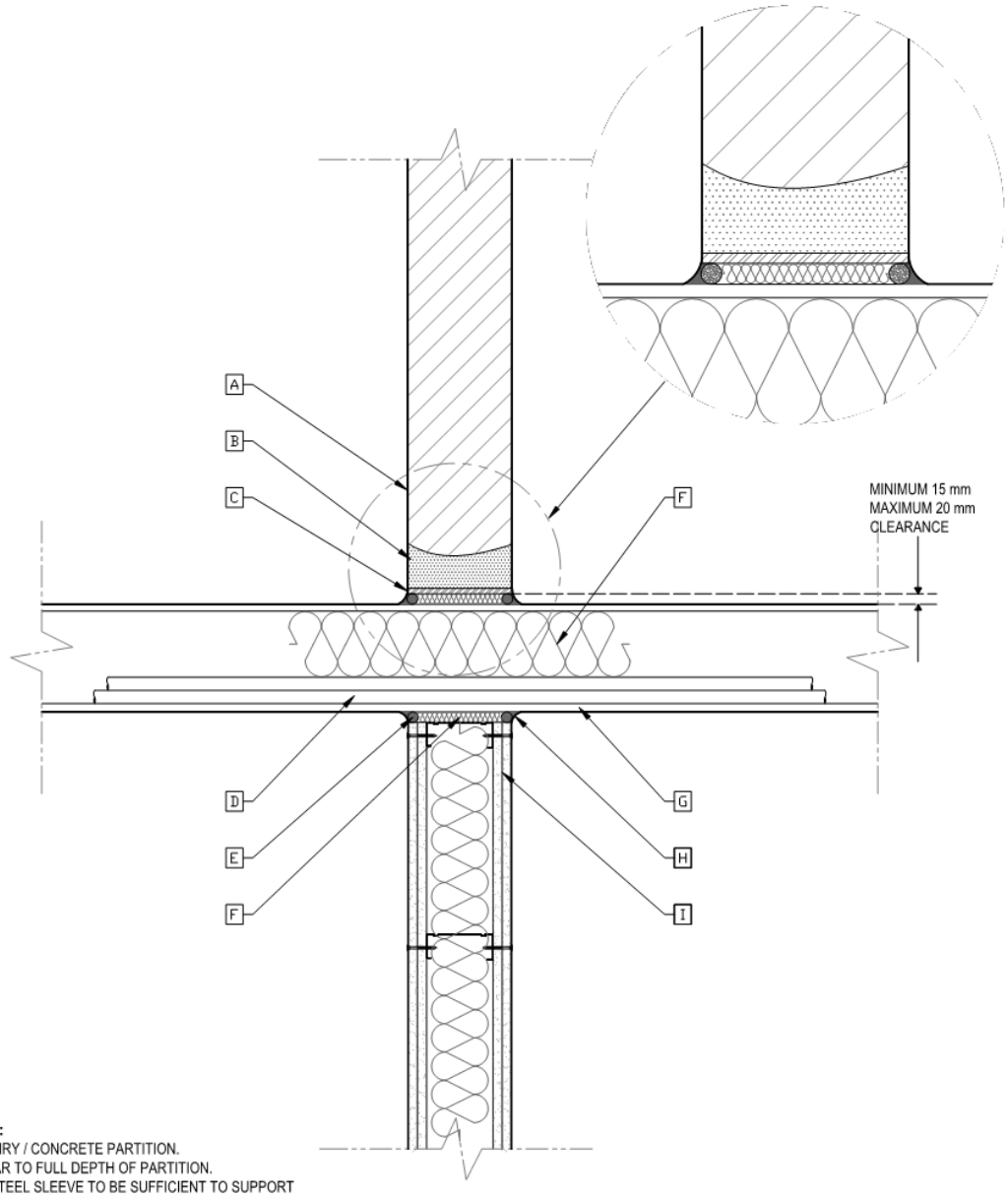
		JOB No. 180035	DRAWING No. AC1104			REV P1



LEGEND:

A - MASONRY / CONCRETE PARTITION.
B - MORTAR TO FULL DEPTH OF PARTITION.
C - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
D - LV CABLES
E - COMPRESSIBLE FOAM BACKING ROD.
F - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
G - CABLE TRUNKING
H - NON-HARDENING RESILIENT SEALANT.
I - LIGHTWEIGHT PARTITION.

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR ELECTRICAL TRUNKING - STANDARD SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035		DRAWING No. AC1105		REV P1

APPENDIX C: MECHANICAL SERVICES SCHEDULE

External Condenser Units:

ID		CU
Manufacturer		Daikin
Model		REYQ20TAY1
Sound Pressure Level (dB ref 20µPa)	*63*	65
	125	64
	250	66
	500	64
	1000	59
	2000	56
	4000	52
	8000	45
Comments		Measured as per JIS standard

Fans:

ID		EF-AL-GF-01		OAF-AL-GF-01 OAF-AL-L1-01 OAF-AL-L1-02 OAF-AL-L1-03		OAF-LIB-01 OAF-LIB-02 OAF-LIB-03	
Model		Fantech TD-800/200ECO		Fantech TD-800/200ECO		Fantech TD-800/200ECO	
		Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sound Power Level (dB ref 1pW)	63	49	61	48	60	50	62
	125	49	51	48	50	50	52
	250	58	57	57	56	59	58
	500	60	62	59	61	61	63
	1000	62	64	61	63	63	65
	2000	60	62	59	61	61	63
	4000	55	57	54	56	56	58
	8000	48	48	47	47	49	49
Comments							

ID		OAF-HOME OAF-PAA		OAF-WITH		TEF-AL-L1-01 TEF-AL-L1-02 TEF-AL-L1-03	
Model		Fantech TD-2000/315ECO		Fantech TD-500/150ECO		Fantech TD-500/150ECO	
		Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sound Power Level (dB ref 1pW)	63	58	67	54	51	55	52
	125	72	71	45	45	46	46
	250	73	78	54	61	55	62
	500	68	75	60	63	61	64
	1000	72	76	58	60	59	61
	2000	67	73	57	55	58	56
	4000	62	64	50	50	51	51
	8000	57	59	45	46	46	47
Comments							

ID		TEF-H1-GF-01	
Model		Fantech PCEEC45	
		Inlet	Outlet
Sound Power Level (dB ref 1pW)	*63*	60	
	125	65	
	250	64	
	500	63	
	1000	60	
	2000	53	
	4000	50	
	8000	46	
Comments			

Fan Coil Units:

ID		Refer below for FCU ID	Refer below for FCU ID	Refer below for FCU ID	Refer below for FCU ID	Refer below for FCU ID	Refer below for FCU ID
Manufacturer		Daikin	Daikin	Daikin	Daikin	Daikin	Daikin
Model		FXMQ40PAVE	FXMQ50PAVE	FXMQ63PAVE	FXMQ80PAVE	FXMQ100PAVE	FXMQ125PAVE
Sound Pressure Level (dB ref 20µPa)	63	35	37	32	35	40	42
	125	41	43	45	46	45	45
	250	39	40	40	41	40	42
	500	36	38	38	39	39	40
	1000	34	37	39	40	40	41
	2000	31	31	34	35	33	39
	4000	24	24	27	29	28	28
	8000	18	22	19	20	28	22
Comments		Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard

ID		Refer below for FCU ID	Refer below for FCU ID	Refer below for FCU ID	Refer below for FCU ID
Manufacturer		Daikin	Daikin	Daikin	Daikin
Model		FXMQ140PAVE	FXMQ160PV1A	FXMQ180PV1A	FXMQ250PV1A
Sound Pressure Level (dB ref 20µPa)	63	46	52	52	53
	125	49	52	52	53
	250	45	46	46	47
	500	42	40	40	41
	1000	42	38	38	39
	2000	36	36	36	37
	4000	31	34	34	33
	8000	25	25	25	28
Comments		Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard

FCU's selection is as follows:

- FXMQ40PAVE: FCU-AL-L1-01
- FXMQ50PAVE: FCU-AL-L1-02 / FCU-AL-L1-03 / FCU-AL-L2-08
- FXMQ63PAVE: FCU-AL-GF-03
- FXMQ80PAVE: FCU-AL-L1-04 / FCU-AL-L1-05 / FCU-AL-L1-06 / FCU-AL-L1-07
- FXMQ100PAVE: FCU-H1-GF-03 / FCU-H1-GF-04
- FXMQ125PAVE: FCU-AL-GF-02 / FCU-AL-L2-03 / FCU-AL-L2-04 / FCU-AL-L2-05 / FCU-AL-L2-06 / FCU-AL-L2-07 / FCU-H1-GF-01 / FCU-H1-GF-02 / FCU-H1-GF-05 / FCU-H1-GF-06 / FCU-H1-L1-01 / FCU-H1-L1-02 / FCU-H1-L1-03 / FCU-H1-L1-04 / FCU-H1-L1-05 / FCU-H1-L1-06 / FCU-H1-L1-07 / FCU-H1-L1-08 / FCU-H1-L1-09 / FCU-H1-L1-10 / FCU-H1-L1-11 / FCU-H1-L1-12 / FCU-H1-L2-02 / FCU-H1-L2-03 / FCU-H1-L2-04 / FCU-H1-L2-05 / FCU-H1-L2-06 / FCU-H1-L2-07 / FCU-H1-L2-08 / FCU-H1-L2-09 / FCU-H1-L2-10 / FCU-H1-L2-12 / FCU-H2-L1-01 / FCU-H2-L1-02 / FCU-H2-L1-03 / FCU-H2-L1-04 / FCU-H2-L1-05 / FCU-H2-L1-06 / FCU-H2-L1-07 / FCU-H2-L1-08 / FCU-H2-L1-09 / FCU-H2-L1-10 / FCU-H2-L1-11 / FCU-H2-L1-12 / FCU-H2-L2-02 / FCU-H2-L2-03 / FCU-H2-L2-05 / FCU-H2-L2-06 / FCU-H2-L2-07 / FCU-H2-L2-08 / FCU-H2-L2-09 / FCU-H2-L2-10 / FCU-H2-L2-11 / FCU-H2-L2-12 / FCU-H3-GF-02 / FCU-H3-GF-06 / FCU-H3-GF-11 / FCU-H3-GF-12
- FXMQ140PAVE: FCU-AL-L1-08 / FCU-AL-L1-09 / FCU-AL-L2-01 / FCU-AL-L2-02 / FCU-H1-L2-01 / FCU-H1-L2-11 / FCU-H2-L2-01 / FCU-H3-GF-01 / FCU-H3-GF-05
- FXMQ160PV1A: FCU-AL-GF-01
- FXMQ180PV1A: FCU-H3-GF-03 / FCU-H3-GF-04 / FCU-H3-GF-07 / FCU-H3-GF-08 / FCU-H3-GF-09 / FCU-H3-GF-10
- FXMQ250PV1A: FCU-H2-L2-04