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Prepared for: Savage Property Enterprises

DRAFT

ORANGE HOSPITAL REDEVELOPMENT

DA SUBMISSION ACOSUTIC INVESTIGATION

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1. INTRODUCTION

This report presents our recommendation for the acoustic elements within the proposed Orange Hospital redevelopment.

The objective of this report is to examine the acoustic requirements of the various space types and services and formulate suitable criteria to represent these requirements. The level of acoustic separation and background noise required is dependant on the nature and type of activities which take place in the various areas and rooms within the Hospital.

In addition the report provides indicative treatment to typical areas within the building to ensure an acceptable environment is provided. It is noted that plant and equipment selections were not available at the time of preparation of this report.

2. SOUND TRANSMISSION CLASS RATINGS

To determine suitable sound transmission class ratings for the various space types the following information was examined and evaluated.

1. Legislative criteria including the BCA for Class 2, 3 and 9C buildings.
2. The project specified STC ratings for the various space types.
3. The architectural layouts for the Hospital. These indicate the various space/activity relationships which will exist on this project.
4. Practices applied on other medical facilities and their degree of success.
5. Previous studies carried out to determine the perception of human speech with varying degrees of STC rated partitions.

The last point is of particular importance, as these studies have been performed for a number of recent projects with the aim of distilling the minimum acceptable sound for sound rated partitions system, taking into consideration both acoustic performance and buildablity. An understanding of the perception of sound and general audibility and intelligibility of human speech with different sound rated partitions is fundamental to the determination the of correct STC ratings for this project.

A second principle in this process which requires consideration is that the attainment of the exact STC ratings and background noise levels should be balanced against the attainment of other project requirements such as reverberation control, provision of clear passage above ceiling spaces for the routing of the myriad of services.

2.1 GENERAL APPROACH

The acoustic advice for this project has been developed to encompass the broader requirements of this facility. The consulting rooms, counselling offices, executive offices, birthing suites and specialised areas of the hospital such as psychiatric observation are seen as the most critical, requiring adequate acoustic isolation to maintain speech and acoustic privacy. Other associated spaces such as waiting areas, patient wards, general treatment and medical areas will require acoustic standards which provide speech privacy under normal conditions. That is when people are talking at normal volumes, these conversations will not be clearly audible in adjoining spaces. Loud events such as screaming or shouting are not seen a normal and hence do not require consideration in these space.

The location of the space is also important in determining the required STC rating. For example a tutorial or consulting room located in the middle of a corridor and adjoined by storage areas should require a lower STC rating than the same room types adjoining a patient ward or another consulting room. Note corridors are transitory spaces, where people either pass along or spend short periods of time, and differ greatly from spaces where people are stationed and are in a position to hear or be disturbed by sound in an adjoining area.

2.2 ACOUSTIC DESIGN APPROACH

A suitable acoustic standard for the different space types was determined by evaluating space function against specific acoustic requirements. Accordingly, the required acoustic environment for a space can be seen as a composite of four elements, namely;

1. The perceived sound privacy requirements.

2. The ambient acoustic environment (background noise levels); this is a direct function of the activities which occur and mechanical services noise.

3. The acoustic character of the space.

4. The levels of noise which are likely to be generated within a space, and how they will affect adjoining spaces.

This evaluation process was carried out to determine the acoustic requirements of the various spaces within this development.

2.3 IMPORTANCE OF SPACE CHARACTER TO PERCEPTION OF SOUND

The acoustic character of a room will determine the quality of the sound, and may lead to a space being perceived to be noisy. Acoustic character specifically refers to the sound absorption properties of the room finishes and the resulting nature of sound. A space with little acoustic absorption will sound reverberant and hollow. Noise heard in such a space tends to sound loud and sharp. Where adequate acoustic absorption is provided, sounds tend to be more natural and intelligible. This also makes the space sound quieter and therefore aurally more comfortable. For this development, it is proposed to provide a room character which is suitable for a heath facility environment, i.e. quiet and comfortable.

2.4 DETERMINATION OF REQUIRED ACOUSTIC MEASURES

In order to determine suitable acoustic measures for this project it is first necessary to understand the level of sound isolation provided by differently rated partition systems. (Note: a partition system as used in this report refers to the total performance of the wall and ceiling).

The best manner in which to describe the level of sound privacy provided by different partition systems is by conducting a comparison between the levels of acoustic privacy provided by three differently rated partitions. In this discussion we will demonstration the level of acoustic privacy afforded by partitions having STC ratings of STC30, 35 and 45. The data presented below was obtained in a simulation performed to actually demonstrate noise heard with each of the above ratings.

The table below provide an indication of various volumes of speech and resultant audibility with different partition systems.

Speech Noise Level	Represents	STC Rating of partitions	Audibility of Speech In Adjacent Office
60 dB(A)	Normal conversation	STC25	Speech clearly audible
60 dB(A)	Normal conversation	STC30 partition	Speech barely audible. Content of speech not recognisable.
70 dB(A)	Raised voice	STC30 partition	Speech clearly audible. Content of speech not fully recognisable.
60 dB(A)	Normal conversation	STC35[1] partition	Speech generally not audible. Content of speech not recognisable.
70 dB(A)	Raised voice	STC35[2] partition	Speech audible. Content of speech not recognisable. Similar to STC 30 partition but not quite as loud.
70 dB(A)	Raised voice	STC45 partition	Speech inaudible.

[1]:With the increase to STC 38 speech would not be audible and contents not recognisable. Note: this is the standard generally used for middle management offices in the private sector

[2]:With the increase to STC 38 speech would generally not be audible.STC 38 represents an improvement on STC 35.

From the above table it can be determined that;

- An STC 30 partition provides a moderate level of privacy for normal conversation levels.
- Raised conversation levels through an STC 30 partition would be clearly audible in an adjacent space.
- Increasing the rating from STC30 to 35 marginally reduces the noise level from raised conversation in the adjacent room. However, speech was still audible, and the content of the speech still intermittently recognisable. However normal conversation levels are not audible.
- Raising the rating to STC 38 provides a suitable level of speech privacy for normal and raised voices.
- An STC45 partition would provide complete privacy.

From the above discussion it can be concluded that an STC 30 partition system provides adequate isolation for normal speech, but is not effective in isolating raised voices.

An STC 35 rating is similar to STC 30, but provides better isolation for raised voices.

An STC 38 rating provides a suitable level of isolation for normal and raised voices.

An STC 45 partitions was found to provide complete privacy for normal and raised voices.

2.5 APPLICATION OF ABOVE STUDY TO THIS PROJECT.

The findings discussed in the previous section generally indicate that three levels of STC rating would be adequate to address the acoustic privacy requirements for this project. This would be STC 35 for general spaces without strict privacy requirement, STC 38 where a moderate level of speech privacy is required and STC 45 where high levels of privacy are required.

However, prior to finalising the ratings which will be used for this project, it is necessary to refer back to the planned space relationships.

The determination of which space assigned the various sound separation grading is then a function of the following;

- Space and activity type.
- Relative location of space to other spaces
- Level of sound privacy required for a space type.
- Level of space privacy experienced in a particular space type. For example it can be stated that minimal acoustic privacy exists in a 2 and 4 bed ward, where as the opposite is true for a 1 bed ward.
- Background noise levels which will occur in the space type.
- Reverberant conditions in the space type.
- Is a door fitted to the space

From the above requirements three basic ratings were derived for this project and allocated accordingly.

These ratings are:

STC 35	To be applied to spaces requiring speech privacy under normal conversation levels
STC 38	To be applied to spaces requiring speech privacy under normal and raised conversation levels
STC 45	To be applied to spaces requiring high degrees of privacy
Notes:	***1*** *STC 30 is not included on this project as it does not provide good isolation against raised voice.* ***2*** *An STC 38 rating provides a superior isolation against raised speech and represents a higher levels of sound isolation than STC 35.*

2.6 NOMINATED STC RATINGS

2.6.1 Hospital and Commercial/ Retail Areas

The nominated STC ratings for various space types within the hospital areas of the development selected following the methodology described above are shown in the table below.

SPACE TYPE	NOMINATED STC VALUES
Conference/Seminar Rooms / Lecture rooms	45
Speech Pathology Rooms	45
Maintenance Workshops	38
Plant Rooms	to be determined based on equipment selections
Tutorial/Case Conference Room	45
Tutorial/Library/Medical Conference and Audiovisual Room.	45
Ward - Inpatient(1 bed)	38
En-Suite (1 Bed)	38
Ward - Inpatient(2 or more beds)	35
En-suite (2 or more beds)	35
Bedrooms	45
Offices –upper management	45
Offices -general	38
Birthing Rooms	50
Nursery Overnight	38
Consultative and Examination Rooms	38/45*
Counselling Rooms	45
Emergency rooms	38
Interview Room / Meeting Rooms	45
Operating Rooms	45
Procedures and Treatment Rooms	38
Recovery	35
Ultrasound / Endoscopy/ Examination Rooms	45
Store Rooms	30
Clean Utility areas	30
Dirty Utility areas / Bathrooms	35
Toilets / change Rooms	38
Reception/Security	38

* - depending on adjacent space. Review of the drawings indicates no Audiology Acoustic Booth VOR or Audiology Speech Observation rooms are included in the redevelopment

In addition to the Hospital area the acoustic performance of partitions within commercial/ retail areas are detailed below.

SPACE TYPE	NOMINATED STC VALUES
Retail Partitions	45
Commercial Partitions	45
Toilets	45
Store Rooms	no rating

2.6.2 Residential / Hotel Acoustic Performances

The acoustic performance of elements within the Class 2, 3 and 9c residential / hotel buildings are detailed in the table below.

Wall Type	**Minimum $R_{w + Ctr}$**	**Minimum R_w**
Intertenancy Walls Dividing Wet Areas from Habitable areas	50 + Discontinuous construction (slab to slab)	N/A
Intertenancy Walls Dividing Habitable areas	50 (slab to slab)	N/A
Intertenancy Walls Dividing Wet areas	50 (slab to slab)	N/A
Walls Between Tenancies and Common Corridors	N/A	50 (slab to slab)
Walls Between Tenancies and Public Stairwells, etc.	N/A	50 (slab to slab)
Walls Between Tenancies and Plant Areas	N/A	60 (slab to slab)
Wall Between Offices and Communal Areas	N/A	45 (slab to slab)
Walls Between Tenancies and Services Ducts/Risers	40 (slab to slab)	N/A
Walls Between Bathrooms and services Ducts/Risers	25 (slab to slab)	N/A
Floors Between Tenancies	50 (slab to slab)	N/A

2.7 REQUIRED ACOUSTIC TREATMENTS

This section presents our recommendations for acoustic treatments.

Firstly, in order to provide the correct acoustic character it is proposed that where ever possible the use of carpet be made on floors rather than the vinyl flooring specified to reduce reverberant sound and improve the acoustic character and comfort of the areas (where vinyl is used it is recommended that it is cushion backed). This would also have the benefit of providing the areas a more domestic reassuring ambience. The ceilings should be formed from acoustically absorptive tiles. This excludes areas where sanitary requirements prohibit the use of such materials.

The acoustically absorptive fibre ceiling tiles nominated above will also be used to control space to space noise transmission. In this way the use of above ceiling baffles can be eliminated. This is advantageous in medical building as it facilities the free passage of the multitude of services which are required. The selected mineral fibre tiles should have a minimum thickness of 20mm, with a density not less than 400 kg/m3. A suitable tile is distributed by Armstrong World Industries, and is the 'Cortega Minaboard', having an NRC value of 0.55 and a minimum CAC of 40. An alternate product is the OW Acoustic ceiling tiles, with a minimum 20mm thickness and a Transverse Sound Reduction Index of 41dB. A third product which may be used is the CSR Ecophone RT tiles, which have a Sound Reduction Index of 41dB. There are no special acoustic requirements for the carpet.

Four wall construction systems are proposed for this project. These systems are illustrated in Figures 1 through 4. As discussed above, the achievable STC rating is dependent on the integration of the ceiling tiles with the wall systems.

To optimise the acoustic performance of the proposed systems, light trophers and mechanical inlets and outlets should be located centrally in a room. Light fittings may be located at the perimeter of a room, provided they do not incorporate slot diffusers for supply or return air or have any other slots in their construction that would lessen the integrity of the ceiling. Return and supply air outlets situated in STC 45 enclosed spaces will require the insertion of a lined plenum box over the inlet. It is also recommended that a 1.2 metre wide band of insulation equal to 75mm thick 11 kg/.m3 glasswool be laid centrally over walls rated at STC 45.

STC50 walls are recommended to be constructed full height. Where the construction of full height walls is not possible upgraded acoustic rated ceilings and/or baffles will be required.

Penetrations through full height STC 50 walls would be required to be treated to maintain the acoustic integrity of the wall. The recommended details for the partition and ceiling interfaces are shown in Figures 5 through 7

3. SERVICES SPECIFICATION

This section nominates the acoustic standards for mechanical and hydraulic services.

The section will be separated into two sub-sections namely;

i. Mechanical services

ii. Hydraulic services

3.1 MECHANICAL SERVICES

Another important consideration on building projects is noise from mechanical services.

Criteria are required to address the following;

- Internal noise levels
- Environmental noise conditions
- Vibration levels from plant to all habitable spaces.

3.1.1 NOISE AND VIBRATION CRITERIA

INTERNAL NOISE LEVELS

Noise from mechanical plant inside the development will be designed to meet the criteria presented below. These criteria apply to noise levels with the plant operating under all normal operating conditions, and at start-up for intermittently operating plant items.

The criteria set out in this section are represented as dB(A) values, this is consistent with the normal practice in Australia and in line with the format used for hospitals in Australian Standard 2107-2000 “Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors”

The table, which follows, presents the recommended criteria for this project in a standardised form.

Table 1 – Noise Criteria For Mechanical Services In Health Buildings – AS2107

SPACE/ACTIVITY TYPE	NOISE LEVEL L_{eq} dB(A)	
	Satisfactory Level	Maximum Level
Corridor and lobby spaces	40	50
Consulting rooms	40	45
Intensive care Wards	40	45
Laboratories	45	50
Office Areas	40	45
Pharmacies	45	50
Ward Spaces - 1 Bed[1]	30	35
Ward Spaces - 2 Beds or more	35	40
Waiting Rooms Reception	40	45

1For wards it is proposed to use the same criterion for both 1 bed and two or more beds. This will be the 2 or more bed criterion.

Noise During a Fire Emergency

Noise from all plant during a fire emergency shall comply with the requirements of AS1668. Noise levels inside the fire control room shall not exceed 65dB(A) during a fire emergency.

3.1.2 EXTERNAL NOISE LEVELS

Property Boundaries

Noise levels emitted by the mechanical plant at all property boundaries and nearby buildings on adjacent properties shall meet the requirements of:

1. Local Council
2. Environment Protection Authority.
3. Any other relevant statutory authority.

Outdoor Areas On The Development Site

Noise levels emitted by the mechanical plant to outdoor public and private areas on the development site shall not exceed the A-weighted background noise level (ie the L90 noise level) by more than 5 dB(A).

Vibration Produced By Plant

Tactile structure vibration levels produced by the plant should not exceed the criteria given in AS2670.2-1990. Where the standard recommends a range of criteria for a particular occupancy, the low end of the range shall be used.

3.2 HYDRAULIC SERVICES

The principal requirements for noise from the hydraulic services is that all waste soil pipe passing through the various spaces of the hospital development comply with satisfactory noise levels. The actual treatment of the waste pipe work will be dependant of the receiver space configuration, the ceiling construction system, the material from which the pipework is constructed and the hydraulic practices adopted on the project.

For the purpose of this schematic design report a series of design criteria is presented, these criteria are based on the maximum design levels presented in AS2107.

Table 2 - Noise Criteria For Hydraulic Services – AS2107

SPACE/ACTIVITY TYPE	NOISE LEVEL L_{eq} dB(A)	
	Satisfactory Level	Maximum Level
Corridor and lobby spaces	40	50
Consulting rooms	40	45
Intensive care Wards	40	45
Laboratories	45	50
Office Areas	40	45
Pharmacies	45	50
Ward Spaces - 1 Bed[1]	30	35
Ward Spaces - 2 Beds or more	35	40
Waiting Rooms Reception	40	45

1For wards it is proposed to use the same criterion for both 1 bed and two or more beds. This will be the 2 or more bed criterion.

4. HELICOPTERS

4.1 INTRODUCTION

This report presents our review of potential helicopter noise to the existing hospital buildings in the vicinity of the proposed general hospital and residential / hotel areas of the development.

Helicopter moments are associated with Orange Public Hospital located opposite the site on Forest Road.

4.2 HELICOPTER NOISE

There are no noise restrictions for emergency helicopter flights as detailed in Schedule 1 of the Protection of the Environmental operations Act. Notwithstanding this the EPA in Chapter 165 recommends the following to reduce the potential for noise impact;

- locating the helipad as far as possible from land zoned residential,
- setting flight paths to minimise noise exposure of residential land, and
- minimising ground idling time.

4.3 HELICOPTER AIRBORNE NOISE

This section discusses the levels of helicopter noise which will be potentially heard within the proposed existing buildings in the vicinity of the Helipad and associated flight path.

The proposed residential, hotel, commercial / retail and hospital buildings would potentially be affected by noise from the proposed hospital's emergency helicopter service.

To determine suitable noise levels for the various space types with regards to the helicopter landing pad the following information was examined and evaluated;

1. Typical frequency of use of the landing facility.
2. Recommended design sound levels for different areas of occupancy as specified in AS 2021.
3. Helicopter flight paths to be confirmed.

It has been assumed that helicopter movements associated with Orange Pubic Hospital are limited to emergency situations. Based on this assumption an acceptable noise level for rare and short term occurrences such as helicopter arrival and departures would be the recommended AS 2021 level plus 20 dB(A) which has been applied on similar hospitals such as Westmead Children's Hospital.

The nominated noise levels for the various spaces types selected following the methodology described above are shown in the table which follows.

Table 3 - Nominated Helicopter Noise Levels

SPACE TYPE	NOISE LEVEL OBJECTIVE dB(A)
Wards	60
Theatres	55
Treatment rooms	60
Consulting rooms	60
Laboratories	65
Service Areas	75
Private offices, conference areas	60
Offices - general	65
Commercial Areas	65
Retail Areas	65
Residential/Hotel Bedrooms	55
Residential/Hotel Living Areas	60

4.4 EVALUATION OF NOISE INTRUSION

Noise intrusion into the proposed spaces within the development buildings has been assessed. The calculations were based on the assumed flight paths of the helicopters associated with Orange Public Hospital.

Noise levels used for assessment purposes were obtained from extensive noise measurements taken by this office of a Jet Ranger Helicopter during the following activities;

- Starting up
- Running hard during starting up
- Taking off
- Various approaches

Of the above activities, taking off was the loudest and thus this level was used for assessment purposes.

Calculations were performed taking into account the orientation of windows, the total area of glazing, facade and roof transmission loss and room sound absorption characteristics. In this way the likely interior noise levels can be predicted.

A sample calculation is presented below into a worst case residential bedroom:

ROOF

1.	Jet Ranger Taking Off Noise Level corrected at 35m:	85 dB(A)
2.	Directivity corrections for angle of roof:	0 dB
3.	Roof Area Correction (Based on 4 x 5 roof area):	+ 13 dB
4.	Transmission loss through concrete roof with suspended mineral fibre tile or set plasterboard ceiling below:	- 55 dB
5.	Room Correction (Based on 4mx5mx3m room with basic furnishings):	- 10dB
	Noise level within bedroom via roof:	33dB(A)

FACADE

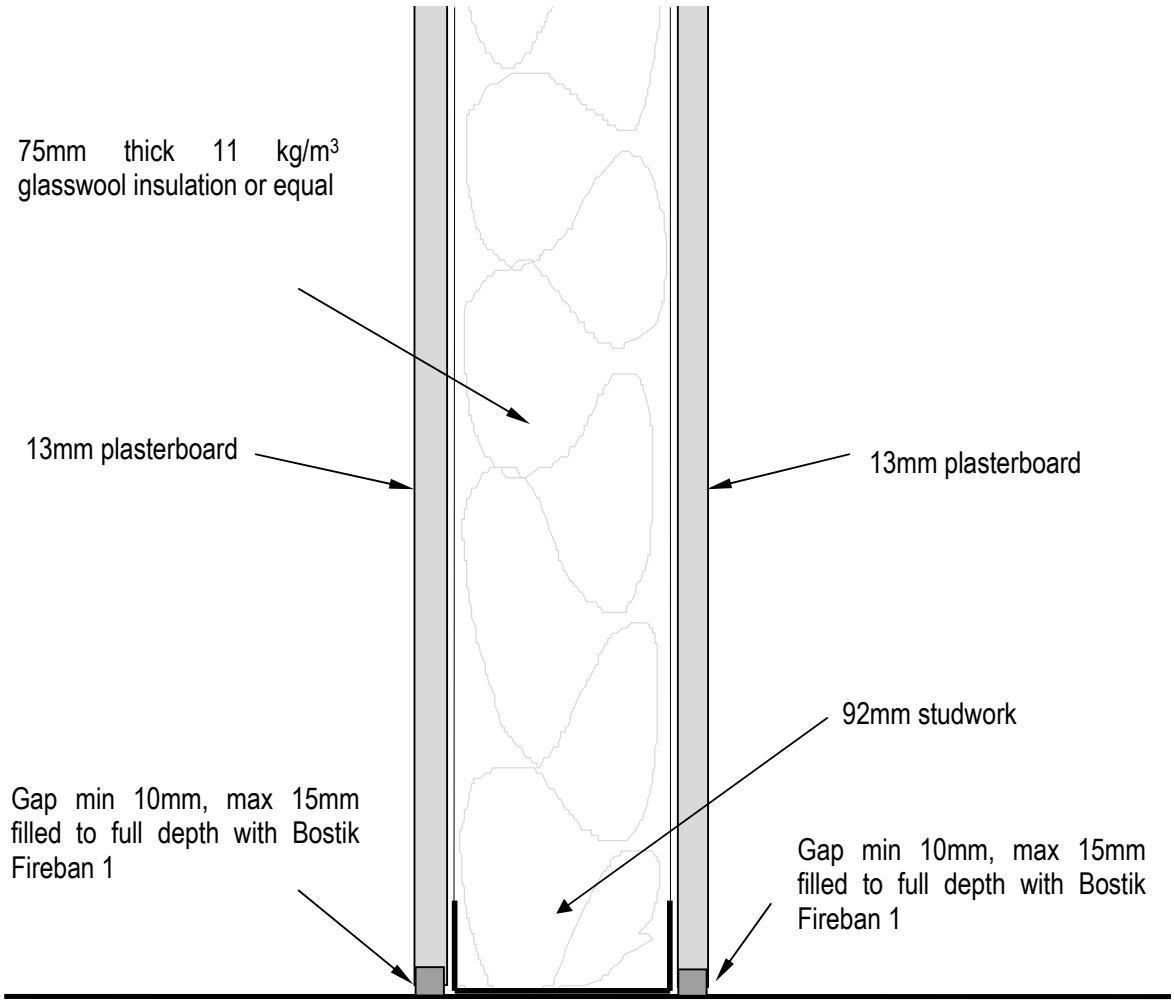
1.	Jet Ranger Taking Off Noise Level corrected at 35:	85 dB(A)
2.	Façade Area Correction (Based on 2.7 x 5 facade area):	+ 11 dB
3.	Transmission loss through standard glazing (nominal 6mm float):	- 28 dB
4.	Correction for directivity:	-10 dB
5.	Room Correction (Based on 4mx5mx3m room with basic furnishings):	- 10dB
	Noise level within Bedroom via facade:	48dB(A)
	Resultant Noise Level with bedroom through roof/façade combined:	49dB(A)

5. CONCLUSION

The recommendations presented in this report were determined to provide a suitable acoustic environment for the proposed re-development of Orange Private Hospital. Careful consideration was given to important issues such as speech and acoustic privacy.

Report prepared by;

Ben White



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			ORANGE HOSPITAL	
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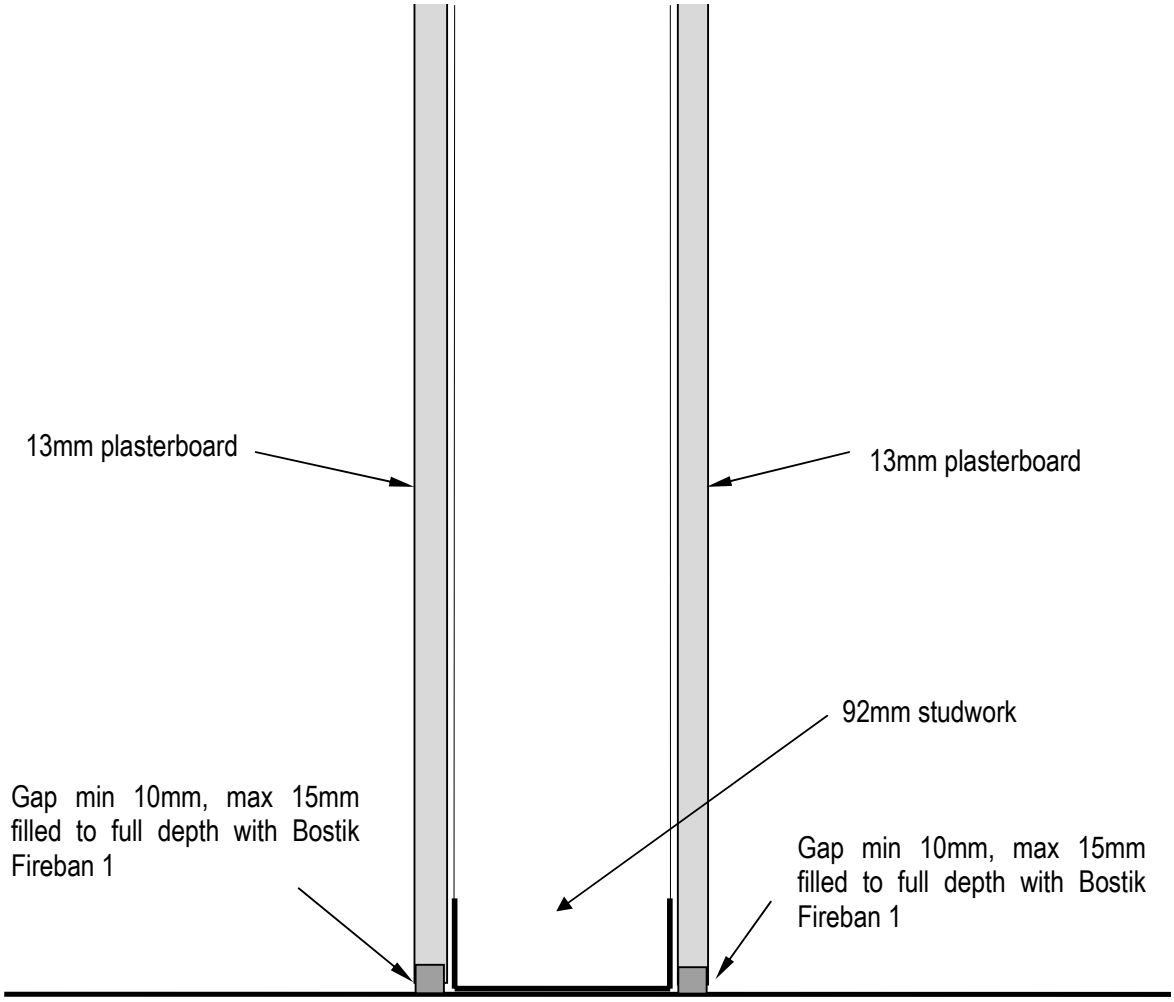

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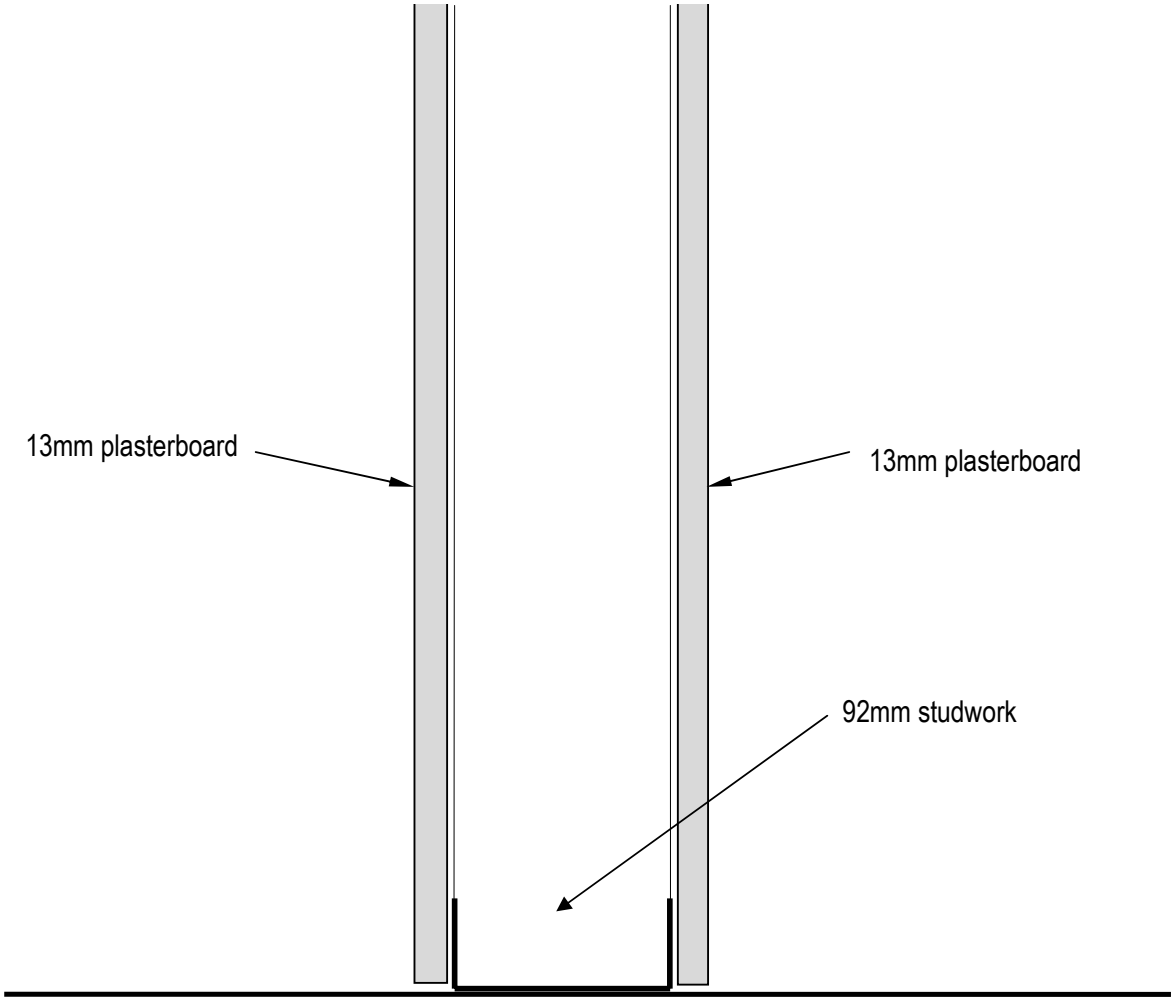

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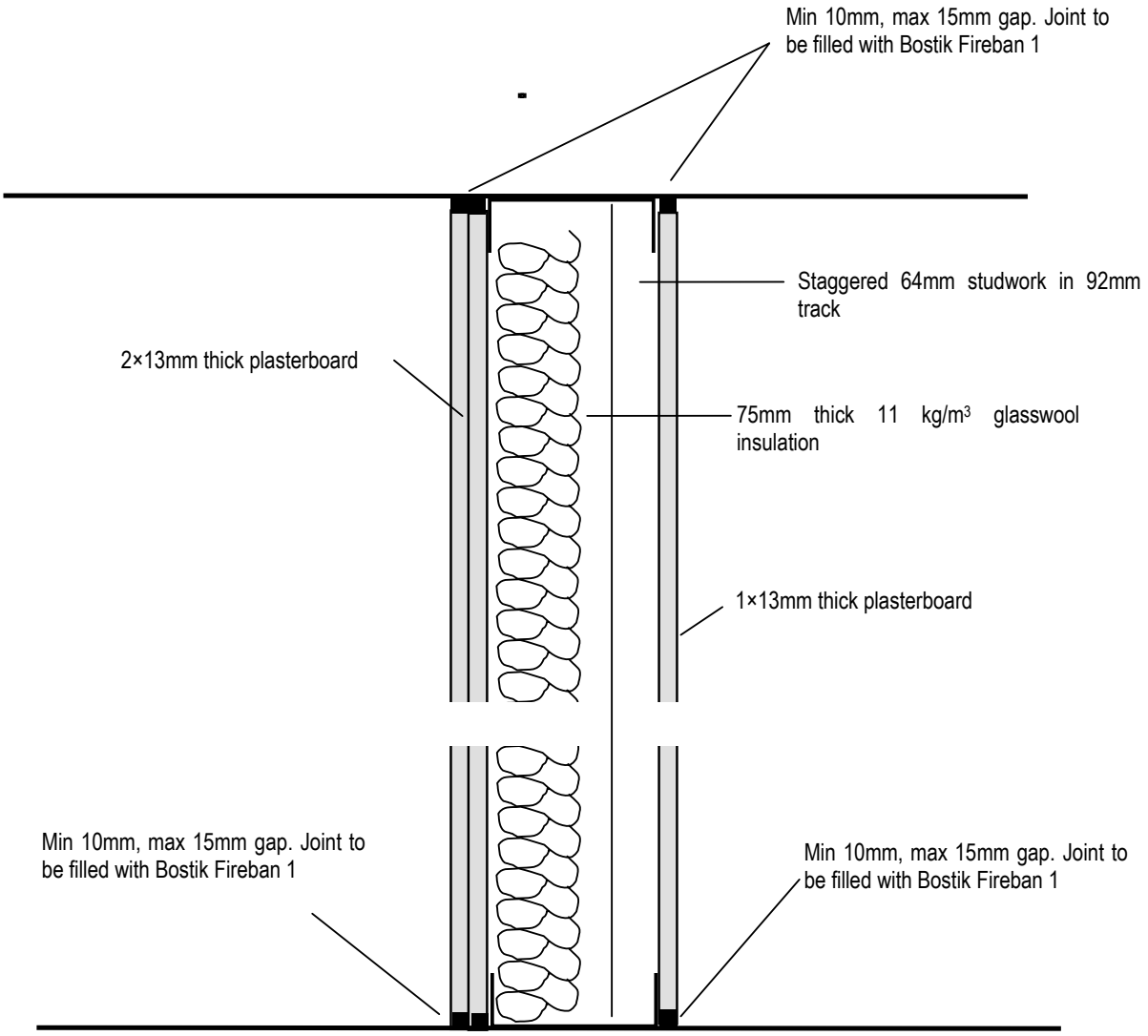

SECTIONAL ELEVATION OF STC 50 WALL SYSTEM

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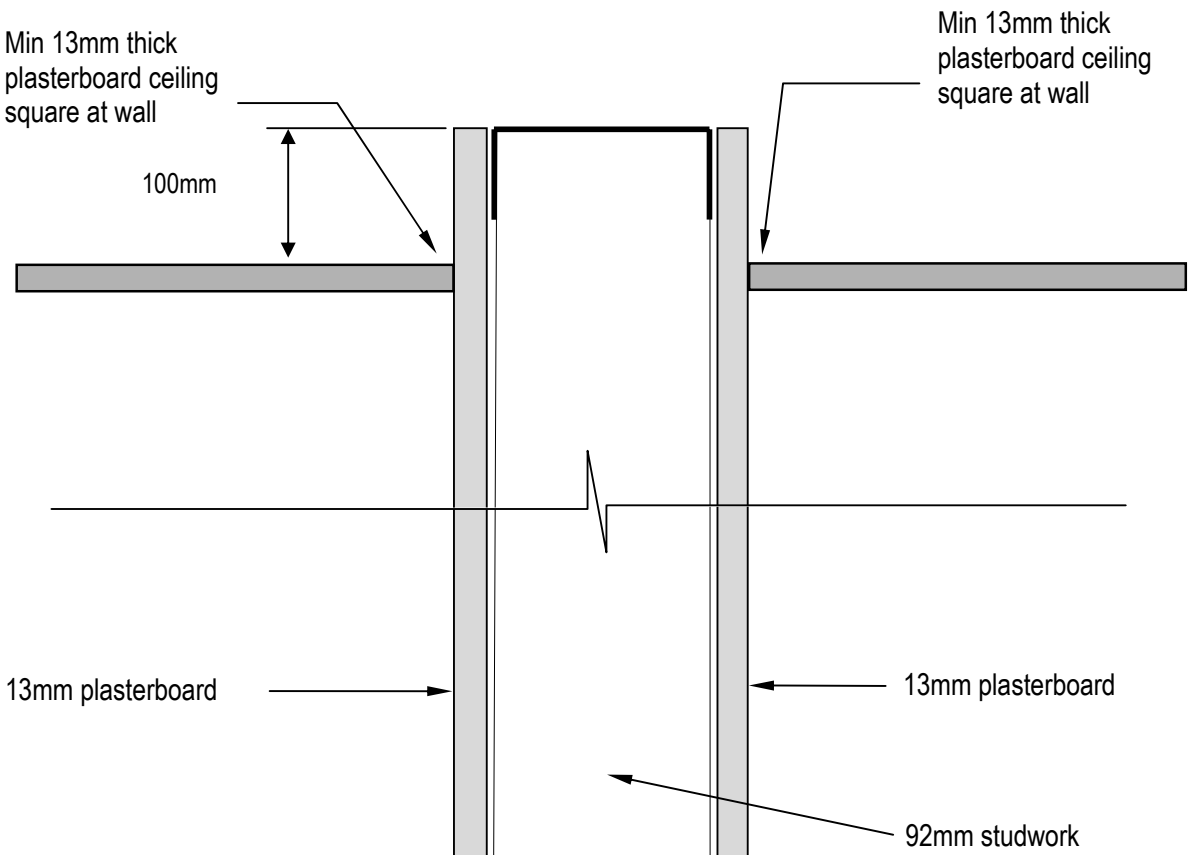

SECTIONAL ELEVATION OF STC 35 WALL/CEILING SYSTEM

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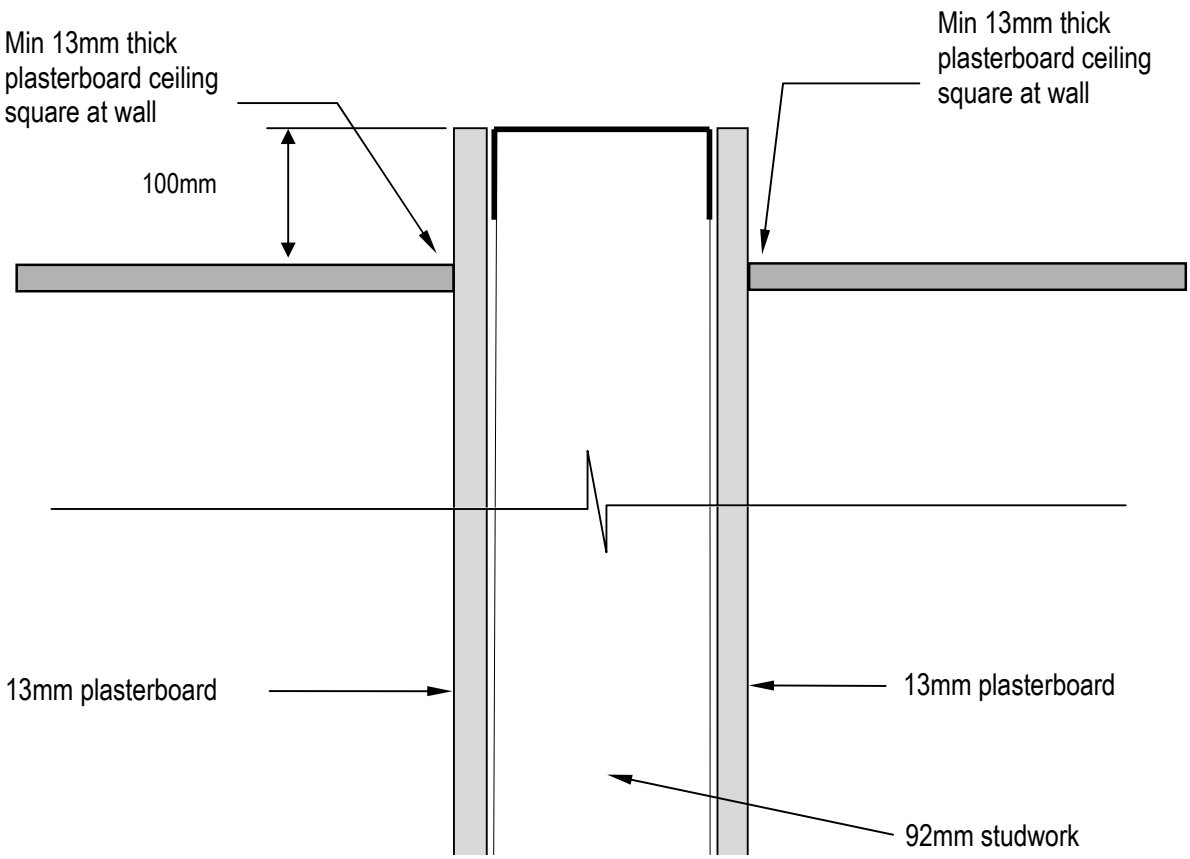

SECTIONAL ELEVATION OF STC 38 WALL/CEILING SYSTEM

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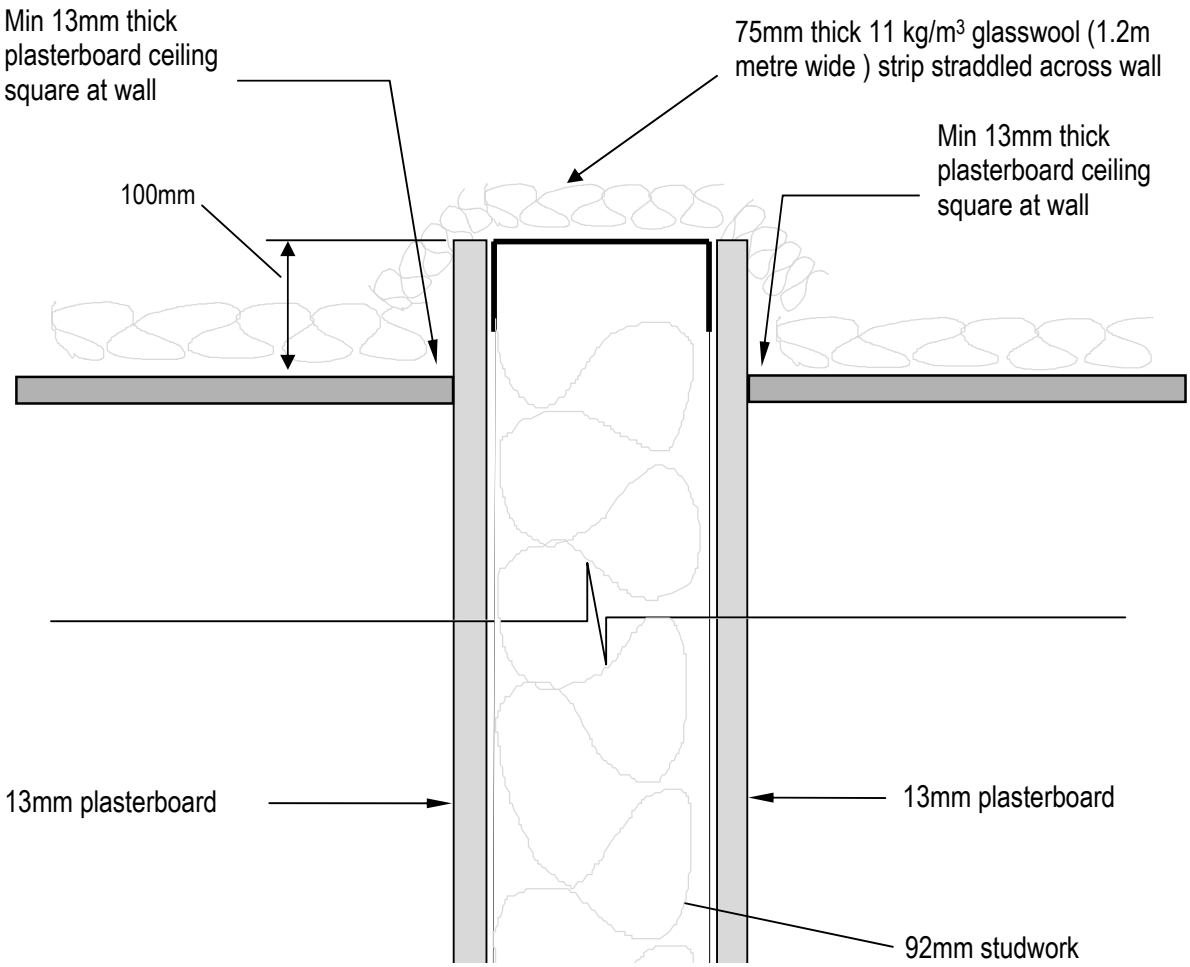

SECTIONAL ELEVATION OF STC 45 WALL/CEILING SYSTEM	**Acoustic Logic Consultancy Pty Ltd** 9 Sarah Street, Mascot Tel: 8338 9888 Fax: 8338 8399
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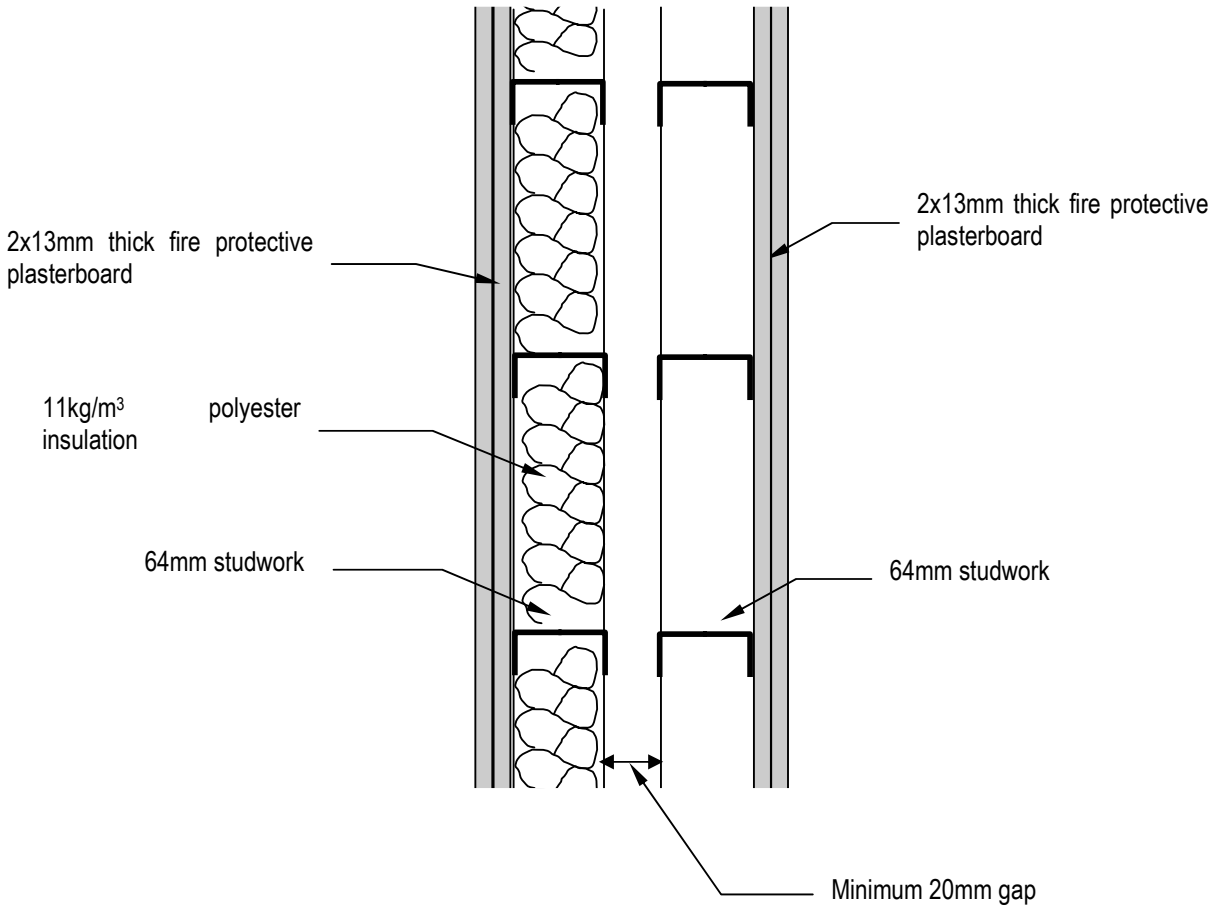

PLAN SECTIONAL VIEW **R_w +C_{tr} 50** **INTERTENANCY WALL**	**Acoustic Logic Consultancy Pty Ltd** 9 Sarah Street, Mascot Tel: 8338 9888 Fax: 8338 8399 **ORANGE HOSPITAL**

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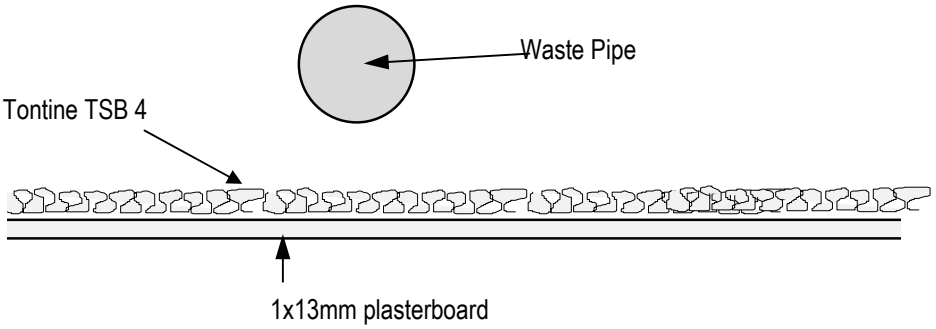

Pipework must be a minimum of 10mm from any support element or plasterboard

WET AREA

WASTE PIPE TREATMENT ABOVE WET AREAS **$R_w + C_{tr}$ 25**			**Acoustic Logic Consultancy Pty Ltd** 9 Sarah Street, Mascot Tel: 8338 9888 Fax: 8338 8399 **ORANGE HOSPITAL**	
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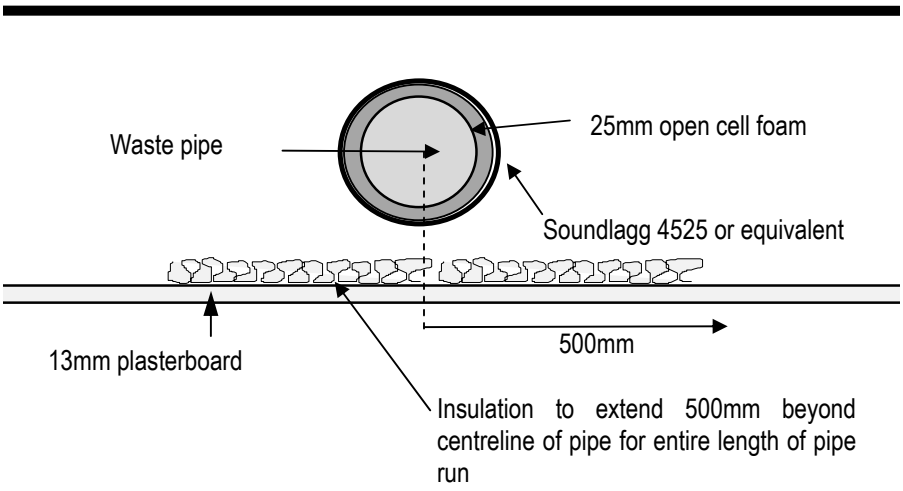

WASTE PIPE TREATMENT ABOVE HABITABLE AREAS **$R_w + C_{tr}$ 40**	**Acoustic Logic Consultancy Pty Ltd** 9 Sarah Street, Mascot Tel: 8338 9888 Fax: 8338 8399 **ORANGE HOSPITAL**

Date:	**Drawn:**	**Checked:**	**Project No:**	**Drawing No:**
November, 2007	BW		2007002	AC010_R0
Issue	**Scale:**	**Approved**		
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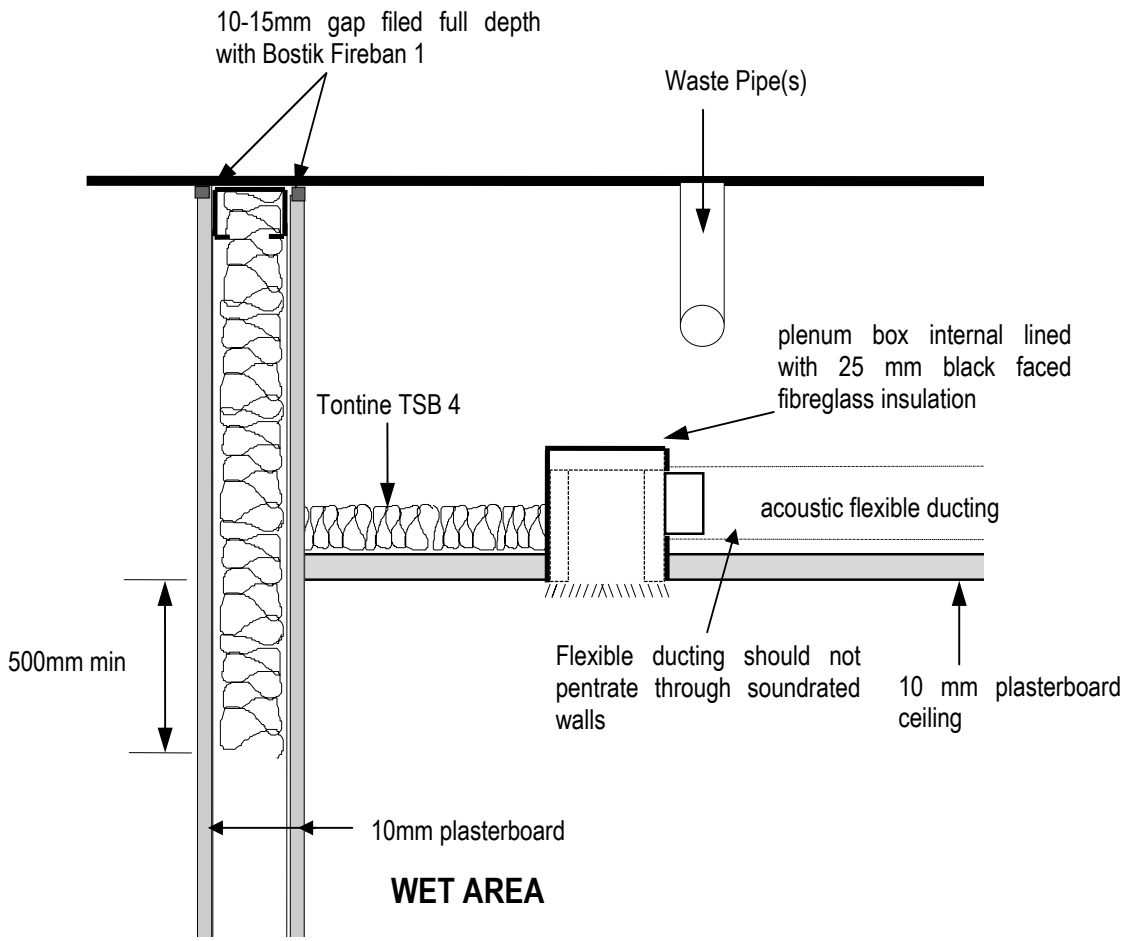

CONTROL OF NOISE BREAK-OUT FROM WASTE SOIL PIPE WORK THROUGH EXHAUST AIR GRILLES ABOVE WET AREA PLASTERBOARD OPTION CLASS 2, 3 AND 9C BUILDINGS			Acoustic Logic Consultancy Pty Ltd 9 Sarah Street, Mascot Tel: 8338 9888 Fax: 8338 8399	
			ORANGE HOSPITAL	
Date:	**Drawn:**	**Checked:**	**Project No:**	**Drawing No:**
November, 2007	BW		2007002	AC011_R0
Issue	**Scale:**	**Approved**		
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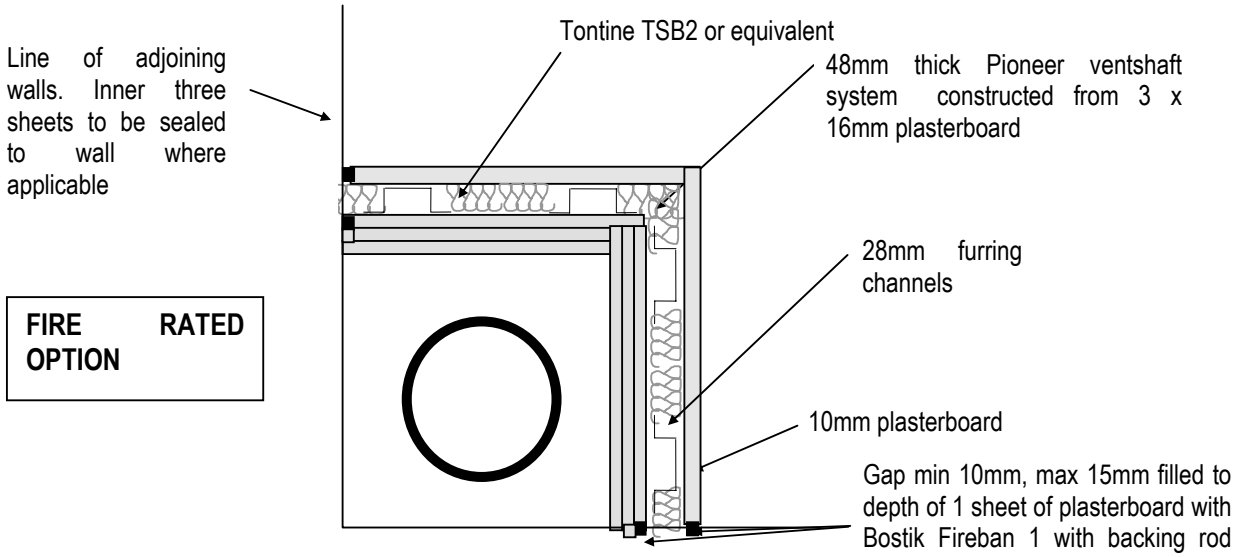
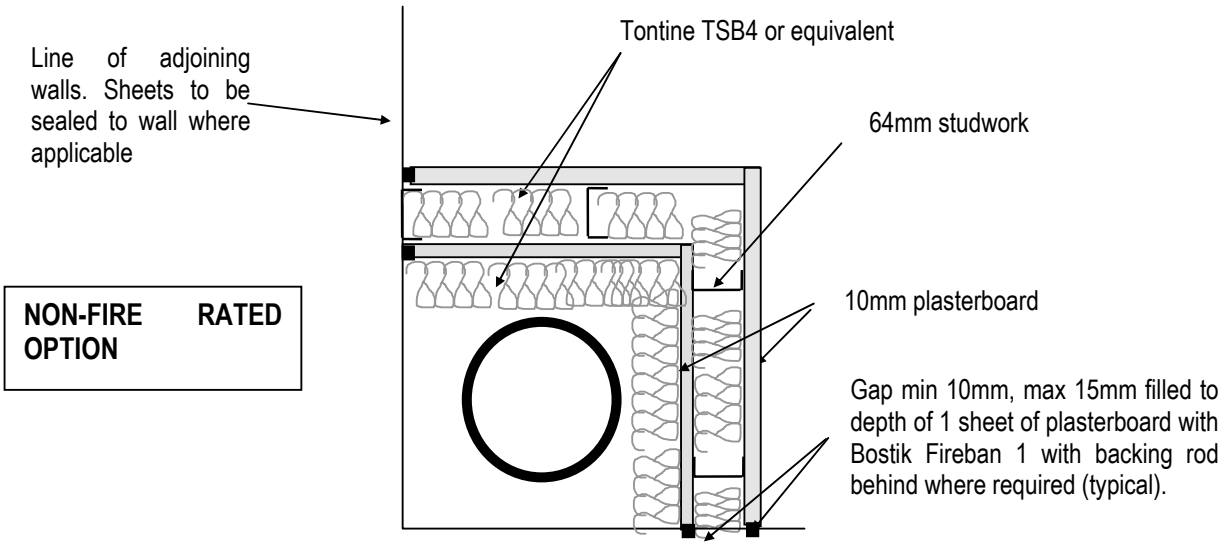


FIRE RATED OPTION



NON-FIRE RATED OPTION

HYDRAULIC RISER LOCATED WITHIN HABITABLE AREA
$R_w + C_{tr}$ 40

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Date:	Drawn:	Checked:	Project No:	Drawing No:
November, 2007	BW		2007002	AC012_R0
Issue	**Scale:**	**Approved**		
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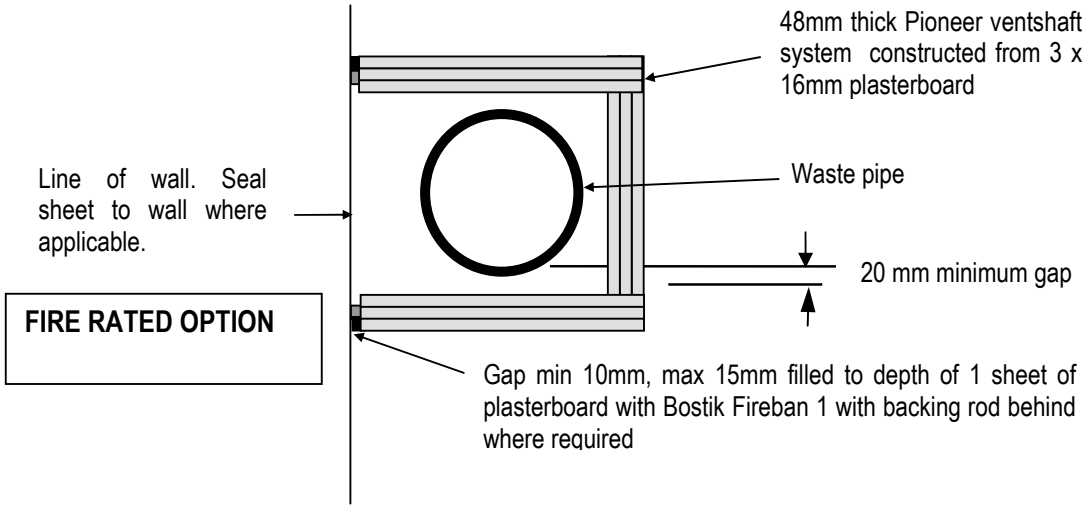

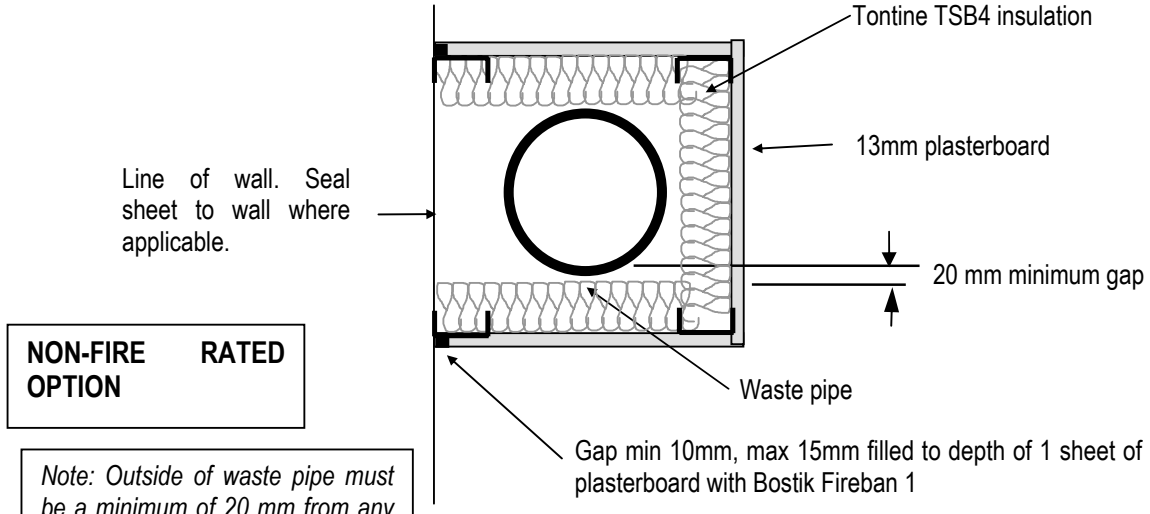

HYDRAULIC RISER LOCATED SOLELY WITHIN WET AREA
$R_w + C_{tr}$ 25

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Date:	Drawn:	Checked:	Project No:	Drawing No:
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Issue	**Scale:**	**Approved**		
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