CDN/17/ 0254

ACOUSTIC INSULATION TO RESIDENTIAL ACCOMODATION SCHEME

PLANNING CONDITION 23

RENAKER

Chester Road Planning Decision notice 113870/FO/2016 - Condition 23

Before the development commences a scheme for acoustically insulating the residential accommodation against noise from the main roads and surrounding road networks, and any other actual or potential sources of noise that require consideration on or near the site, including any local commercial/industrial premises, shall be submitted to and approved in writing by the City Council as local planning authority. The approved noise insulation scheme shall be completed before any of the dwelling units are first occupied.

Please find enclosed the supporting information submitted to satisfy the above Planning Condition in relation to the above application number as follows:

1. REC Noise Impact Assessment report reference AC100607-1R1 submitted with the Planning application
2. Report from Fisher Acoustics reference Z1-FAC-A180-RP-XX-001 detailing the internal noise criteria, noise survey data and the required window and through wall façade construction required to achieve the criteria
3. Typical OMI Architects design intent details through the stone cladding, metal cladding and windows numbered A2000, A2002, A2003, A2004, A2005, A2425 to be issued to the specialist trade contractors for tender
4. Elevations detailed acoustic requirements numbered L1770 AND L1771 to be issued to the specialist trade contractors for tender
5. Specification clauses H43 and H92 for the glazing and façade to be issued to the specialist trade contractors for tender

The above information will be used by the specialist trade contractor to produce a detailed design for all elements of the façade in accordance with the required and agreed criteria.

Currently no acoustic benefit has been taken from the outer finish material. If the final selected material has a certified acoustic benefit the wall build ups may be changed as appropriate.

REC
Resource & Environmental Consultants Ltd

National Consultancy, Locally Delivered

PLANNING AND
BUILDING CONTROL
12 MAY 2017

NOISE IMPACT ASSESSMENT
CHESTER ROAD, MANCHESTER

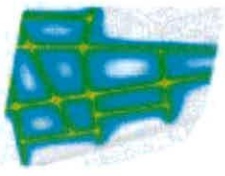
REC REFERENCE: AC100607-1R1

REPORT PREPARED FOR: CASTLEFIELD DEVELOPMENTS (MANCHESTER) LIMITED

15TH FEBRUARY 2016









QUALITY ASSURANCE

Issue/revision	Issue 1	Revision 1	Revision 2
Remarks	Draft, for comment	Final	
Date	1st February 2016	15th February 2016	
Prepared by	Lee Faulkner	Lee Faulkner	
Qualifications	BSc (Hons), AMIOA	BSc (Hons), AMIOA	
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Qualifications	BSc (Hons), MIOA	BSc (Hons), MIOA	
Signature			
Authorised by	John Goodwin	John Goodwin	
Qualifications	BSc (Hons), MIOA	BSc (Hons), MIOA	
Signature			
Project number	AC100607-1r0	AC100607-1r1	

EXECUTIVE SUMMARY

Noise Survey

A series of Noise Surveys have been completed in order to measure the noise levels as a result of road traffic on Chester Road, ambient noise levels due to a combination of local road and rail traffic and also the existing level of background sound which prevails across the Site.

Noise Impact Assessment

The Noise Impact Assessment has identified that the key sources of noise that have the potential to impact upon the proposed residential receptors are road traffic using Chester Road, noise from train and tram pass-bys and noise associated with the proposed fixed plant items associated with the development.

Recommended Mitigation Measures

This assessment has recommended higher specification glazing for the majority of habitable rooms and alternative ventilation for all habitable rooms in order to meet the internal target criteria.

This assessment has set M&E plant noise emission limits based on the existing measured background noise level and the adopted criteria given in BS4142:2014 for the proposed commercial units.

Subject to the incorporation of the identified mitigation measures and compliance with the specified plant noise emission limits, it is anticipated that a commensurate level of protection can be provided against development-generated noise for the closest residential receptors.

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1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants (REC) Limited have been commissioned by Castlefield Developments (Manchester) Limited to undertake a Noise Impact Assessment for a primarily residential development off Chester Road in Manchester, to be referred to hereafter as *'the Site'*.

This assessment has been undertaken to identify key noise sources impacting upon the Site and also associated with the proposed development that may have the potential to impact upon the noise-sensitive residential receptors at the Site, both existing and proposed.

REC have previously, and recently, had correspondence with the Environmental Health Department at Manchester City Council for similar schemes further down Chester Road and, as such, will use the information garnered from these discussions to ensure this application satisfies their requirements.

All acronyms used within this report are defined in the Glossary presented in Appendix II.

1.2 Site Location & Proposed Development

The Site comprises a parcel of land off Chester Road which is currently unoccupied. To the north, the Site is bound by the canal which also runs along the north eastern boundary. To the west lay existing residential dwelling sin the form of a six storey building. Chester Road runs along the southern boundary. The Site is located in a city centre location and is surrounded by residential use, specifically, to the north, south east and west.

The key noise source impacting upon the Site are vehicles using Chester Road to the south and trains/trams using the viaduct which is linked to Deasngate Station which is visible to the north west and north east.

Proposals include for the construction of a residential development with ground floor leisure and concierge facilities. The remaining floors are exclusively residential in use. The proposed building is made up of Block A and Block B. Block A will comprise 86 2/3 bed apartments across eleven floors. Block B will comprise 110 1/2/3 bed apartments across twenty floors. The ground floor will be home to the concierge facilities, plant rooms and gym/spa facilities.

This assessment has been undertaken with due regard to the supplied Site plans shown on the following planning drawings:

- Level 00 Plan – (Road Level) (drawing numbers L1002 Rev B) dated November 2015 and produced by OMI Architects.

The Ground Floor Plan Layout is shown in Figure 1 of Appendix III. Further plans detauiling the floor layouts have been used with drawing numbers of L1001, L1002, L1009, L1201, L1202, L1206 and L1219 and all dated November 2015.

1.3 Limitations

The limitations of this report are presented in Appendix I.

1.4 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2.0 ASSESSMENT CRITERIA

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) provides very brief guidance on planning and noise. The NPPF replaces the now revoked Planning Policy Guidance (PPG) Note 24. Paragraph 123 of the NPPF document states that planning policies and decisions should aim to:

- *'avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of development;*
- *mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*
- *recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and,*
- *Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.'*

This has been considered throughout the assessment where applicable.

No further guidance is given as to what a 'significant' impact would entail. It is therefore considered that meeting the criteria outlined in BS8233 and recommendations contained within the World Health Organisation guidelines, "significant adverse impacts" on health and quality of life associated with noise would be avoided.

2.2 Local Authority Guidance and Criteria – Manchester City Council's Environmental Health Department

REC have previously contacted Richard Knightley at Manchester City Council in order to discuss appropriate criteria for a scheme on Chester Road in Manchester in August 2015. Richard provided the following information regarding the assessments and criteria:

> ***"Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating noise level of 5dB (L_{Aeq}) below the existing background (L_{A90}) at the nearest noise sensitive location'.***
>
> *Where a planning application includes a proposal to contain a potentially noisy development within the same building as a noise sensitive use or visa versa the noise survey should consider the transfer of noise between the noisy and noise sensitive uses. An example of where this should be considered would be a proposal for a bar or club within the same building as residential properties.*
>
> *Consultants should demonstrate that the structure of the development will be sufficient to adequately contain the noise generated within the development. In doing so consultants should consider:*
>
> *- flanking noise;*

- structure borne noise;
- the overall level of noise (L_{Aeq}) generated by the use in question and any tonal or impulsive characteristics that the noise may contain; and
- the acoustic properties of the development (Including the construction of party floors and/or walls, windows and doors, ventilation systems, and structural columns.).

Residential noise criteria are:

Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq} (individual noise events should not normally exceed 45 dB L_{Amax} by more than 15 times)

Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}

Gardens and terraces (daytime) 55 dB L_{Aeq}

The above has been noted, however, it is important to note that this assessment will not be addressing flanking noise, structure borne noise or noise transfer between floors/rooms. Additionally, any noise from the proposed commercial premises will only be addressed in terms of plant noise emission limits and any assessment required in regard to flanking noise and noise transfer should be addressed by a suitably qualified Building Acoustics Consultant at the detailed design stage.

2.3 Calculation of Road Traffic Noise 1988

The Calculation of Road Traffic Noise (CRTN) memorandum, produced by the Department of Transport for the Welsh Office, describes the procedures for calculating noise from road traffic. Section III of this memorandum details the shortened measurement procedure whereby measurements of the L_{10} parameter are made over any three consecutive hours between 10:00 and 17:00. From the arithmetic average of the three 1-hour values, the $L_{10,18hr}$ noise levels is derived before derivation of the $L_{Aeq,16hr}$ value.

2.4 Transport Research Laboratory – Converting the UK Traffic Noise Index $L_{A10,18hr}$ to EU Noise Indices for Noise Mapping

This document provides a method for converting the $L_{A10,18hr}$ level to the L_{night} level using the following formula, applicable to non-motorway roads;

$$L_{night} = 0.90 \times L_{A10,18hr} - 3.77dB$$

2.5 British Standard BS8233: 2014: Guidance on Sound Insulation and Noise Reduction for Buildings

The scope of this standard is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new buildings or refurbished buildings undergoing a change of use, rather than to assess the effect of changes in the external noise climate.

The standard suggests suitable internal noise levels within different types of buildings, including dwellings, as shown in Table 2.1:

Table 2.1: BS8233 Recommended Internal Noise Levels

Criterion	Typical Situation	Design $L_{Aeq,T}$ (dB)
Suitable resting / sleeping conditions	Living Room	35
	Bedroom	30
For a reasonable standard in bedrooms at night, individual noise events (measured with fast time weighting) should not normally exceed 45dB L_{Amax}		

BS8233 goes on to recommend noise levels for gardens. According to BS8233;

> *"It is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors might be warranted".*

BS8233 goes on to say:

> *"In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.*
>
> *Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB LAeq,T or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space".*

2.6 World Health Organisation's (WHO) 'Guidelines for Community Noise'

The WHO 'Guidelines for Community Noise' offers advice with regard to setting noise criteria applicable to sleep disturbance. Section 4.2.3 specifies:

> *'If the noise is not continuous, L_{Amax} or SEL are used to indicate the probability of noise-induced awakenings. Effects have been observed at individual L_{Amax} exposures of 45 dB or less. Consequently, it is important to limit the number of noise events with a L_{Amax} exceeding 45 dB.'*

The guidelines go on to state:

> *'At night, sound pressure levels at the outside façades of the living spaces should not exceed 45 dB L_{Aeq} and 60 dB L_{Amax}, so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with*

the window partly open is 15 dB.'

The sound insulation performance value of 15dB for a façade containing a partially open window accords with the guidance offered in BS8233:2014.

The guidelines reference a study by Vallet & Vernet, 1991, which concluded that:

> *'For a good sleep, it is believed than indoor sound pressure levels should not exceed approximately 45 dB $L_{AF,max}$ more than 10-15 times per night.'*

Accordingly this assessment has utilised the 10th highest measured maximum noise level from the night-time period and allows for an assessment of a typical maximum noise level in determining façade sound insulation performance.

2.7 BS4142: 2014 *'Methods for rating and assessing industrial and commercial sound'*

This standard describes methods for rating and assessing sound of an industrial or commercial nature which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials at industrial and / or commercial premises; and,
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from processes or premises, such as that from forklift trucks, or that from train or ship movements on or around an industrial or commercial Site.

The procedure detailed in the standard compares the measured or predicted noise level 'the specific noise level' from any of the above detailed noise sources with the background sound level at a residential dwelling. The measured background sound level at a receptor should be reliable and should not necessarily ascertain a lowest measured background sound level, but rather to quantify what is typical.'

The specific noise level also acknowledges the following reference time intervals depending upon whether the noise source operates during daytime or night-time periods:

- Daytime (07:00 – 23:00): 1 hr; and,
- Night-time (23:00 – 07:00): 15 minutes.

There are a number of 'penalties' which can be attributed to the specific sound level depending upon the 'acoustic features' of the sound level under investigation as follows. These penalties vary in their weighting depending upon the severity of the acoustic feature, as follows:

Tonality

- +2dB: where the tonality is just perceptible;
- +4dB: where the tonality is clearly perceptible; and,
- +6dB: where the tonality is highly perceptible.

Impulsivity

- +3dB: where the impulsivity is just perceptible;

- +6dB: where the impulsivity is clearly perceptible; and,
- +9dB: where the impulsivity is highly perceptible.

Intermittency

- +3dB: where the intermittency is readily distinctive against the acoustic environment.

In addition to the above acoustic features, there is a penalty for 'other sound characteristics' of +3dB where a sound exhibits characteristics that are neither tonal nor impulsive, though are readily distinctive against the acoustic environment.

BS4142 goes on to state that the rating level is equal to the specific sound level if there are no such features present or expected to be present.

Assessment of the rating level relative to the background noise level can yield the following commentary:

- Typically the greater this difference (between the rating level and the background sound level), the greater the magnitude of impact;
- A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context;
- A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context; and,
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

With the above in mind, it is common that a Local Planning Authority will specify their own criteria for the rating level relative to the background sound level and, where this is the case, this criteria usually takes precedence over a simple comparison of the rating level against the background sound level.

3.0 NOISE SURVEY

REC has conducted a series of Noise Surveys which included:

- Road Traffic Noise Survey for Chester Road to the south of the Site;
- Attended Friday Night Survey for patron and entertainment noise; and,
- A Background and Ambient Sound Survey.

3.1 Road Traffic Noise Survey – Chester Road

REC has conducted a Road Traffic Noise Survey in order to measure the level of noise generated by vehicles using Chester Road. The survey was carried out over the following time period:

- Thursday 21st January 2016 between 11:02 and 15:02.

The following noise measurement position was chosen for the Road Traffic Noise Survey:

- Noise Measurement Position 1 (NMP1): Located on the southern site boundary, 5m from the nearside kerbstone of Chester Road and at a height of 2m in order to clear the existing security boarding around the Site. The microphone was located in free-field conditions. Noise sources at this location consisted predominately of vehicle pass-bys on Chester Road.

During consultation MCC requested that road traffic measurements should take account of rush hour periods. However, a 3-hour measurements was undertaken in accordance with the guidance in CRTN which stipulates measurements be taken between 10:00 and 17:00. Measurements obtained from the background noise meter were analysed to determine whether the rush hour period resulted in increased noise levels. However, it is clear from the results that the noise levels are lower due to standing traffic; therefore, the 3 hour CRTN measurement is considered worst case.

A summary of the measured sound pressure levels from the Road Traffic Noise Survey are presented in Table 3.1.

Table 3.1: Summary of Measured Noise Levels for NMP1

Measurement Position	Period	Measured Sound Pressure Level, free-field (dB)			
		$L_{Aeq,T}$	$L_{Amax,fast}$ [1]	$L_{A90,T}$	$L_{A10,T}$
NMP1	21/01/2016 11:02	76	87.4	65.9	78.9
	21/01/2016 12:02	75.4		66.1	78.8
	21/01/2016 13:02	76.3		67	79.2

[1] 10th highest $L_{Amax,fast}$ from three 1-hour periods

3.2 Attended Entertainment and Patron Noise Survey

REC have undertaken an attended noise survey in order to measure any noise associated with the nearby entertainment venues, specifically Dukes 92 to the north and the nearby Deansgate Locks.

The survey was undertaken during a typical Friday night between the following periods:

- 22:15 Friday 22nd until 00:30 Saturday 23rd January 2016.

During the survey the main noise source noted was road traffic using Chester Road which remained dominant until the end of the Survey. Patron noise from the north was audible at times, whilst patrons were outside talking, but this was not readily discernible against the noise environment on the sound level meter. No music break out was audible at any point. Furthermore, by consulting the ambient sound data it is clear that no entertainment noise is audible and that the noise environment is dominated by road traffic.

Following research, it was found that Dukes 92 is currently being refurbished and so was closed. However, given the separation distance it is not envisaged that any significant noise break out, due to music or patrons, will be audible given the main outdoor area is located on the north western façade of the venue and is completely shielded by the building. However, it is recommended that at the detailed design stage an additional assessment is undertaken in order to ensure sufficient protection for future residents.

Additionally, during the attended survey, train pass-bys were noted but, as above, these were not discernible from the residual noise environment.

The following location was chosen for the survey:

- Noise Monitoring Position 2 (NMP2): Located close to the north west boundary but elevated above the boundary in order to clear the existing security fencing. The microphone of the sound level meter was positioned at a height of 1.5m above ground level. The noise climate at this location was dominated by road traffic movements on Chester Road.

3.3 Background and Ambient Sound Survey

REC has conducted a full weekday and weekend Background and Ambient Sound Survey to establish the prevailing noise environment that currently exists across the Site. This comprised of an unattended noise measurement over the following periods:

- 22:15 Friday 22nd to 10:17 Tuesday 26th January 2016.

This time period has allowed for the measurement of the lowest background noise levels during the daytime and night-time periods across an entire weekday and weekend period.

The following location was chosen for the survey:

- Noise Monitoring Position 3 (NMP3): Located centrally within the Site and at a height of 1.5m above ground level, thus road traffic noise was screened from the meter. As such, the location is consisted representative of any facades that are in the shadow zone of Chester Road and are subject to noise from train/tram pass-bys and noise from road traffic on the local road network as a whole.

Given the Site is relatively small and completely open it is not possible to pinpoint one particular source given the various sources around the Site. Therefore, the above measurement is considered worst case for all facades that don't have line of sight to the road, similar to the environment the meter was installed in.

A summary of the average measured 1-hour sound pressure levels are presented in Table 3.2. The full tabulated results are contained in Table A1 of Appendix IV.

Table 3.2: Summary of the Average Measured 1-Hour Background and Ambient Sound Levels

Date	Period	Average Measured Sound Pressure Level (dB)	
		$L_{Aeq,1hr}$	$L_{A90,1hr}$
Friday 22nd January 2016	Night-time (23:00 – 07:00)	56.9	52.2
Saturday 23rd January 2016	Daytime (07:00 – 23:00)	60.3	57.2
	Night-time (23:00 – 07:00)	58.1	53.5
Sunday 24th January 2016	Daytime (07:00 – 23:00)	58.9	55.7
	Night-time (23:00 – 07:00)	55.7	50.5
Monday 25th January 2016	Daytime (07:00 – 23:00)	59.9	56.9
	Night-time (23:00 – 07:00)	56.9	52.7

The weather conditions during the Noise Survey were conducive towards the measurement of environmental noise with wind speeds below 5.0m/s.

The Noise Surveys were completed using the following noise measurement equipment.

Table 3.3: Noise Measurement Equipment

Noise Survey	Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
NMP1	Sound Level Meter	01dB-Metravib Black Solo	65882	30th January 2016
	Pre-amplifier	01dB-Metravib PRE 21 S	16614	
	Microphone	01dB Metravib MCE212	175374	
	Calibrator	01dB-Metravib CAL-21	35134328	24th February 2016
NMP2	Sound Level Meter	01dB-Metravib Black Solo	65947	10th September 2016
	Pre-amplifier	01dB-Metravib PRE 21 S	16831	
	Microphone	01dB Metravib MCE212	181856	
	Calibrator	01dB-Metravib CAL-21	34744600	5th November 2016
NMP3	Sound Level Meter	01dB-Metravib Black Solo	65771	19th October 2017
	Pre-amplifier	01dB-Metravib PRE 21 S	16640	
	Microphone	01dB Metravib MCE212	16539	

Calibrator	01dB-Metravib CAL-21	34634218	19th October 2016

The sound level meters were field-calibrated on Site prior to and after noise measurements were taken. No significant drift was witnessed. Calibration certificates are available upon request.

4.0 NOISE IMPACT ASSESSMENT

Given the Site is split between Block A and Block B, each Block will be considered separately within each assessment.

4.1 Road Traffic Noise Impact Assessment

The noise levels measured for the CRTN have been converted to the wider 16 hour daytime and 8 hour night-time noise levels using the following calculation:

1. Calculation of the $L_{A10,18hr}$ noise level by using the following formula:

$$L_{10,18hr} = L_{10,3hr} - 1dB$$

2. Calculation of the $L_{Aeq,16hr}$ noise level by using the following formula:

$$L_{eq,16hr} = L_{10,18hr} - 2dB$$

3. Calculation of the night-time $L_{Aeq,8hr}$ noise level by using the following formula:

$$L_{night}\ (L_{eq,8hr}) = 0.90 \times L_{10,18hr} - 3.77dB$$

Table 4.1 details the calculated daytime and night-time noise levels.

Table 4.1: Calculation of Daytime and Night-time Noise Levels

Measurement Position	Period	Calculated Noise Level (dB)	10th Highest Measured $L_{Amax,fast}$ (dB)
NMP1	Daytime (07:00 – 23:00)	76.0 $L_{Aeq,16hr}$	-
	Night-time (23:00 – 07:00)	66.4 $L_{Aeq,8hr}$	87.4

4.1.1 Chester Road – External Amenity Areas

4.1.1.1 Block A

It is understood from the supplied plans that there will be balconies associated with certain apartments on the 2nd to 11th floors. Table 4.2 details the calculated noise levels within the balcony areas. Given the guidance in BS8233:2014, the assessment will aim to achieve 55dB $L_{Aeq,16hr}$ however, where this is exceeded, the lowest practicable levels will be achieved by way of mitigation. Any balconies that have no line of sight to Chester Road will be considered separately in accordance with the measured data from NMP3 as the proposed building will act as an effective barrier to Chester Road alone, resulting in at least -18dB attenuation, for example, the balconies of apartments 2 to 4 on floor 2 to 8 have no line of sight to Chester Road.

Table 4.2: Calculation of Unmitigated External Noise Levels for the Balconies – Block A

Floor/Apartment	Calculated $L_{Aeq,16hr}$ (dB)	Distance to Balcony (m)	Line of Sight or Barrier Attenuation (dB)	Calculated Daytime $L_{Aeq,16hr}$ Noise Level (dB)	External Noise Criteria Level (dB)	Difference (dB)
2nd 1	76.0	35.9	-5	64.2	55	**+9.2**
2nd 5 to 7	76.0	17.1	0	72.4	55	**+17.4**
2nd 8 and 9	76.0	20.7	0	71.6	55	**+16.6**
3rd 1	76.0	36.7	-5	64.1	55	**+9.1**
3rd 5 to 7	76.0	18.6	0	72.0	55	**+17.0**
3rd 8 and 9	76.0	22	0	71.3	55	**+16.3**
4th 1	76.0	37.3	-5	64.0	55	**+9.0**
4th 5 to 7	76.0	19.8	0	71.8	55	**+16.8**
4th 8 and 9	76.0	23	0	71.1	55	**+16.1**
5th 1	76.0	38.4	-5	63.9	55	**+8.9**
5th 5 to 7	76.0	21.8	0	71.3	55	**+16.3**
5th 8 and 9	76.0	24.7	0	70.8	55	**+15.8**
6th 1	76.0	39.6	-5	63.7	55	**+8.7**
6th 5 to 7	76.0	23.9	0	70.9	55	**+15.9**
6th 8 and 9	76.0	26.6	0	70.5	55	**+15.5**
7th 1	76.0	41.1	-5	63.6	55	**+8.6**
7th 5 to 7	76.0	26.2	0	70.5	55	**+15.5**
7th 8 and 9	76.0	28.7	0	70.1	55	**+15.1**
8th 1	76.0	42.6	-5	63.4	55	**+8.4**
8th 5 to 7	76.0	28.6	0	70.2	55	**+15.2**
8th 8 and 9	76.0	30.8	0	69.8	55	**+14.8**
9th 4 to 6	76.0	31	0	69.8	55	**+14.8**
9th 7	76.0	33.1	0	69.5	55	**+14.5**
10th 4 to 6	76.0	33.5	0	69.5	55	**+14.5**

10th 7	76.0	35.5	0	69.2	55	**+14.2**
11th 4 to 6	76.0	36.1	0	69.1	55	**+14.1**
11th 7	76.0	37.9	0	68.9	55	**+13.9**

Table 4.2 indicates that all balconies associated with Block A that have line of sight to Chester Road are in exceedence of the 55dB criteria and, as such, the predicted levels are not considered the lowest practicable levels. Therefore, mitigation measures are required for Block A

4.1.1.2 Block B

It is understood from the supplied plans that there will be balconies associated with certain apartments on the 1st to 18th floors with terraced areas on the 19th floor. Table 4.3 details the calculated noise levels within the balconies and terrace areas. Given the guidance in BS8233:2014, the assessment will aim to achieve 55dB $L_{Aeq,16hr}$ however, where this is exceeded, the lowest practicable levels will be achieved by way of mitigation. Any balconies that have no line of sight to Chester Road will be considered separately in accordance with the measured data from NMP3 as the proposed building will act as an effective barrier to Chester Road alone, resulting in at least -18dB attenuation.

Table 4.3: Calculation of Unmitigated External Noise Levels for the Balconies – Block B

Floor/Apartment	Calculated $L_{Aeq,16hr}$ (dB)	Distance to Balcony (m)	Line of Sight or Barrier Attenuation (dB)	Calculated Daytime $L_{Aeq,16hr}$ Noise Level (dB)	External Noise Criteria Level (dB)	Difference (dB)
1st 2	76.0	21.4	-5	66.4	55	**+11.4**
2nd 1	76.0	36.7	-5	64.1	55	**+9.1**
2nd 3	76.0	22.2	-5	66.3	55	**+11.3**
2nd 6	76.0	26	-5	65.6	55	**+10.6**
3rd 1	76.0	37.4	-5	64.0	55	**+9.0**
3rd 3	76.0	23.3	-5	66.0	55	**+11.0**
3rd 6	76.0	26.9	-5	65.4	55	**+10.4**
4th 1	76.0	38.2	-5	63.9	55	**+8.9**
4th 3	76.0	24.6	-5	65.8	55	**+10.8**
4th 6	76.0	28.1	-5	65.2	55	**+10.2**
5th 1	76.0	39.3	-5	63.8	55	**+8.8**
5th 3	76.0	26.3	-5	65.5	55	**+10.5**
5th 6	76.0	29.5	-5	65.0	55	**+10.0**

6th 1	76.0	40.5	-5	63.6	55	**+8.6**
6th 3	76.0	22.7	0	71.2	55	**+16.2**
6th 5	76.0	22.7	0	71.2	55	**+16.2**
6th 6	76.0	31.2	-5	64.8	55	**+9.8**
7th 1	76.0	41.9	-5	63.5	55	**+8.5**
7th 3	76.0	25.1	0	70.7	55	**+15.7**
7th 5	76.0	25.1	0	70.7	55	**+15.7**
7th 6	76.0	32.9	-5	64.5	55	**+9.5**
8th 1	76.0	43.4	-5	63.3	55	**+8.3**
8th 3	76.0	27.6	0	70.3	55	**+15.3**
8th 5	76.0	27.6	0	70.3	55	**+15.3**
8th 6	76.0	34.9	-5	64.3	55	**+9.3**
9th 1	76.0	45.1	-5	63.2	55	**+8.2**
9th 3	76.0	30.1	0	69.9	55	**+14.9**
9th 5	76.0	30.1	0	69.9	55	**+14.9**
9th 6	76.0	36.9	-5	64.0	55	**+9.0**
10th 1	76.0	46.9	-5	63.0	55	**+8.0**
10th 3	76.0	32.7	0	69.6	55	**+14.6**
10th 5	76.0	32.7	0	69.6	55	**+14.6**
10th 6	76.0	39.1	-5	63.8	55	**+8.8**
11th 1	76.0	48.7	-5	62.8	55	**+7.8**
11th 3	76.0	35.3	0	69.2	55	**+14.2**
11th 5	76.0	35.3	0	69.2	55	**+14.2**
11th 6	76.0	41.3	-5	63.6	55	**+8.6**
12th 1	76.0	50.7	-5	62.7	55	**+7.7**
12th 3	76.0	38	0	68.9	55	**+13.9**
12th 5	76.0	38	0	68.9	55	**+13.9**

12th 6	76.0	43.6	-5	63.3	55	**+8.3**
13th 1	76.0	52.7	-5	62.5	55	**+7.5**
13th 3	76.0	40.7	0	68.6	55	**+13.6**
13th 5	76.0	40.7	0	68.6	55	**+13.6**
13th 6	76.0	45.9	-5	63.1	55	**+8.1**
14th 1	76.0	54.9	-5	62.3	55	**+7.3**
14th 3	76.0	43.4	0	68.3	55	**+13.3**
14th 5	76.0	43.4	0	68.3	55	**+13.3**
14th 6	76.0	48.4	-5	62.9	55	**+7.9**
15th 1	76.0	57	-5	62.2	55	**+7.2**
15th 3	76.0	46.1	0	68.1	55	**+13.1**
15th 5	76.0	46.1	0	68.1	55	**+13.1**
15th 6	76.0	50.8	-5	62.7	55	**+7.7**
16th 1	76.0	59.3	-5	62.0	55	**+7.0**
16th 3	76.0	48.9	0	67.8	55	**+12.8**
16th 5	76.0	48.9	0	67.8	55	**+12.8**
16th 6	76.0	53.3	-5	62.5	55	**+7.5**
17th 1	76.0	61.6	-5	61.8	55	**+6.8**
17th 3	76.0	51.6	0	67.6	55	**+12.6**
17th 5	76.0	51.6	0	67.6	55	**+12.6**
17th 6	76.0	55.9	-5	62.2	55	**+7.2**
18th 1	76.0	63.9	-5	61.7	55	**+6.7**
18th 3	76.0	54.4	0	67.4	55	**+12.4**
18th 5	76.0	54.4	0	67.4	55	**+12.4**
18th 6	76.0	58.4	-5	62.1	55	**+7.1**
19th Terrace north	76.0	66.3	-5	61.5	55	**+6.5**
19th Terrace south	76.0	57.1	0	67.2	55	**+12.2**

Table 4.3 indicates that all balconies associated with Block B that have line of sight to Chester Road are in exceedence of the 55dB criteria and, as such, the predicted levels are not considered the lowest practicable levels. Therefore, mitigation measures are required.

4.1.2 Chester Road – Internal Habitable Rooms

4.1.2.1 Block A

Given the large amount of data, the calculated internal sound pressure levels and the comparison with the criteria are shown in Table A2 for Block A.

In performing these calculations, it has been assumed that standard thermal double glazing will be used. BS8233:2014 suggest that a glazing unit with configuration 6mm glass/12mm air space/6mm glass affords sound insulation performance in the order of 33dB however this is for a pink noise spectrum. The same unit, weighted for road traffic noise using the '+C_{tr}' correction, has a sound insulation performance value of approximately 30dB and so this value has been used to calculate internal noise levels. During summer months it may be necessary to open a window within a habitable room in order to gain a supply of fresh air. BS8233:2014 suggests that a partially open window will attenuate noise in the order of 15dB.

Any exceedences are highlighted in bold. Angle of View correction has been applied where applicable. It can be seen from the Table that standard thermal double glazing will not be appropriate for certain habitable rooms. Therefore, Section 5.0 details the required glazing specification for the required performance given in Table A2. Furthermore, the vast majority of habitable rooms would be in exceedence of the criteria if windows were opened. Therefore, alternative ventilation is also recommended in Section 5.0. Where habitable rooms have no line of sight to Chester Road, the following assessment should be used in determining the requirements for mitigation on these facades.

4.1.2.2 Block B

Given the large amount of data, the calculated internal sound pressure levels and the comparison with the criteria are shown in Table A3 for Block B.

In performing these calculations, it has been assumed that standard thermal double glazing will be used. BS8233:2014 suggest that a glazing unit with configuration 6mm glass/12mm air space/6mm glass affords sound insulation performance in the order of 33dB however this is for a pink noise spectrum. The same unit, weighted for road traffic noise using the '+C_{tr}' correction, has a sound insulation performance value of approximately 30dB and so this value has been used to calculate internal noise levels. During summer months it may be necessary to open a window within a habitable room in order to gain a supply of fresh air. BS8233:2014 suggests that a partially open window will attenuate noise in the order of 15dB.

Any exceedences are highlighted in bold. Angle of View correction has been applied where applicable. It can be seen from the Table that standard thermal double glazing will not be appropriate for certain habitable rooms. Therefore, Section 5.0 details the required glazing specification for the required performance given in Table A3. Furthermore, the vast majority of habitable rooms would be in exceedence of the criteria if windows were opened. Therefore, alternative ventilation is also recommended in Section 5.0. Where habitable rooms have no line of sight to Chester Road, the following assessment should be used in determining the requirements for mitigation on these facades.

4.2 Ambient Sound Level Assessment – All Sources

4.2.1 External Amenity Areas

It is understood from the supplied plans that there will be balconies associated with certain apartments on the 2nd to 11th floors within Block A and on the 1st to 18th floors with terraced areas on the 19th floor within Block B. Table 4.4 details the measured noise levels within the balcony areas. Given the measured levels apply to road traffic on the local road network and rail traffic, no distance correction has been applied. Given the guidance in BS8233:2014, the assessment will aim to achieve 55dB $L_{Aeq,16hr}$ however, where this is exceeded, the lowest practicable levels will be achieved by way of mitigation.

The highest measured $L_{Aeq,16hr}$ of 60.3dB has been applied in order to inform worst case assessment. Assuming a person stood in the centre of the balcony, it is assumed that partial line of sight removal, -5dB, can be applied to account for the surrounding walls and proposed balcony safety barrier.

Table 4.4: Calculation of Unmitigated External Noise Levels for the Balconies – Block A and B

Floor/Apartment	Highest Measured $L_{Aeq,16hr}$ (dB)	Line of Sight Removal (dB)	Calculated Daytime $L_{Aeq,16hr}$ Noise Level (dB)	External Noise Criteria Level (dB)	Difference (dB)
All Balconies with no line of sight to Chester Road	60.3	-5	55.3	55	**+0.3**

Table 4.4 indicates that all balconies on the facades that have no line of sight to Chester Road are marginally in exceedence of the 55dB criteria. However, given the guidance in BS8233:2014, this is considered negligible. Furthermore, these are based on worst case assumptions and that the floors above the 1st floor will experience even lower noise levels, as the measured level refers to ground/first floors. As such, no consideration, in addition to any standard balcony barriers, is required for these balconies.

Where a balcony has even partial line of sight to Chester Road, the mitigation measures detailed in Section 5.0 apply.

4.2.2 Internal Habitable Rooms

Using the highest measured daytime level of 60.3dB $L_{Aeq,16hr}$ the resulting internal noise level for any living rooms that do not have any line of sight to Chester Road would be 30.3 $L_{Aeq,16hr}$ with standard thermal double glazing. This falls comfortably below the BS8233:2014 criteria of 35dB $L_{Aeq,16hr}$. Therefore, higher specification glazing is not required for these living rooms.

The highest measured night-time noise level was 58.1dB $L_{Aeq,8hr.}$ Assuming standard thermal double glazing achieves 28.1dB $L_{Aeq,8hr}$ internally. This falls comfortably below the BS8233:2014 criteria of 30dB $L_{Aeq,8hr}$. Therefore, higher specification glazing is not required for these bedrooms.

However, with a partially open window, the internal noise criteria during the daytime and night-time periods will be exceeded. Therefore, further to stated previously, alternative ventilation is required for all habitable rooms.

4.3 Plant Noise Emission Limits Assessment

At the time of producing this report, the proposed M&E plant items associated with the proposed development had not been confirmed. Accordingly, it is necessary to set plant noise emission limits for which any plant items shall not exceed, when measured or calculated at the closest proposed residential receptors.

MCC have stipulated the following criteria:

- $L_{Ar} = L_{A90} - 5dB$

This indicates that the Rating Level, from any single or combined plant items, shall fall below the existing background noise level by at least 5dB, when measured or calculated at the façade of the closest proposed residential receptor. With regards applying the feature penalties given in BS4142:2014, in our opinion the fixed plant items, such as, air conditioning units and extractor fans will have a tonal aspect to them. Therefore, a penalty of 4dB has been applied as the tones would be clearly perceptible but due to the dominance of road traffic noise across the Site, the tones should not be highly perceptible.

The proposed operating periods for M&E plant had not been finalised at the time of producing this assessment, as such Table 4.x details the calculated plant noise emission limit based on the typical measured 1-hour background sound level for the daytime and night-time period.

Table 4.5: Calculated Plant Noise Emission Limits

Period	Lowest Average Measured Background Noise Level, $L_{A90,1hr}$ (dB)	Criteria	Calculated Plant Noise Emission Limit L_{Ar} (dB)
Daytime (07:00 – 23:00)	55.7	$L_{A,r} = L_{A90} - 5dB$	50.7
Night-time (23:00 – 07:00)	50.5		45.5

5.0 MITIGATION

5.1 Road Traffic Noise Mitigation

5.1.1 Internal Amenity Areas

The previous section has indicated that habitable rooms in certain apartments with line of sight to Chester Road will exceed the internal target noise criteria with standard thermal double glazing, as detailed in Tables A2 and A3. Table 5.1 details the required specification of upgraded glazing in order to achieve the performance detailed in Tables A2 and A3. As the glazing units are associated with living rooms and bedrooms, the highest exceedence has been used to determine the required performance. A denotes acoustic laminate glass.

Table 5.1: Upgraded Glazing Specifications

Required Performance of Glazing Unit $R_w + C_{tr}$ (dB)	Typical Glazing Configuration (glass / air space / glass)	Unit Thickness (mm)
38	6 / 16 / 12.4A or 8 / 16 / 10.4A	34.4
37	8 / 8 / 8.4A or 6 / 12 / 10.8A	24.4 or 28.8
36	6 / 12 / 8.8A or 6 / 15 / 8.4A	26.8 or 29.4
35	6 / 6 / 8.4A or 4 / 16 / 8.8A	20.4 or 28.8
34	4 / 8 / 8.4A or 12 / 16 / 6	20.4 or 34
33	6 / 9 / 6.4A or 10 / 12 / 12	21.4 or 34
32	4 / 6 / 6.4A or 6 / 12 / 10	16.4 or 28
31	4 / 6 / 6.4A or 4 / 12 / 8	16.4 or 24

The previous section indicated that with a partially open window, the internal noise levels for all habitable rooms will exceed the internal target criteria. Accordingly, it is recommended that a through-frame window mounted trickle ventilator is incorporated into the glazing unit of the habitable rooms so that fresh air can enter the room without having to open windows. One such acoustic trickle ventilator is as follows:

- Greenwoods EAR42W Trickle Ventilator, which provides acoustic attenuation of up to 42 dB $D_{n,e,w} + C_{tr}$ in its open position.

Alternatively, a through wall trickle ventilator could be used. It is recommended that the trickle ventilator be combined with a Mechanical Extract Ventilation (MEV), a Mechanical Ventilation Heat Recovery (MVHR) or a Passive Extract Ventilation (PEV) system which extracts air from the habitable rooms and can provide purge ventilation negating the need to open windows. This is especially important for those habitable rooms with line of sight to Chester Road and to a lesser extent for those located on the northern aspects. Ideally, any inlet for fresh air should be located away from Chester Road to ensure the freshest air available is brought into the habitable rooms.

The exact performance of any trickle ventilators or through wall ventilators can be determined by adding the exceedence value, last column of Tables A2 and A3, to 15dB, which is the attenuation applied for a partially open window.

The exact requirement for alternative ventilation ultimately falls to the developer and, from an acoustics perspective, needs to ensure that fresh air flow can be achieved without the need for opening windows. It is necessary to meet the requirements given in BS8233:2014, Section 8.4.5.4, which states that:

> *"The Building Regulations' supporting documents on ventilation [48, 49, 50] recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant's choice.*
>
> *Alternatively, acoustic ventilation units (see **7.7.2**) are available for insertion in external walls. These can provide sound reduction comparable with double glazed windows. However, ducted systems with intakes on the quiet side of the building might be required in very noisy situations, or where appearance rules out through-the-wall fans."*

Section 7.7.2 states:

> *"NOTE 5 If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level."*

6.0 CONCLUSION

REC Limited have been commissioned by Castlefield Developments (Manchester) Limited to undertake a Noise Impact Assessment for a proposed mixed use development off Chester Road in Castlefield, Manchester.

This assessment has been undertaken to identify key noise sources impacting upon the Site and also associated with the proposed development that may have the potential to impact upon the noise-sensitive residential receptors at the Site. This assessment has been completed with due regard to the requirements of MCC's Environmental Health Department.

This assessment has recommended higher specification glazing for the majority of habitable rooms and alternative ventilation for all habitable rooms in order to meet the internal target criteria.

This assessment has set M&E plant noise emission limits based on the existing measured background noise level and the adopted criteria given in BS4142:2014 for the proposed commercial units.

Subject to the incorporation of the identified mitigation measures and compliance with the specified plant noise emission limits, it is anticipated that a commensurate level of protection can be provided against development-generated noise for the closest residential receptors.

APPENDIX I LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Limited and the Client as indicated in Section 1.2.

2. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.

3. REC cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.

APPENDIX II GLOSSARY OF ACOUSTICAL TERMINOLOGY

Noise

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the following table.

Table A1: Typical Sound Pressure Levels

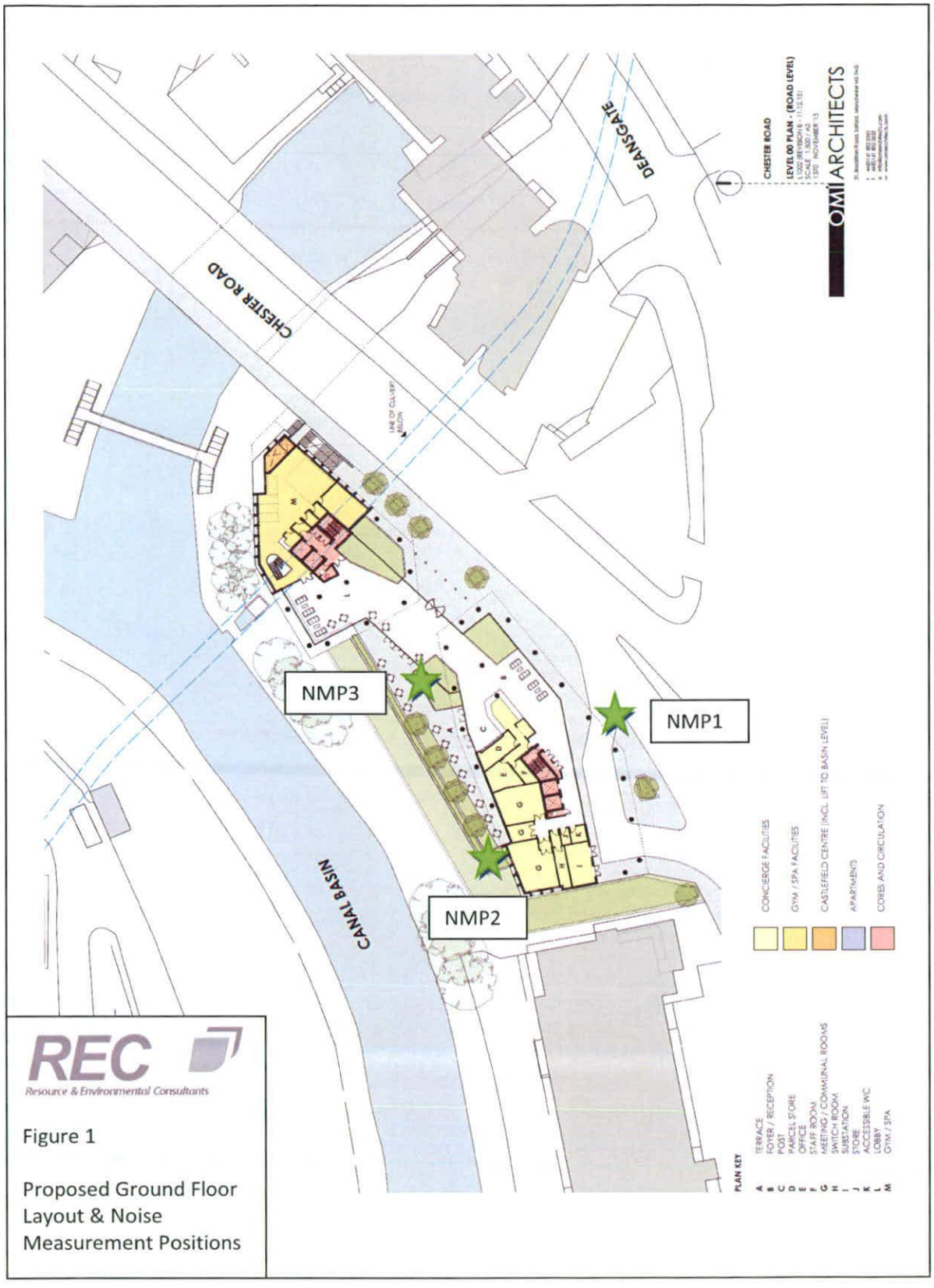
Sound Pressure Level dB(A)	Location
0	Threshold of hearing
20 - 30	Quiet bedroom at night
30 - 40	Living room during the day
40 - 50	Typical office
50 - 60	Inside a car
60 - 70	Typical high street
70 - 90	Inside factory
100 - 110	Burglar alarm at 1m away
110 - 130	Jet aircraft on take off
140	Threshold of pain

Acoustic Terminology

Table A2: Terminology

Descriptor	Explanation
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (2x10-5Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
$L_{Aeq,T}$	L_{Aeq} is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
L_{Amax}	L_{Amax} is the maximum A - weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L_{10} & L_{90}	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The Ln indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L_{10} index to describe traffic noise.
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally as measured outside and away from buildings.
Fast	A time weighting used in the root mean square section of a sound level meter with a 125millisecond time constant.
Slow	A time weighting used in the root mean square section of a sound level meter with a 1000millisecond time constant.

APPENDIX III FIGURES



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Figure 1

Proposed Ground Floor Layout & Noise Measurement Positions

APPENDIX IV MEASURED SOUND PRESSURE LEVELS

Table A1: Measured Noise Levels – NMP3

Measurement Start Time	Measured Sound Pressure Level	
	$L_{Aeq,t}$	$L_{A90,t}$
22/01/2016 22:17	61.5	56.1
22/01/2016 23:17	58.7	55
23/01/2016 00:17	59.1	54.1
23/01/2016 01:17	57.2	52.7
23/01/2016 02:17	56.1	51.8
23/01/2016 03:17	56.4	49.7
23/01/2016 04:17	55	48.1
23/01/2016 05:17	54.5	49.5
23/01/2016 06:17	55.7	51.9
23/01/2016 07:17	57.4	53.8
23/01/2016 08:17	59.4	56
23/01/2016 09:17	59.2	56.1
23/01/2016 10:17	61.1	57.2
23/01/2016 11:17	60.6	57.6
23/01/2016 12:17	60.7	57.9
23/01/2016 13:17	60.1	57.5
23/01/2016 14:17	59.5	56.5
23/01/2016 15:17	60.5	57.6
23/01/2016 16:17	60.9	57.8
23/01/2016 17:17	60.6	57.7
23/01/2016 18:17	60.7	58
23/01/2016 19:17	60.7	57.9
23/01/2016 20:17	60.6	57.4
23/01/2016 21:17	60.6	57
23/01/2016 22:17	60.4	57.4
23/01/2016 23:17	59.5	56.2
24/01/2016 00:17	58.5	54.5
24/01/2016 01:17	58.4	54
24/01/2016 02:17	58.9	54.2
24/01/2016 03:17	58.4	53.4
24/01/2016 04:17	57.6	51.6
24/01/2016 05:17	56.8	50.3
24/01/2016 06:17	55.7	50.5
24/01/2016 07:17	55.4	50.9
24/01/2016 08:17	56.3	52.5
24/01/2016 09:17	57.9	54.1
24/01/2016 10:17	59	55.9
24/01/2016 11:17	59.4	56.6

24/01/2016 12:17	59.4	56.5
24/01/2016 13:17	60.5	57.3
24/01/2016 14:17	59.7	57
24/01/2016 15:17	59.3	56
24/01/2016 16:17	60.9	57.8
24/01/2016 17:17	59	56.1
24/01/2016 18:17	58.7	55.7
24/01/2016 19:17	58.8	55.5
24/01/2016 20:17	58.7	55
24/01/2016 21:17	57.8	54.6
24/01/2016 22:17	59.1	54.2
24/01/2016 23:17	55.1	49.7
25/01/2016 00:17	53.9	48.5
25/01/2016 01:17	52.8	46.7
25/01/2016 02:17	54.6	46.6
25/01/2016 03:17	54.4	47.2
25/01/2016 04:17	54.1	49.1
25/01/2016 05:17	56	50.2
25/01/2016 06:17	60	56.1
25/01/2016 07:17	60.6	56.8
25/01/2016 08:17	59.7	56.7
25/01/2016 09:17	60.4	57.9
25/01/2016 10:17	60.7	57.8
25/01/2016 11:17	61.8	59.3
25/01/2016 12:17	60.7	57.7
25/01/2016 13:17	61.3	58.3
25/01/2016 14:17	60.9	58.1
25/01/2016 15:17	60.6	57.3
25/01/2016 16:17	60.4	57.3
25/01/2016 17:17	59	56.3
25/01/2016 18:17	59.3	56.5
25/01/2016 19:17	58	54.9
25/01/2016 20:17	57.7	53.1
25/01/2016 21:17	57.1	53.6
25/01/2016 22:17	56.6	51.8
25/01/2016 23:17	55.3	50.2
26/01/2016 00:17	53.9	48
26/01/2016 01:17	55.1	45.9
26/01/2016 02:17	52.9	44.8
26/01/2016 03:17	54.5	46.3
26/01/2016 04:17	54.4	48.9
26/01/2016 05:17	58.3	54.3

26/01/2016 06:17	62	59.4
26/01/2016 07:17	62.7	59.7
26/01/2016 08:17	62.7	59.8
26/01/2016 09:17	63.2	60.1

APPENDIX V CALCULATED INTERNAL SOUND PRESSURE LEVELS

Table A2: Internal Noise Levels for Block A – Chester Road

Floor and Apartment	Period	Calculated Noise Level at Façade (dB)	Internal Noise Level with Standard Double Glazing (dB)	Difference with BS8233:2014 Criteria +/- (dB)	Required Glazing Performance, $R_w + C_{tr}$ (dB)	Internal Noise Level with Partially Open Window (dB)	Difference with BS8233:2014 Criteria +/- (dB)
2nd Floor Apartment 1	Day, $L_{Aeq,16hr}$	46.6	16.6	-18.4	-	31.6	-3.4
	Night, $L_{Aeq,8hr}$	51.8	21.8	-8.2	-	36.8	**+6.8**
	Night, $L_{Amax,fast}$	66.0	36.0	-9.0	-	51.0	**+6.0**
2nd Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	46.6	16.6	-18.4	-	31.6	-3.4
	Night, $L_{Aeq,8hr}$	37.0	7.0	-23.0	-	22.0	-8.0
	Night, $L_{Amax,fast}$	51.2	21.2	-23.8	-	36.2	-8.8
2nd Floor Apartment 4	Day, $L_{Aeq,16hr}$	67.1	37.1	**+2.1**	**33**	52.1	**+17.1**
	Night, $L_{Aeq,8hr}$	38.0	8.0	-22.0	-	23.0	-7.0
	Night, $L_{Amax,fast}$	53.1	23.1	-21.9	-	38.1	-6.9
2nd Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	72.4	42.4	**+7.4**	**38**	57.4	**+22.4**
	Night, $L_{Aeq,8hr}$	62.8	32.8	**+2.8**	**33**	47.8	**+17.8**
	Night, $L_{Amax,fast}$	80.2	50.2	**+5.2**	**36**	65.2	**+20.2**
2nd Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	71.3	41.3	**+6.3**	**37**	56.3	**+21.3**
	Night, $L_{Aeq,8hr}$	61.7	31.7	**+1.7**	**32**	46.7	**+16.7**
	Night, $L_{Amax,fast}$	78.3	48.3	**+3.3**	**34**	63.3	**+18.3**
3rd Floor Apartment 1	Day, $L_{Aeq,16hr}$	46.5	16.5	-18.5	-	31.5	-3.5
	Night, $L_{Aeq,8hr}$	51.7	21.7	-8.3	-	36.7	**+6.7**
	Night, $L_{Amax,fast}$	65.8	35.8	-9.2	-	50.8	**+5.8**
3rd Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	46.5	16.5	-18.5	-	31.5	-3.5
	Night, $L_{Aeq,8hr}$	37.0	7.0	-23.0	-	22.0	-8.0
	Night, $L_{Amax,fast}$	51.1	21.1	-23.9	-	36.1	-8.9
3rd Floor Apartment 4	Day, $L_{Aeq,16hr}$	67.0	37.0	2.0	**32**	52.0	**+17.0**
	Night, $L_{Aeq,8hr}$	37.9	7.9	-22.1	-	22.9	-7.1
	Night, $L_{Amax,fast}$	52.9	22.9	-22.1	-	37.9	-7.1
3rd Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	72.0	42.0	**+7.0**	**37**	57.0	**+22.0**
	Night, $L_{Aeq,8hr}$	62.5	32.5	**+2.5**	**33**	47.5	**+17.5**
	Night, $L_{Amax,fast}$	79.5	49.5	**+4.5**	**35**	64.5	**+19.5**
3rd Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	71.0	41.0	**+6.0**	**36**	56.0	**+21.0**
	Night, $L_{Aeq,8hr}$	61.5	31.5	**+1.5**	**32**	46.5	**+16.5**
	Night, $L_{Amax,fast}$	77.8	47.8	**+2.8**	**33**	62.8	**+17.8**
4th Floor Apartment 1	Day, $L_{Aeq,16hr}$	46.4	16.4	-18.6	-	31.4	-3.6
	Night, $L_{Aeq,8hr}$	51.7	21.7	-8.3	-	36.7	**+6.7**
	Night, $L_{Amax,fast}$	65.7	35.7	-9.3	-	50.7	**+5.7**
4th Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	46.4	16.4	-18.6	-	31.4	-3.6
	Night, $L_{Aeq,8hr}$	36.9	6.9	-23.1	-	21.9	-8.1
	Night, $L_{Amax,fast}$	50.9	20.9	-24.1	-	35.9	-9.1
4th Floor Apartment 4	Day, $L_{Aeq,16hr}$	66.8	36.8	1.8	**32**	51.8	**+16.8**
	Night, $L_{Aeq,8hr}$	37.7	7.7	-22.3	-	22.7	-7.3
	Night, $L_{Amax,fast}$	52.6	22.6	-22.4	-	37.6	-7.4
4th Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	71.8	41.8	**+6.8**	**37**	56.8	**+21.8**
	Night, $L_{Aeq,8hr}$	62.2	32.2	**+2.2**	**33**	47.2	**+17.2**
	Night, $L_{Amax,fast}$	79.0	49.0	**+4.0**	**34**	64.0	**+19.0**
4th Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	70.9	40.9	**+5.9**	**36**	55.9	**+20.9**
	Night, $L_{Aeq,8hr}$	61.3	31.3	**+1.3**	**32**	46.3	**+16.3**
	Night, $L_{Amax,fast}$	77.4	47.4	**+2.4**	**33**	62.4	**+17.4**
5th Floor	Day, $L_{Aeq,16hr}$	46.3	16.3	-18.7	-	31.3	-3.7

Apartment 1	Night, $L_{Aeq,8hr}$	51.5	21.5	-8.5	-	36.5	**+6.5**
	Night, $L_{Amax,fast}$	65.4	35.4	-9.6	-	50.4	**+5.4**
5th Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	46.3	16.3	-18.7	-	31.3	-3.7
	Night, $L_{Aeq,8hr}$	36.8	6.8	-23.2	-	21.8	-8.2
	Night, $L_{Amax,fast}$	50.7	20.7	-24.3	-	35.7	-9.3
5th Floor Apartment 4	Day, $L_{Aeq,16hr}$	66.6	36.6	**+1.6**	**32**	51.6	**+16.6**
	Night, $L_{Aeq,8hr}$	37.5	7.5	-22.5	-	22.5	-7.5
	Night, $L_{Amax,fast}$	52.2	22.2	-22.8	-	37.2	-7.8
5th Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	71.3	41.3	**+6.3**	**37**	56.3	**+21.3**
	Night, $L_{Aeq,8hr}$	61.8	31.8	**+1.8**	**32**	46.8	**+16.8**
	Night, $L_{Amax,fast}$	78.1	48.1	**+3.1**	**34**	63.1	**+18.1**
5th Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	70.5	40.5	**+5.5**	**36**	55.5	**+20.5**
	Night, $L_{Aeq,8hr}$	61.0	31.0	**+1.0**	**31**	46.0	**+16.0**
	Night, $L_{Amax,fast}$	76.8	46.8	**+1.8**	**32**	61.8	**+16.8**
6th Floor Apartment 1	Day, $L_{Aeq,16hr}$	46.2	16.2	-18.8	-	31.2	-3.8
	Night, $L_{Aeq,8hr}$	51.4	21.4	-8.6	-	36.4	**+6.4**
	Night, $L_{Amax,fast}$	65.2	35.2	-9.8	-	50.2	**+5.2**
6th Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	46.2	16.2	-18.8	-	31.2	-3.8
	Night, $L_{Aeq,8hr}$	36.6	6.6	-23.4	-	21.6	-8.4
	Night, $L_{Amax,fast}$	50.4	20.4	-24.6	-	35.4	-9.6
6th Floor Apartment 4	Day, $L_{Aeq,16hr}$	66.4	36.4	**+1.4**	**32**	51.4	**+16.4**
	Night, $L_{Aeq,8hr}$	37.3	7.3	-22.7	-	22.3	-7.7
	Night, $L_{Amax,fast}$	51.8	21.8	-23.2	-	36.8	-8.2
6th Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	70.9	40.9	**+5.9**	**36**	55.9	**+20.9**
	Night, $L_{Aeq,8hr}$	61.4	31.4	**+1.4**	**32**	46.4	**+16.4**
	Night, $L_{Amax,fast}$	77.3	47.3	**+2.3**	**33**	62.3	**+17.3**
6th Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	70.2	40.2	**+5.2**	**36**	55.2	**+20.2**
	Night, $L_{Aeq,8hr}$	60.7	30.7	**+0.7**	**31**	45.7	**+15.7**
	Night, $L_{Amax,fast}$	76.2	46.2	**+1.2**	**32**	61.2	**+16.2**
7th Floor Apartment 1	Day, $L_{Aeq,16hr}$	46.0	16.0	-19.0	-	31.0	-4.0
	Night, $L_{Aeq,8hr}$	51.2	21.2	-8.8	-	36.2	**+6.2**
	Night, $L_{Amax,fast}$	64.8	34.8	-10.2	-	49.8	**+4.8**
7th Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	46.0	16.0	-19.0	-	31.0	-4.0
	Night, $L_{Aeq,8hr}$	36.5	6.5	-23.5	-	21.5	-8.5
	Night, $L_{Amax,fast}$	50.1	20.1	-24.9	-	35.1	-9.9
7th Floor Apartment 4	Day, $L_{Aeq,16hr}$	66.2	36.2	**+1.2**	**32**	51.2	**+16.2**
	Night, $L_{Aeq,8hr}$	37.1	7.1	-22.9	-	22.1	-7.9
	Night, $L_{Amax,fast}$	51.4	21.4	-23.6	-	36.4	-8.6
7th Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	70.5	40.5	**+5.5**	**36**	55.5	**+20.5**
	Night, $L_{Aeq,8hr}$	61.0	31.0	**+1.0**	**31**	46.0	**+16.0**
	Night, $L_{Amax,fast}$	76.5	46.5	**+1.5**	**32**	61.5	**+16.5**
7th Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	69.9	39.9	**+4.9**	**35**	54.9	**+19.9**
	Night, $L_{Aeq,8hr}$	60.3	30.3	**+0.3**	**31**	45.3	**+15.3**
	Night, $L_{Amax,fast}$	75.5	45.5	**+0.5**	**31**	60.5	**+15.5**
8th Floor Apartment 1	Day, $L_{Aeq,16hr}$	45.9	15.9	-19.1	-	30.9	-4.1
	Night, $L_{Aeq,8hr}$	51.1	21.1	-8.9	-	36.1	**+6.1**
	Night, $L_{Amax,fast}$	64.5	34.5	-10.5	-	49.5	**+4.5**
8th Floor Apartments 2 and 3	Day, $L_{Aeq,16hr}$	45.9	15.9	-19.1	-	30.9	-4.1
	Night, $L_{Aeq,8hr}$	36.3	6.3	-23.7	-	21.3	-8.7
	Night, $L_{Amax,fast}$	49.8	19.8	-25.2	-	34.8	-10.2

8th Floor Apartment 4	Day, $L_{Aeq,16hr}$	66.0	36.0	**+1.0**	**31**	51.0	**+16.0**
	Night, $L_{Aeq,8hr}$	36.9	6.9	-23.1	-	21.9	-8.1
	Night, $L_{Amax,fast}$	51.0	21.0	-24.0	-	36.0	-9.0
8th Floor Apartments 5 to 7	Day, $L_{Aeq,16hr}$	70.2	40.2	**+5.2**	**36**	55.2	**+20.2**
	Night, $L_{Aeq,8hr}$	60.6	30.6	**+0.6**	**31**	45.6	**+15.6**
	Night, $L_{Amax,fast}$	75.8	45.8	**+0.8**	**31**	60.8	**+15.8**
8th Floor Apartments 8 and 9	Day, $L_{Aeq,16hr}$	69.6	39.6	**+4.6**	**35**	54.6	**+19.6**
	Night, $L_{Aeq,8hr}$	60.0	30.0	0.0	-	45.0	**+15.0**
	Night, $L_{Amax,fast}$	74.9	44.9	-0.1	-	59.9	**+14.9**
9th Floor Apartments 1 and 2	Day, $L_{Aeq,16hr}$	45.7	15.7	-19.3	-	30.7	-4.3
	Night, $L_{Aeq,8hr}$	36.1	6.1	-23.9	-	21.1	-8.9
	Night, $L_{Amax,fast}$	49.4	19.4	-25.6	-	34.4	-10.6
9th Floor Apartment 3	Day, $L_{Aeq,16hr}$	65.2	35.2	**+0.2**	**31**	50.2	**+15.2**
	Night, $L_{Aeq,8hr}$	36.1	6.1	-23.9	-	21.1	-8.9
	Night, $L_{Amax,fast}$	49.4	19.4	-25.6	-	34.4	-10.6
9th Floor Apartments 4 to 6	Day, $L_{Aeq,16hr}$	69.8	39.8	**+4.8**	**35**	54.8	**+19.8**
	Night, $L_{Aeq,8hr}$	60.2	30.2	**+0.2**	**31**	45.2	**+15.2**
	Night, $L_{Amax,fast}$	75.1	45.1	**+0.1**	**31**	60.1	**+15.1**
9th Floor Apartment 7	Day, $L_{Aeq,16hr}$	69.3	39.3	**+4.3**	**35**	54.3	**+19.3**
	Night, $L_{Aeq,8hr}$	59.7	29.7	-0.3	-	44.7	**+14.7**
	Night, $L_{Amax,fast}$	74.3	44.3	-0.7	-	59.3	**+14.3**
10th Floor Apartments 1 and 2	Day, $L_{Aeq,16hr}$	45.5	15.5	-19.5	-	30.5	-4.5
	Night, $L_{Aeq,8hr}$	36.0	6.0	-24.0	-	21.0	-9.0
	Night, $L_{Amax,fast}$	49.1	19.1	-25.9	-	34.1	-10.9
10th Floor Apartment 3	Day, $L_{Aeq,16hr}$	65.1	35.1	**+0.1**	**31**	50.1	**+15.1**
	Night, $L_{Aeq,8hr}$	36.0	6.0	-24.0	-	21.0	-9.0
	Night, $L_{Amax,fast}$	49.1	19.1	-25.9	-	34.1	-10.9
10th Floor Apartments 4 to 6	Day, $L_{Aeq,16hr}$	69.5	39.5	**+4.5**	**35**	54.5	**+19.5**
	Night, $L_{Aeq,8hr}$	59.9	29.9	-0.1	-	44.9	**+14.9**
	Night, $L_{Amax,fast}$	74.4	44.4	-0.6	-	59.4	**+14.4**
10th Floor Apartment 7	Day, $L_{Aeq,16hr}$	69.0	39.0	**+4.0**	**34**	54.0	**+19.0**
	Night, $L_{Aeq,8hr}$	59.4	29.4	-0.6	-	44.4	**+14.4**
	Night, $L_{Amax,fast}$	73.6	43.6	-1.4	-	58.6	**+13.6**
11th Floor Apartments 1 and 2	Day, $L_{Aeq,16hr}$	45.4	15.4	-19.6	-	30.4	-4.6
	Night, $L_{Aeq,8hr}$	35.8	5.8	-24.2	-	20.8	-9.2
	Night, $L_{Amax,fast}$	48.7	18.7	-26.3	-	33.7	-11.3
11th Floor Apartment 3	Day, $L_{Aeq,16hr}$	64.9	34.9	-0.1	-	49.9	**+14.9**
	Night, $L_{Aeq,8hr}$	35.8	5.8	-24.2	-	20.8	-9.2
	Night, $L_{Amax,fast}$	48.7	18.7	-26.3	-	33.7	-11.3
11th Floor Apartments 4 to 6	Day, $L_{Aeq,16hr}$	69.1	39.1	**+4.1**	**35**	54.1	**+19.1**
	Night, $L_{Aeq,8hr}$	59.6	29.6	-0.4	-	44.6	**+14.6**
	Night, $L_{Amax,fast}$	73.8	43.8	-1.2	-	58.8	**+13.8**
11th Floor Apartment 7	Day, $L_{Aeq,16hr}$	68.7	38.7	**+3.7**	**34**	53.7	**+18.7**
	Night, $L_{Aeq,8hr}$	59.1	29.1	-0.9	-	44.1	**+14.1**
	Night, $L_{Amax,fast}$	73.1	43.1	-1.9	-	58.1	**+13.1**

Note: Where a negative result is predicted with windows open, this is to be ignored as this relates only to Chester Road. Assessments based on NMP3 have determined that alternative ventilation is also required for facades that don't have direct line of sight to Chester Road.
- denotes standard thermal double glazing to be sufficient.

Table A3: Internal Noise Levels for Block B – Chester Road

Floor and Apartment	Period	Calculated Noise Level at Façade (dB)	Internal Noise Level with Standard Double Glazing (dB)	Difference with BS8233:2014 Criteria +/- (dB)	Required Glazing Performance, $R_W + C_{tr}$ (dB)	Internal Noise Level with Partially Open Window (dB)	Difference with BS8233:2014 Criteria +/- (dB)
	Day, $L_{Aeq,16hr}$	46.6	16.6	-18.4	-	31.6	-3.4
1st Apartment 1	Night, $L_{Aeq,8hr}$	50.0	20.0	-10.0	-	35.0	**+5.0**
	Night, $L_{Amax,fast}$	64.2	34.2	-10.8	-	49.2	**+4.2**
	Day, $L_{Aeq,16hr}$	61.9	31.9	-3.1	-	46.9	**+11.9**
1st Apartment 2	Night, $L_{Aeq,8hr}$	61.8	31.8	**+1.8**	**32**	46.8	**+16.8**
	Night, $L_{Amax,fast}$	78.3	48.3	**+3.3**	**34**	63.3	**+18.3**
	Day, $L_{Aeq,16hr}$	72.5	42.5	**+7.5**	**38**	57.5	**+22.5**
1st Apartment 3	Night, $L_{Aeq,8hr}$	62.9	32.9	**+2.9**	**33**	47.9	**+17.9**
	Night, $L_{Amax,fast}$	80.5	50.5	**+5.5**	**36**	65.5	**+20.5**
	Day, $L_{Aeq,16hr}$	65.0	35.0	0.0	-	50.0	**+15.0**
2nd Apartment 1	Night, $L_{Aeq,8hr}$	37.0	7.0	-23.0	-	22.0	-8.0
	Night, $L_{Amax,fast}$	51.1	21.1	-23.9	-	36.1	-8.9
	Day, $L_{Aeq,16hr}$	46.5	16.5	-18.5	-	31.5	-3.5
2nd Apartment 2	Night, $L_{Aeq,8hr}$	50.0	20.0	-10.0	-	35.0	**+5.0**
	Night, $L_{Amax,fast}$	64.1	34.1	-10.9	-	49.1	**+4.1**
	Day, $L_{Aeq,16hr}$	61.6	31.6	-3.4	-	46.6	**+11.6**
2nd Apartment 3	Night, $L_{Aeq,8hr}$	61.6	31.6	**+1.6**	**32**	46.6	**+16.6**
	Night, $L_{Amax,fast}$	77.8	47.8	**+2.8**	**33**	62.8	**+17.8**
	Day, $L_{Aeq,16hr}$	72.3	42.3	**+7.3**	**38**	57.3	**+22.3**
2nd Apartment 4	Night, $L_{Aeq,8hr}$	62.7	32.7	**+2.7**	**33**	47.7	**+17.7**
	Night, $L_{Amax,fast}$	80.1	50.1	**+5.1**	**36**	65.1	**+20.1**
	Day, $L_{Aeq,16hr}$	72.3	42.3	**+7.3**	**38**	57.3	**+22.3**
2nd Apartment 5	Night, $L_{Aeq,8hr}$	62.7	32.7	**+2.7**	**33**	47.7	**+17.7**
	Night, $L_{Amax,fast}$	80.1	50.1	**+5.1**	**36**	65.1	**+20.1**
	Day, $L_{Aeq,16hr}$	65.6	35.6	**+0.6**	**31**	50.6	**+15.6**
2nd Apartment 6	Night, $L_{Aeq,8hr}$	58.1	28.1	-1.9	-	43.1	**+13.1**
	Night, $L_{Amax,fast}$	74.3	44.3	-0.7	-	59.3	**+14.3**
	Day, $L_{Aeq,16hr}$	64.9	34.9	-0.1	-	49.9	**+14.9**
3rd Apartment 1	Night, $L_{Aeq,8hr}$	36.8	6.8	-23.2	-	21.8	-8.2
	Night, $L_{Amax,fast}$	50.8	20.8	-24.2	-	35.8	-9.2
	Day, $L_{Aeq,16hr}$	46.4	16.4	-18.6	-	31.4	-3.6
3rd Apartment 2	Night, $L_{Aeq,8hr}$	49.8	19.8	-10.2	-	34.8	**+4.8**
	Night, $L_{Amax,fast}$	63.8	33.8	-11.2	-	48.8	**+3.8**
	Day, $L_{Aeq,16hr}$	61.4	31.4	-3.6	-	46.4	**+11.4**
3rd Apartment 3	Night, $L_{Aeq,8hr}$	61.4	31.4	**+1.4**	**32**	46.4	**+16.4**
	Night, $L_{Amax,fast}$	77.4	47.4	**+2.4**	**33**	62.4	**+17.4**
	Day, $L_{Aeq,16hr}$	72.1	42.1	**+7.1**	**38**	57.1	**+22.1**
3rd Apartment 4	Night, $L_{Aeq,8hr}$	62.5	32.5	**+2.5**	**33**	47.5	**+17.5**
	Night, $L_{Amax,fast}$	79.6	49.6	**+4.6**	**35**	64.6	**+19.6**
	Day, $L_{Aeq,16hr}$	72.1	42.1	**+7.1**	**38**	57.1	**+22.1**
3rd Apartment 5	Night, $L_{Aeq,8hr}$	62.5	32.5	**+2.5**	**33**	47.5	**+17.5**
	Night, $L_{Amax,fast}$	79.6	49.6	**+4.6**	**35**	64.6	**+19.6**
	Day, $L_{Aeq,16hr}$	65.4	35.4	**+0.4**	**31**	50.4	**+15.4**
3rd Apartment 6	Night, $L_{Aeq,8hr}$	57.9	27.9	-2.1	-	42.9	**+12.9**
	Night, $L_{Amax,fast}$	73.9	43.9	-1.1	-	58.9	**+13.9**
4th Apartment 1	Day, $L_{Aeq,16hr}$	64.7	34.7	-0.3	-	49.7	**+14.7**

	Night, $L_{Aeq,8hr}$	36.7	6.7	-23.3	-	21.7	-8.3
	Night, $L_{Amax,fast}$	50.6	20.6	-24.4	-	35.6	-9.4
	Day, $L_{Aeq,16hr}$	46.3	16.3	-18.7	-	31.3	-3.7
4th Apartment 2	Night, $L_{Aeq,8hr}$	49.7	19.7	-10.3	-	34.7	**+4.7**
	Night, $L_{Amax,fast}$	63.6	33.6	-11.4	-	48.6	**+3.6**
	Day, $L_{Aeq,16hr}$	61.2	31.2	-3.8	-	46.2	**+11.2**
4th Apartment 3	Night, $L_{Aeq,8hr}$	61.2	31.2	**+1.2**	**32**	46.2	**+16.2**
	Night, $L_{Amax,fast}$	77.0	47.0	**+2.0**	**32**	62.0	**+17.0**
	Day, $L_{Aeq,16hr}$	71.8	41.8	**+6.8**	**37**	56.8	**+21.8**
4th Apartment 4	Night, $L_{Aeq,8hr}$	62.3	32.3	**+2.3**	**33**	47.3	**+17.3**
	Night, $L_{Amax,fast}$	79.1	49.1	**+4.1**	**35**	64.1	**+19.1**
	Day, $L_{Aeq,16hr}$	71.8	41.8	**+6.8**	**37**	56.8	**+21.8**
4th Apartment 5	Night, $L_{Aeq,8hr}$	62.3	32.3	**+2.3**	**33**	47.3	**+17.3**
	Night, $L_{Amax,fast}$	79.1	49.1	**+4.1**	**35**	64.1	**+19.1**
	Day, $L_{Aeq,16hr}$	65.2	35.2	**+0.2**	**31**	50.2	**+15.2**
4th Apartment 6	Night, $L_{Aeq,8hr}$	57.7	27.7	-2.3	-	42.7	**+12.7**
	Night, $L_{Amax,fast}$	73.5	43.5	-1.5	-	58.5	**+13.5**
	Day, $L_{Aeq,16hr}$	64.6	34.6	-0.4	-	49.6	**+14.6**
5th Apartment 1	Night, $L_{Aeq,8hr}$	36.6	6.6	-23.4	-	21.6	-8.4
	Night, $L_{Amax,fast}$	50.4	20.4	-24.6	-	35.4	-9.6
	Day, $L_{Aeq,16hr}$	46.2	16.2	-18.8	-	31.2	-3.8
5th Apartment 2	Night, $L_{Aeq,8hr}$	49.6	19.6	-10.4	-	34.6	**+4.6**
	Night, $L_{Amax,fast}$	63.4	33.4	-11.6	-	48.4	**+3.4**
	Day, $L_{Aeq,16hr}$	61.1	31.1	-3.9	-	46.1	**+11.1**
5th Apartment 3	Night, $L_{Aeq,8hr}$	61.1	31.1	**+1.1**	**32**	46.1	**+16.1**
	Night, $L_{Amax,fast}$	76.7	46.7	**+1.7**	**32**	61.7	**+16.7**
	Day, $L_{Aeq,16hr}$	71.6	41.6	**+6.6**	**37**	56.6	**+21.6**
5th Apartment 4	Night, $L_{Aeq,8hr}$	62.1	32.1	**+2.1**	**33**	47.1	**+17.1**
	Night, $L_{Amax,fast}$	78.7	48.7	**+3.7**	**34**	63.7	**+18.7**
	Day, $L_{Aeq,16hr}$	71.6	41.6	**+6.6**	**37**	56.6	**+21.6**
5th Apartment 5	Night, $L_{Aeq,8hr}$	62.1	32.1	**+2.1**	**33**	47.1	**+17.1**
	Night, $L_{Amax,fast}$	78.7	48.7	**+3.7**	**34**	63.7	**+18.7**
	Day, $L_{Aeq,16hr}$	65.1	35.1	**+0.1**	**31**	50.1	**+15.1**
5th Apartment 6	Night, $L_{Aeq,8hr}$	57.5	27.5	-2.5	-	42.5	**+12.5**
	Night, $L_{Amax,fast}$	73.2	43.2	-1.8	-	58.2	**+13.2**
	Day, $L_{Aeq,16hr}$	65.1	35.1	**+0.1**	**31**	50.1	**+15.1**
6th Apartment 1	Night, $L_{Aeq,8hr}$	36.5	6.5	-23.5	-	21.5	-8.5
	Night, $L_{Amax,fast}$	50.2	20.2	-24.8	-	35.2	-9.8
	Day, $L_{Aeq,16hr}$	46.1	16.1	-18.9	-	31.1	-3.9
6th Apartment 2	Night, $L_{Aeq,8hr}$	49.5	19.5	-10.5	-	34.5	**+4.5**
	Night, $L_{Amax,fast}$	63.2	33.2	-11.8	-	48.2	**+3.2**
	Day, $L_{Aeq,16hr}$	71.2	41.2	**+6.2**	**37**	56.2	**+21.2**
6th Apartment 3	Night, $L_{Aeq,8hr}$	61.6	31.6	**+1.6**	**32**	46.6	**+16.6**
	Night, $L_{Amax,fast}$	77.8	47.8	**+2.8**	**33**	62.8	**+17.8**
	Day, $L_{Aeq,16hr}$	71.2	41.2	**+6.2**	**37**	56.2	**+21.2**
6th Apartment 4	Night, $L_{Aeq,8hr}$	61.6	31.6	**+1.6**	**32**	46.6	**+16.6**
	Night, $L_{Amax,fast}$	77.8	47.8	**+2.8**	**33**	62.8	**+17.8**
	Day, $L_{Aeq,16hr}$	70.7	40.7	**+5.7**	**36**	55.7	**+20.7**
6th Apartment 5	Night, $L_{Aeq,8hr}$	60.9	30.9	**+0.9**	**31**	45.9	**+15.9**
	Night, $L_{Amax,fast}$	76.9	46.9	**+1.9**	**32**	61.9	**+16.9**

	Day, $L_{Aeq,16hr}$	64.4	34.4	-0.6	-	49.4	**+14.4**
6th Apartment 6	Night, $L_{Aeq,8hr}$	58.4	28.4	-1.6	-	43.4	**+13.4**
	Night, $L_{Amax,fast}$	74.4	44.4	-0.6	-	59.4	**+14.4**
	Day, $L_{Aeq,16hr}$	65.0	35.0	0.0	-	50.0	**+15.0**
7th Apartment 1	Night, $L_{Aeq,8hr}$	36.4	6.4	-23.6	-	21.4	-8.6
	Night, $L_{Amax,fast}$	50.0	20.0	-25.0	-	35.0	-10.0
	Day, $L_{Aeq,16hr}$	46.0	16.0	-19.0	-	31.0	-4.0
7th Apartment 2	Night, $L_{Aeq,8hr}$	49.4	19.4	-10.6	-	34.4	**+4.4**
	Night, $L_{Amax,fast}$	63.0	33.0	-12.0	-	48.0	**+3.0**
	Day, $L_{Aeq,16hr}$	71.0	41.0	**+6.0**	**37**	56.0	**+21.0**
7th Apartment 3	Night, $L_{Aeq,8hr}$	61.4	31.4	**+1.4**	**32**	46.4	**+16.4**
	Night, $L_{Amax,fast}$	77.4	47.4	**+2.4**	**33**	62.4	**+17.4**
	Day, $L_{Aeq,16hr}$	71.0	41.0	**+6.0**	**36**	56.0	**+21.0**
7th Apartment 4	Night, $L_{Aeq,8hr}$	61.4	31.4	**+1.4**	**32**	46.4	**+16.4**
	Night, $L_{Amax,fast}$	77.4	47.4	**+2.4**	**33**	62.4	**+17.4**
	Day, $L_{Aeq,16hr}$	70.5	40.5	**+5.5**	**36**	55.5	**+20.5**
7th Apartment 5	Night, $L_{Aeq,8hr}$	60.7	30.7	**+0.7**	**31**	45.7	**+15.7**
	Night, $L_{Amax,fast}$	76.5	46.5	**+1.5**	**32**	61.5	**+16.5**
	Day, $L_{Aeq,16hr}$	64.3	34.3	-0.7	-	49.3	**+14.3**
7th Apartment 6	Night, $L_{Aeq,8hr}$	58.2	28.2	-1.8	-	43.2	**+13.2**
	Night, $L_{Amax,fast}$	74.0	44.0	-1.0	-	59.0	**+14.0**
	Day, $L_{Aeq,16hr}$	64.9	34.9	-0.1	-	49.9	**+14.9**
8th Apartment 1	Night, $L_{Aeq,8hr}$	36.3	6.3	-23.7	-	21.3	-8.7
	Night, $L_{Amax,fast}$	49.8	19.8	-25.2	-	34.8	-10.2
	Day, $L_{Aeq,16hr}$	45.9	15.9	-19.1	-	30.9	-4.1
8th Apartment 2	Night, $L_{Aeq,8hr}$	49.3	19.3	-10.7	-	34.3	**+4.3**
	Night, $L_{Amax,fast}$	62.8	32.8	-12.2	-	47.8	**+2.8**
	Day, $L_{Aeq,16hr}$	70.8	40.8	**+5.8**	**36**	55.8	**+20.8**
8th Apartment 3	Night, $L_{Aeq,8hr}$	61.2	31.2	**+1.2**	**32**	46.2	**+16.2**
	Night, $L_{Amax,fast}$	77.0	47.0	**+2.0**	**32**	62.0	**+17.0**
	Day, $L_{Aeq,16hr}$	70.8	40.8	**+5.8**	**36**	55.8	**+20.8**
8th Apartment 4	Night, $L_{Aeq,8hr}$	61.2	31.2	**+1.2**	**32**	46.2	**+16.2**
	Night, $L_{Amax,fast}$	77.0	47.0	**+2.0**	**32**	62.0	**+17.0**
	Day, $L_{Aeq,16hr}$	70.4	40.4	**+5.4**	**36**	55.4	**+20.4**
8th Apartment 5	Night, $L_{Aeq,8hr}$	60.5	30.5	**+0.5**	**31**	45.5	**+15.5**
	Night, $L_{Amax,fast}$	76.2	46.2	**+1.2**	**32**	61.2	**+16.2**
	Day, $L_{Aeq,16hr}$	64.1	34.1	-0.9	-	49.1	**+14.1**
8th Apartment 6	Night, $L_{Aeq,8hr}$	58.0	28.0	-2.0	-	43.0	**+13.0**
	Night, $L_{Amax,fast}$	73.7	43.7	-1.3	-	58.7	**+13.7**
	Day, $L_{Aeq,16hr}$	64.8	34.8	-0.2	-	49.8	**+14.8**
9th Apartment 1	Night, $L_{Aeq,8hr}$	36.2	6.2	-23.8	-	21.2	-8.8
	Night, $L_{Amax,fast}$	49.6	19.6	-25.4	-	34.6	-10.4
	Day, $L_{Aeq,16hr}$	45.8	15.8	-19.2	-	30.8	-4.2
9th Apartment 2	Night, $L_{Aeq,8hr}$	49.2	19.2	-10.8	-	34.2	**+4.2**
	Night, $L_{Amax,fast}$	62.6	32.6	-12.4	-	47.6	**+2.6**
	Day, $L_{Aeq,16hr}$	70.6	40.6	**+5.6**	**36**	55.6	**+20.6**
9th Apartment 3	Night, $L_{Aeq,8hr}$	61.1	31.1	**+1.1**	**32**	46.1	**+16.1**
	Night, $L_{Amax,fast}$	76.7	46.7	**+1.7**	**32**	61.7	**+16.7**
9th Apartment 4	Day, $L_{Aeq,16hr}$	70.6	40.6	**+5.6**	**36**	55.6	**+20.6**
	Night, $L_{Aeq,8hr}$	61.1	31.1	**+1.1**	**32**	46.1	**+16.1**

	Night, $L_{Amax,fast}$	76.7	46.7	**+1.7**	**32**	61.7	**+16.7**
	Day, $L_{Aeq,16hr}$	70.2	40.2	**+5.2**	**36**	55.2	**+20.2**
9th Apartment 5	Night, $L_{Aeq,8hr}$	60.4	30.4	**+0.4**	**31**	45.4	**+15.4**
	Night, $L_{Amax,fast}$	75.9	45.9	**+0.9**	**31**	60.9	**+15.9**
	Day, $L_{Aeq,16hr}$	63.9	33.9	-1.1	-	48.9	**+13.9**
9th Apartment 6	Night, $L_{Aeq,8hr}$	57.9	27.9	-2.1	-	42.9	**+12.9**
	Night, $L_{Amax,fast}$	73.4	43.4	-1.6	-	58.4	**+13.4**
	Day, $L_{Aeq,16hr}$	64.7	34.7	-0.3	-	49.7	**+14.7**
10th Apartment 1	Night, $L_{Aeq,8hr}$	36.1	6.1	-23.9	-	21.1	-8.9
	Night, $L_{Amax,fast}$	49.4	19.4	-25.6	-	34.4	-10.6
	Day, $L_{Aeq,16hr}$	45.7	15.7	-19.3	-	30.7	-4.3
10th Apartment 2	Night, $L_{Aeq,8hr}$	49.1	19.1	-10.9	-	34.1	**+4.1**
	Night, $L_{Amax,fast}$	62.4	32.4	-12.6	-	47.4	**+2.4**
	Day, $L_{Aeq,16hr}$	70.5	40.5	**+5.5**	**36**	55.5	**+20.5**
10th Apartment 3	Night, $L_{Aeq,8hr}$	60.9	30.9	**+0.9**	**31**	45.9	**+15.9**
	Night, $L_{Amax,fast}$	76.4	46.4	**+1.4**	**32**	61.4	**+16.4**
	Day, $L_{Aeq,16hr}$	70.5	40.5	**+5.5**	**36**	55.5	**+20.5**
10th Apartment 4	Night, $L_{Aeq,8hr}$	60.9	30.9	**+0.9**	**31**	45.9	**+15.9**
	Night, $L_{Amax,fast}$	76.4	46.4	**+1.4**	**32**	61.4	**+16.4**
	Day, $L_{Aeq,16hr}$	70.0	40.0	**+5.0**	**35**	55.0	**+20.0**
10th Apartment 5	Night, $L_{Aeq,8hr}$	60.2	30.2	**+0.2**	**31**	45.2	**+15.2**
	Night, $L_{Amax,fast}$	75.5	45.5	**+0.5**	**31**	60.5	**+15.5**
	Day, $L_{Aeq,16hr}$	63.8	33.8	-1.2	-	48.8	**+13.8**
10th Apartment 6	Night, $L_{Aeq,8hr}$	57.7	27.7	-2.3	-	42.7	**+12.7**
	Night, $L_{Amax,fast}$	73.0	43.0	-2.0	-	58.0	**+13.0**
	Day, $L_{Aeq,16hr}$	64.6	34.6	-0.4	-	49.6	**+14.6**
11th Apartment 1	Night, $L_{Aeq,8hr}$	36.0	6.0	-24.0	-	21.0	-9.0
	Night, $L_{Amax,fast}$	49.2	19.2	-25.8	-	34.2	-10.8
	Day, $L_{Aeq,16hr}$	45.6	15.6	-19.4	-	30.6	-4.4
11th Apartment 2	Night, $L_{Aeq,8hr}$	49.0	19.0	-11.0	-	34.0	**+4.0**
	Night, $L_{Amax,fast}$	62.2	32.2	-12.8	-	47.2	**+2.2**
	Day, $L_{Aeq,16hr}$	70.3	40.3	**+5.3**	**36**	55.3	**+20.3**
11th Apartment 3	Night, $L_{Aeq,8hr}$	60.7	30.7	**+0.7**	**31**	45.7	**+15.7**
	Night, $L_{Amax,fast}$	76.1	46.1	**+1.1**	**32**	61.1	**+16.1**
	Day, $L_{Aeq,16hr}$	70.3	40.3	**+5.3**	**36**	55.3	**+20.3**
11th Apartment 4	Night, $L_{Aeq,8hr}$	60.7	30.7	**+0.7**	**31**	45.7	**+15.7**
	Night, $L_{Amax,fast}$	76.1	46.1	**+1.1**	**32**	61.1	**+16.1**
	Day, $L_{Aeq,16hr}$	69.9	39.9	**+4.9**	**35**	54.9	**+19.9**
11th Apartment 5	Night, $L_{Aeq,8hr}$	60.1	30.1	**+0.1**	**31**	45.1	**+15.1**
	Night, $L_{Amax,fast}$	75.2	45.2	**+0.2**	**31**	60.2	**+15.2**
	Day, $L_{Aeq,16hr}$	63.6	33.6	-1.4	-	48.6	**+13.6**
11th Apartment 6	Night, $L_{Aeq,8hr}$	57.6	27.6	-2.4	-	42.6	**+12.6**
	Night, $L_{Amax,fast}$	72.7	42.7	-2.3	-	57.7	**+12.7**
	Day, $L_{Aeq,16hr}$	64.5	34.5	-0.5	-	49.5	**+14.5**
12th Apartment 1	Night, $L_{Aeq,8hr}$	35.9	5.9	-24.1	-	20.9	-9.1
	Night, $L_{Amax,fast}$	49.0	19.0	-26.0	-	34.0	-11.0
	Day, $L_{Aeq,16hr}$	45.5	15.5	-19.5	-	30.5	-4.5
12th Apartment 2	Night, $L_{Aeq,8hr}$	48.9	18.9	-11.1	-	33.9	**+3.9**
	Night, $L_{Amax,fast}$	62.0	32.0	-13.0	-	47.0	**+2.0**
12th Apartment	Day, $L_{Aeq,16hr}$	70.1	40.1	**+5.1**	**36**	55.1	**+20.1**

3	Night, $L_{Aeq,8hr}$	60.6	30.6	**+0.6**	**31**	45.6	**+15.6**
	Night, $L_{Amax,fast}$	75.7	45.7	**+0.7**	**31**	60.7	**+15.7**
12th Apartment 4	Day, $L_{Aeq,16hr}$	70.1	40.1	**+5.1**	**36**	55.1	**+20.1**
	Night, $L_{Aeq,8hr}$	60.6	30.6	**+0.6**	**31**	45.6	**+15.6**
	Night, $L_{Amax,fast}$	75.7	45.7	**+0.7**	**31**	60.7	**+15.7**
12th Apartment 5	Day, $L_{Aeq,16hr}$	69.7	39.7	**+4.7**	**35**	54.7	**+19.7**
	Night, $L_{Aeq,8hr}$	59.9	29.9	-0.1	-	44.9	**+14.9**
	Night, $L_{Amax,fast}$	74.9	44.9	-0.1	-	59.9	**+14.9**
12th Apartment 6	Day, $L_{Aeq,16hr}$	63.5	33.5	-1.5	-	48.5	**+13.5**
	Night, $L_{Aeq,8hr}$	57.4	27.4	-2.6	-	42.4	**+12.4**
	Night, $L_{Amax,fast}$	72.4	42.4	-2.6	-	57.4	**+12.4**
13th Apartment 1	Day, $L_{Aeq,16hr}$	64.4	34.4	-0.6	-	49.4	**+14.4**
	Night, $L_{Aeq,8hr}$	35.8	5.8	-24.2	-	20.8	-9.2
	Night, $L_{Amax,fast}$	48.8	18.8	-26.2	-	33.8	-11.2
13th Apartment 2	Day, $L_{Aeq,16hr}$	45.4	15.4	-19.6	-	30.4	-4.6
	Night, $L_{Aeq,8hr}$	48.8	18.8	-11.2	-	33.8	**+3.8**
	Night, $L_{Amax,fast}$	61.8	31.8	-13.2	-	46.8	**+1.8**
13th Apartment 3	Day, $L_{Aeq,16hr}$	70.0	40.0	**+5.0**	**35**	55.0	**+20.0**
	Night, $L_{Aeq,8hr}$	60.4	30.4	**+0.4**	**31**	45.4	**+15.4**
	Night, $L_{Amax,fast}$	75.4	45.4	**+0.4**	**31**	60.4	**+15.4**
13th Apartment 4	Day, $L_{Aeq,16hr}$	70.0	40.0	**+5.0**	**35**	55.0	**+20.0**
	Night, $L_{Aeq,8hr}$	60.4	30.4	**+0.4**	**31**	45.4	**+15.4**
	Night, $L_{Amax,fast}$	75.4	45.4	**+0.4**	**31**	60.4	**+15.4**
13th Apartment 5	Day, $L_{Aeq,16hr}$	69.6	39.6	**+4.6**	**35**	54.6	**+19.6**
	Night, $L_{Aeq,8hr}$	59.8	29.8	-0.2	-	44.8	**+14.8**
	Night, $L_{Amax,fast}$	74.6	44.6	-0.4	-	59.6	**+14.6**
13th Apartment 6	Day, $L_{Aeq,16hr}$	63.3	33.3	-1.7	-	48.3	**+13.3**
	Night, $L_{Aeq,8hr}$	57.3	27.3	-2.7	-	42.3	**+12.3**
	Night, $L_{Amax,fast}$	72.1	42.1	-2.9	-	57.1	**+12.1**
14th Apartment 1	Day, $L_{Aeq,16hr}$	64.3	34.3	-0.7	-	49.3	**+14.3**
	Night, $L_{Aeq,8hr}$	35.7	5.7	-24.3	-	20.7	-9.3
	Night, $L_{Amax,fast}$	48.6	18.6	-26.4	-	33.6	-11.4
14th Apartment 2	Day, $L_{Aeq,16hr}$	45.3	15.3	-19.7	-	30.3	-4.7
	Night, $L_{Aeq,8hr}$	48.8	18.8	-11.2	-	33.8	**+3.8**
	Night, $L_{Amax,fast}$	61.6	31.6	-13.4	-	46.6	**+1.6**
14th Apartment 3	Day, $L_{Aeq,16hr}$	69.8	39.8	**+4.8**	**35**	54.8	**+19.8**
	Night, $L_{Aeq,8hr}$	60.3	30.3	**+0.3**	**31**	45.3	**+15.3**
	Night, $L_{Amax,fast}$	75.2	45.2	**+0.2**	**31**	60.2	**+15.2**
14th Apartment 4	Day, $L_{Aeq,16hr}$	69.8	39.8	**+4.8**	**35**	54.8	**+19.8**
	Night, $L_{Aeq,8hr}$	60.3	30.3	**+0.3**	**31**	45.3	**+15.3**
	Night, $L_{Amax,fast}$	75.2	45.2	**+0.2**	**31**	60.2	**+15.2**
14th Apartment 5	Day, $L_{Aeq,16hr}$	69.5	39.5	**+4.5**	**35**	54.5	**+19.5**
	Night, $L_{Aeq,8hr}$	59.6	29.6	-0.4	-	44.6	**+14.6**
	Night, $L_{Amax,fast}$	74.4	44.4	-0.6	-	59.4	**+14.4**
14th Apartment 6	Day, $L_{Aeq,16hr}$	63.2	33.2	-1.8	-	48.2	**+13.2**
	Night, $L_{Aeq,8hr}$	57.1	27.1	-2.9	-	42.1	**+12.1**
	Night, $L_{Amax,fast}$	71.9	41.9	-3.1	-	56.9	**+11.9**
15th Apartment 1	Day, $L_{Aeq,16hr}$	64.2	34.2	-0.8	-	49.2	**+14.2**
	Night, $L_{Aeq,8hr}$	35.7	5.7	-24.3	-	20.7	-9.3
	Night, $L_{Amax,fast}$	48.5	18.5	-26.5	-	33.5	-11.5

15th Apartment 2	Day, $L_{Aeq,16hr}$	45.2	15.2	-19.8	-	30.2	-4.8
	Night, $L_{Aeq,8hr}$	48.7	18.7	-11.3	-	33.7	**+3.7**
	Night, $L_{Amax,fast}$	61.5	31.5	-13.5	-	46.5	**+1.5**
15th Apartment 3	Day, $L_{Aeq,16hr}$	69.7	39.7	**+4.7**	**35**	54.7	**+19.7**
	Night, $L_{Aeq,8hr}$	60.1	30.1	**+0.1**	**31**	45.1	**+15.1**
	Night, $L_{Amax,fast}$	74.9	44.9	-0.1	-	59.9	**+14.9**
15th Apartment 4	Day, $L_{Aeq,16hr}$	69.7	39.7	**+4.7**	**35**	54.7	**+19.7**
	Night, $L_{Aeq,8hr}$	60.1	30.1	**+0.1**	**31**	45.1	**+15.1**
	Night, $L_{Amax,fast}$	74.9	44.9	-0.1		59.9	**+14.9**
15th Apartment 5	Day, $L_{Aeq,16hr}$	69.3	39.3	**+4.3**	**35**	54.3	**+19.3**
	Night, $L_{Aeq,8hr}$	59.5	29.5	-0.5	-	44.5	**+14.5**
	Night, $L_{Amax,fast}$	74.1	44.1	-0.9	-	59.1	**+14.1**
15th Apartment 6	Day, $L_{Aeq,16hr}$	63.0	33.0	-2.0	-	48.0	**+13.0**
	Night, $L_{Aeq,8hr}$	57.0	27.0	-3.0	-	42.0	**+12.0**
	Night, $L_{Amax,fast}$	71.6	41.6	-3.4	-	56.6	**+11.6**
16th Apartment 1	Day, $L_{Aeq,16hr}$	64.2	34.2	-0.8	-	49.2	**+14.2**
	Night, $L_{Aeq,8hr}$	35.6	5.6	-24.4	-	20.6	-9.4
	Night, $L_{Amax,fast}$	48.3	18.3	-26.7	-	33.3	-11.7
16th Apartment 2	Day, $L_{Aeq,16hr}$	45.1	15.1	-19.9	-	30.1	-4.9
	Night, $L_{Aeq,8hr}$	48.6	18.6	-11.4	-	33.6	**+3.6**
	Night, $L_{Amax,fast}$	61.3	31.3	-13.7	-	46.3	**+1.3**
16th Apartment 3	Day, $L_{Aeq,16hr}$	69.6	39.6	**+4.6**	**35**	54.6	**+19.6**
	Night, $L_{Aeq,8hr}$	60.0	30.0	0.0	-	45.0	**+15.0**
	Night, $L_{Amax,fast}$	74.6	44.6	-0.4	-	59.6	**+14.6**
16th Apartment 4	Day, $L_{Aeq,16hr}$	69.6	39.6	**+4.6**	**35**	54.6	**+19.6**
	Night, $L_{Aeq,8hr}$	60.0	30.0	0.0	-	45.0	**+15.0**
	Night, $L_{Amax,fast}$	74.6	44.6	-0.4		59.6	**+14.6**
16th Apartment 5	Day, $L_{Aeq,16hr}$	69.2	39.2	**+4.2**	**35**	54.2	**+19.2**
	Night, $L_{Aeq,8hr}$	59.4	29.4	-0.6	-	44.4	**+14.4**
	Night, $L_{Amax,fast}$	73.8	43.8	-1.2	-	58.8	**+13.8**
16th Apartment 6	Day, $L_{Aeq,16hr}$	62.9	32.9	-2.1	-	47.9	**+12.9**
	Night, $L_{Aeq,8hr}$	56.9	26.9	-3.1	-	41.9	**+11.9**
	Night, $L_{Amax,fast}$	71.3	41.3	-3.7	-	56.3	**+11.3**
17th Apartment 1	Day, $L_{Aeq,16hr}$	64.1	34.1	-0.9	-	49.1	**+14.1**
	Night, $L_{Aeq,8hr}$	35.5	5.5	-24.5	-	20.5	-9.5
	Night, $L_{Amax,fast}$	48.1	18.1	-26.9	-	33.1	-11.9
17th Apartment 2	Day, $L_{Aeq,16hr}$	45.0	15.0	-20.0	-	30.0	-5.0
	Night, $L_{Aeq,8hr}$	48.5	18.5	-11.5	-	33.5	**+3.5**
	Night, $L_{Amax,fast}$	61.1	31.1	-13.9	-	46.1	**+1.1**
17th Apartment 3	Day, $L_{Aeq,16hr}$	69.4	39.4	**+4.4**	**35**	54.4	**+19.4**
	Night, $L_{Aeq,8hr}$	59.9	29.9	-0.1	-	44.9	**+14.9**
	Night, $L_{Amax,fast}$	74.3	44.3	-0.7	-	59.3	**+14.3**
17th Apartment 4	Day, $L_{Aeq,16hr}$	69.4	39.4	**+4.4**	**35**	54.4	**+19.4**
	Night, $L_{Aeq,8hr}$	59.9	29.9	-0.1	-	44.9	**+14.9**
	Night, $L_{Amax,fast}$	74.3	44.3	-0.7	-	59.3	**+14.3**
17th Apartment 5	Day, $L_{Aeq,16hr}$	69.1	39.1	**+4.1**	**35**	54.1	**+19.1**
	Night, $L_{Aeq,8hr}$	59.2	29.2	-0.8	-	44.2	**+14.2**
	Night, $L_{Amax,fast}$	73.6	43.6	-1.4	-	58.6	**+13.6**
17th Apartment 6	Day, $L_{Aeq,16hr}$	62.8	32.8	-2.2	-	47.8	**+12.8**
	Night, $L_{Aeq,8hr}$	56.7	26.7	-3.3	-	41.7	**+11.7**

	Night, $L_{Amax,fast}$	71.1	41.1	-3.9	-	56.1	**+11.1**
18th Apartment 1	Day, $L_{Aeq,16hr}$	64.5	34.5	-0.5	-	49.5	**+14.5**
	Night, $L_{Aeq,8hr}$	35.4	5.4	-24.6	-	20.4	-9.6
	Night, $L_{Amax,fast}$	47.9	17.9	-27.1	-	32.9	-12.1
18th Apartment 2	Day, $L_{Aeq,16hr}$	45.0	15.0	-20.0	-	30.0	-5.0
	Night, $L_{Aeq,8hr}$	48.4	18.4	-11.6	-	33.4	**+3.4**
	Night, $L_{Amax,fast}$	61.0	31.0	-14.0	-	46.0	**+1.0**
18th Apartment 3	Day, $L_{Aeq,16hr}$	69.3	39.3	**+4.3**	**35**	54.3	**+19.3**
	Night, $L_{Aeq,8hr}$	59.7	29.7	-0.3	-	44.7	**+14.7**
	Night, $L_{Amax,fast}$	74.1	44.1	-0.9	-	59.1	**+14.1**
18th Apartment 4	Day, $L_{Aeq,16hr}$	69.3	39.3	**+4.3**	**35**	54.3	**+19.3**
	Night, $L_{Aeq,8hr}$	59.7	29.7	-0.3	-	44.7	**+14.7**
	Night, $L_{Amax,fast}$	74.1	44.1	-0.9	-	59.1	**+14.1**
18th Apartment 5	Day, $L_{Aeq,16hr}$	68.9	38.9	**+3.9**	**34**	53.9	**+18.9**
	Night, $L_{Aeq,8hr}$	59.1	29.1	-0.9	-	44.1	**+14.1**
	Night, $L_{Amax,fast}$	73.3	43.3	-1.7	-	58.3	**+13.3**
18th Apartment 6	Day, $L_{Aeq,16hr}$	62.7	32.7	-2.3	-	47.7	**+12.7**
	Night, $L_{Aeq,8hr}$	56.6	26.6	-3.4	-	41.6	**+11.6**
	Night, $L_{Amax,fast}$	70.8	40.8	-4.2	-	55.8	**+10.8**
19th and 20th Apartment 1	Day, $L_{Aeq,16hr}$	64.4	34.4	-0.6	-	49.4	**+14.4**
	Night, $L_{Aeq,8hr}$	54.9	24.9	-5.1	-	39.9	**+9.9**
	Night, $L_{Amax,fast}$	67.3	37.3	-7.7	-	52.3	**+7.3**
19th and 20th Apartment 2	Day, $L_{Aeq,16hr}$	57.9	27.9	-7.1	-	42.9	**+7.9**
	Night, $L_{Aeq,8hr}$	48.3	18.3	-11.7	-	33.3	**+3.3**
	Night, $L_{Amax,fast}$	60.8	30.8	-14.2	-	45.8	**+0.8**
19th and 20th Apartment 3	Day, $L_{Aeq,16hr}$	69.2	39.2	**+4.2**	**35**	54.2	**+19.2**
	Night, $L_{Aeq,8hr}$	59.6	29.6	-0.4	-	44.6	**+14.6**
	Night, $L_{Amax,fast}$	73.8	43.8	-1.2	-	58.8	**+13.8**
19th and 20th Apartment 4	Day, $L_{Aeq,16hr}$	69.2	39.2	**+4.2**	**35**	54.2	**+19.2**
	Night, $L_{Aeq,8hr}$	59.6	29.6	-0.4	-	44.6	**+14.6**
	Night, $L_{Amax,fast}$	73.8	43.8	-1.2	-	58.8	**+13.8**
19th and 20th Apartment 5	Day, $L_{Aeq,16hr}$	69.1	39.1	**+4.1**	**35**	54.1	**+19.1**
	Night, $L_{Aeq,8hr}$	59.5	29.5	-0.5	-	44.5	**+14.5**
	Night, $L_{Amax,fast}$	73.6	43.6	-1.4	-	58.6	**+13.6**

Note: Where a negative result is predicted with windows open, this is to be ignored as this relates only to Chester Road. Assessments based on NMP3 have determined that alternative ventilation is also required for facades that don't have direct line of sight to Chester Road.
- denotes standard thermal double glazing to be sufficient.

PLANNING AND
BUILDING CONTROL
12 MAY 2017

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Chester Road, Manchester

Façade Sound Insulation

May 2017

Report Reference: Z1-FAC-A180-RP-XX-001

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1.0 INTRODUCTION

The Planning submission for Chester Road, Manchester (Planning reference 113870/FO/2016) included a Noise Impact Assessment report issued by REC Ltd (report reference AC100607-1R1, dated 15 February 2016). The report included a guide on determining the recommended sound insulation performance of glazing to the apartments. A revised version of the report was issued on 29 November 2016 (report reference AC100607-3R0). The revised report clarified the recommended sound reduction index of glazing to the apartments. The REC Ltd reports do not give the recommended sound insulation performance of the external wall to the apartments.

Planning Condition 23

Planning Condition 23 of the Planning Approval for 113870/FO/2016 states:

- Before the development commences a scheme for acoustically insulating the residential accommodation against noise from the main roads and surrounding road networks, and any other actual or potential sources of noise that require consideration on or near the site, including any local commercial/industrial premises, shall be submitted to and approved in writing by the City Council as local planning authority. The approved noise insulation scheme shall be completed before any of the dwelling units are first occupied.

  Reason - To secure a reduction in noise from the main roads and surrounding road networks and any other potential sources of noise, in order to protect future residents from noise nuisance, pursuant to policies SP1, H1 and DM1 of the Core Strategy.

Fisher Acoustics has been appointed by Renaker Build Limited to determine the recommended sound insulation performance of the windows and external wall to apartments to allow Planning Condition 23 to be discharged.

2.0 INTERNAL NOISE CRITERIA

Section 3.5 'National & International Standards' of 'Planning & Noise, Technical Guidance', dated December 2015, issued by the Environmental Protection Section of Manchester City Council identifies the preferred internal noise criteria for dwellings. The document states that 'Manchester City Council has adopted the following internal noise limits for residential properties':

- Living Rooms: Daytime (0700-2300 hrs) 35dB L_{Aeq}
- Bedrooms: Daytime (0700-2300 hrs) 35dB L_{Aeq}
- Bedrooms: Night time (2300-0700 hrs) 30dB L_{Aeq}, 45dB L_{Amax}

(fifteen excesses over 45dB LAmax allowed per night)

- Gardens and terraces (daytime) 55 dB L_{Aeq}

The criteria identified above have formed the basis of the assessment discussed herein.

3.0 ENVIRONMENTAL NOISE SURVEY DATA

In order to calculate the minimum recommended sound insulation performance of the elements of the external façade to achieve the noise criteria identified above, Fisher Acoustics has been provided with external daytime and night time noise survey data gathered by REC Ltd.

The calculations have been carried out on the basis that the measured noise survey data are a true representation of the daytime noise climate at the site.

An additional night time noise survey has been conducted at the site by Fisher Acoustics. The survey was conducted on Friday 7 April 2017 between 2255 hours and 0045 hrs. The measurement location employed for the noise survey represented the closest facades of the proposed development to Chester Road.

Reference has also been made to historical noise survey data relating to noise from the rail line that lies approximately sixty five metres to the north of the site. The data in question was gathered at an elevated position above the train line and thus allow an assessment to be made of the potential noise ingress levels to apartments at the upper levels of the Development.

Figure 1 identifies the night time noise survey measurement location employed on 7 April 2017.

Noise egress from Dukes 92

During the weekend night time noise surveys carried out by both Fisher Acoustics and REC, no music noise was audible at the Chester Road site due to noise egress from Dukes 92 or any other commercial unit. Noise levels at the site were governed primarily by road trafif and occasion train movements.

Therefore, it is considered that no mitigation measures relating to music noise would be required to comply with Planning Condition 23.

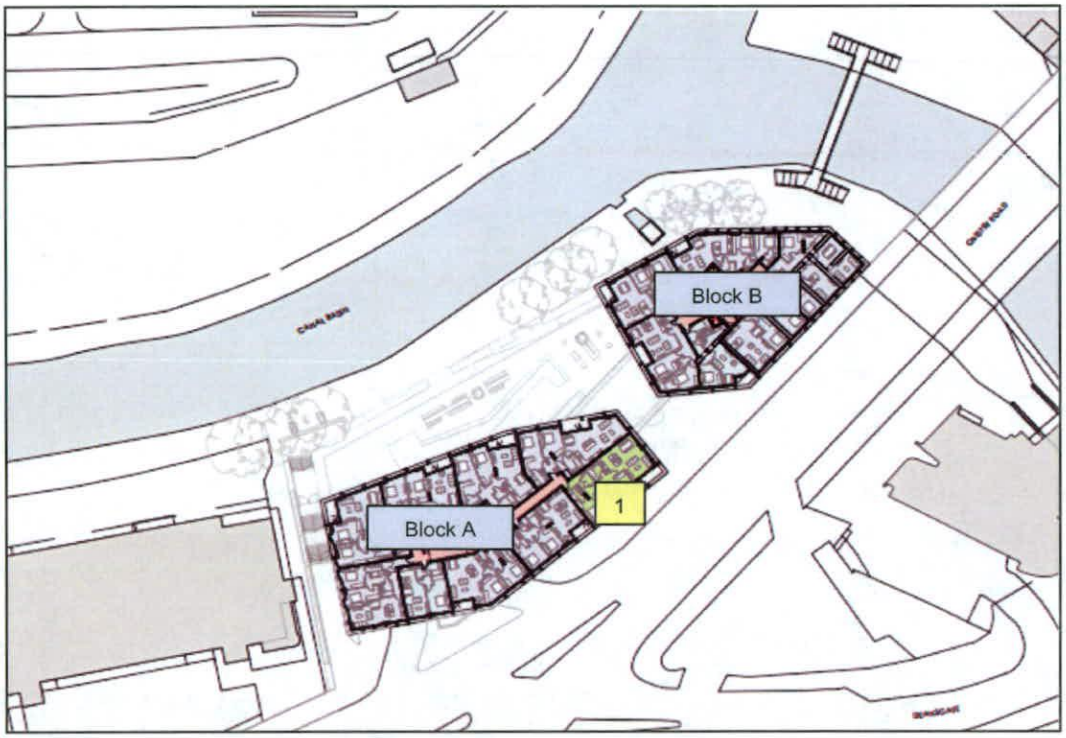


Figure 1: Site plan showing noise survey measurement location

4.0 NOISE INGRESS

By taking into account the measured levels of noise at the site, the areas of façade elements and the likely reverberation time of the residential rooms, the required sound reduction of the windows and external wall can be determined.

Calculations of noise ingress have been carried out to determine the façade specifications to achieve the internal noise criteria identified above. These calculations are based upon the glazing areas and room sizes and layouts shown on the drawings submitted for Planning purposes.

Windows

Table 1 identifies the minimum recommended sound reduction index of the windows to habitable rooms in Block A. The recommended performance figures in Table 1 relate to the composite performance of the glazing, the window frames and seals to any opening lights. The recommendations apply to each floor level of the elevation in question, unless identified otherwise.

Elevation, room type, window type	Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
South Elevation (Chester Road) Living Rooms and Bedrooms Level 02 to 11 TYPE A	28	26	34	41	44	45	54
North East Elevation Living Rooms and Bedrooms up to 7.5m from Chester Road façade Level 02 to 11 TYPE A	28	26	34	41	44	45	54
North East Elevation Bedrooms more than 7.5m from Chester Road facade Level 02 to 11 TYPE A	28	26	34	41	44	45	54
North East Elevation Living Rooms more than 7.5m from Chester Road façade Level 02 to 11 TYPE B	20	23	24	34	42	43	45
North and North West Elevations Living Rooms and Bedrooms Level 01 to 11 TYPE E	19	23	23	30	38	40	39
West Elevation, Living Rooms and Bedrooms up to 10m from Chester Road façade Levels 02 to 11 TYPE A	28	26	34	41	44	45	54
West Elevation, Living Rooms and Bedrooms more than 10m from Chester Road façade Levels 02 to 11 TYPE D	23	26	28	35	44	48	54

Table 1: Minimum Recommended Sound Reduction Index of windows, Block A

Table 2 identifies the minimum recommended sound reduction index of the windows to habitable rooms in Block B. The recommended performance figures in Table 2 relate to the composite performance of the glazing, the window frames and seals to any opening lights. The recommendations apply to each floor level of the elevation in question, unless identified otherwise.

Elevation, room type, window type	Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
South Elevation (Chester Road) Living Rooms and Bedrooms Level 01 to 11 TYPE A	28	26	34	41	44	45	54
South Elevation (Chester Road) Living Rooms and Bedrooms Level 12 to 18 TYPE D	23	26	28	35	44	48	54
South Elevation (Chester Road) Bedrooms Level 20 TYPE F	21	26	27	34	37	38	38
South Elevation (Chester Road) Bedrooms on Northwest and Southwest corners Level 20 TYPE D	23	26	28	35	44	48	54
South Elevation (Chester Road) Living Rooms Level 19 TYPE B	20	23	24	34	42	43	45
North East Elevation Living Rooms and Bedrooms Level 01 to 11 TYPE A	28	26	34	41	44	45	54
North East Elevation Living Rooms Level 12 to 18 TYPE B	20	23	24	34	42	43	45
North East Elevation Bedrooms Level 20 TYPE D	23	26	28	35	44	48	54
North East Elevation Living Room Level 19 TYPE B	20	23	24	34	42	43	45
North and North West Elevations Living Rooms and Bedrooms Level 01 to 18 TYPE E	19	23	23	30	38	40	39
North and North West Elevations Living Rooms and Bedrooms Level 19 to 20 TYPE F	21	26	27	34	37	38	38
South West Elevation Bedrooms Level 02 to 11 TYPE A	28	26	34	41	44	45	54

Elevation, room type, window type	Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
South West Elevation Living Rooms Level 02 to 11 TYPE D	23	26	28	35	44	48	54
South West Elevation Bedrooms Level 12 to 20 TYPE D	23	26	28	35	44	48	54
South West Elevation Living Rooms Level 12 to 20 TYPE B	20	23	24	34	42	43	45

Table 2: Minimum Recommended Sound Reduction Index of windows, Block B

For guidance purposes, the following glazing configurations are expected to allow compliance with the performance figures given in Tables 1 and 2:

- Type A: 10 mm float / 20 mm thermal cavity / 8.4 mm acoustic laminate
- Type B: 6 mm float / 16 mm thermal cavity / 6.8 mm acoustic laminate
- Type C: 6mm float / 16 mm thermal cavity / 10.8 mm acoustic laminate
- Type D: 8mm float / 12 mm thermal cavity / 8.8 mm acoustic laminate
- Type E: 4 mm float / 12 mm thermal cavity / 6 mm float
- Type F: 10 mm float / 12 mm thermal cavity / 6 mm float

External Wall

Table 3 identifies the minimum recommended sound reduction index of the external wall to the proposed habitable rooms in Block A.

Elevation, room type, wall type	Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
South Elevation (Chester Road) Bedrooms Level 02 to 11 TYPE i	28	40	50	55	60	60	60
South Elevation (Chester Road) Living Rooms Level 02 to 11 TYPE ii	25	35	50	55	55	55	55
North East Elevation Bedrooms up to 7.5m from Chester Road façade Level 02 to 11 TYPE i	28	40	50	55	60	60	60
North East Elevation Living Rooms up to 7.5m from Chester Road façade Level 02 to 11 TYPE ii	25	35	50	55	55	55	55
North East Elevation Living rooms and Bedrooms more than 7.5m from Chester Road façade Level 02 to 11 TYPE iii	17	25	39	50	50	50	50
North and North West Elevations Living Rooms and Bedrooms Level 01 to 11 TYPE iii	17	25	39	50	50	50	50
West Elevation Bedrooms up to 10m from Chester Road façade Levels 02 to 11 TYPE i	28	40	50	55	60	60	60
West Elevation Living Rooms up to 10m from Chester Road façade Levels 02 to 11 TYPE ii	25	35	50	55	55	55	55
West Elevation Living Rooms and Bedrooms more than 10m from Chester Road façade Levels 02 to 11 TYPE ii	25	35	50	55	55	55	55

Table 3: Minimum Recommended Sound Reduction Index of external wall, Block A

Table 4 identifies the minimum recommended sound reduction index of the external wall to the proposed habitable rooms in Block B.

Elevation, room type, wall type	Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
South Elevation (Chester Road) Bedrooms Level 01 to 11 TYPE i	28	40	50	55	60	60	60
South Elevation (Chester Road) Living Rooms Level 01 to 11 TYPE ii	25	35	50	55	55	55	55
South Elevation (Chester Road) Living Rooms and Bedrooms Level 12 to 20 TYPE ii	25	35	50	55	55	55	55
North East Elevation Bedrooms Level 01 to 05 TYPE i	28	40	50	55	60	60	60
North East Elevation Living Rooms and Bedrooms Level 01 to 20 TYPE ii	25	35	50	55	55	55	55
North and North West Elevations Living Rooms and Bedrooms Level 01 to 20 TYPE iii	17	25	39	50	50	50	50
South West Elevation Bedrooms Level 02 to 11 TYPE ii	25	35	50	55	55	55	55
South West Elevation Living Rooms Level 02 to 11 TYPE iii	17	25	39	50	50	50	50
South West Elevation Living Rooms and Bedrooms Level 12 to 20 TYPE iii	17	25	39	50	50	50	50

Table 4: Minimum Recommended Sound Reduction Index of external wall, Block B

The proposed external wall construction for the non-Penthouse levels of the Development is as follows:

- Engineered stone 'infill panel' fixed to metal rails fixed to structural steel studs (SFS), 80mm rigid foil faced insulation. Cement bonded particle board fixed board fixed to lightweight structural frame (SFS) studwork, SFS studs drylined internally with plasterboard, with mineral wool within SFS stud zone.

The proposed external wall construction for the Penthouse level is as follows:

- Insulated Aluminium cladding 'infill panel' fixed to metal rails fixed to structural steel studs (SFS), 80mm rigid foil faced insulation. Cement bonded particle board fixed to lightweight structural frame (SFS) studwork, SFS studs drylined internally with plasterboard, with mineral wool within SFS stud zone.

In order to achieve the recommended sound insulation performance of the external wall, the recommended dimensions and drylining of the SFS studwork is follows:

- Wall Type i: Two layers of 10 mm thick cement bonded particle board fixed to outer face of 150 mm SFS studwork, internal drylining of three layers of 15 mm dense plasterboard (minimum density 830 kg/m^3) fixed to 16 mm deep Resilient Bar, 100 mm mineral wool of minimum density 12 kg/m^3 within stud cavity (thermal insulation requirements to be advised by others).

- Wall Type ii: Two layers of 10 mm thick cement bonded particle board fixed to outer face of 150 mm SFS studwork, internal drylining of two layers of 15 mm dense plasterboard (minimum density 830 kg/m^3) fixed to 16 mm deep Resilient Bar, 100 mm mineral wool of minimum density 12 kg/m^3 within stud cavity (thermal insulation requirements to be advised by others).

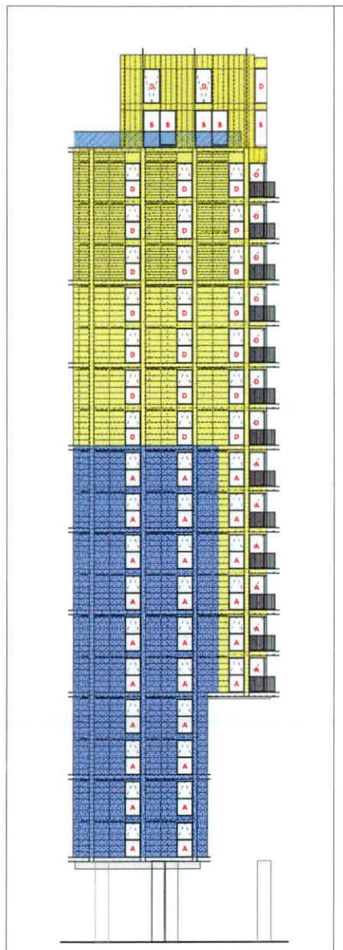
- Wall Type iii: One layer of 10 mm thick cement bonded particle board fixed to outer face of 100 mm or 150 mm SFS studwork, internal drylining of two layers of 12.5 mm dense plasterboard (minimum density 830 kg/m^3) fixed to SFS studwork, 100 mm mineral wool of minimum density 12 kg/m^3 within stud cavity (thermal insulation requirements to be advised by others).

Others must advise on any fire requirements for the external wall drylining.

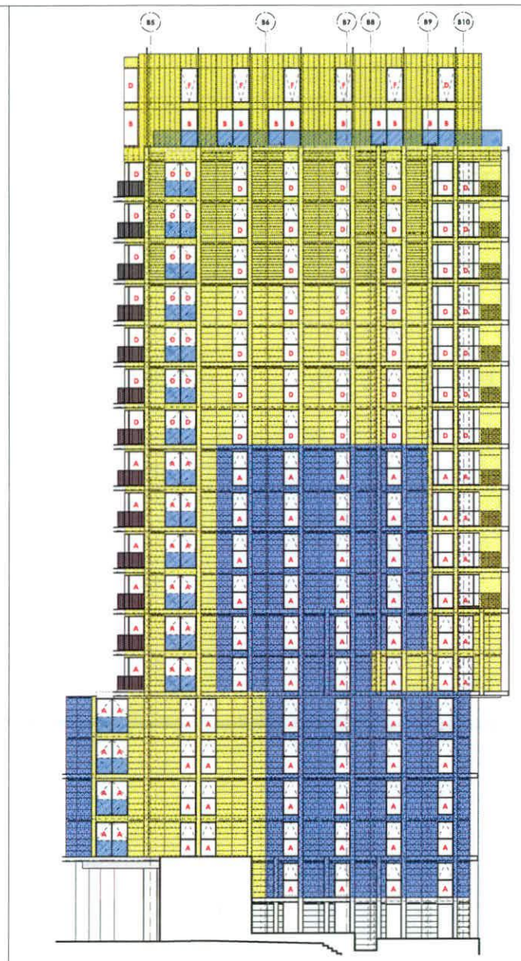
If it can be shown that the external cladding panels contribute positively to the sound insulation provided by the external, then it may be possible to revise the internal drylining requirements to the external wall.

The recommended drylining specification to the external wall must continue up to the structural soffit. The full perimeter of the drylining to the external wall must be acoustically sealed with non-hardening acoustic sealant.

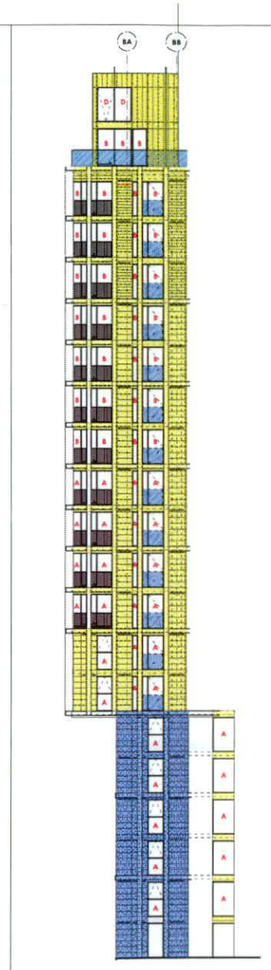
REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY ISSUE
P2	27.02.17	PRELIMINARY
P3	08.05.17	PRELIMINARY



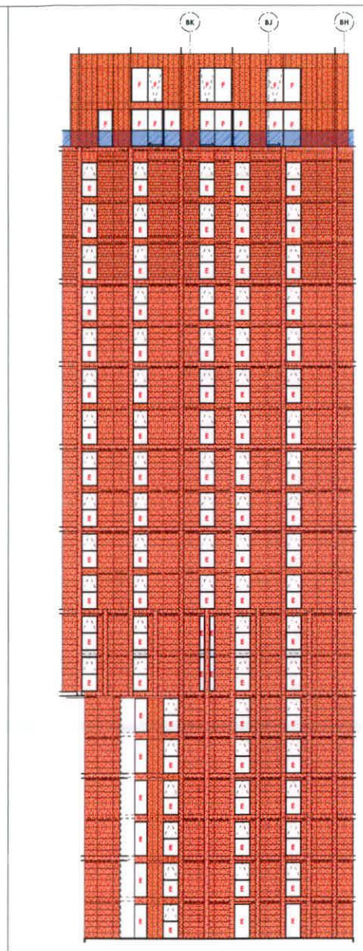
BLOCK B - **ELEVATION 1**
1:200 @ A1



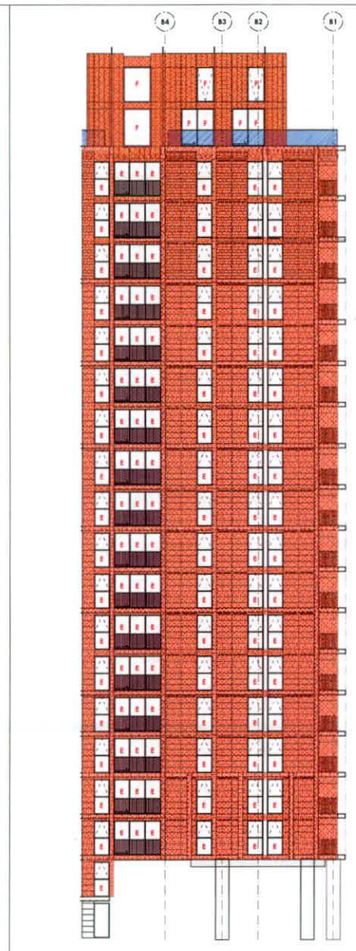
BLOCK B - **ELEVATION 2**
1:200 @ A1



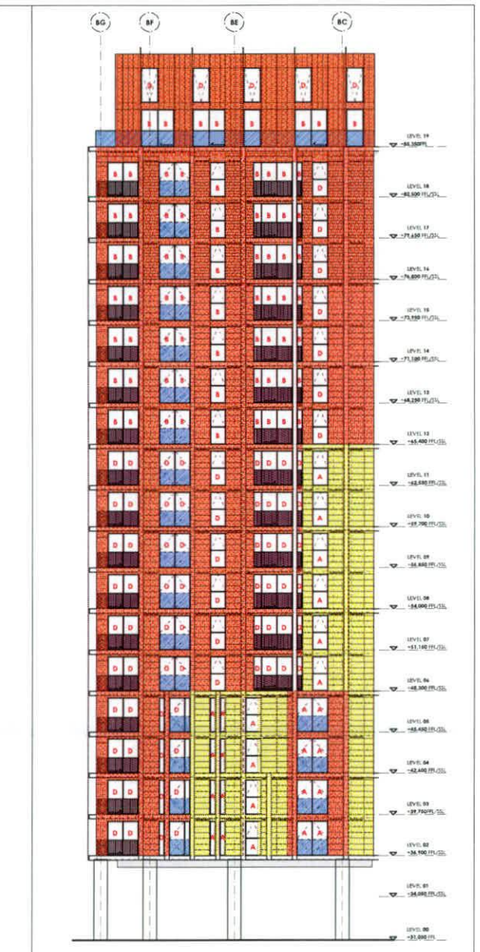
BLOCK B - **ELEVATION 3**
1:200 @ A1



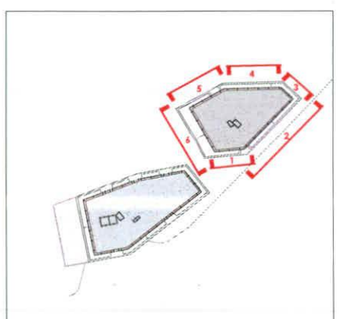
BLOCK B - **ELEVATION 4**
1:200 @ A1



BLOCK B - **ELEVATION 5**
1:200 @ A1



BLOCK B - **ELEVATION 6**
1:200 @ A1



ELEVATION KEY

KEY

- WALL TYPE I.
- WALL TYPE II.
- WALL TYPE III.

- A WINDOW TYPE A
- B WINDOW TYPE B
- C WINDOW TYPE C
- D WINDOW TYPE D
- E WINDOW TYPE E
- F WINDOW TYPE F

NOTES:

DRAWINGS TO BE READ IN CONJUNCTION WITH FISHER ACOUSTIC REPORT.

REFER TO FISHER ACOUSTIC REPORT OF RECOMMENDED GLAZING CONFIGURATIONS AND EXTERNAL WALL CONSTRUCTION.

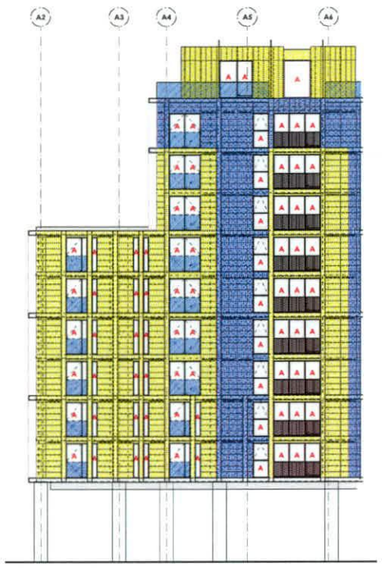
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PROJECT	CHESTER ROAD				
DRAWING	BLOCK B ACOUSTIC ELEVATIONS				
DATE	NOV 16	DRAWN BY	ET	SCALE	1:200@A1
JOB NO.	1370	DWG NO.	B8-OMI-G321-EI-L1771		

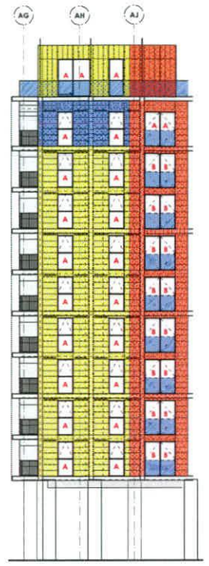
REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY ISSUE
P2	27.02.17	PRELIMINARY
P3	08.05.17	PRELIMINARY



BLOCK A - **ELEVATION 1**
1:200 @ A1



BLOCK A - **ELEVATION 2**
1:200 @ A1



BLOCK A - **ELEVATION 3**
1:200 @ A1



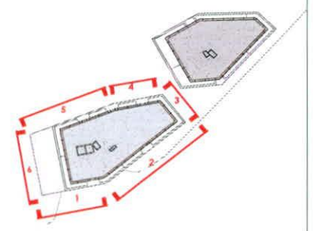
BLOCK A - **ELEVATION 4**
1:200 @ A1



BLOCK A - **ELEVATION 5**
1:200 @ A1



BLOCK A - **ELEVATION 6**
1:200 @ A1



ELEVATION KEY

KEY

- **WALL TYPE I.**
- **WALL TYPE II.**
- **WALL TYPE III.**

- A **WINDOW TYPE A**
- B **WINDOW TYPE B**
- C **WINDOW TYPE C**
- D **WINDOW TYPE D**
- E **WINDOW TYPE E**
- F **WINDOW TYPE F**

NOTES:

DRAWINGS TO BE READ IN CONJUNCTION WITH FISHER ACOUSTIC REPORT.

REFER TO FISHER ACOUSTIC REPORT OF RECOMMENDED GLAZING CONFIGURATIONS AND EXTERNAL WALL CONSTRUCTION.

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PROJECT	CHESTER ROAD				
DRAWING	BLOCK A ACOUSTIC ELEVATIONS				
DATE	NOV 16	DRAWN BY	ET	SCALE	1:200@A1
JOB NO.	1370	DWG NO.	BA-OMI-G321-EI-L1700		

H43-A
PLANNING AND
BUILDING CONTROL
12 MAY 2017

H43 RAINSCREEN CLADDING

To be read with Preliminaries/General conditions.

GENERAL CONDITIONS

Complete rainscreen wall design to take licence of all structural, thermal, acoustic, and air-tightness requirements to ensure compliance with the current building regulations.

Approved, trained & certified design / installation contractors to install the system and components.

System selected to have formal test certification from a UK accredited testing facility. The testing should comply with testing requirements laid out in the "CWCT Testing for Ventilated Rainscreen Facades".

TENDERING

010 INFORMATION TO BE PROVIDED WITH TENDER

- Submit the following cladding particulars:
  - Typical plan, section and elevation drawings at suitable scales.
  - Typical detailed drawings at 1:5/1:10 scales.
  - Technical information and certification demonstrating compliance with specification of proposed incorporated products and finishes, including sample panels of all finishes.
  - Certification, reports and calculations demonstrating compliance with specification of proposed cladding.
  - Proposals for connections to and support from the primary support structure.
  - Proposals for primary support structure additional to that shown on preliminary design drawings.
  - Schedule of builder's work, special provisions and special attendance by others.
  - Examples of standard documentation from which project quality plan will be prepared.
  - Preliminary fabrication and installation method statements and programme.
  - Proposals for replacing damaged or failed products.
  - Areas of non-compliance with specification.

110 RAINSCREEN CLADDING

- Drawing reference(s): Refer to GA Elevations and A 2400 Series details
  Primary support structure: Insitu concrete frame and floor slabs with SFS infill walling.
- Rainscreen cladding system: Rainscreen System – secret-fix, baffle jointed, pre-finished aluminium material cassette panels
  Type: Drained and back-ventilated
- Rainscreen panel: Cassette, individually demountable, panel return flanges mechanically secured at corners.
  Material: 0.5mm aluminium sheet bonded to each side of a 3mm thermoplastic core.
  Manufacture controlled by a CNC controlled quality assured process.
  Thickness: Nominal 2mm to comply with performance criteria.
  Finish: Anodised Finish
  Colour: Champagne/Light Gold
  Joint type: Baffle jointed
  Joint width: 20mm standard. No sealant, mastic or gaskets to be used
- Air gap: 2 Not less than 25mm to meet CWCT guidance.
- Support system: Support system and wall attachment brackets, panel holding hooks, and neoprene anti-rattle compression gasket. The support framing must allow for calculated expansion movement of the whole system vertically and horizontally.
  Material: Extruded aluminium to BS1474 in 6063/T6 grade alloy; grade 304 stainless steel connecting bolts and locking tension cams.
  Fasteners: panel holding hooks locate into slots in panel returns – secret fix.

Number and location of fasteners: As Manufacturers/Installers structural design to comply with performance criteria.
- Backing wall: Insitu concrete frame and floor slabs with SFS infill walling.
- Breather membrane: As section 785
- Thermal insulation: As clause 775.
  Accessories:
  Integrate Anodised Aluminium Flashings to parapet, jamb, head and cills as indicated on A 2400 series drawings. Colour: Champagne Gold to match Cladding.
- Incorporated components: Horizontal Ventilation slot to comply with AD Part H
- Locations as set out on elevations.
- Parapet to withstand maintenance access loads from abseil ropes and personnel.
  Other requirements: None.

GENERAL REQUIREMENTS/PREPARATORY WORK

DESIGN/PERFORMANCE REQUIREMENTS

210 DESIGN

- Design responsibility:
  Complete the detailed design, manufacture, supply, install and warrant the works whilst complying with the visual intent indicated on the design drawings and performance criteria stated in the Architectural Specification
  - Where no material, product or supplier is indicated in the Architectural Specification, propose suitable materials and systems prior to Contract award, which comply with the visual intent and performance criteria stated and remain fully responsible for the design of the works.
  - Where a particular material, product or supplier is indicated in the Architectural Specification, such material, product or supplier shall be deemed indicative representing the Employer's design intent only. The Contractor may complete the installation using that product, or such other confirmed as acceptable by the Employer in writing, but shall remain fully responsible for the detailed design and performance of the works.
  Particular interfaces:
  - Complete the detailed design of all interfaces with adjoining trades prior to commencement of manufacture.
  - Ensure that all interfaces are fully co-ordinated prior to commencement.
- Design standard: To CWCT 'Standard for systemised building envelopes' + relevant BS + EN standards.

215 DESIGN PROPOSALS

- Submission of alternative proposals: Preliminary design drawings indicate intent. Other reasonable proposals will be considered.

220 SPECIFICATION

- Compliance standards: The Centre for Window and Cladding Technology (CWCT) 'Standard for systemised building envelopes'.
- Reference information: For the duration of the contract, keep available at the design office, workshop and on site copies of:
- The Centre for Window and Cladding Technology (CWCT) 'Standard for systemised building envelopes'.
- Publications invoked by the CWCT 'Standard for systemised building envelopes' + all relevant CWCT Technical Notes (TN) + Updates (TU) and incorporating relative BS?EN standards.

230 INFORMATION TO BE PROVIDED DURING DETAILED DESIGN

- Submit the following cladding particulars:
  - A schedule of detailed drawings and dates for submission for comment.
  - A schedule of loads that will be transmitted from the rainscreen cladding to the structure.
  - Proposed fixing details and systems relevant to the structural design and construction with methods of adjustment and tolerances.

- A schedule of fabrication tolerances/ size + installation tolerances.
- A detailed testing programme in compliance with the Main Contract master programme.
- A detailed fabrication and installation programme in compliance with the Main Contract master programme.
- Proposals to support outstanding applications for Building Regulation consents or relaxations.

232 QUALITY PLAN

- Requirement: Submit during detailed design.
- Content: In accordance with BS EN ISO 9001 and including the following:
  - Name of the quality manager.
  - Quality assessment procedures.
  - Inspection procedures to be adopted in checking the work.
  - Stages at which check lists will be used and samples of the lists.
  - List of work procedures on the correct use of materials or components, both off site and on site.
  - List of product information with latest revisions.
  - Subcontractors involved in the work.
  - Subcontractors quality plans.
  - Storage, handling, transport and protection procedures.
  - Procedure for registering and reporting non compliances.
  - Maintenance procedures and calibration records.
  - Certification that completed work complies with specification.
  - Check list register to ensure all items have been inspected and non compliances discharged.

235 INFORMATION TO BE PROVIDED BEFORE COMMENCEMENT OF TESTING OR MANUFACTURE OF RAINSCREEN CLADDING SYSTEM

- Submit the following cladding particulars:
  - Detailed drawings to fully describe fabrication and installation.
  - Detailed calculations to prove compliance with design/ performance requirements.
  - Project specific fabrication, handling and installation method statements.
  - Certification for incorporated components manufactured by others confirming their suitability for proposed locations in the rainscreen cladding.
  - Recommendations for spare parts for future repairs or replacements.
  - Recommendations for safe dismantling and recycling or disposal of products.

240 PRODUCT SAMPLES

- General: Before commencing mock up/detailed design, submit labelled samples of:
  H43.110 (TYPES 1-3) 300 x 300mm panel size.

250 SAMPLES OF FIXINGS

- General: During detailed design, submit labelled samples of each type of fixing, together with manufacturers' recommended torque figures.

260 FABRICATION SAMPLES

- General: During detailed design, submit samples of:
  Panel Types
  Corner Details
  Control samples for PPC finishes to Accessories required to complete the design.
- Obtain approval of appearance before proceeding.

270 MOCK-UP

- General: Construct during detailed design work in an agreed location. Satisfy purpose and obtain approval of appearance before proceeding. Retain undisturbed until completion of cladding installation.
- Purpose: Approval of Materials and Workmanship prior to Fabrication.

DESIGN/ PERFORMANCE REQUIREMENTS

310 CWCT 'STANDARD FOR SYSTEMISED BUILDING ENVELOPES'

- General: Unless specified or agreed otherwise comply with:
  Part 2 - Loads, fixings and movement.
  Part 3 - Air, water and wind resistance.
  Part 4 - Operable components, additional elements and means of access.
  Part 5 - Thermal, moisture and acoustic performance.
  Part 6 - Fire performance.
  Part 7 - Robustness, durability, tolerances and workmanship.
- Project performance requirements specified in this subsection: Read in conjunction with CWCT performance requirements and CWCT Technical Notes (TN) + Updates (TU).

330 INTEGRITY OF VENTILATED RAINSCREEN CLAD WALLS: Determine size(s) and thickness of panels, the size(s), number and spacing of fixings, configuration and location of secondary support systems and incorporation of other accessories and fittings to ensure the cladding system, primary support structure and other elements forming the rainscreen wall will resist all factored dead, imposed and design live loads, and accommodate all deflections and movements without damage.

- Calculate wind loads on rainscreen walls appropriate to location, exposure, height, building shape, and size in accordance with To BSEN 1991-1-4 + BS6399 -2 standard method, taking full account of existing and known future adjacent structures.

342A CONTRACTOR'S DESIGN OF RAINSCREEN

- Design responsibility:
  Complete the detailed design, manufacture, supply, install and warrant the works whilst complying with the visual intent indicated on the design drawings and performance criteria stated in the Architectural Specification
  - Where no material, product or supplier is indicated in the Architectural Specification, propose suitable materials and systems prior to Contract award, which comply with the visual intent and performance criteria stated and remain fully responsible for the design of the works.
  - Where a particular material, product or supplier is indicated in the Architectural Specification, such material, product or supplier shall be deemed indicative representing the Employer's design intent only. The Contractor may complete the installation using that product, or such other confirmed as acceptable by the Employer in writing, but shall remain fully responsible for the detailed design and performance of the works.
  Particular interfaces:
  - Complete the detailed design of all interfaces with adjoining trades prior to commencement of manufacture.
  - Ensure that all interfaces are fully co-ordinated prior to commencement.
- Design standard: To CWCT 'Standard for systemised building envelopes' + relevant BS + EN standards.

355 SPECIFIC DEAD LOADS

a) Self-weight Gravity Loads: The works shall be capable of accommodating the selfweight of the system including all of its framing and supporting system.

b) The works shall be capable of accommodating loads imposed by adjacent and/ or attached elements that bear onto, are suspended from or fixed to the system. Refer to the Design Drawings for information on such elements and/ or required load capacities. No elements from other trades shall be fixed to and/ or supported by the cladding, unless accurately specified, shown on the Design Drawings and/ or accepted by the Employer.

357 SPECIFIC LIVE LOADS:
The works shall be capable of accommodating the following live loads without any reduction in performance:

a) Horizontally applied loads acting on the surface of any component. The works shall sustain safely, without reduction in performance and without permanent deformation to any component, a static 500N load applied horizontally through a square of 100mm sides on any

part of the framing.

b) A horizontal line load applied to the works, due to the occupants, in accordance with BS 6180:2011 and BSEN 1991-1-1:2002 + 1991-1-7: 2006 + A1:2014.

c) Impact loads from abseilers onto the vertical cladding panels.

359 DEFLECTIONS

The maximum allowable deflection of any element of the works, when carrying full design loads, shall not exceed 1/90 of their clear span between points of attachment, in a direction normal to the plane of that element, whichever is the lesser value.
The works shall not deflect under loading in any way that is detrimental to any element of the works or adjacent structural or building elements.
All components, couplings and fixings shall be capable of accommodating all of the above deflection without permanent distortion, deformation or failure.
The works shall accommodate differential structural movements arising from any loads imposed by adjacent structures.
The magnitude of the allowable deflections shall be reduced if they are detrimental to any part of the works, their support structure or internal finishes.
A frame movement and tolerance report will be produced and submitted for approval by the subcontractor.

365 WIND LOADS

The works shall be designed to withstand, without permanent deformation, the effects of wind loads. Booth King Structural Engineers have prepared a 'Wind Calculations for Cladding' report that can be used as a starting point, but the cladding contractor must verify and complete the wind loading design.
Note: To BSEN 1991-1-4 + BS6399 -2.

370A APPEARANCE AND FIT

- Requirement: Design rainscreen wall:
  - To ensure position and alignment of all parts and features as shown on preliminary design drawings.
  - To accommodate deviations in the primary support structure.
  - Maximum permitted component and installation tolerances: Panel tolerance ± 2mm, installation tolerance; As stated by CWCT SSBE 7.4.5 + 7.4.6.

380A GENERAL MOVEMENT

Please refer to the Structural Engineer's Movement and Tolerances Report .

385 THERMAL MOVEMENT - SERVICE TEMPERATURE RANGES

• Requirement: To CWCT 'Standard for systemised building envelopes' clause 2.7.2 amended and/ or with the addition of the following:
Cladding walling and roofing
Heavyweight, light colour
-25°C to +50°C
Heavyweight dark colour
-20°C to +65°C
Lightweight (insulated), light colour
-25°C to +60C
Lightweight (insulated) dark colour
-20°C to +80°C
The design shall cater for all temporary and permanent conditions envisaged for the works.

390 AIR PERMEABILITY EXFILTRATION

- Requirement: The maximum permissible air exfiltration rate through the building envelope system must not exceed: 2.5 mÑ/(h.mÇ at 50 Pa in residential elements and
  5 mÑ/(h.mÇ at 50 Pa in leisure.

420A WATER PENETRATION

- Watertightness class to be tested using a dynamic water testing engine.
  - Peak test pressure: TBC by Subcontractor following windload calcs and to meet CWCT guidance.
- Additional requirements: Mineral wool insulation attached to backing wall not to be wetted at peak test pressure. To comply with CWCT TN 33.

425 WIND LOAD SERVICEABILITY AND SAFETY OF RAINSCREEN PANELS - CYCLIC WIND LOADING

- Method of determination: By calculation: Submit verification performance.

430 THERMAL PROPERTIES

- Method for calculating the thermal transmittance (U-value) of the rainscreen wall: Weighted Uvalue.
- Average U-value of rainscreen wall: 0.22W/mÇK
- Average U-value of floor (soffit): 0.12W/mÇK .
- Method for assessing thermal transmittance (U-value) of assemblies: By calculation.

440 AVOIDANCE OF CONDENSATION

- Requirement: Psychrometric conditions under which condensation must not form within or on the interior surface of the rainscreen wall or any surface of the wall that is on the warm side of insulation are:
  - Notional outdoor psychrometric conditions as BS 6229, table A1.
  - Notional indoor psychrometric conditions:
  Temperature: 20°C.
  Relative humidity: 55%.
  Vapour pressure: 1.28 kPa .
- Winter interstitial condensate:
  - Calculated amount (maximum): 0.35 kg/mÇ.
  - Calculated annual net retention: Nil.
  - Calculations to be submitted.

450 VAPOUR CONTROL LAYER

- Interstitial condensation risk within rainscreen wall: Determine using the method described in BS 5250 Annex D. If necessary, provide a suitable vapour control layer to ensure that damage and nuisance from interstitial condensation does not occur.
  Design Calculations (or FEA) to be submitted.

460 SOUND TRANSMITTANCE

Refer to Elevation Drawings Series: L 1770 + L 1771

- Minimum weighted sound reduction index (Rw) to BS EN ISO 717-1:
  - Between internal and external surfaces of rainscreen clad wall: As specified in the REC Acoustic Report.
- Minimum weighted standardized level difference (DnTw) to BS EN ISO 717-1.
  - Between adjacent floors abutting rainscreen clad wall: **45** DnT,w + Ctr dB via party walls and party floors.

480 FIRE RESISTANCE OF BACKING WALL TO BS 476- 21

- Minimum periods and criteria: As indicated in L1600 series Fire Strategy drawings.

485 INTERNAL SURFACE SPREAD OF FLAME OF BACKING WALL TO BS 476-7

- Class: 0 .

490 CAVITY FIRE BARRIERS TO BS 476-20

- Requirement: To resist the passage of flame and smoke for not less than 30 minutes integrity, 15 minutes insulation, without impeding ventilation of the rainscreen system (except in fire situation).
  - Cavity barriers and fire stopping to be provided at the junction of perimeter cavity walls and compartment floors or walls which form a fire resisting barrier. See L1700 series Fire compartmentation drawings and L1600 series Elevations.
  - Cavity barriers required to seal the edge of all cavities to all external wall cavity construction, including around openings.
  - Cavity barriers should also be positioned to ensure there is no cavity in the external wall construction that is continuous for more than 20m .

495A DURABILITY

- Visit the Site in order to become familiar with local requirements. Local microclimatic conditions shall be taken into account and grades of materials assessed as suitably durable for the location shall be selected and performance demonstrated.
  An assessment of microclimatic conditions shall be made with due allowance for any factors likely to have an adverse effect upon materials intended for the works. More appropriate materials shall be substituted if adverse effects are predicted.
  Design life of the rainscreen cladding system: [Not less than 60 years].
  Secondary components: Submit details together with required maintenance regime, replacement periods and methods of replacement.

496 DEMOUNTABILITY

Elements of the works shall be individually and independently removable.
The removal of cladding units shall not affect the performance or safety of adjacent or any other part of the works.

497 LIGHTNING PROTECTION SYSTEM

- Rainscreen components used as part of lightning protection system: None.

TESTING

The Centre for Window and Cladding Technology have developed "The Standard for Testing of Ventilated Rainscreen" and "Test Methods for Ventilated Rainscreen" Proposed system must have passed the following tests which are required by these standards for rainscreen systems –

- Weathertightness and water penetration as test regime no 6 (barrier wall air permeability assumed as 5m3/hour/m2).
- Wind loading – Serviceability – as test regime no 8 (load applied 1.75kN/m2)
- Wind loading – Safety – as test regime no 9 (load applied as serviceability test x 1.5 for safety factor)
- Wind resistance – Cyclic loading as test regime defined in "Standard for Walls with Ventilated Rainscreen" section 2.8.2 and BRE digest 346 part 7 (load applied as wind loading, serviceability test level)

510 COMPARISON (TYPE) TESTING

- Verification of performance:
  - Submit: Certification and reports satisfying CWCT 'Standard for systemised building envelopes', clause 1.5.5, items a and b, or c..
- Commencement of fabrication and installation of rainscreen cladding: Not until test results and reports showing compliance with this specification have been submitted + approved.

515 PROJECT TESTING (LABORATORY)

- Timing of testing: At an agreed stage in detailed design work arrange for laboratory testing of specimens of rainscreen cladding and components in accordance with relevant clauses of this specification.
- Commencement of fabrication and installation of rainscreen cladding: Not until test results and reports showing compliance with this specification have been submitted.

530 TESTING AUTHORITY

- Requirement: Project testing must be carried out by a United Kingdom Accreditation Service (UKAS) approved independent laboratory.

560 TEST SEQUENCE - STANDARD LABORATORY TESTS

- Requirement: To CWCT 'Standard for systemised building envelopes' Standard sequence B, clause 8.12.2, and as follows:
- Air permeability (infiltration): Not required.
  - Peak test pressure: As clause 410.
  - Method for identifying areas of concentrated air leakage: Not applicable.
- Air permeability (exfiltration): Not required.

- Peak test pressure: As clause 410.
- Allowable exfiltration rates: As clause 390.
- Method of identifying areas of concentrated air leakage: Not applicable.

• Water penetration resistance - static: Not required.
- Peak test pressure: As clause 420.

• Wind resistance - serviceability: To CWCT clause 8.8.
- Peak test pressure: Equal to design wind pressure specified in clause 420.
- Position of displacement measuring devices: .
- Allowable elastic and residual deformation: As CWCT Standard.

• Air permeability (infiltration): Repeat as above.
• Air permeability (exfiltration): Repeat as above.
• Water penetration resistance - static: Repeat as above.
• Water penetration resistance - dynamic: To CWCT clause 8.7.2.
- Test method: Dynamic aero engine.
- Test pressure: As clause 420.

• Hose test: As CWCT SSBE 8.9.2.
- Joints to be tested: Not applicable.

• Wind resistance - safety: To CWCT clause 8.8
- Peak test pressure: Equal to 1.5 times design wind pressure specified in clause 420.
- Position of displacement measuring devices: .
- Allowable residual deformation: As CWCT Standard.

• Impact - safety: As CWCT TN 76.
- Location, sequence and number of impacts to be applied: Not applicable.
- Type of soft body impactor: Not applicable.
- Energy of soft body impactor (E): Not applicable.
- Required hard body impact load category: Not applicable.
- Required soft body impact classification: Not applicable.

• Testing of wind loading on rainscreen panels: To CWCT 'Standard test methods for building envelopes' Section 13.
- Peak test pressure: Equal to design wind pressure specified in clause 420.
- Position of displacement measuring devices: .
- Allowable residual deformation: As CWCT Standard.

• Dismantle inspect and record.

660 TEST SEALANTS

• Requirement: Carry out in accordance with requirements of clause 770 to verify that sealants shall not leak or bleed causing any discolouration and runoff staining to any adjoining materials.

PRODUCTS

710 ALUMINIUM ALLOY FRAMING SECTIONS:
- To BS 1474, alloy 6063 and suitable for the specified finish.
- Structural members to comply with BS 8118.

712 ALUMINIUM ALLOY SHEET: To BS EN 485, BS EN 515 and BS EN 573 in an alloy, temper and thickness suitable for the application and specified finish.

715 MILD STEEL FRAMING SECTIONS/ REINFORCEMENT: To the relevant parts of BS 7668, BS EN 10029, BS EN 10113, BS EN 10137, BS EN 10155 and BS EN 10210, in a thickness suitable for the application, and for galvanizing or other protective coating.

717 MILD STEEL SHEET: To the relevant parts of BS 1449-1, BS EN 10048, BS EN 10051, BS EN 10111, BS EN 10131, BS EN 10139, BS EN 10140, BS EN 10149, BS EN 10209, and BS EN 10268 in a grade and thickness suitable for the application, and suitable for galvanizing or other protective coating.

720 STAINLESS STEEL SHEET: To the relevant parts of BS EN 10029, BS EN 10048, BS EN 10051, BS EN 10095, BS EN 10258, BS EN 10259 and BS EN 10088-2, austenitic, grade 1.4301 (304) generally, grade 1.4401 (316) when used externally or in severely corrosive environments, and in a thickness suitable for the application.

730 MECHANICAL FIXINGS:

- Stainless steel to BS EN ISO 3506 grade A2 generally, grade A4 when used in severely corrosive environments, or
- Mild steel to BS 4190 and suitable for galvanizing or other protective coating, or
- Aluminium complying with BS 1474 and BS EN 755.

732 ADHESIVES must not be degradable by moisture or water vapour.

735 FIXINGS AND FASTENERS must be:
- Of dimensions not less than recommended by their manufacturers.
- Capable of adequate three dimensional adjustment to accommodate primary support structure and rainscreen cladding fabrication/installation tolerances.

760 GASKETS:
- Non-cellular rubber to BS 4255-1
- Cellular rubber to ASTM-C509.
- Resistant to oxidation, ozone and UV degradation.

770 GENERAL SEALANTS: Must be stable and compatible with all contact products and finishes and be selected in accordance with BS 6213 from:
Silicone to BS 5889
One part poly-sulphide to BS 5215
Two part poly-sulphide to BS 4254
One or two-part polyurethane.

775 THERMAL INSULATION
• Determine the type and thickness of the insulation and any integral or separate overlay to satisfy the following criteria:
a) The insulation thickness shall comply with the thermal and acoustic requirements for solid wall's as specified in Element's Sustainability and Carbon Reduction Report and the REC Acoustic Report and OMI drawings L 1770 + 1771.
NOTE: The maximum thickness for any insulation outside of the SFS frame (in the cavity) is to be **80mm.**
b) The insulation boards shall be inert, durable, rot-proof, vermin-proof and not be degradable by moisture, extreme temperatures or water vapour.
c) The selected insulation shall comply with all requirements for fire, including those associated with buildings taller than 18m in height. Refer to Building Regulations Part B, BR135 parts 1 and 2 as well as BS 8414 parts 1 and 2.
d) The insulation shall comply with with all relevant British Standards and be BBA certified and tested to meet the standards specified.
e) The insulation shall not bulge, sag, delaminate or detach during its installation or in situ during the life of the cladding.
F) The insulation shall be kept dry during installation

780A VAPOUR CONTROL LAYER
• Material: [High performance reinforced membranes of foil or plastics, protected both sides by rigid facings / linings to give a class 0 spread of flame to meet the performance criteria specified].
- Minimum vapour resistance: [250MN.s/g].
- Manufacturer: [Submit proposals].
Product reference: [Submit proposals].
Continuity: No breaks and with the minimum of joints.
- Penetrations and abutments: Seal to vapour control layer. If necessary, prime substrates to achieve full bond.
- Sheet laps: Not less than 150 mm, seal with tape. Prime substrates as necessary to achieve full bond.
Sheet tape: Double sided sealant with vapour resistivity not less than the vapour control sheet.
Sheet repairs and punctures: Seal with lapped patch of vapour control membrane and continuous band of sealant tape along edges.

785A BREATHER MEMBRANE
• a) The breather membrane shall be water-resistant, water vapour permeable and manufactured from non-woven, spunbonded high density polyethylene and be BBA

Certificate approved.
b) Installation: The membrane shall be installed strictly in accordance with the manufacturer's instructions.
c) Fix carefully and neatly to provide a complete barrier to water, snow and wind blown dust.
d) Horizontal laps to be 100mm and vertical laps 150mm and staggered, to shed water away from the substrate and structure in accordance with manufacturers recommendations.
e) Ensure that the membrane is secured at the reveals / perimeter of all openings.

790A SHEATHING BOARD
Cement particle board, thickness to suit loadings (fixed by cladding contractor) to SFS by Cladding contractor to provide weather tight shell.

FINISHES

810 PROTECTIVE COATING OF MILD STEEL FRAMING SECTIONS/REINFORCEMENT: All surfaces must be:
- Hot dip galvanized to BS EN ISO 1461, or
- Treated with an appropriate equivalent coating to BS 5493, BS EN ISO 12944 and BS EN ISO 14713.

820 PROTECTIVE COATING OF MILD STEEL MECHANICAL FIXINGS: All surfaces must be:
- Hot dip galvanized to BS EN ISO 1461, or
- Sherardized to BS 4921, class 1 coating thickness and passivated, or
- Zinc plated to BS 1706, coating classification Fe/Zn 12 and chromate conversion class 2C or 2D.

FABRICATION AND INSTALLATION

910 GENERALLY:
- Fabricate and install rainscreen cladding in accordance with this specification and the final detailed drawings.
- Fabricators and installers must employ competent rainscreen cladding operatives. Records of their experience are to be provided to the CA on request.
- Select and align all products to ensure uniformity of appearance.
- Joints must only occur at positions indicated on final detailed drawings.
- Isolate dissimilar metals to prevent electrolytic corrosion.
- Machine cut and drill all products in the workshop wherever possible.
- Mark or tag all products to facilitate identification during assembly, handling, storage and installation. Do not mark surfaces visible in the complete installation.

912 METALWORK: As section Z11, unless specified otherwise in this section.

922 FIXINGS/ADHESIVES APPLICATION: As section Z20, unless specified otherwise in this section.

925 SEALANT APPLICATION: As section Z22, unless specified otherwise in this section.

930 ASSEMBLY:
- Carry out as much assembly as possible in the workshop.
- Joints, other than movement joints and designed open joints, must be rigidly secured, reinforced where necessary and fixed with hairline abutments.
- Take precautions to prevent displacement of components in assembled units. Obtain approval for any reassembly on site.

935 INSPECTION:
- All fabrications and assembled units must be carefully inspected for match with approved samples and for compliance with this specification and the final detailed drawings before dispatch to site.
- Give adequate notice of inspection arrangements to enable the CA and/or other affected parties to be present.

940 PROTECTION:
- All fabrications and assembled units must be protected against damage, corrosion and disfigurement during handling, installation and subsequent site operations.
- Protective coverings must be applied before dispatch to site and must not be detrimental to rainscreen cladding products, finishes or installation procedures.

945 HANDLING AND STORAGE:
- Do not deliver to site any rainscreen cladding products and units which cannot be installed immediately or unloaded into a suitable well protected storage area.
- Store products and units on level bearers clear of the ground and separate with resilient spacers.

950 SUITABILITY OF STRUCTURE:
- Not less than 4 weeks before commencement of rainscreen cladding installation carry out a geometric survey of the supporting structure, checking line, level and fixing points. Report immediately to the CA if structure will not allow the required accuracy or security of erection.
- Coordinate geometric survey for rainscreen cladding with any other survey(s) for adjacent cladding.
- Set out erection datum points, lines and levels for a complete elevation at a time unless otherwise agreed with the CA.

960 PRELIMINARY RAINSCREEN CLADDING INSTALLATION: Complete a preliminary area of rainscreen cladding as set out below for inspection and approval of appearance by the CA.

970 RAINSCREEN CLADDING INSTALLATION:
- Set out straight, parallel and truly aligned.
- Tighten all mechanical fixings to manufacturer's recommended torque figures. Do not over tighten fixings intended to permit differential movement.
- Remove protective coverings only where necessary to facilitate installation and from surfaces which will be inaccessible on completion.

975 IN SITU WELDING is not permitted.

980 INTERFACES: Ensure that flashings, closers, etc. (specified in another section) are located correctly and neatly overlap the rainscreen cladding to form a weather tight junction.

985 DAMAGE:
- Do not repair rainscreen cladding without approval. Such approval will not be given where products and units are badly damaged or where the proposed repair will impair performance or appearance.
- Repairs may require additional site testing at the discretion of the CA.
- Schedule repairs or record on drawings for inclusion in the maintenance manual.

990 CLEANING: At practical completion or when otherwise agreed with the CA, remove any protective coverings and thoroughly clean rainscreen cladding areas. Cleaning agents for the purpose must be approved by the rainscreen cladding manufacturer and incorporated products manufacturers.

995 MAINTENANCE: Prepare a maintenance manual in accordance with CWCT 'Guide to good practice for facades', Section 10. Unless otherwise instructed or agreed the manual must be completed and handed over to the CA at practical completion.

H92 RAINSCREEN CLADDING

To be read with Preliminaries/ General conditions.

TENDERING

010 INFORMATION TO BE PROVIDED WITH TENDER

- Submit the following cladding particulars:
  - Typical plan, section and elevation drawings at suitable scales.
  - Typical detailed drawings at 1:5/1:10 scales.
  - Technical information and certification demonstrating compliance with specification of proposed incorporated products and finishes, including sample panels of all finishes.
  - Certification, reports and calculations demonstrating compliance with specification of proposed cladding.
  - Proposals for connections to and support from the primary support structure.
  - Proposals for primary support structure additional to that shown on preliminary design drawings.
  - Schedule of builder's work, special provisions and special attendance by others.
  - Examples of standard documentation from which project quality plan will be prepared.
  - Preliminary fabrication and installation method statements and programme.
  - Proposals for replacing damaged or failed products.
  - Areas of non-compliance with specification.

TYPES OF RAINSCREEN CLADDING

110 STONE RAINSCREEN CLADDING

- Primary support structure: Insitu concrete frame and floor slabs with SFS infill walling.
- Rainscreen cladding system:
  - Type: drained and back ventilated.
  - Requirement: Include products, fixings and interfaces necessary to complete the fabrication and installation. Performance criteria to comply with Design/ Performance Requirements and Testing subsections.
- Rainscreen panel:
  - Type: Flat Panel.
  - Material: Engineered Stone panels.
  - Thickness: Nominal 12mm or 20mm to comply with performance criteria.
  - Colour: Light Portland/Buff.
  - Finish: Refer to A 2000 Series Drawings + Mock Up Drawing A 2060
    TYPE **1:** Honed to Cills/Soffit members.
    TYPE **2:** Light Sandtextured to Vertical members of Expressed Grid
    TYPE **3:** Full Sandtextured to Infill Panels
  - Other panel requirements: All cutting work, corner details and birds-beak mitring to be carried out in factory conditions (not on site)
  - Fixing system: Secret (inc. Soffit Panels).
  - Fasteners: Physical.
    Number and location of fasteners: As determined by clause 335.
  - Joint type: Open:
    - Expressed Grid to inc. 3mm Joint
    - Infil Panels to inc. 8mm Joint.
- Air gap: Not less than 25mm to meet CWCT guidance.
- Secondary support/ framing system: Horizontal carrier rails.
  Thermal isolator pads on brackets back to primary support structure.
  - Material: Extruded Aluminium to BS 1474 in 6063/T6 grade alloy.
  - All visible framing behind cladding to have black PPE finish.
  - Fasteners: stainless steel.
    Number and location: As determined by clause 335.
- Backing wall: Insitu concrete frame with SFS infill walling.

- Thermal insulation: As Clause 775.
- Breather membrane: As Clause 785.
- Vapour Barrier: As Clause 780.
- Acoustic Performance: As Clause 460.

- Accessories:
  Cills to withstand maintenance access loads from abseil ropes and personnel. Integrate Anodised Aluminium Flashings to jamb, head and cills as indicated on A 2000 series drawings. Colour – Bronze to match Window frames (Specification. L10.410 + 520)
- Incorporated components: Horizontal Ventilation slot to comply with AD Part H Locations as set out on elevations.
- Other requirements: None.

210 DESIGN

- Rainscreen cladding system and associated features: Complete detailed design in accordance with this specification and the preliminary design intent drawings and submit for approval before commencement of fabrication.
- Related works: Coordinate in detailed design.

215 DESIGN PROPOSALS

- Submission of alternative proposals: Preliminary design drawings indicate intent. Other reasonable proposals will be considered.

220 SPECIFICATION

- Compliance standards: The Centre for Window and Cladding Technology (CWCT) 'Standard for systemised building envelopes'.
- Reference information: For the duration of the contract, keep available at the design office, workshop and on site copies of:
- The Centre for Window and Cladding Technology (CWCT) 'Standard for systemised building envelopes'.
- Publications invoked by the CWCT 'Standard for systemised building envelopes' + all relevant CWCT Technical Notes (TN) + Updates (TU) and incorporating relative BS?EN standards.

230 INFORMATION TO BE PROVIDED DURING DETAILED DESIGN

- Submit the following cladding particulars:
  - A schedule of detailed drawings and dates for submission for comment.
  - A schedule of loads that will be transmitted from the rainscreen cladding to the structure.
  - Proposed fixing details and systems relevant to the structural design and construction with methods of adjustment and tolerances.
  - A schedule of fabrication tolerances/ size + installation tolerances.
  - A detailed testing programme in compliance with the Main Contract master programme.
  - A detailed fabrication and installation programme in compliance with the Main Contract master programme.
  - Proposals to support outstanding applications for Building Regulation consents or relaxations.

232 QUALITY PLAN

- Requirement: Submit during detailed design.
- Content: In accordance with BS EN ISO 9001 and including the following:
  - Name of the quality manager.
  - Quality assessment procedures.
  - Inspection procedures to be adopted in checking the work.
  - Stages at which check lists will be used and samples of the lists.
  - List of work procedures on the correct use of materials or components, both off site and on site.
  - List of product information with latest revisions.
  - Subcontractors involved in the work.
  - Subcontractors quality plans.
  - Storage, handling, transport and protection procedures.

- Procedure for registering and reporting non compliances.
- Maintenance procedures and calibration records.
- Certification that completed work complies with specification.
- Check list register to ensure all items have been inspected and non compliances discharged.

235 INFORMATION TO BE PROVIDED BEFORE COMMENCEMENT OF TESTING OR MANUFACTURE OF RAINSCREEN CLADDING SYSTEM

- Submit the following cladding particulars:
  - Detailed drawings to fully describe fabrication and installation.
  - Detailed calculations to prove compliance with design/ performance requirements.
  - Project specific fabrication, handling and installation method statements.
  - Certification for incorporated components manufactured by others confirming their suitability for proposed locations in the rainscreen cladding.
  - Recommendations for spare parts for future repairs or replacements.
  - Recommendations for safe dismantling and recycling or disposal of products.

240 PRODUCT SAMPLES

- General: Before commencing mock up/detailed design, submit labelled samples of:

H92.110 (TYPES 1-3) 300 x 300mm panel size.

250 SAMPLES OF FIXINGS

- General: During detailed design, submit labelled samples of each type of fixing, together with manufacturers' recommended torque figures.

260 FABRICATION SAMPLES

- General: During detailed design, submit samples of:
  Panel Types
  Corner Details
  Control samples for PPC finishes to Accessories required to complete the design.
- Obtain approval of appearance before proceeding.

270 MOCK-UP

- General: Construct during detailed design work in an agreed location. Satisfy purpose and obtain approval of appearance before proceeding. Retain undisturbed until completion of cladding installation.
- Extent: As set out on Drawing A 2060.
- Purpose: Approval of Materials and Workmanship prior to Fabrication.

DESIGN/ PERFORMANCE REQUIREMENTS

310 CWCT 'STANDARD FOR SYSTEMISED BUILDING ENVELOPES'

- General: Unless specified or agreed otherwise comply with:
  Part 2 - Loads, fixings and movement.
  Part 3 - Air, water and wind resistance.
  Part 4 - Operable components, additional elements and means of access.
  Part 5 - Thermal, moisture and acoustic performance.
  Part 6 - Fire performance.
  Part 7 - Robustness, durability, tolerances and workmanship.
- Project performance requirements specified in this subsection: Read in conjunction with CWCT performance requirements and CWCT Technical Notes (TN) + Updates (TU).

342A CONTRACTOR'S DESIGN OF RAINSCREEN

• Design responsibility:
Complete the detailed design, manufacture, supply, install and warrant the works whilst complying with the visual intent indicated on the design drawings and performance criteria stated in the Architectural Specification
- Where no material, product or supplier is indicated in the Architectural Specification, propose suitable materials and systems prior to Contract award, which comply with the visual

intent and performance criteria stated and remain fully responsible for the design of the works.
- Where a particular material, product or supplier is indicated in the Architectural Specification, such material, product or supplier shall be deemed indicative representing the Employer's design intent only. The Contractor may complete the installation using that product, or such other confirmed as acceptable by the Employer in writing, but shall remain fully responsible for the detailed design and performance of the works.

Particular interfaces:
- Complete the detailed design of all interfaces with adjoining trades prior to commencement of manufacture.
- Ensure that all interfaces are fully co-ordinated prior to commencement.

• Design standard: To CWCT 'Standard for systemised building envelopes' + relevant BS +EN standards.

355 SPECIFIC DEAD LOADS

a) Self-weight Gravity Loads: The works shall be capable of accommodating the selfweight of the system including all of its framing and supporting system.

b) The works shall be capable of accommodating loads imposed by adjacent and/ or attached elements that bear onto, are suspended from or fixed to the system. Refer to the Design Drawings for information on such elements and/ or required load capacities. No elements from other trades shall be fixed to and/ or supported by the cladding, unless accurately specified, shown on the Design Drawings and/ or accepted by the Employer.

357 SPECIFIC LIVE LOADS:

The works shall be capable of accommodating the following live loads without any reduction in performance:

a) Horizontally applied loads acting on the surface of any component. The works shall sustain safely, without reduction in performance and without permanent deformation to any component, a static 500N load applied horizontally through a square of 100mm sides on any part of the framing.

b) A horizontal line load applied to the works, due to the occupants, in accordance with BS 6180:2011 and BSEN 1991-1-1:2002 + 1991-1-7: 2006 + AI:2014.

c) Impact loads from abseilers onto the horizontal grid.

359 DEFLECTIONS

The maximum allowable deflection of any element of the works, when carrying full design loads, shall not exceed 1/90 of their clear span between points of attachment, in a direction normal to the plane of that element, whichever is the lesser value.
The works shall not deflect under loading in any way that is detrimental to any element of the works or adjacent structural or building elements.
All components, couplings and fixings shall be capable of accommodating all of the above deflection without permanent distortion, deformation or failure.
The works shall accommodate differential structural movements arising from any loads imposed by adjacent structures.
The magnitude of the allowable deflections shall be reduced if they are detrimental to any part of the works, their support structure or internal finishes.
A frame movement and tolerance report will be produced and submitted for approval by the subcontractor.

365 WIND LOADS

The works shall be designed to withstand, without permanent deformation, the effects of wind loads. Booth King Structural Engineers have prepared a 'Wind Calculations for Cladding' report that can be used as a starting point, but the cladding contractor must verify and complete the wind loading design.
Note: To BSEN 1991-1-4 + BS6399 -2.

370A APPEARANCE AND FIT

• Requirement: Design rainscreen wall:
- To ensure position and alignment of all parts and features as shown on preliminary design drawings.
- To accommodate deviations in the primary support structure.
- Maximum permitted component and installation tolerances: Panel tolerance ± 2mm, installation tolerance; As stated by CWCT SSBE 7.4.5 + 7.4.6.

380A GENERAL MOVEMENT
Please refer to the Structural Engineer's Movement and Tolerances Report .

385 THERMAL MOVEMENT - SERVICE TEMPERATURE RANGES
• Requirement: To CWCT 'Standard for systemised building envelopes' clause 2.7.2 amended and/ or with the addition of the following:
Cladding walling and roofing
Heavyweight, light colour
-25°C to +50°C
Heavyweight dark colour
-20°C to +65°C
Lightweight (insulated), light colour
-25°C to +60C
Lightweight (insulated) dark colour
-20°C to +80°C
The design shall cater for all temporary and permanent conditions envisaged for the works.

390 AIR PERMEABILITY EXFILTRATION
- Requirement: The maximum permissible air exfiltration rate through the building envelope system must not exceed: 2.5 mÑ/(h.mÇ at 50 Pa in residential elements and
5 mÑ/(h.mÇ at 50 Pa in leisure.

420A WATER PENETRATION
- Watertightness class to be tested using a dynamic water testing engine.
  - Peak test pressure: TBC by Subcontractor following windload calcs and to meet CWCT guidance.
- Additional requirements: Mineral wool insulation attached to backing wall not to be wetted at peak test pressure. To comply with CWCT TN 33.

425 WIND LOAD SERVICEABILITY AND SAFETY OF RAINSCREEN PANELS - CYCLIC WIND LOADING
- Method of determination: By calculation: Submit verification performance.

430 THERMAL PROPERTIES
- Method for calculating the thermal transmittance (U-value) of the rainscreen wall: Weighted Uvalue.
- Average U-value of rainscreen wall: 0.22W/mÇK
- Average U-value of floor (soffit): 0.12W/mÇK .
- Method for assessing thermal transmittance (U-value) of assemblies: By calculation.

440 AVOIDANCE OF CONDENSATION
- Requirement: Psychrometric conditions under which condensation must not form within or on the interior surface of the rainscreen wall or any surface of the wall that is on the warm side of insulation are:
  - Notional outdoor psychrometric conditions as BS 6229, table A1.
  - Notional indoor psychrometric conditions:
  Temperature: 20°C.
  Relative humidity: 55%.
  Vapour pressure: 1.28 kPa .
- Winter interstitial condensate:
  - Calculated amount (maximum): 0.35 kg/mÇ.
  - Calculated annual net retention: Nil.
  - Calculations to be submitted.

450 VAPOUR CONTROL LAYER
- Interstitial condensation risk within rainscreen wall: Determine using the method described in BS 5250 Annex D. If necessary, provide a suitable vapour control layer to ensure that damage and nuisance from interstitial condensation does not occur.
Design Calculations (or FEA) to be submitted.

460 SOUND TRANSMITTANCE

Refer to Elevation Drawings Series: L 1770 + L 1771

- Minimum weighted sound reduction index (Rw) to BS EN ISO 717-1:
  - Between internal and external surfaces of rainscreen clad wall: As specified in the REC Acoustic Report.
- Minimum weighted standardized level difference (DnTw) to BS EN ISO 717-1.
  - Between adjacent floors abutting rainscreen clad wall: **45** DnT,w + Ctr dB via party walls and party floors.

480 FIRE RESISTANCE OF BACKING WALL TO BS 476- 21

- Minimum periods and criteria: As indicated in L1600 series Fire Strategy drawings.

485 INTERNAL SURFACE SPREAD OF FLAME OF BACKING WALL TO BS 476-7

- Class: 0.

490 CAVITY FIRE BARRIERS TO BS 476-20

- Requirement: To resist the passage of flame and smoke for not less than 30 minutes integrity, 15 minutes insulation, without impeding ventilation of the rainscreen system (except in fire situation).
  - Cavity barriers and fire stopping to be provided at the junction of perimeter cavity walls and compartment floors or walls which form a fire resisting barrier. See L1700 series Fire compartmentation drawings and L1600 series Elevations.
  - Cavity barriers required to seal the edge of all cavities to all external wall cavity construction, including around openings.
  - Cavity barriers should also be positioned to ensure there is no cavity in the external wall construction that is continuous for more than 20m .

495A DURABILITY

- Visit the Site in order to become familiar with local requirements. Local microclimatic conditions shall be taken into account and grades of materials assessed as suitably durable for the location shall be selected and performance demonstrated.
  An assessment of microclimatic conditions shall be made with due allowance for any factors likely to have an adverse effect upon materials intended for the works. More appropriate materials shall be substituted if adverse effects are predicted.
  Design life of the rainscreen cladding system: [Not less than 60 years].
  Secondary components: Submit details together with required maintenance regime, replacement periods and methods of replacement.

496 DEMOUNTABILITY

Elements of the works shall be individually and independently removable.
The removal of cladding units shall not affect the performance or safety of adjacent or any other part of the works.

497 LIGHTNING PROTECTION SYSTEM

- Rainscreen components used as part of lightning protection system: None.

TESTING

510 COMPARISON (TYPE) TESTING

- Verification of performance:
  - Submit: Certification and reports satisfying CWCT 'Standard for systemised building envelopes', clause 1.5.5, items a and b, or c..
- Commencement of fabrication and installation of rainscreen cladding: Not until test results and reports showing compliance with this specification have been submitted + approved.

515 PROJECT TESTING (LABORATORY)

- Timing of testing: At an agreed stage in detailed design work arrange for laboratory testing of specimens of rainscreen cladding and components in accordance with relevant clauses of this specification.
- Commencement of fabrication and installation of rainscreen cladding: Not until test

results and reports showing compliance with this specification have been submitted.

530 TESTING AUTHORITY
- Requirement: Project testing must be carried out by a United Kingdom Accreditation Service (UKAS) approved independent laboratory.

560 TEST SEQUENCE - STANDARD LABORATORY TESTS
- Requirement: To CWCT 'Standard for systemised building envelopes' Standard sequence B, clause 8.12.2, and as follows:
- Air permeability (infiltration): Not required.
  - Peak test pressure: As clause 410.
  - Method for identifying areas of concentrated air leakage: Not applicable.
- Air permeability (exfiltration): Not required.
  - Peak test pressure: As clause 410.
  - Allowable exfiltration rates: As clause 390.
  - Method of identifying areas of concentrated air leakage: Not applicable.
- Water penetration resistance - static: Not required.
  - Peak test pressure: As clause 420.
- Wind resistance - serviceability: To CWCT clause 8.8.
  - Peak test pressure: Equal to design wind pressure specified in clause 420.
  - Position of displacement measuring devices: .
  - Allowable elastic and residual deformation: As CWCT Standard.
- Air permeability (infiltration): Repeat as above.
- Air permeability (exfiltration): Repeat as above.
- Water penetration resistance - static: Repeat as above.
- Water penetration resistance - dynamic: To CWCT clause 8.7.2.
  - Test method: Dynamic aero engine.
  - Test pressure: As clause 420.
- Hose test: As CWCT SSBE 8.9.2.
  - Joints to be tested: Not applicable.
- Wind resistance - safety: To CWCT clause 8.8
  - Peak test pressure: Equal to 1.5 times design wind pressure specified in clause 420.
  - Position of displacement measuring devices: .
  - Allowable residual deformation: As CWCT Standard.
- Impact - safety: As CWCT TN 76.
  - Location, sequence and number of impacts to be applied: Not applicable.
  - Type of soft body impactor: Not applicable.
  - Energy of soft body impactor (E): Not applicable.
  - Required hard body impact load category: Not applicable.
  - Required soft body impact classification: Not applicable.
- Testing of wind loading on rainscreen panels: To CWCT 'Standard test methods for building envelopes' Section 13.
  - Peak test pressure: Equal to design wind pressure specified in clause 420.
  - Position of displacement measuring devices: .
  - Allowable residual deformation: As CWCT Standard.
- Dismantle inspect and record.

660 TEST SEALANTS
- Requirement: Carry out in accordance with requirements of clause 770 to verify that sealants shall not leak or bleed causing any discolouration and runoff staining to any adjoining materials.

PRODUCTS

710 ALUMINIUM ALLOY FRAMING SECTIONS
- Standards: To BS EN 755 alloy EN AW-6063 and suitable for the specified finish.
- Structural members: To comply with BS EN 1999-1-1, -3 and -4.

712 ALUMINIUM ALLOY SHEET
- Standards: To BS EN 485, BS EN 515 and BS EN 573.
- Alloy, temper and thickness: Suitable for the application and specified finish.

715 CARBON STEEL FRAMING SECTIONS/ REINFORCEMENT

- Standards: To the relevant parts of BS 7668, BS EN 10029, BS EN 10025, and BS EN 10210.
- Thickness: Suitable for the application, and for galvanizing or other protective coating.

717 CARBON STEEL SHEET
- Standards: To the relevant parts of BS 1449-1, BS EN 10048, BS EN 10051, BS EN 10111, BS EN 10131, BS EN 10132, BS EN 10139, BS EN 10140, BS EN 10149, BS EN 10209, and BS EN 10268.
- Grade and thickness: Suitable for the application, and for galvanizing or other protective coating.

720 STAINLESS STEEL SHEET
- Standards: To the relevant parts of BS EN 10029, BS EN 10048, BS EN 10051, BS EN 10095 and BS EN ISO 9445-1 and -2.
- Grade: To BS EN 10088-2, austenitic 1.4301 (304) generally, 1.4301 (316) when used externally or in severely corrosive environments.
- Thickness: Suitable for the application.

730 MECHANICAL FIXINGS - MATERIAL REQUIREMENTS
- Stainless steel: To BS EN ISO 3506 grade A2 generally, grade A4 when used in severely corrosive environments.
- Carbon steel: To BS 4190 and suitable for galvanizing or other protective coating.
- Aluminium: To BS EN 755.

732 ADHESIVES
- General: Not degradable by moisture or water vapour.

735 FIXINGS AND FASTENERS
- Type and use: Reviewed and approved by manufacturers. Submit confirmatory information on request.
- Dimensions: Not less than recommended by their manufacturers.
- Adjustment capability: Sufficient in three dimensions to accommodate primary support structure and rainscreen cladding fabrication/ installation tolerances.

760 GASKETS
- Material:
  - Noncellular rubber to BS 4255-1.
  - Cellular rubber to ASTM-C509.
- Durability: Resistant to oxidation, ozone and UV degradation.

770 GENERAL SEALANTS
- Selection: In accordance with BS 6213 from:
  - Silicone.
  - One part polysulfide.
  - Two part polysulfide.
  - One or two part polyurethane.
- Classification and requirements: To BS EN ISO 11600.
- Reaction to contact products and finishes: Stable and compatible.

775 THERMAL INSULATION
- Determine the type and thickness of the insulation and any integral or separate overlay to satisfy the following criteria:
  a) The insulation thickness shall comply with the thermal and acoustic requirements for solid wall's as specified in Element's Sustainability and Carbon Reduction Report and the REC Acoustic Report and OMI drawings L 1770 + 1771.
  NOTE: The maximum thickness for any insulation outside of the SFS frame (in the cavity) is to be **80mm.**
  b) The insulation boards shall be inert, durable, rot-proof, vermin-proof and not be degradable by moisture, extreme temperatures or water vapour.
  c) The selected insulation shall comply with all requirements for fire, including those associated with buildings taller than 18m in height. Refer to Building Regulations Part B, BR135 parts 1 and 2 as well as BS 8414 parts 1 and 2.
  d) The insulation shall comply with with all relevant British Standards and be BBA certified and tested to meet the standards specified.

e) The insulation shall not bulge, sag, delaminate or detach during its installation or in situ during the life of the cladding.
F) The insulation shall be kept dry during installation

780A VAPOUR CONTROL LAYER
• Material: [High performance reinforced membranes of foil or plastics, protected both sides by rigid facings / linings to give a class 0 spread of flame to meet the performance criteria specified].
- Minimum vapour resistance: [250MN.s/g].
- Manufacturer: [Submit proposals].
Product reference: [Submit proposals].
Continuity: No breaks and with the minimum of joints.
- Penetrations and abutments: Seal to vapour control layer. If necessary, prime substrates to achieve full bond.
- Sheet laps: Not less than 150 mm, seal with tape. Prime substrates as necessary to achieve full bond.
Sheet tape: Double sided sealant with vapour resistivity not less than the vapour control sheet.
Sheet repairs and punctures: Seal with lapped patch of vapour control membrane and continuous band of sealant tape along edges.

785A BREATHER MEMBRANE
• a) The breather membrane shall be water-resistant, water vapour permeable and manufactured from non-woven, spunbonded high density polyethylene and be BBA Certificate approved.
b) Installation: The membrane shall be installed strictly in accordance with the manufacturer's instructions.
c) Fix carefully and neatly to provide a complete barrier to water, snow and wind blown dust.
d) Horizontal laps to be 100mm and vertical laps 150mm and staggered, to shed water away from the substrate and structure in accordance with manufacturers recommendations.
e) Ensure that the membrane is secured at the reveals / perimeter of all openings.

790A SHEATHING BOARD
Cement particle board, thickness to suit loadings (fixed by cladding contractor) to SFS by Cladding contractor to provide weather tight shell.

FINISHES
810 PROTECTIVE COATING OF CARBON STEEL FRAMING SECTIONS/ REINFORCEMENT
• Treatment: All surfaces to one of the following:
- Hot dip galvanized to BS EN ISO 1461.
- An appropriate equivalent coating to BS EN ISO 12944 and BS EN ISO 14713-1 and -2.

820 PROTECTIVE COATING OF CARBON STEEL MECHANICAL FIXINGS
• Treatment: All surfaces to one of the following:
- Hot dip galvanized to BS EN ISO 1461.
- Sherardized to BS 4921, class 1 coating thickness and passivated.
- Zinc plated to BS EN ISO 2081, coating designation of FE//Zn//C for an iridescent (yellow passivate) chromate conversion coating or FE//Zn//D for an opaque (olive green) chromate conversion coating.

830 POWDER COATING
• Requirement: As section Z31.

840 ANODIZING
• Requirement: As section Z33.

FABRICATION AND INSTALLATION

910A GENERALLY

- a) All works shall be true to detail + tolerances.
  b) Dimensions and levels of the structure shall be verified.
  c) All fixing bolts and anchors shall be installed in accordance with the manufacturer's recommended procedures.
  d) Materials shall be kept dry until fixed.
  e) Acceptance shall be obtained from the Employer before drilling or cutting parts of the structure, other than where shown on the Working Drawings within tolerances.
  f) Isolating tape, plastic washers or other suitable means shall be used to prevent bimetallic corrosion between dissimilar metals.
  g) Bars shall be set out at evenly spaced centres, straight, parallel and truly aligned with other features where shown on the Working Drawings.
  h) The finished work shall be square, regular, true to line, level and plane with a satisfactory fit at all junctions within tolerances.
  Electrolytic corrosion: Take necessary measures to prevent.
  Identification of products: Mark or tag to facilitate identification during assembly, handling, storage and installation. Do not mark surfaces visible in the complete installation.

911 SETTING OUT
The Design Drawings provided shall show levels and other data required for setting out components. Responsibility shall be taken to set out the works as indicated on the Design Drawings.

912 METALWORK
- Requirement: As section Z11, unless specified otherwise in this section.

915 TIMBER TREATMENT
- Requirement: As section Z12, unless specified otherwise in this section.
- Exposed cut and drilled surfaces: Treat with two flood coats of a solution recommended for the purpose by main treatment solution manufacturer.

922 FIXINGS/ ADHESIVES APPLICATION
- Requirement: As section Z20, unless specified otherwise in this section.

925 SEALANT APPLICATION
- Requirement: As section Z22, unless specified otherwise in this section.

930 ASSEMBLY
- Location: Carry out as much assembly as possible in the workshop.
- Joints: Other than movement joints and designed open joints, must be rigidly secured, reinforced where necessary and fixed with hairline abutments.
- Displacement of components in assembled units: Submit proposals for reassembly on site.

960 PRELIMINARY RAINSCREEN CLADDING INSTALLATION
- Requirement: Complete an area of cladding as set out below for inspection and approval of appearance.
  Expressed grid and infill wall and balustrade return/soffit cladding in an area to be agreed with the Employer .

970 RAINSCREEN CLADDING INSTALLATION
- Tightening mechanical fasteners: To manufacturer's recommended torque figures. Do not overtighten fasteners intended to permit differential movement.
- Protective coverings: Remove only where necessary to facilitate installation and from surfaces which will be inaccessible on completion.

975 WELDING
- In situ welding: Not permitted.

980 INTERFACES
- Installation: Locate flashings, closers etc. correctly and neatly overlap cladding to form a weathertight junction.

985 DAMAGE
- Repairs: Do not repair cladding without approval.
  - Approval: Will not be given where the proposed repair will impair performance or

appearance.
- Record of repairs: Prepare schedule or record on drawings for inclusion in the maintenance manual.

990 CLEANING
General
a) Clean any dirt or blemishes from exposed surfaces.
b) Wash and rinse in accordance with the manufacturer's recommendations.
c) Protect adjacent surfaces from damage due to cleaning operations.
d) Do not use cleaning materials or processes that could alter the character of exposed finishes.

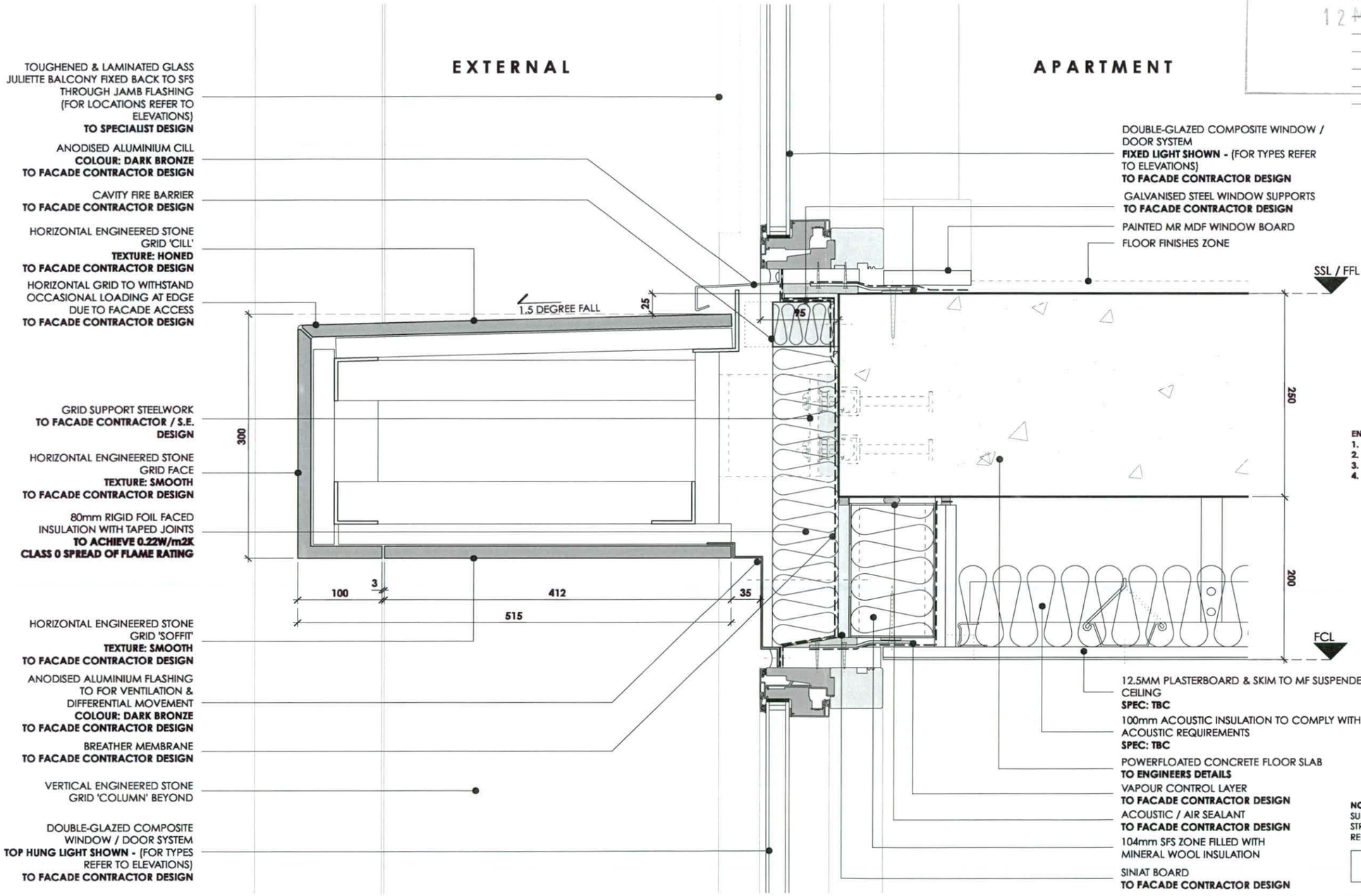
992 TOLERANCES
Installation: Refer to CWCT SSBE as previously stated.

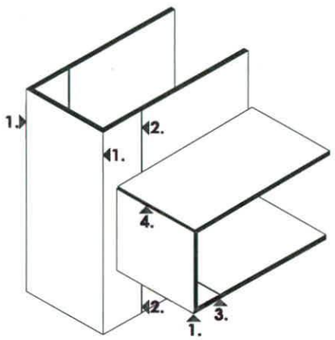
995 MAINTENANCE
- Maintenance manual: Incorporate details within the Building Manual in accordance with CWCT 'Standard for systemised building envelopes', clause 7.6.1.
- Materials certification and test reports to be included:
" Contact details for subcontractors and suppliers.
" Design criteria for the rainscreen system.
" Product information for components and materials including manufacturers literature, COSSH data sheets and recommendations for cleaning maintenance and repair.
" Copies of material, components and finishes certification and test report.
" A full set of construction drawings, updated to include any changes made up to the time of completion.
" The terms and conditions of any guarantee.
" Method statement for means of access for maintenance and for use of any permanent equipment.
" Method statement covering the procedures for replacement of parts that have a design life less than the design life of the rainscreen system.
" Recommendations for routine maintenance and cleaning, including suitable cleaning agents and lubrication/ adjustments to working parts.
" Record book for listing defects, maintenance and repairs. .

997 MANUFACTURER'S RECOMMENDATIONS
All instructions and recommendations contained in the guidelines for specification and installation published by Manufacturer must be applied.

REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY
P2	22.12.16	PRELIMINARY - ISSUED FOR COMMENT
P3	17.02.17	PRELIMINARY

PLANNING AND BUILDING CONTROL
12 MAY 2017





ENGINEERED STONE GRID JOINTS KEY (INDICATIVE 3D)
1. PRE-FORMED 'CUT & STUCK' CORNER
2. 3mm OPEN JOINT
3. 8mm OPEN JOINT
4. BIRDS BEAK JOINT WITH MASTIC SEAL

NOTE:
SUBCONTRACTOR TO COMPLETE THE DESIGN, FINALISE DETAILS TO MEET STRUCTURAL AND SAFETY REQUIREMENTS OF BS5395 AND ALL OTHER RELEVENT STANDARDS

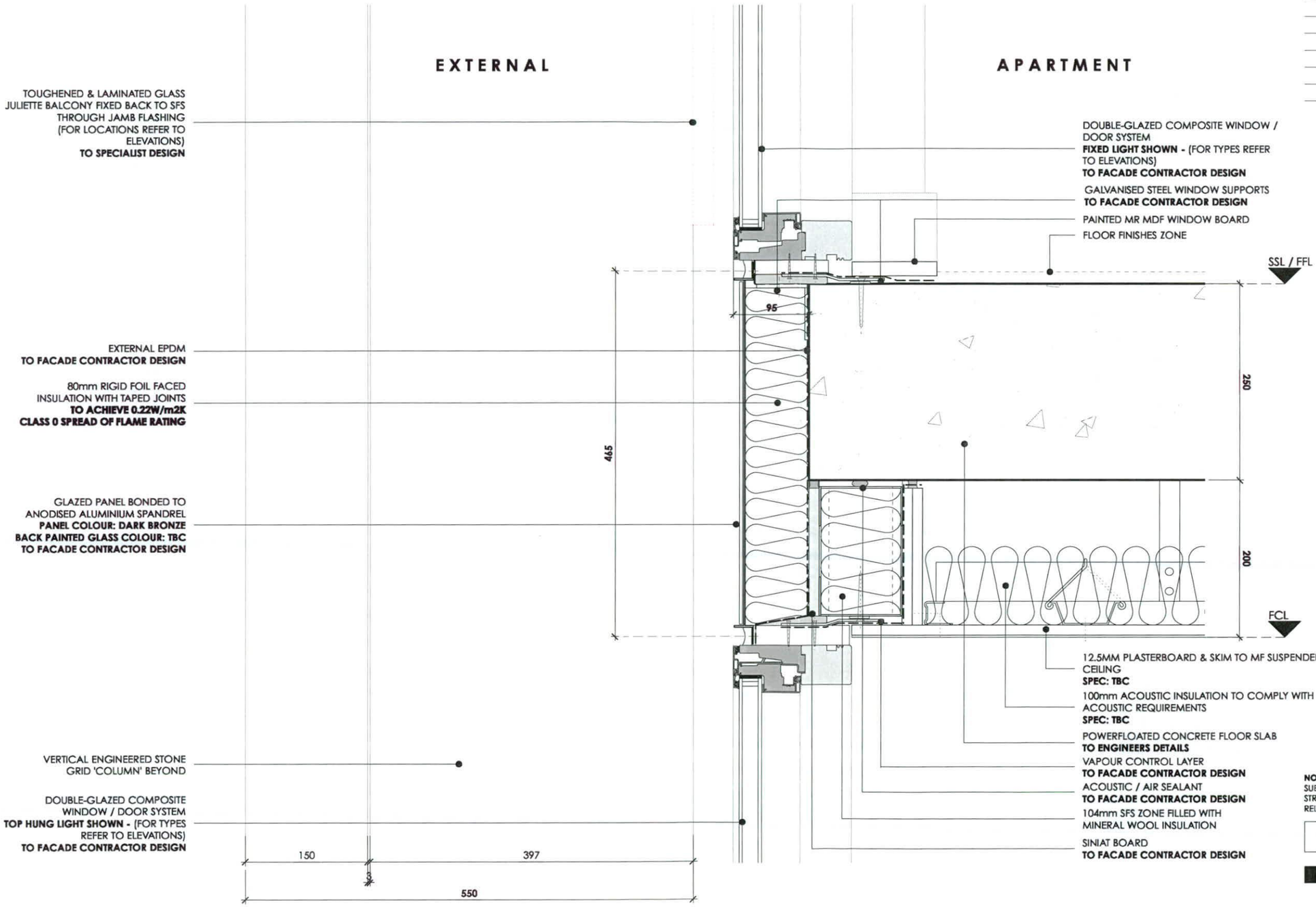
DESIGN INTENT ONLY

TYPICAL FLOOR SLAB / WINDOW JUNCTION - (AT HORIZONTAL GRID)
1:5 @ A3

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PROJECT	CHESTER ROAD				
DRAWING	TYPICAL FLOOR SLAB WINDOW JUNCTION - GRID				
DATE	NOV' 16	DRAWN BY	PE	SCALE	1:5 @ A3
JOB NO.	1370	DWG.NO.	Z1-OMI-G251-DE-XX-A2000		

REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY
P2	22.12.16	PRELIMINARY - ISSUED FOR COMMENT
P3	17.02.17	PRELIMINARY



TYPICAL FLOOR SLAB / WINDOW JUNCTION
1:5 @ A3

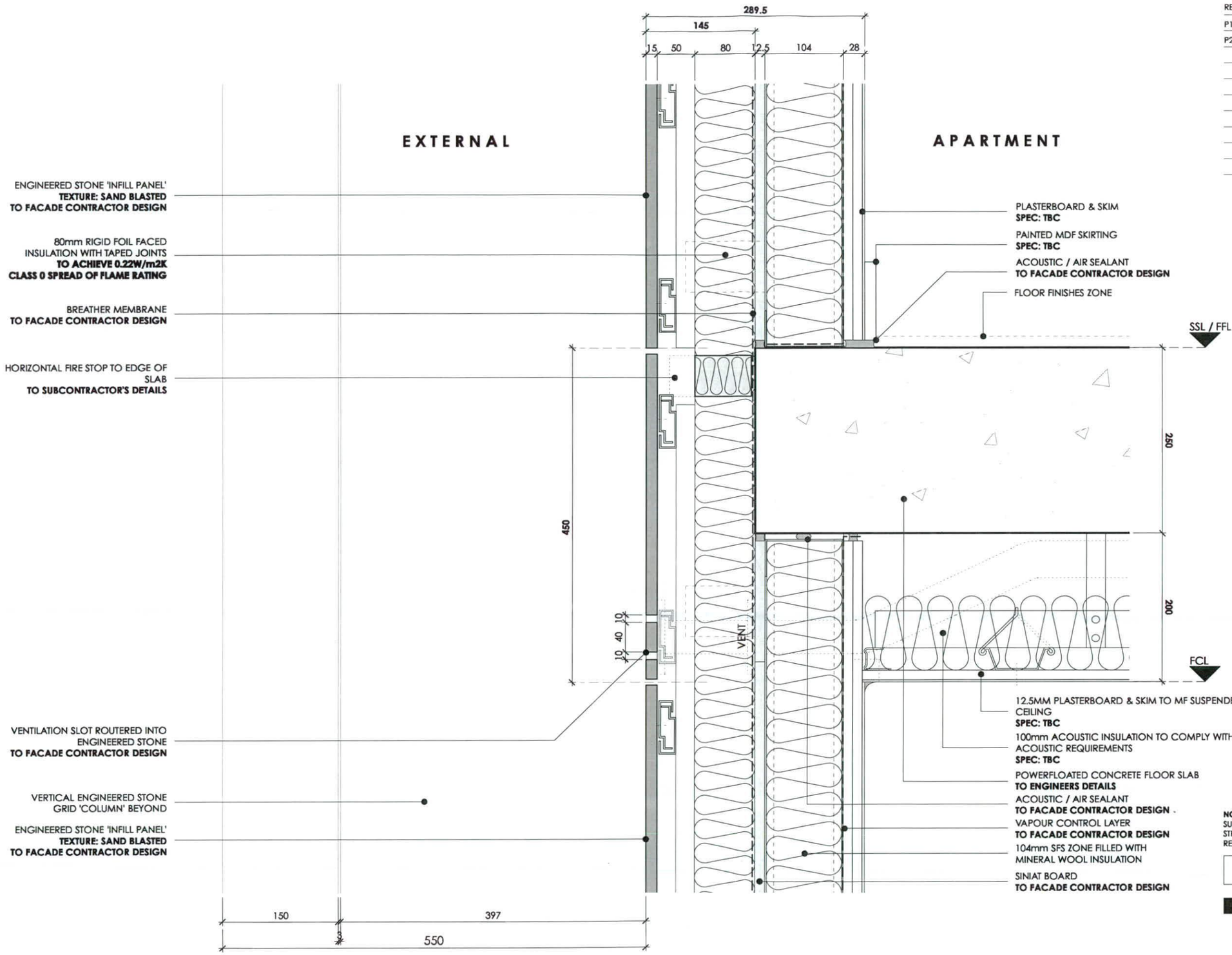
NOTE:
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PROJECT	CHESTER ROAD				
DRAWING	TYPICAL FLOOR SLAB WINDOW JUNCTION				
DATE	NOV' 16	DRAWN BY	PE	SCALE	1:5 @ A3
JOB NO.	1370	DWG.NO.	Z1-OMI-G251-DE-XX-A2002		

REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY
P2	17.02.17	PRELIMINARY



TYPICAL FLOOR SLAB JUNCTION
1:5 @ A3

NOTE:
SUBCONTRACTOR TO COMPLETE THE DESIGN, FINALISE DETAILS TO MEET STRUCTURAL AND SAFETY REQUIREMENTS OF BS5395 AND ALL OTHER RELEVENT STANDARDS

DESIGN INTENT ONLY

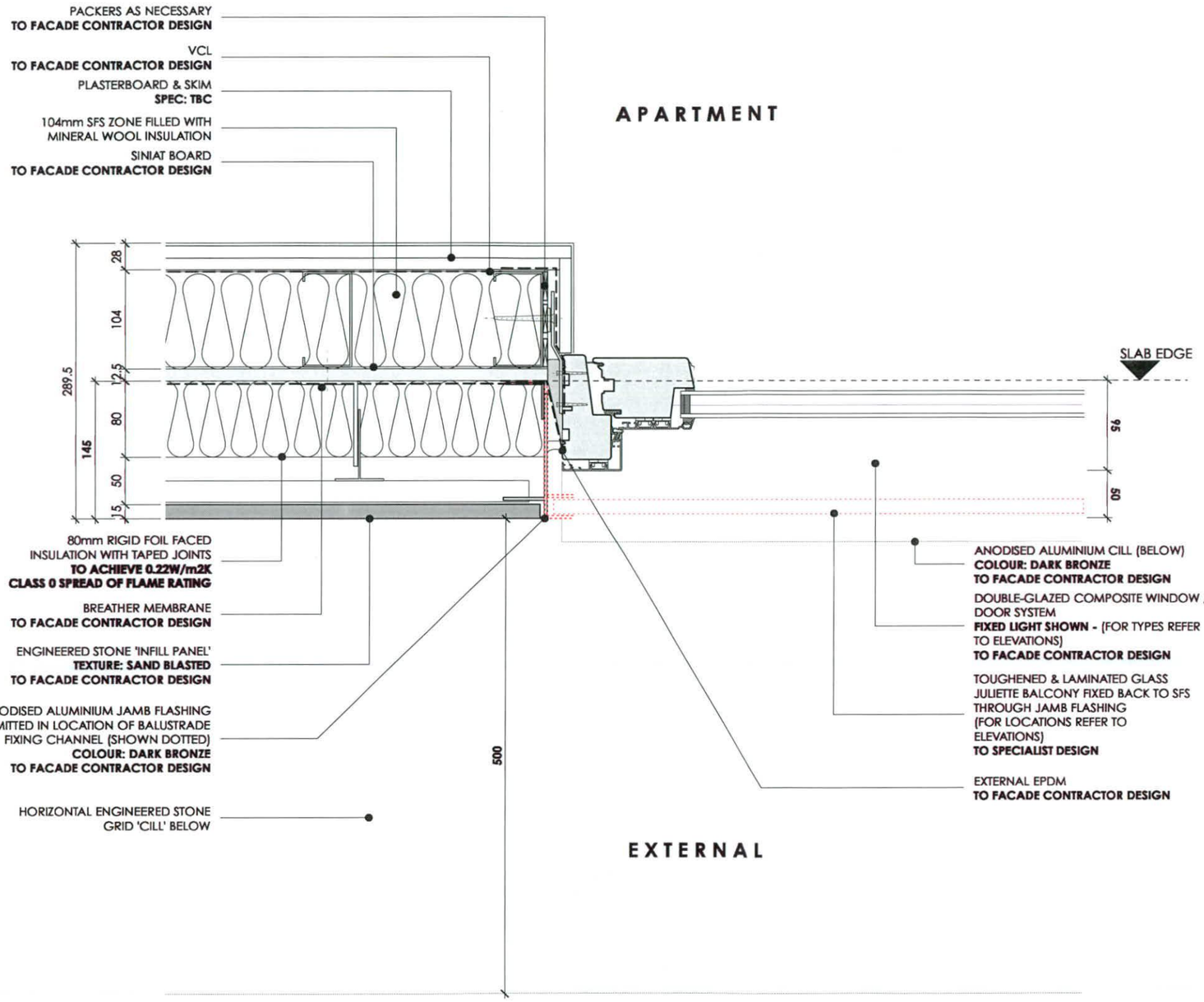
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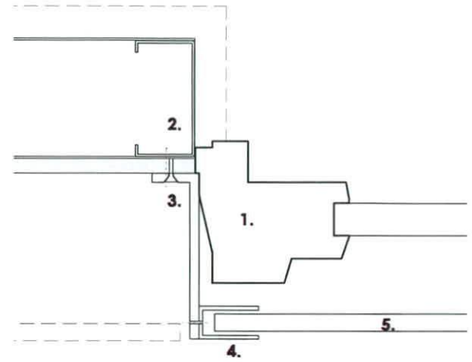
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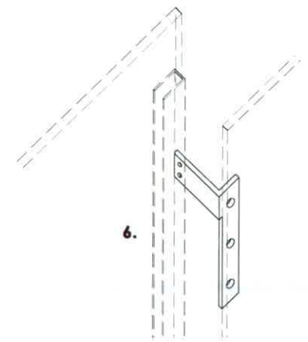
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DATE	NOV' 16	DRAWN BY	PE	SCALE	1:5 @ A3
JOB NO.	1370	DWG.NO.	Z1-OMI-G251-DE-XX-A2003		

REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY
P2	22.12.16	PRELIMINARY - ISSUED FOR COMMENT
P3	17.02.17	PRELIMINARY



TYPICAL WINDOW JAMB DETAIL
1:5 @ A3





SIMPLIFIED DETAIL AT JULIETTE BALCONY SUPPORT (& INDICATIVE 3D)
1. SIMPLIFIED WINDOW FRAME (INWARD OPENING DOOR)
2. SFS STUD
3. BALCONY BRACKET FIXED THROUGH TO STUD
4. GLASS BALCONY CLAMP (WITH FOOT AT BASE TO SUPPORT GLASS)
5. TOUGHENED & LAMINATED GLASS BALUSTRADE
6. INDICATIVE 3D LOOKING AT BRACKET FROM INSIDE

ALL BALCONIES TO BE TO SPECIALIST DESIGN TO COMPLY WITH PART K OF THE BUILDING REGULATIONS & BS6180:2011 & ALL OTHER RELEVENT STANDARDS

READ IN CONJUNCTION WITH BALCONY DRAWINGS

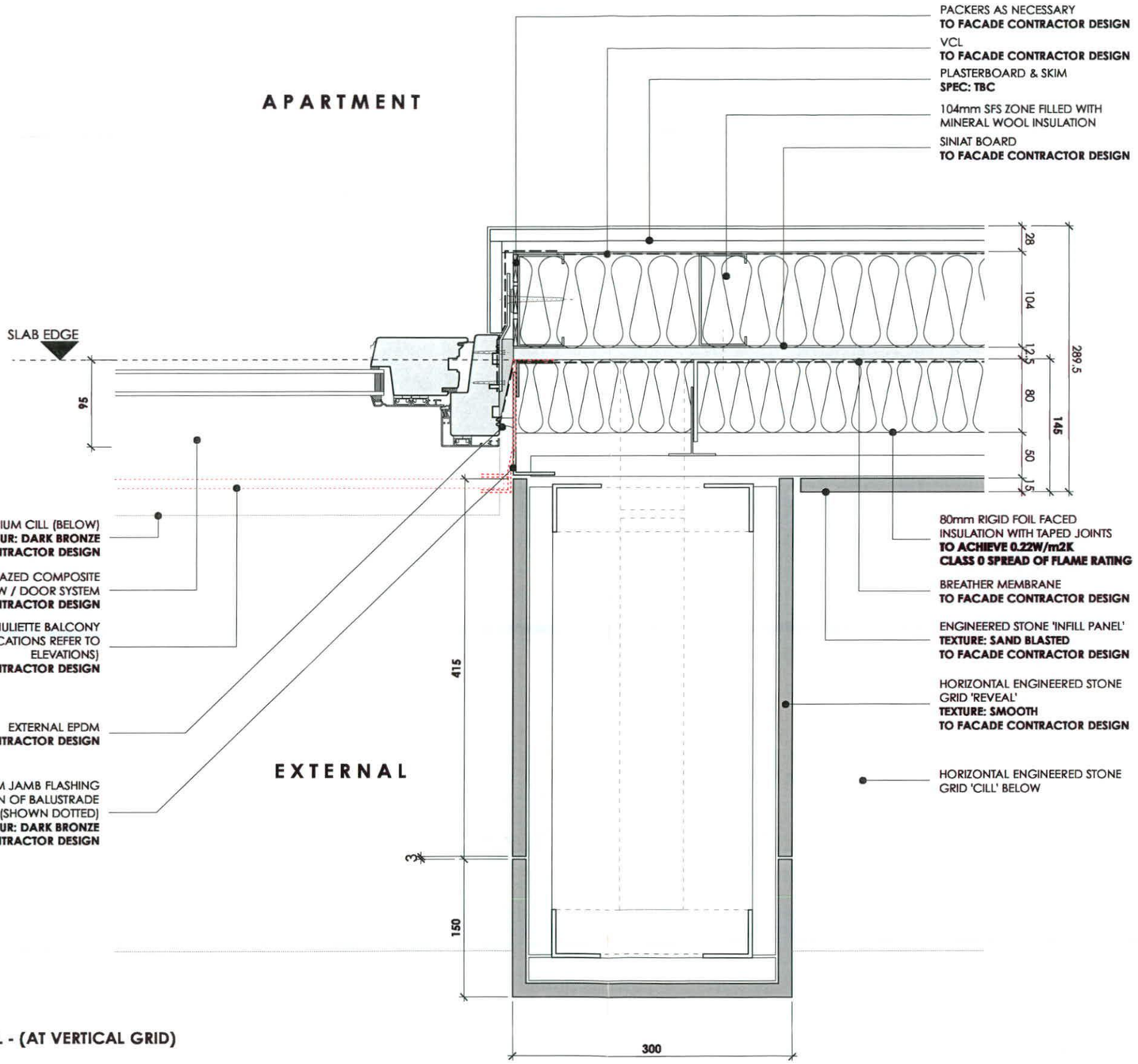
NOTE:
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DESIGN INTENT ONLY

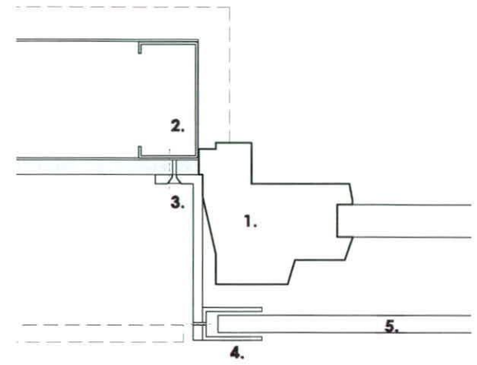
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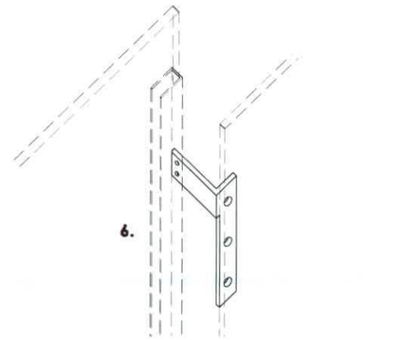
PROJECT	CHESTER ROAD				
DRAWING	TYPICAL WINDOW JAMB				
DATE	NOV' 16	DRAWN BY	PE	SCALE	1:5 @ A3
JOB NO.	1370	DWG.NO.	Z1-OMI-G251-DE-XX-A2004		

REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY
P2	17.02.17	PRELIMINARY



TYPICAL WINDOW JAMB DETAIL - (AT VERTICAL GRID)
1:5 @ A3





SIMPLIFIED DETAIL AT JULIETTE BALCONY SUPPORT (& INDICATIVE 3D)
1. SIMPLIFIED WINDOW FRAME (INWARD OPENING DOOR)
2. SFS STUD
3. BALCONY BRACKET FIXED THROUGH TO STUD
4. GLASS BALCONY CLAMP (WITH FOOT AT BASE TO SUPPORT GLASS)
5. TOUGHENED & LAMINATED GLASS BALUSTRADE
6. INDICATIVE 3D LOOKING AT BRACKET FROM INSIDE

ALL BALCONIES TO BE TO SPECIALIST DESIGN TO COMPLY WITH PART K OF THE BUILDING REGULATIONS & BS6180:2011 & ALL OTHER RELEVENT STANDARDS

READ IN CONJUNCTION WITH BALCONY DRAWINGS

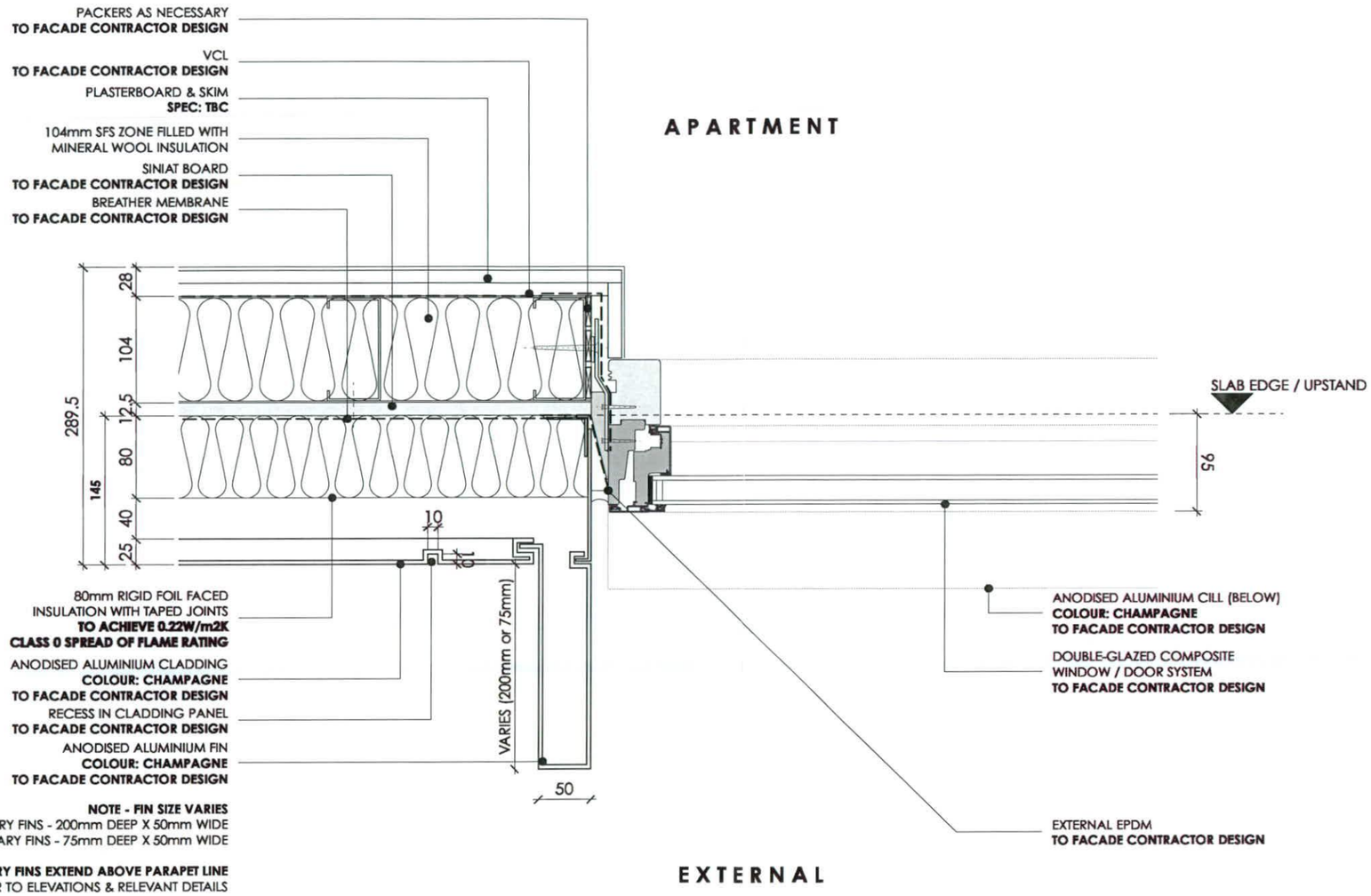
NOTE:
SUBCONTRACTOR TO COMPLETE THE DESIGN, FINALISE DETAILS TO MEET STRUCTURAL AND SAFETY REQUIREMENTS OF BS5395 AND ALL OTHER RELEVENT STANDARDS

DESIGN INTENT ONLY

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PROJECT	CHESTER ROAD				
DRAWING	TYPICAL WINDOW JAMB - GRID				
DATE	NOV' 16	DRAWN BY	PE	SCALE	1:5 @ A3
JOB NO.	1370	DWG.NO.	Z1-OMI-G251-DE-XX-A2005		

REVISION	DATE	DESCRIPTION
P1	09.12.16	PRELIMINARY
P2	17.02.17	PRELIMINARY



PENTHOUSE - TYPICAL JAMB
1:5 @ A3

NOTE:
SUBCONTRACTOR TO COMPLETE THE DESIGN, FINALISE DETAILS TO MEET STRUCTURAL AND SAFETY REQUIREMENTS OF BS5395 AND ALL OTHER RELEVENT STANDARDS

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PROJECT	CHESTER ROAD				
DRAWING	PENTHOUSE - TYPICAL JAMB DETAIL				
DATE	NOV' 16	DRAWN BY	PE	SCALE	1:5 @ A3
JOB NO.	1370	DWG.NO.	Z1-OMI-G251-DE-XX-A2425		