RIBA Stage D Acoustic Report
Manchester Metropolitan University Business School & Student Exchange

Manchester Metropolitan University
September 2008

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Acoustic Criteria

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Table of Contents

1 Executive Summary 1

2 Introduction 2

3 External Noise Survey 3
3.1 Survey Details 3
3.2 Site and Surroundings 3
3.3 Methodology 4
3.4 Survey Results 5

4 External Noise Ingress 6

5 Internal Sound Insulation 8
5.1 Airborne Sound Insulation: Walls and Floors 8
5.2 Impact Sound Insulation: Floors 13
5.3 Corridor Partitions, Glazed Screens, ventilators and Doors 13
5.4 Moveable Walls 15
5.5 Plant Rooms 15
5.6 Flanking Details 9

6 Room Acoustics 16

7 Building Services Noise 18

Appendix A: Acoustic Terminology 19

Appendix B: Full Measurement Results For Attended Measurements 21

Appendix C: Full Measurement Results For Continuous Unattended Measurements (VC Office) 23

Appendix D: Full Measurement Results For Continuous Unattended Measurements (Site) 25

1 Executive Summary

1.1 The acoustic design of the MMU Business Hub and Student Exchange has progressed to a level nearing RIBA stage D and is described within this document.

1.2 Acoustic criteria were set down based upon the performance standards of Building Bulletin 93.

1.3 An external noise survey was conducted at the site of the proposed development. External noise levels incident upon the facades of the development overlooking the Mancunian Way will be in the order of 73 dB $L_{Aeq.}$ Consequently these facades will require a sound insulation performance of approximately 43 dB $R_{w.}$

1.4 Based upon the lowest measured background noise level established during the survey and criteria agreed with Manchester City Council, plant noise limits were set down at the facades of the neighbouring residential properties.

1.5 Partition sound insulation performance requirements were set down in accordance with the criteria of BB93. The laboratory sound insulation performance requirements for each partition are provided on marked up floor plans contained in Appendix E.

1.6 Potential partition flanking pathways via the raised access floor were considered and a rationale for the platform for constructing partitions in relation to the raised access floor has been set down.

1.7 Mullions and transoms to be part of a partition system must be considered in terms of sound insulation. Unitised systems have a greater performance in terms of sound insulation as opposed to Stick systems. A mullion and transom arrangement used in partitions separating teaching spaces should have a performance of 55 dB $D_{nf,w}$.

1.8 The proposed floors are expected to meet the airborne and impact sound insulation requirements.

1.9 In lieu of a suspended ceiling within teaching spaces, acoustic absorption will be introduced to the walls in the form of either proprietary wall panels or perforated plasterboard.

1.10 The Atria will accommodate acoustic absorption on the internal walls, beneath the balconies and on the ceiling. Establishing enough absorption within this space is fundamental to the acoustic design of the project.

1.11 Partitions separating teaching rooms, offices and atria will incorporate proprietary acoustic ventilator units allowing cross ventilation between these spaces whilst maintatining the acoustic performance of the partitions. The acoustic performance of these units is set down within this document.

2 Introduction

2.1 Manchester Metropolitan University (MMU) propose to construct a new building to house the Business School and Student Exchange and the project has now reached RIBA Stage D. This document sets down the acoustic criteria, results of an environmental noise survey and outline design strategies to be adopted for the development.

2.2 Given that the development is a Higher Education building, there is no statutory requirement to comply with section E4 of Part E of the Building Regulations relating to acoustics. Although achieving the correct acoustic design for this facility is essential.

2.3 Building Bulletin 93 “Acoustic Design of Schools” (BB93) provides guidance on acoustic issues in schools such as internal noise level limits and appropriate reverberation times that should be achieved within different types of space as well as the sound insulation performances that should be achieved between different spaces. The acoustic criteria for this project have therefore been proposed based on the recommendations provided in BB93.

2.4 The current designs of the building include the measures necessary to achieve the required acoustic performance standards and are expected to be developed over the next design phases.

2.5 The acoustic terminology used in this report is explained in Appendix A.

3 External Noise Survey

An external noise survey was undertaken in order to determine the prevailing noise climate at the site. The following section provides details of the development site and surroundings, the survey methodology and survey results. Full measurement results can be found in Appendices B to D.

3.1 Survey Details

3.1.1 The survey, including both attended and unattended measurements was undertaken at the site of the proposed Manchester Metropolitan University Business School and Student Exchange on the 7th and 8th April 2008.

3.2 Site and Surroundings

3.2.1 The site of the proposed development is situated on the corner of Cambridge Street and the Mancunian Way. A plan of the site can be found in figure 2.1.

3.2.2 The dominant source of noise in the area is the Mancunian Way, which runs adjacent to the development site and is elevated to a height of approximately 10 metres. Running perpendicular to Mancunian Way along the east side of the development site is Cambridge Street which extends from a large roundabout; this provides access for traffic to and from the Mancunian way as well as the city centre. The road network around the proposed business school site can be seen following in Figure 3.1.

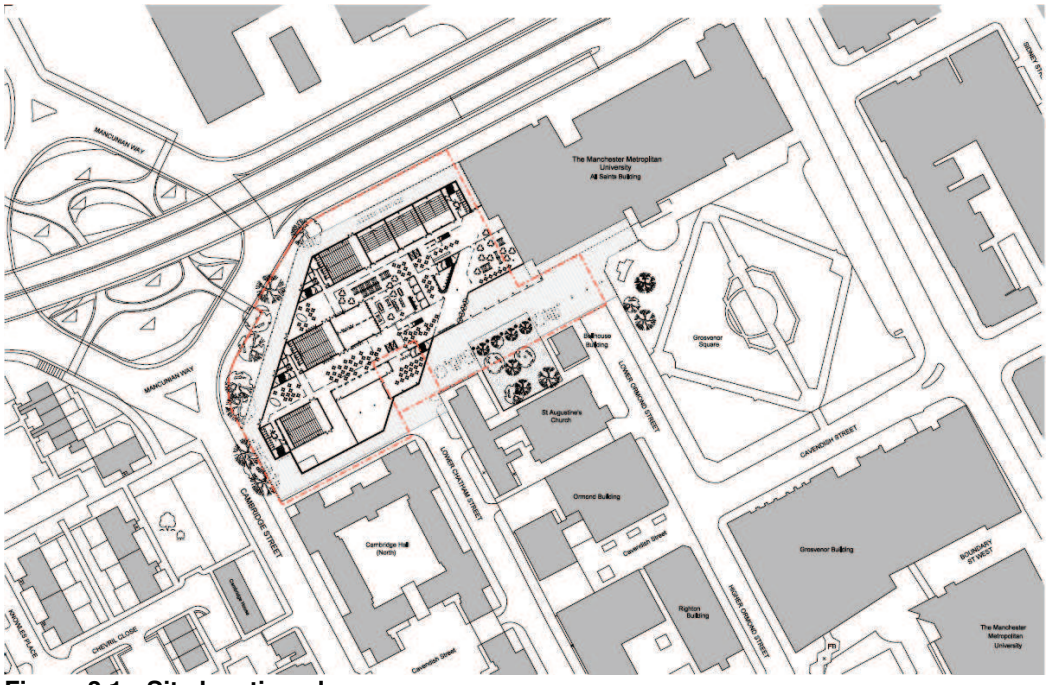


Figure 3.1: Site location plan

3.2.3 To the north of the development, beyond the Mancunian Way, is the Manchester Central Business District. This area is subject to high levels of activity in terms of traffic and pedestrian movements as well as general commercial and industrial activities.

3.2.4 The area immediately south of the development is made up predominantly of university owned developments with high levels of traffic and pedestrian movements in the area, similar to the Central Business District.

3.3 Methodology

3.3.1 Both attended and unattended measurements were made on and around the MMU development site on the 7th and 8th April 2008. Attended and unattended measurement positions are referenced in the following Figure 3.2.

3.3.2 Continuous unattended measurements were made at two separate locations throughout the duration of the survey. The first of these was from the Vice Chancellor's office situated on the fifth floor of the Manchester Metropolitan University All Saints Building. This position was chosen because it directly overlooks the Mancunian Way at a height representative of noise from both lanes of traffic (east and west travelling). Noise measurements at this position were taken between 14:00 and 17:00 in order to coincide with peak traffic movements.

3.3.3 The second continuous unattended measurement location was situated at the edge of the MMU development site close to St Augustine's Church. Continuous measurements were taken between 17:30 on the 7th April and 07:00 on the 8th April 2008. This measurement location was chosen in order ascertain the lowest background noise level ($L_{AF,90}$) throughout the evening and night time periods.

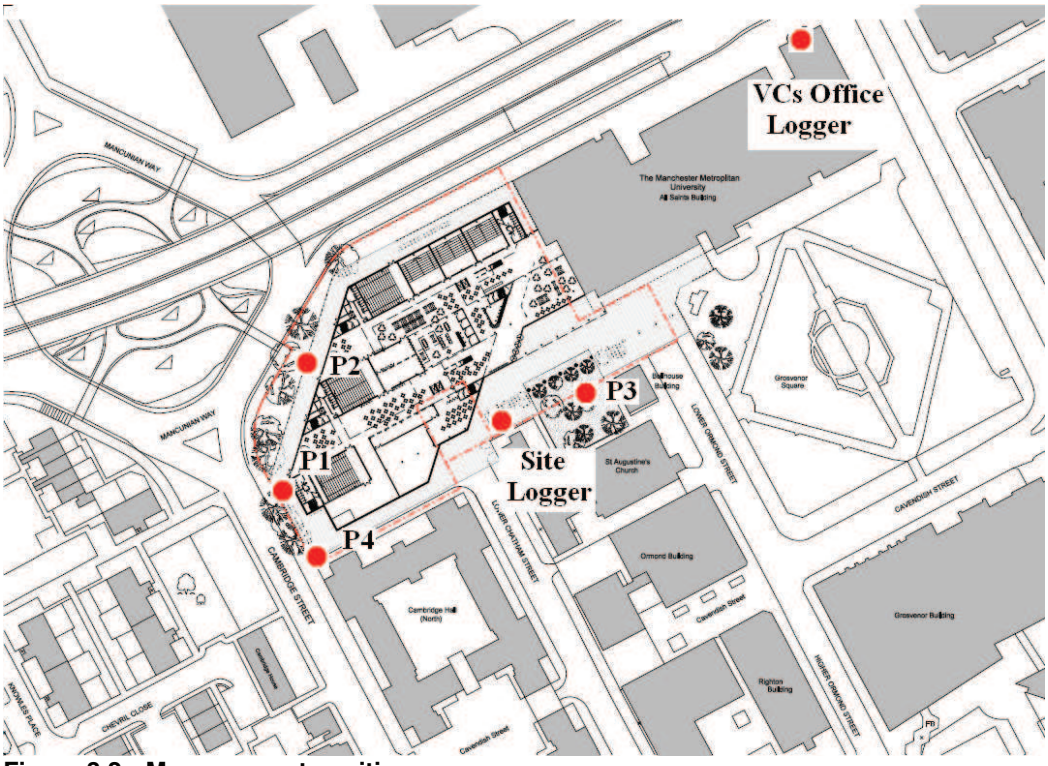


Figure 3.2: Measurement positions

3.3.4 The equipment used to carry out the external noise survey included the following:

Equipment	Description	Serial No.
NOR Type 118	Integrating-averaging Sound Level Meter	31509
NOR Type 1251	Sound Calibrator	27485
RION NA-28	Sound Level Meter	00570400
RION NA	Sound Calibrator	34973231
GRAS 41AL	Environmental Microphone	55090

Table 3.1: Equipment

3.3.5 The instrumentation was calibrated prior to and on completion of all measurement periods. The calibration was found to be correct and no significant drift occurred. The accuracy of the calibrator used can be traced to National Physical Laboratory Standards.

3.3.6 Weather conditions at the time of the survey were fair with little to no wind. There were some brief and light showers on the afternoon of the 7th April but the weather conditions are deemed to have had no significant affect on the results of the noise survey.

3.4 Survey Results

3.4.1 A summary of the attended noise measurement results are presented in the following Table 3.1.

Measurement Position	Typical $L_{Aeq,(15mins)}$	Typical $L_{AF,1\ (15mins)}$	Typical $L_{AF,90\ (15mins)}$
1 (Cambridge Street)	71 dB (14:53 – 15:08)	76 dB (14:53 – 15:08)	68 dB (14:53 – 15:08)
2 (Cambridge Street Roundabout)	71 dB (15:10 – 15:25)	75 dB (15:10 – 15:25)	69 dB (15:10 – 15:25)
3 (Courtyard by St Augustine's)	62 dB (15:35 – 15:50)	65 dB (15:35 – 15:50)	60 dB (15:35 – 15:50)
4 (Cambridge Hall)	70 dB (15:52 – 14:07)	76 dB (15:52 – 14:07)	67 dB (15:52 – 14:07)
Logger 1 (VCs Office)	78 dB (14:00 – 17:10)	81 dB (14:00 – 17:10)	75 dB (14:00 – 17:10)

Table 3.2: Typical day time noise measurements taken from both attended and unattended measurement data from the MMU development site 7th April 2008

	Minimum Evening (18:00 - 23:00) $L_{AF,90}$	Minimum Night-Time (23:00 - 06:00) $L_{AF,90}$
Logger 2 (Development Site)	53	42

Table 3.3: Minimum evening and night-time background noise measurements

3.4.2 The following graphs present the results of the continuous unattended measurements for both of the stated measurement positions. Full numerical data can be found in Appendices B, C and D respectively.

4 External Noise Ingress

4.1 The level of internal noise resulting from external noise sources is dependent upon the external noise level, the room volume and surface finishes of the internal space and the sound insulation performance of the building envelope.

4.2 BB93 gives recommended limits for indoor ambient noise levels in internal spaces resulting from external sources, including any contribution from building services both within the space and from adjacent plantrooms, etc. These levels specifically exclude noise contributions from any equipment use, rain noise or from teaching activities within the building.

4.3 To meet the internal noise level limits stated in BB93, the building envelope is required to have an adequate level of sound insulation such that ingress of external noise levels is suitably attenuated.

4.4 Table 4.1 shows the proposed criteria for internal noise levels in mechanically ventilated spaces, resulting from external noise sources. The information provided within the table is specifically related to room types which are currently understood to be included within the proposed development.

Space	Upper limit for indoor ambient noise level Limit (dB)	
	$L_{Aeq,30min}$	$L_{A1,30min}$
Lecture Theatres	35	55
General Teaching Areas Seminar Rooms Quiet Study Rooms Counselling / Medical Rooms	35	55
Open plan teaching / resource areas, Library Resource Areas, Office / Staff Room	40	n/a
Atria / Circulation Space Dining Areas	45	n/a
Toilets Kitchens	50	n/a

Table 4.1: BB93 Internal Noise Level Limits

4.5 Current proposals allow for a fully mechanically ventilated building negating the need to utilise openable façade elements to supply air to the workspaces. Given the high external noise levels the glazed curtain walling for teaching rooms facades over looking the Mancunian Way will need to achieve a sound insulation performance in the order 43 dB R_w, which could typically be achieved by a glazing arrangement of 10 mm pane / 12 mm air gap / 16 mm pane. The other facades of the development will require a less onerous glazing specification.

4.6 The façade supplier will need to demonstrate that the façade system can achieve this sound insulation requirement, in-situ. This is usually demonstrated via the manufacturer via laboratory sound insulation tests of the proposed façade arrangement. It is expected that this process will take place during the next design phase.

4.7 BB93 requires that consideration be given to the control of rain noise, even though it does not stipulate acceptable rain noise internal limits. Based on published guidance, it is recommended that rain noise during 'heavy' periods of rain (i.e. 40 mm/hr; a 50 year event) be controlled so as not to exceed the limits in Table 4.1 by more than 20 dB.

5 Internal Sound Insulation

This section of the report concentrates on the issue of sound insulation between internal spaces.

5.1 Airborne Sound Insulation: Walls and Floors

5.1.1 BB93 gives values of airborne sound insulation in terms of $D_{nT(Tmf,max),w}$ which represents the minimum weighted standardised level difference. The $D_{nT(Tmf,max),w}$ value is standardised to the maximum mid-frequency reverberation time ($T_{mf,max}$). The required $D_{nT(Tmf,max),w}$ value for each partition is derived from a classification of noise activity for a given source room and a noise tolerance for the adjacent receiver room.

5.1.2 Calculations were carried out in order to determine the required R_w (weighted sound reduction index) value for each partition to achieve the required $D_{nT(Tmf,max),w}$. The weighted sound reduction index is a laboratory measurement of the sound insulation performance of a partition and is the performance descriptor typically quoted by dry-lining and blockwork suppliers.

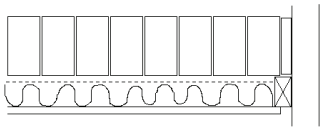
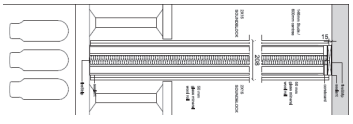
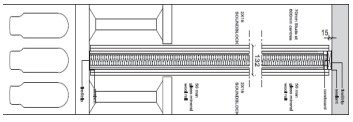
5.1.3 A set of marked-ups plans have been prepared detailing the required sound insulation performances (dB R_w) for partition walls. The marked-up plans can be found in Appendix E.

5.1.4 Table 5.1 provides a key to the colours used to represent the sound insulation performance of the various partitions.

Colour	R_w (dB)
	40
	45
	50
	55
	60
	65

Table 5.1: Colour Key to Supplied Partition Mark-ups

5.1.5 The following constructions have been proposed in order to achieve the required sound insulation performances.

Laboratory Performance (dB R_w)	Proposed Partition	Partition Description
67		230 mm blockwork with 15 mm plasterboard on 48 mm metal stud with 5 mm air gap and 50 mm cavity insulation.
60		**A206A243** = 2 layers of 15 mm SoundBlock either side of a 146 mm stud at 600 mm centres with a layer of 50 mm insulation within the cavity
56		**A206231** = 2 layers of 15mm SoundBlock either side of a 70 mm stud at 600 mm centres with a layer of 50 mm insulation within the cavity

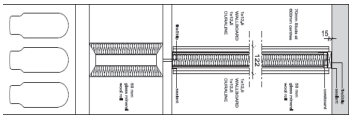
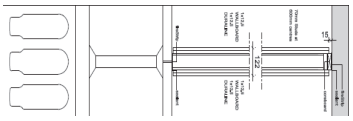
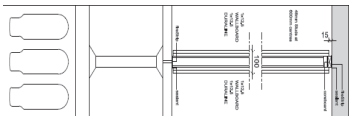
50		**A206142** = 1 layer of 12.5 mm Wallboard with 1 layer 12.5 mm Duraline either side of a 70 mm stud at 600 mm centres with 50 mm of insulation within the cavity
45		**A206015** = 1 layer of 12.5 mm Wallboard with 1 layer 12.5 mm Duraline either side of a 70 mm stud at 600 mm centres
42		**A206003** = 1 layer of 12.5 mm Wallboard with 1 layer 12.5 mm Duraline either side of a 48 mm stud at 600 mm centres

Table 5.2: Proposed Construction Details for

5.2 Flanking Details

5.2.1 It is understood that a raised access floor system is currently proposed. If the partitions are built upon the raised access floor, sound will flank through this floor element and limit the overall sound insulation of the partition system to approximately 40 dB $D_{nT(Tmf,max),w}$ irrespective of the partition specification. To minimise such flanking, the placement of cavity barriers and partition construction requirements should follow the following rationale:

Partition Sound Insulation Requirement (dB R_w)	Construction/Cavity Barrier Requirement
40 – 45	Partitions constructed from raised access floor level but floor must be broken along the partition line, i.e. the floor must not bridge the two rooms that the partition is separating. No cavity barrier required
46 – 50	Partitions constructed from raised access floor level but floor must be broken along the partition line, i.e. the floor must not bridge the two rooms that the partition is separating. In addition a proprietary cavity barrier must be installed beneath the partition within the floor void
51+	Partitions should be constructed from structural slab to structural soffit and incorporate suitable deflection details.

Table 5.3: Construction Requirements for Partitions on Raised Access Floor

5.2.2 Given the glazed curtain walling making up the majority of the building envelope, consideration must be given to the mullions which connect the internal partitions to the glazed façade. These connecting elements can allow excessive transfer of sound between rooms; as such an acoustically effective mullion design will be required. Typically a mullion connected to a partition separating teaching spaces should achieve a sound insulation performance of 55 dB $D_{nf,w}$.

5.2.3 Where high performance partitions separating teaching spaces and the like meet lower performance corridor walls, it is important that the inner leaf of the corridor wall is broken in order to avoid flanking transmission. An example of a detail that could be adopted with the use of lightweight partitions in this situation is presented in Figure 5.1.

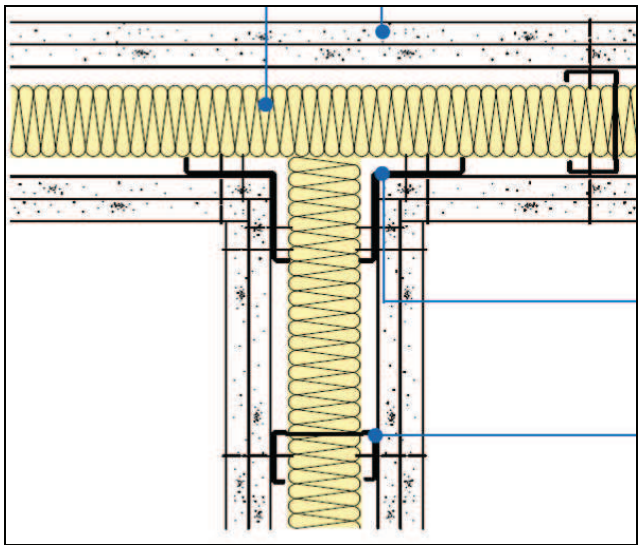


Figure 5.1: T' junction detail where acoustic performance is required of crosswall

5.2.4 This principle of breaking the plasterboard or 'tapering in', should also be maintained where partitions abut the inner leaves of external walls.

5.2.5 Where partitions are required to allow for deflection, an acoustic deflection head detail is required in order that the sound insulation performance of the partition is not undermined. Figure 5.2 presents an example of the acoustic deflection head detail that has been deemed appropriate. This detail should be applied to partition walls with a required sound insulation performance of 50 dB R_w and above, not including blockwork partitions where a separate acoustic deflection head detail has been recommended and can be seen in Figure 5.3.

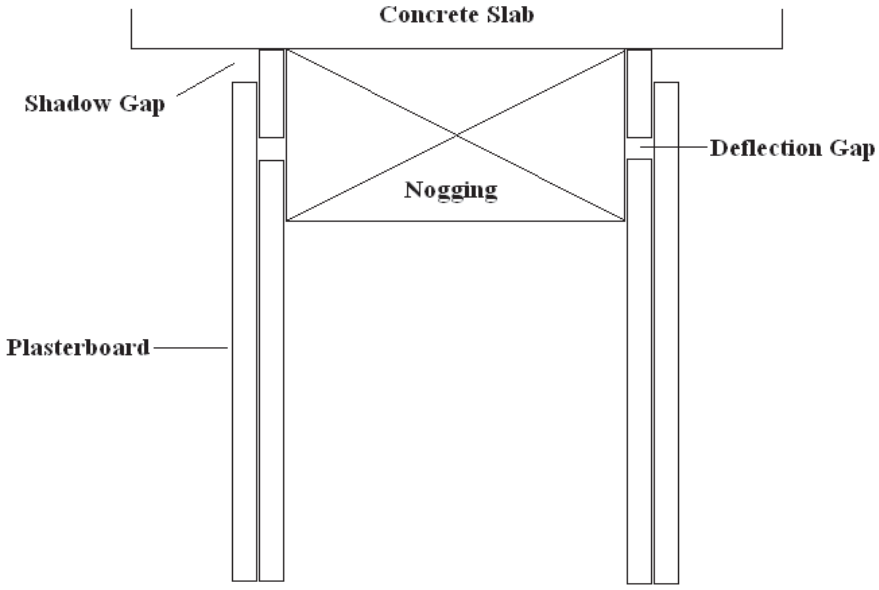


Figure 5.2: Example of Acoustic Deflection Head Detail

5.2.6 It is understood that for partitions requiring a sound insulation performance of 65 dB R_w, a blockwork construction with additional dry lining has been adopted. The recommended acoustic deflection head detail for this construction can be seen in Figure 5.3.

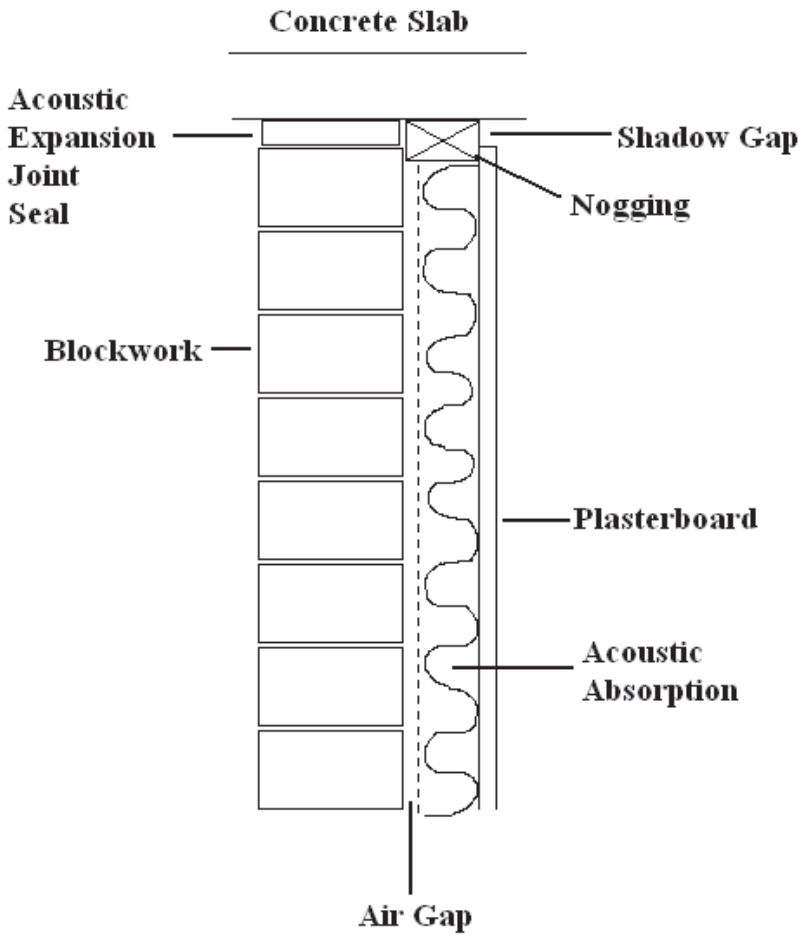


Figure 5.3: Example of Acoustic Deflection Head Detail for Blockwork Partition

5.2.7 Given that, in most areas, it is proposed to utilise exposed concrete soffits, there will be no ceilings to provide additional protection against flanking transmission, which makes this element of the design critical. The development of a suitable defection head detail is likely to be a significant challenge.

5.3 Partitions Separating Teaching Spaces and Atria

5.3.1 For partitions separating seminar rooms and atrium spaces the construction detailed in Figure 5.4 has been proposed.

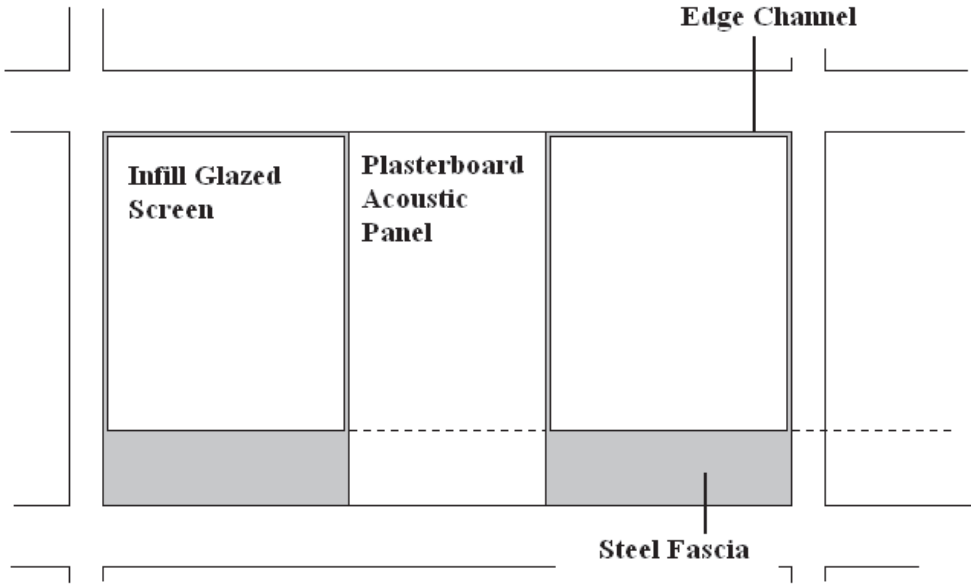


Figure 5.4: Detail of Proposed Partition Separating Seminar Rooms and Atrium Spaces

5.3.2 The required sound insulation performance for the partition detailed above is 50 dB R_w. However, it is understood that the infill glazing element will only achieve a sound insulation performance of 43 dB R_w. It has been agreed that a sound insulation performance of 43 dB R_w for the glazing element would be acceptable provided that dry lining element still achieved a performance of 50 dB R_w.

5.4 Impact Sound Insulation: Floors

5.4.1 For floors, in addition to the airborne sound insulation requirements, the finished floor construction must also provide sufficient impact sound insulation. Impact sound is typically generated by footfall or the scraping of table or chair legs against the floor.

5.4.2 Impact sound insulation is stated in terms of the in-situ impact sound pressure level, dB $L'_{nT(Tmf,max),w}$, which is measured in and is dependent on the characteristics of the room below the floor in question. It is preferable that the $L'_{nT(Tmf,max),w}$ is kept as low as possible.

5.4.3 To insulate against impact sound transmission from a room to the room below, it is necessary to introduce a resilient element into the floor build-up. This may be achieved by the raised access floor as proposed.

5.4.4 Table 5.4 sets down the maximum impact sound pressure level for the different room types expected to occur within the proposed development:-

Type of room	Maximum Weighted Standardised Impact Sound Pressure Level $L'_{nT(Tmf,max),w}$, (dB)
Large Lecture Theatres (>50 people)	55
Small Lecture Theatres (<50 people) General Teaching Rooms Seminar / Study Rooms Audio-visual Rooms Interviewing/Counselling/Medical Room Multi-Faith Room	60
Office / Staff Room Atria, circulation spaces Toilets Kitchens	65

Table 5.4: BB93 Performance Standards for Impact Sound Insulation of Floors

5.5 Corridor Partitions, Glazed Screens, ventilators and Doors

5.5.1 Where partitions separating teaching areas and atria include a doorset, the sound insulation performance of that partition is capped at a value of 40 dB R_w for general teaching rooms and 45dB R_w for lecture theatres. In these circumstances the doorset provides the weakest acoustic element of the partition system which will limit the achievable in situ acoustic performance of a high specification partition.

5.5.2 Doors in corridor walls to teaching/office spaces should achieve the sound insulation performance as stated in the following table:

Doorset Sound Insulation Requirement (dB R_w)	Where Required
25	Office spaces
30	General teaching areas and meeting rooms
35	All lecture theatres and noise sensitive spaces

Table 5.5: Doorset Sound Insulation Requirements

5.5.3 It is proposed to exhaust air from the classrooms into the atria via apertures situated within part of the wall separating the teaching / academic room and atrium. Current proposals incorporate a 'Quiet-Vent' periscope ventilation system. The proposed design detail can be found in Figure 5.6.

5.5.4 Up to three periscope ventilation units will be incorporated in to the partition separating the atria and the teaching rooms / offices. The lecture theatres on the ground floor will have alternative means of ventilation and will incorporate ventilation units such as these within the partition wall separating the theatre and adjacent atria.

5.5.5 The sound insulation performance of the 'Quiet-Vent' periscope ventilation unit can be seen in Table 5.6.

	Octave Band Centre Frequency							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
D_{ne} dB	23	32	35	41	51	57	58	50

Table 5.6: Sound Insulation Performance of 'Quiet-Vent' Periscope Ventilation System

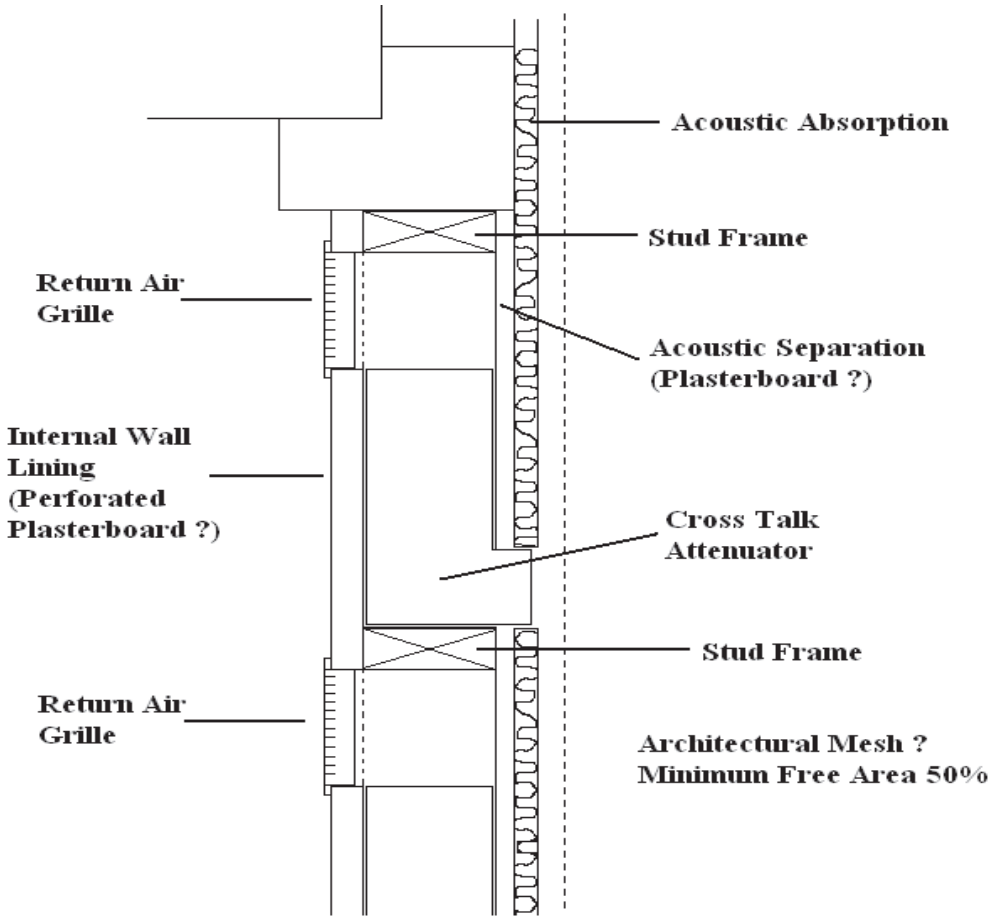


Figure 5.6: Section Detailing Proposed Periscope Ventilation Unit

5.6 Moveable Walls

5.6.1 The on-site sound insulation performance of moveable walls is usually significantly lower than that of fixed walls with similar laboratory performances. The maximum laboratory performance generally available for moveable walls is 59 dB R_w, but this is unlikely to achieve the required in-situ sound insulation performance due to the complexity of detailing of these constructions.

5.6.2 It must also be appreciated that general wear and tear usually reduces the sound insulation performance of the moveable wall over time.

5.7 Plant Rooms

5.7.1 The sound insulation between a plant room and an adjacent space needs to be such that the performance standards are met for indoor ambient noise level in the adjacent space. Since the sound insulation is calculated using the noise levels of the actual equipment within the plant room, the final selection of the separating element between a plant room and the adjacent space will need to be made when details of the noise levels of the equipment to be located within the plant room are confirmed.

6 Room Acoustics

This section of the report presents the design proposals currently in place for the purpose of achieving the required reverberation times within the different spaces of the building, which can be seen within the following table:

Room / Space	Reverberation Time (T60)
Lecture Theatres	1.0
Seminar Rooms	0.8
Atria	1.5
Offices	1.0

Table 6.1 Reverberation Time Requirements

6.1 Control of Reverberation in the Atrium Spaces

6.1.1 The control of reverberation time in the atria will be a significant challenge for this project. It will be necessary to utilise large areas of acoustically absorbent surface finishes within the atria including balustrades, slab edges, walls and possibly suspended fins or other features.

6.1.2 A design scheme has been agreed for the control of reverberation time in the Student Exchange and Business School atria. This scheme aims to achieve a reverberation time of < 1.5 seconds (T_{mf}) via the application of absorptive panelling and tiles to surfaces throughout the respective atria. Acoustic modelling software has been used to predict the acoustic characteristics of the atrium spaces and to derive a strategy for the application of absorptive materials for the control of reverberation.

6.1.3 It has been agreed that acoustic absorption should be applied to the following surfaces, the details of which have been derived from the stage C amendment L drawings:

Description	Business School Atrium Approximate Area (m^2)	Student Exchange Atrium Approximate Area (m^2)
Partition walls separating lecture theatres and atrium spaces	250 m²	180 m²
Concrete soffit underlining for atrium walkways and social platforms*	590 m²	1180 m²
Dry lining element of glazed partitions separating seminar rooms and atrium spaces	207 m²	228 m²
Dry lining element included in ceiling construction	360 m²	360 m²

Table 6.2: Example of Acoustic Deflection Head Detail

6.1.4 The dry lining element seen in the partitions separating seminar rooms and atrium spaces (Figure 5.6) shall be perforated plasterboard with a mineral wool backing. This detail, especially in the case of the lower levels should demonstrate a rating of NRC ≥ 0.7.

6.1.5 For the soffits of the atria walkways and social platforms a standard glass/mineral fibre ceiling tile has been proposed which is to be hung from the concrete slab. The ceiling tile should have a rating of NRC ≥ 0.9.

6.1.6 It is expected that large numbers of people will congregate in and around the social and dining areas on the lower levels of the respective atria. This localisation of sound energy means that the application of absorptive materials in these areas will be critical. It may be feasible to facilitate a reduction in the required NRC rating of acoustically active surfaces applied to the higher levels of the respective atria.

6.2 Control of Reverberation in Lecture Theatres

6.2.1 It is understood that the ceiling area of the lecture theatres is largely unavailable for application of absorptive panels. It is therefore recommended that the back wall of lecture theatres should consist of absorptive panels with additional panels placed upon the side walls of each theatre. The absorption performance of the panels should be no less than NRC 0.8. The following surface areas of absorptive material should be located in the following sized lecture theatres:

Lecture Theatre Floor Area m²	Surface Area Of Acoustic Panels m²
105	53
140	82
210	188
115 (MBA Lecture Theatre)	≈ 53

Table 6.3: Lecture Theatre Absorption Requirements

6.2.2 The above surface areas of acoustic panels have been calculated with consideration of the other internal wall, floor and ceiling finishes which contribute towards the overall reverberation time.

6.2.3 No specific information has been provided for the MBA lecture theatre regarding the surface areas available for treatment with absorptive materials. An indicative value of the required surface area has been provided in Table 6.3. As with the other lecture theatres it is recommended that the back wall of the MBA lecture theatre consists of absorptive panels with additional panels on the side walls. These panels should demonstrate a performance of no less than NRC 0.8.

6.3 Control of Reverberation in Seminar Rooms

Within seminar rooms proposals are in place to install acoustic panels on the walls. The absorption performance of the acoustic panels should be no less than NRC 0.8 and the following areas of panels should be located within the different seminar room sizes:

Seminar Room Floor Area m²	Surface Area Of Acoustic Panels m²
68	35
83	37
102	40
110 – 113	47

Table 6.4: Seminar Room Absorption Requirements

6.4 Control of Reverberation in Offices and Stairwells

6.4.1 In the case of office spaces it has been recommended that the control of reverberation should be achieved with the application of absorptive tiles which should cover 40% the ceiling area in question. The tile should exhibit an rating of NRC ≥ 0.8. Some of the offices will also incorporate the sections of partition wall exhibiting perforated sections which could form part of the 40 % target.

6.4.2 Within corridors, entrance halls and stairwells, the BB93 requirement is to provide additional absorption calculated according to Approved Document E of the Building Regulations. This describes two calculation methods, A and B. Method A requires that an area equal to or greater than the floor area be treated with a Class C absorber (or better) for corridors. However, this is only relevant to enclosed corridors and not circulation areas included within atria.

7 Building Services Noise

7.1.1 Noise from external building services equipment has the potential to cause nuisance or give rise to complaints. Further to preliminary discussions with Manchester City Council Environmental Health, it has been established that noise from the development should be assessed in accordance with BS4142 1997 'Method for rating industrial noise affecting mixed residential and industrial areas'.

7.1.2 BS 4142 provides guidance on the assessment of the likelihood of complaints relating to noise from building services equipment. The standard presents a method of rating noise levels by comparing the noise level of the new source (the Rating Level) with that of the existing background noise level in the area in the absence of the building services noise (the Background Noise Level).

7.1.3 The rating method according to BS 4142 accounts for unusual acoustic features such as a whine, hiss, impulsive or irregular noise by the addition of a single 5 dB correction to the Specific Noise Level. The corrected Specific Noise Level is the Rating Level.

7.1.4 Manchester City Council are likely to set a Planning Condition relating to the control of noise from external items of building services plant. At this stage it is not known what will be required by the Planners.

7.1.5 Notwithstanding the Local Authority's requirements, it must also be considered that there is the potential that neighbours may take direct noise nuisance action under the provisions of the Environmental Protection Act 1990, if they believe they have been subjected to noise nuisance.

7.1.6 During discussions it was established that normally the Council specify that the rating level from building services should be no less than 5 dB below the lowest background noise level, measured in dB L_{AF90}, during plant operation at any noise sensitive facade. Considering the on site measured noise levels taken during the evening and night time period, the following noise limits are appropriate.

	Evening (18:00 - 23:00)	**Night-Time (23:00 - 07:00)**
BS4142 Rating Level noise limit from plant items at façade of the nearest residential properties	48	37

Table 7.1: Noise limits for plant items at the nearby residences

7.1.7 The above noise limits should be considered indicative at this stage, until the criterion can be confirmed by Manchester City Council.

Appendix A: Acoustic Terminology

An explanation of the specific acoustic terminology referred to within this report is provided below.

dB — Sound levels from any source can be measured in frequency bands in order to provide detailed information about the spectral content of the noise i.e. whether is it high pitched, low pitched or with no distinct tonal character. These measurements are usually undertaken in octave or 1/3 octave frequency bands. If these values are logarithmically summed a single dB figure is obtained. This is usually not very helpful as it simply describes the total amount of acoustic energy measured and does not take any account of the ear's ability to hear certain frequencies more readily than others.

dBL_A — Instead, the dBL_A figure is used, as this is found to relate better to the loudness of the sound heard. The dBL_A figure is obtained by subtracting an appropriate correction, which represents the variation in the ear's ability to hear different frequencies, from the individual octave or 1/3 octave band values, before logarithmically summing them. As a result the single dBL_A value provides a good representation of how loud a sound is.

L_{Aeq} — As almost all sounds vary or fluctuate with time it is helpful instead of having an instantaneous value to describe the noise event, to have an average of the total acoustic energy experienced over its duration. The $L_{Aeq,\ 07:00\text{-}19:00}$ for example, describes the equivalent continuous noise level over the 12 hour period between 7am and 7pm. During this time period the L_{pA} at any particular time is likely to have been either greater or lower than the $L_{Aeq,\ 07:00\text{-}19:00}$

L_{Amax} — The L_{Amax} is the loudest instantaneous noise level. This is usually the loudest 125 milliseconds measured during any given period of time.

L_{An} — Another method of describing with a single value a noise level which varies over a given time period, is instead of considering the average amount of acoustic energy, to consider the length of time for which a particular noise level is exceeded. If a level of x dB(A) is exceed for say 6 minutes within one hour, that level can be described as being exceeded for 10% of the measurement period. This is denoted as the $L_{A10,1hr}$ = x dB.

The L_{A10} index is often used to describe road traffic noise whilst the L_{A90}, the noise level exceeded for 90% of the time, is the usual descriptor of the underlying background noise. L_{A1} in addition to L_{Amax} are common descriptors of construction noise.

D — The sound insulation performance of a construction is a function of the difference in noise level either side of the construction in the presence of a loud noise source to one side. *D*, is therefore simply the *level difference* between the two rooms of interest.

D_w — D_w is the *weighted level difference.* The *level difference* is determined as above, but weighted in accordance with the procedures set down in BS EN ISO 717-1.

R — *R* is the *sound reduction index* of a material or construction measured under laboratory conditions in accordance with BS EN ISO 140-3. *R* differs from *D* in that it takes account of the area of the construction under test as well as the absorption in the receiving room, both of these factors influence the measured *D*. Taking into account these factors allows the *R* for different constructions to be compared on a like for like basis.

R_w — R_w is the *weighted sound reduction index* determined using the above measurement procedure, but weighted in accordance with the procedures set down in BS EN ISO

717-1. Partitioning and building board manufacturers commonly use this index to describe the inherent sound insulation performance of their products.

R' — *R'* is the *apparent sound reduction index* of a material or construction. The *R'* is used when either the laboratory does not have fully isolated measurement chambers or in-situ when there is the potential for flanking via other routes around the construction. Measurements are made in accordance with BS EN ISO 140-4.

R'_w — R'_w is the *weighted apparent sound reduction* index determined using the above measurement procedure, but weighted in accordance with BS EN ISO 717-1.

D_{nT} — There are occasions when neither *D* alone or *R'* are the most appropriate descriptors for in situ measurements. An alternative is the D_{nT} the *standardised level difference*, which is *D* corrected to allow for the reverberation time within the receiving room. Measurements are made in accordance with BS EN ISO 140-4.

D_{nTw} — D_{nTw} is the *weighted standardised level difference* determined using the above measurement procedure, but weighted in accordance with BS EN ISO 717-1.

L_n — This is the *normalised impact sound pressure level* determined using the evaluation method described in BS EN ISO 140-6. The value is a measure of the performance of a floor system and its ability to attenuate foot fall or impact noise under laboratory conditions. The lower the L_n the better the impact isolation achieved.

L'_{nT} — This is the *normalised impact sound pressure level* determined using the evaluation method described in BS EN ISO 140-7. The value is a measure of the performance of an *in situ* floor system and its ability to attenuate foot fall or impact noise. The value takes into account the quantity of acoustic absorption within the receiving room. The lower the L'_{nT} the better the impact isolation achieved.

$L'_{nT,w}$ — This is the *normalised weighted impact sound pressure level* determined using the method described above and rated in accordance with BS EN ISO 717-2.

RT — The *Reverberation Time* (RT) is a the length of time in seconds it would take for a sound to decay by 60dB and it is therefore a measure of the echo within the room. This reverberation time is often referred to as the T_{60} however it is often impractical to measure such a 60dB noise level decay and so the reverberation time is often based upon the T_{20} or T_{30} which relate to the decay over 20dB or 30dB normalised to a decay of 60dB. Measurements of the reverberation time are usually undertaken in accordance with BS EN 354.

NRC — The *Noise Reduction Coefficient* is the arithmetic average of the coefficient α of a material in the four octave frequency bands from 250-2000Hz. It is a convenient way of describing the absorption performance without defining α in each frequency band.

D_{ne} — The D_{ne} is the normalised level difference of a building element, commonly used to describe the sound insulation performance of trickle ventilators. The level difference is established within a laboratory and normalised to a reference area of absorption which is $10m^2$.

Appendix B: Full Measurement Results For Attended Measurements

Position 1 Measurement 1	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	67.5	71.1	75.9	68.3	64.8	63.2	65.9	60.5	53.6	45.5	37.0
$L_{ZF,max}$	82.7	81.6	93.2	75.8	71.1	70.6	71.9	68.9	61.9	54.3	48.9
$L_{ZF,min}$	54.8	60.0	61.5	58.9	58.0	56.0	61.4	53.0	40.5	31.6	26.3
$L_{ZF,1}$	77.3	79.5	85.5	76.2	70.9	69.3	70.3	66.8	62.3	56.5	49.4
$L_{ZF,10}$	70.6	74.6	79.2	71.5	67.5	65.6	68.1	62.9	54.4	46.9	37.2
$L_{ZF,90}$	55.8	61.9	66.3	61.5	60.2	59.3	63.0	56.6	43.6	29.0	16.0
$L_{ZF,99}$	49.1	57.0	61.2	58.0	57.5	57.1	61.2	54.8	41.4	25.0	14.5

Table B1: Full unweighted measurement data for position 1, measurement 1 7th April 2008

Position 1 Measurement 2	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	67.0	71.3	76.1	68.9	66.2	64.9	67.8	63.3	55.9	48.7	42.5
$L_{ZF,max}$	80.8	86.4	82.4	76.2	78.5	75.1	72.6	72.0	68.0	61.5	51.7
$L_{ZF,min}$	46.7	55.3	63.5	56.7	54.2	55.3	59.1	54.7	43.5	31.4	19.1
$L_{ZF,1}$	77.7	80.6	84.6	77.4	73.0	71.5	72.7	69.1	64.9	59.4	53.5
$L_{ZF,10}$	69.6	74.8	79.7	72.2	68.9	67.5	70.0	65.8	58.9	52.3	42.9
$L_{ZF,90}$	55.1	62.2	67.3	62.2	61.5	60.6	64.7	59.3	48.4	35.8	19.7
$L_{ZF,99}$	48.1	57.2	61.8	58.5	58.7	58.2	62.8	57.3	45.7	31.8	15.8

Table B2: Full unweighted measurement data for position 1, measurement 2 7th April 2008

Position 1 Measurement 3	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	65.4	74.0	77.3	73.7	67.4	65.0	66.7	62.4	54.1	48.1	49.3
$L_{ZF,max}$	67.0	74.2	90.0	102.4	88.2	78.5	71.7	71.5	67.6	63.8	56.2
$L_{ZF,min}$	54.4	63.5	59.9	57.3	56.5	56.3	60.1	56.6	44.0	28.7	14.0
$L_{ZF,1}$	74.5	82.4	86.4	81.2	76.4	73.2	72.3	69.2	63.0	59.9	57.0
$L_{ZF,10}$	68.6	77.8	80.6	73.9	69.2	67.0	69.1	64.9	56.6	49.9	42.3
$L_{ZF,90}$	54.7	65.1	68.5	63.2	61.2	59.5	62.5	57.8	47.1	35.6	21.9
$L_{ZF,99}$	48.1	60.1	63.2	59.4	58.3	56.9	60.4	55.3	44.1	30.7	15.8

Table B3: Full unweighted measurement data for position 1, measurement 3 7th April 2008

Position 2 Measurement 1	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	66.9	69.9	75.1	68.3	64.5	65.4	68.1	63.0	54.5	46.5	35.9
$L_{ZF,max}$	70.3	72.8	89.0	74.4	67.2	67.8	73.4	65.9	53.4	46.0	35.4
$L_{ZF,min}$	51.2	58.4	62.9	60.0	54.6	58.5	62.6	56.8	46.0	33.4	19.7
$L_{ZF,1}$	76.7	78.1	82.9	76.3	72.0	71.3	72.0	68.5	62.3	55.4	45.2
$L_{ZF,10}$	70.3	73.3	78.6	71.2	67.0	67.8	70.1	64.9	56.9	49.3	38.8
$L_{ZF,90}$	55.7	62.1	67.2	61.9	59.7	61.8	65.5	60.0	50.2	39.2	23.8
$L_{ZF,99}$	48.9	57.0	62.8	58.3	56.8	59.7	63.6	58.1	47.9	35.2	17.7

Table B4: Full unweighted measurement data for position 2, measurement 1 7th April 2008

Position 2 Measurement 2	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	66.3	71.8	76.3	69.6	64.3	64.4	67.9	63.2	54.5	47.1	37.6
$L_{ZF,max}$	75.2	77.9	92.1	85.8	73.6	67.9	71.1	64.4	54.1	46.8	35.4
$L_{ZF,min}$	54.5	66.2	59.5	59.2	53.3	59.0	61.7	57.4	50.2	42.2	30.0
$L_{ZF,1}$	75.7	78.8	84.4	78.6	71.4	69.5	72.6	68.9	61.0	55.5	47.2
$L_{ZF,10}$	69.7	75.2	79.8	72.2	66.7	66.5	70.1	65.2	57.1	50.1	40.1
$L_{ZF,90}$	55.8	64.5	68.1	62.4	59.8	61.1	64.9	60.1	50.7	41.2	28.7
$L_{ZF,99}$	48.8	59.5	63.2	58.7	57.1	59.0	63.0	58.3	48.8	38.4	23.2

Table B5: Full unweighted measurement data for position 2, measurement 2 7th April 2008

Position 3 Measurement 1	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	65.0	67.5	68.7	61.5	58.1	57.5	59.5	52.8	43.2	37.7	18.8
$L_{ZF,max}$	75.3	73.1	74.0	65.3	61.5	61.8	61.3	53.2	41.2	30.2	22.5
$L_{ZF,min}$	55.0	62.5	56.7	57.9	50.6	51.8	54.7	51.2	36.8	25.3	14.8
$L_{ZF,1}$	74.0	74.7	76.4	67.9	64.7	61.8	63.5	57.2	53.7	50.9	27.9
$L_{ZF,10}$	68.6	70.9	72.2	64.2	60.5	59.5	61.4	54.7	42.2	32.5	20.2
$L_{ZF,90}$	54.4	60.0	61.1	56.0	53.3	54.4	56.9	50.1	37.2	23.6	14.4
$L_{ZF,99}$	47.5	55.0	56.9	52.4	50.1	52.3	55.0	48.3	35.2	20.6	13.9

Table B6: Full unweighted measurement data for position 3, measurement 1 7th April 2008

Position 4 Measurement 1	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	70.6	73.5	75.6	68.4	65.3	65.0	67.9	63.0	53.5	45.9	47.5
$L_{ZF,max}$	91.3	86.6	84.7	74.2	66.8	67.0	70.9	64.5	53.6	46.0	34.3
$L_{ZF,min}$	54.0	60.9	62.4	60.5	58.0	57.7	62.3	55.5	42.6	28.7	16.1
$L_{ZF,1}$	82.0	82.0	83.9	75.9	71.3	71.0	73.5	69.4	60.8	55.9	51.9
$L_{ZF,10}$	71.5	77.2	79.3	71.5	68.2	67.7	70.4	65.7	56.3	49.2	42.0
$L_{ZF,90}$	55.1	64.4	66.7	62.2	60.4	60.3	64.1	58.1	46.3	32.7	19.0
$L_{ZF,99}$	48.9	58.4	61.9	58.3	57.5	58.1	61.6	55.7	43.9	28.5	15.1

Table B7: Full unweighted measurement data for position 4, measurement 1 7th April 2008

Position 4 Measurement 2	Octave Band Centre Frequency (Hz)										
	16	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
L_{Zeq}	64.9	72.8	76.8	70.2	66.4	64.8	66.4	62.0	56.8	50.4	49.2
$L_{ZF,max}$	58.5	80.1	94.7	77.0	72.8	73.0	73.8	68.3	60.5	50.7	41.4
$L_{ZF,min}$	57.4	58.4	63.2	57.9	54.7	54.2	57.4	51.6	38.1	27.2	20.0
$L_{ZF,1}$	74.9	80.9	86.0	81.0	75.3	72.9	72.8	68.6	64.2	59.3	58.1
$L_{ZF,10}$	68.1	76.2	80.4	73.0	69.3	67.5	69.3	65.0	56.2	48.9	42.1
$L_{ZF,90}$	54.2	64.3	67.1	61.4	60.1	59.2	61.8	56.7	45.8	34.6	22.1
$L_{ZF,99}$	47.8	59.1	61.5	57.5	56.8	56.3	59.5	53.6	39.7	24.6	14.6

Table B8: Full unweighted measurement data for position 4, measurement 2 7th April 2008

Appendix C: Full Measurement Results For Continuous Unattended Measurements (VC Office)

Time	$L_{Aeq,5min}$	$L_{AF,max}$	$L_{AF,1}$	$L_{AF,10}$	$L_{AF,90}$	$L_{AF,99}$	$L_{AF,min}$
14:03	76.5	80.3	79.9	78.7	73.8	72.4	71.7
14:05	76.7	89.7	79.6	78.1	74.8	71.8	70.6
14:10	76.7	81.5	80.3	78.6	73.9	71.2	69.7
14:15	77.0	83.8	81.4	78.6	74.5	72.0	70.6
14:20	76.5	81.1	79.7	78.2	73.9	71.3	68.7
14:25	76.4	83.0	79.7	78.1	73.9	71.0	68.1
14:30	76.5	81.7	79.4	78.2	74.1	72.3	70.8
14:35	76.6	81.0	79.8	78.2	74.3	71.1	69.9
14:40	76.9	80.5	79.1	78.2	75.2	73.8	72.3
14:45	77.6	88.7	81.0	79.2	75.1	69.1	68.0
14:50	77.9	82.9	81.1	79.5	75.8	74.1	72.2
14:55	77.8	81.9	80.6	79.5	75.7	74.2	72.9
15:00	77.4	83.9	80.3	79.0	75.2	73.5	72.6
15:05	77.6	82.3	80.8	79.2	74.8	73.4	72.3
15:10	77.4	81.2	80.2	79.2	74.9	73.2	72.0
15:15	77.1	81.1	80.1	78.8	74.7	73.1	72.0
15:20	77.4	83.0	80.4	79.0	75.3	73.7	72.3
15:25	77.1	82.9	80.4	78.7	74.9	72.8	71.8
15:30	77.0	83.7	79.6	78.3	75.2	73.6	72.8
15:35	77.0	83.4	80.2	78.5	74.9	73.1	71.8
15:40	77.4	81.2	80.3	79.1	75.1	73.9	72.7
15:45	77.3	82.0	79.5	78.7	75.3	73.8	72.7
15:50	77.2	85.5	80.4	78.8	75.0	73.9	72.5
15:55	77.7	81.7	80.2	79.1	75.7	73.5	72.2
16:00	77.8	81.9	80.1	79.2	75.6	74.4	73.4
16:05	75.7	80.5	78.2	77.2	73.5	72.2	71.4
16:10	75.9	85.2	78.6	77.6	73.1	71.1	70.2
16:15	77.0	91.3	87.5	77.9	72.7	70.7	69.4
16:20	75.2	84.5	79.4	76.5	72.6	69.7	68.3
16:25	75.4	85.8	79.3	77.3	72.4	71.4	70.7
16:30	75.3	90.0	77.8	76.6	72.4	69.8	68.0
16:35	74.7	80.4	77.0	76.2	72.7	71.3	70.4
16:40	76.8	82.2	80.1	78.2	74.9	74.0	73.3
16:45	75.5	79.6	77.8	76.9	73.3	72.1	70.8
16:50	76.2	80.6	79.6	77.9	73.7	72.3	71.2
16:55	76.5	80.5	79.6	78.1	74.0	72.0	70.5
17:00	76.6	81.4	79.5	78.1	74.4	71.7	70.0
17:05	77.8	95.0	83.6	78.6	74.7	72.5	71.4
17:10	76.5	79.9	79.0	77.7	74.8	73.0	72.2

Table C1: Full measurement results for continuous noise measurement located in MMU VCs office overlooking the Mancunian Way 7th April 2008

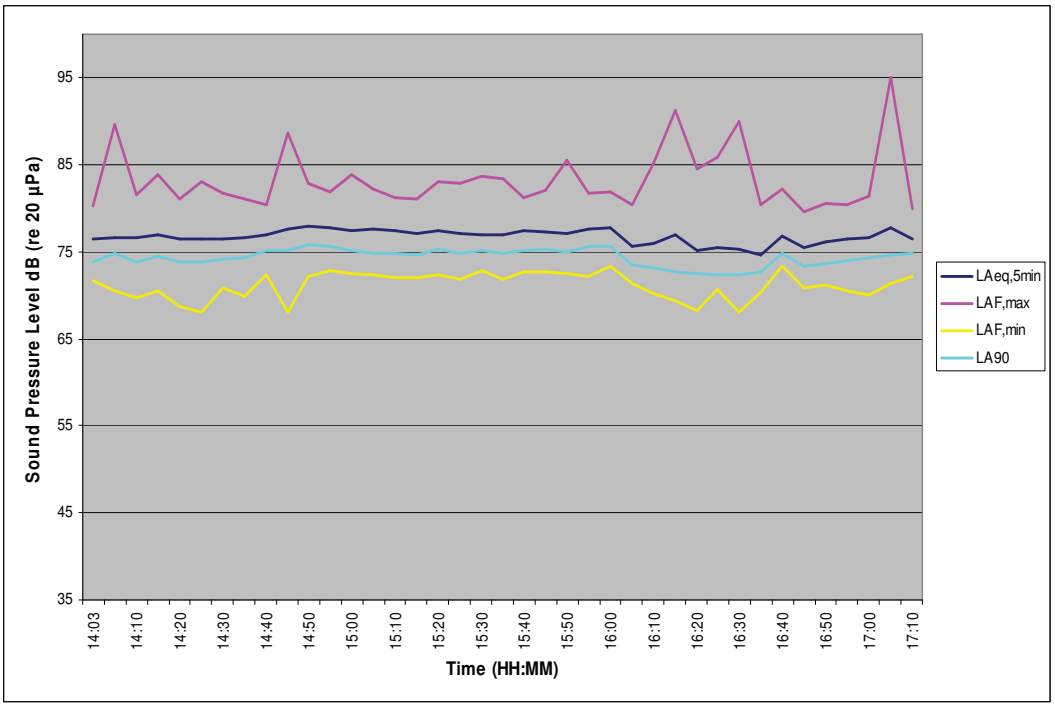


Figure C.1: Graphical representation of continuous unattended noise measurements between 14:00 and 17:00, 7th April 2008.

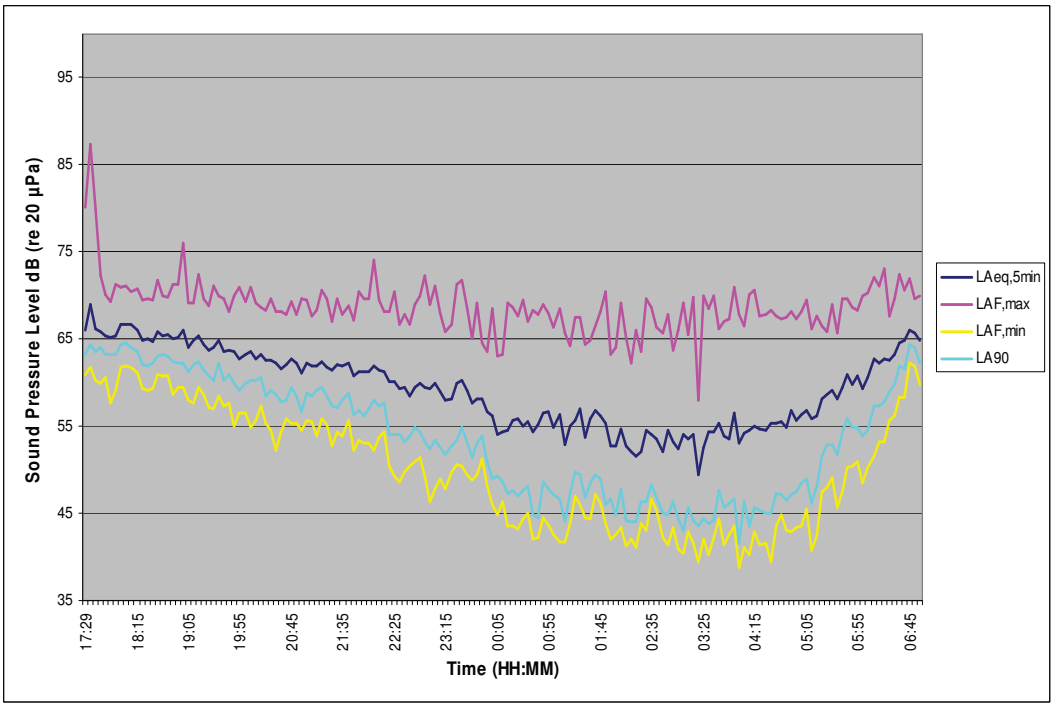


Figure C.2: Graphical representation of continuous unattended noise measurements between 17:30 and 07:00, 7th and 8th April 2008.

Appendix D: Full Measurement Results For Continuous Unattended Measurements (Site)

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
17:29	66.1	80.2	78.5	65.8	63.2	61.4	61.0
17:30	68.9	87.3	78.5	71.0	64.3	63.0	61.7
17:35	66.2	79.9	71.9	67.6	63.5	61.5	60.3
17:40	65.9	72.3	69.2	67.5	64.0	62.0	59.9
17:45	65.4	70.1	68.4	66.9	63.2	61.5	60.6
17:50	65.2	69.3	68.1	66.8	63.2	59.2	57.6
17:55	65.3	71.3	68.2	66.9	63.2	61.3	59.1
18:00	66.7	70.9	69.6	68.4	64.4	63.0	61.7
18:05	66.6	71.1	70.0	68.3	64.5	63.0	61.9
18:10	66.6	70.4	69.4	68.3	64.0	62.8	61.8
18:15	66.1	70.8	69.1	67.8	63.6	62.0	61.1
18:20	64.8	69.5	68.5	66.7	62.1	60.0	59.3
18:25	65.1	69.7	68.3	67.1	61.9	60.3	59.1
18:30	64.7	69.5	67.9	66.5	62.3	60.5	59.3
18:35	65.8	71.7	69.6	67.9	63.0	61.6	61.0
18:40	65.3	70.0	68.6	66.9	63.2	61.8	60.8
18:45	65.6	69.8	68.8	67.4	63.0	61.7	60.7
18:50	65.0	71.3	68.4	66.8	62.4	59.2	58.6
18:55	65.2	71.3	69.1	67.3	62.3	60.5	59.5
19:00	66.0	76.1	71.6	67.8	62.2	60.2	59.4
19:05	64.1	69.2	67.6	66.2	61.2	59.3	58.0

Table D1: Full measurement results for continuous noise measurement located on MMU Business School development site 7th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
19:10	64.8	69.1	67.6	66.7	62.1	58.8	57.6
19:15	65.3	72.5	70.2	67.4	62.4	60.3	59.4
19:20	64.3	69.6	68.1	66.5	61.5	59.3	58.6
19:25	63.7	68.8	67.6	65.6	60.8	58.5	57.2
19:30	64.1	71.1	67.8	66.3	60.3	58.3	57.0
19:35	64.9	69.9	68.3	66.8	62.3	59.0	58.4
19:40	63.6	69.7	67.6	65.8	60.2	58.6	57.3
19:45	63.7	68.1	67.3	65.9	60.9	59.3	57.6
19:50	63.6	70.0	68.2	66.0	60.0	56.2	55.1
19:55	62.7	71.0	67.6	64.8	59.2	57.4	56.5
20:00	63.2	69.3	68.4	65.3	60.0	57.6	56.5
20:05	63.6	71.0	67.5	65.6	60.3	56.0	54.8
20:10	62.7	69.2	66.6	64.7	60.2	58.0	55.6
20:15	63.2	68.7	67.3	65.1	60.6	59.0	57.4
20:20	62.5	68.4	66.9	65.0	58.4	56.0	55.3
20:25	62.5	69.7	66.6	64.6	59.2	55.4	54.6
20:30	62.3	68.2	66.3	64.7	58.7	54.1	52.3
20:35	61.6	68.2	66.2	63.7	57.8	55.5	54.3
20:40	62.1	67.8	66.3	64.5	58.0	56.6	55.8
20:45	62.8	69.3	68.2	65.0	59.4	56.7	55.4
20:50	62.2	67.9	66.5	64.5	58.4	56.8	55.3

Table D2: Full measurement results for continuous noise measurement located on MMU Business School development site 7th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
20:55	61.1	69.6	65.8	63.6	56.7	55.2	54.5
21:00	62.2	69.5	66.9	64.5	58.8	56.9	55.7
21:05	62.0	67.6	66.7	64.4	58.4	56.8	55.5
21:10	62.0	68.3	66.0	64.0	59.2	55.3	53.8
21:15	62.4	70.7	67.5	64.4	59.4	56.7	55.9
21:20	61.8	69.7	67.0	64.0	58.5	56.2	55.2
21:25	61.4	67.0	65.8	64.0	57.4	54.3	52.8
21:30	62.1	69.7	66.9	64.8	57.2	55.3	54.4
21:35	62.0	67.8	66.2	64.4	58.0	54.5	53.9
21:40	62.3	68.8	66.8	64.8	58.8	57.0	55.6
21:45	60.7	67.2	65.4	63.4	56.3	53.9	52.2
21:50	61.2	70.4	67.6	63.9	56.8	54.3	53.4
21:55	61.2	69.6	67.0	64.0	56.1	54.2	53.0
22:00	61.2	69.6	66.6	63.5	57.0	54.3	53.0
22:05	61.9	74.0	69.0	64.1	57.9	53.8	52.2
22:10	61.4	69.5	65.9	64.1	57.3	54.6	53.7
22:15	61.2	68.1	65.7	63.3	57.6	55.6	54.3
22:20	60.1	68.2	65.7	63.0	54.1	51.4	50.5
22:25	60.1	70.5	66.9	63.0	54.1	50.7	49.2
22:30	59.3	66.6	64.7	62.5	54.0	49.6	48.7
22:35	59.4	67.8	65.0	62.2	53.2	50.6	49.7

Table D3: Full measurement results for continuous noise measurement located on MMU Business School development site 7th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
22:40	58.5	66.6	64.2	61.5	53.9	51.6	50.4
22:45	59.5	68.9	65.1	62.2	54.8	52.3	51.0
22:50	60.0	69.9	66.1	63.2	54.4	52.3	51.4
22:55	59.5	72.2	67.9	62.5	53.3	50.1	49.2
23:00	59.3	68.9	65.5	62.7	52.4	47.5	46.3
23:05	60.0	71.1	67.6	62.8	53.4	49.7	47.8
23:10	58.9	68.0	65.2	62.0	52.6	50.2	49.0
23:15	58.0	65.8	64.1	61.2	51.8	49.1	47.8
23:20	58.1	66.7	63.5	61.0	52.7	50.6	49.7
23:25	60.0	71.3	67.0	62.9	53.4	51.4	50.6
23:30	60.2	71.7	67.6	63.0	54.9	51.6	50.5
23:35	59.2	68.6	65.6	62.3	53.3	50.6	49.5
23:40	57.7	65.1	63.4	60.5	51.4	49.5	48.8
23:45	58.2	69.1	65.1	61.4	53.1	50.5	49.5
23:50	58.1	64.5	62.6	60.8	53.9	52.4	51.2
23:55	56.6	63.5	62.0	59.5	50.9	48.8	48.2
00:00	56.2	68.5	62.6	59.6	49.0	46.7	46.0
00:05	54.0	63.0	61.0	57.3	49.3	45.9	44.9
00:10	54.3	63.3	61.2	57.5	48.6	47.2	46.4
00:15	54.6	69.1	63.4	57.5	47.3	43.9	43.5
00:20	55.6	68.6	65.5	58.7	47.7	44.8	43.5

Table D4: Full measurement results for continuous noise measurement located on MMU Business School development site 7th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
00:25	55.9	67.7	64.7	59.2	47.0	43.9	43.2
00:30	55.1	69.5	64.0	57.8	47.6	45.2	44.4
00:35	55.5	67.0	63.1	59.4	48.2	46.1	45.0
00:40	54.3	68.3	64.5	58.0	44.8	42.9	42.1
00:45	55.2	67.9	64.0	59.1	44.6	42.9	42.2
00:50	56.5	69.0	65.8	59.8	48.6	45.5	44.6
00:55	56.6	68.0	64.4	60.7	47.8	45.1	43.7
01:00	54.8	66.3	63.8	58.4	47.1	43.7	42.6
01:05	56.3	68.5	66.0	59.8	46.7	43.1	41.7
01:10	52.9	65.7	61.9	56.0	44.0	42.5	41.7
01:15	55.1	64.2	61.6	58.8	47.3	44.7	43.8
01:20	55.7	67.5	63.7	58.7	49.8	48.7	47.0
01:25	57.0	67.5	65.7	60.7	49.5	46.9	46.0
01:30	53.7	64.3	62.0	57.3	46.9	45.5	44.6
01:35	55.9	64.9	62.9	59.3	48.5	45.2	44.3
01:40	56.9	66.5	64.5	60.7	49.4	48.0	47.2
01:45	56.1	68.2	65.2	59.6	48.9	47.2	46.2
01:50	55.4	70.5	66.0	58.3	46.0	44.4	43.9
01:55	52.8	63.3	61.0	56.3	46.6	43.2	42.1
02:00	52.8	64.0	61.0	56.4	44.9	43.4	42.6
02:05	54.7	69.1	65.3	57.5	47.8	44.2	43.3

Table D5: Full measurement results for continuous noise measurement located on MMU Business School development site 8th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
02:10	52.8	65.2	61.3	57.1	44.2	41.8	41.2
02:15	52.1	62.2	60.2	56.1	44.1	42.7	42.0
02:20	51.5	66.0	62.6	54.8	44.0	41.9	41.0
02:25	52.1	63.6	59.9	55.7	46.4	44.7	43.8
02:30	54.6	69.7	65.7	57.1	46.3	44.0	43.1
02:35	54.1	68.6	65.4	55.8	48.3	47.3	46.6
02:40	53.5	66.3	62.4	56.7	46.9	46.0	45.3
02:45	52.0	65.7	60.1	55.2	45.0	43.0	42.2
02:50	54.5	67.9	64.7	58.1	44.8	42.4	41.4
02:55	53.2	63.8	61.8	56.8	46.3	43.9	43.3
03:00	52.4	66.0	62.8	55.8	44.4	42.2	40.9
03:05	54.0	69.1	65.7	57.0	43.0	41.4	40.4
03:10	53.6	65.6	62.8	57.1	45.7	43.6	42.8
03:15	54.0	69.8	65.9	55.7	44.2	42.3	41.5
03:20	49.4	57.9	56.0	52.5	43.6	40.5	39.5
03:25	52.5	69.9	63.2	55.7	44.4	42.8	42.0
03:30	54.4	68.5	65.2	57.7	43.9	41.0	40.2
03:35	54.3	70.0	65.5	56.9	44.2	43.0	42.3
03:40	55.4	66.2	63.5	59.0	47.6	45.2	44.3
03:45	53.9	67.0	63.7	57.3	45.7	42.2	41.4
03:50	53.6	67.3	63.0	56.5	46.1	44.1	42.6

Table D6: Full measurement results for continuous noise measurement located on MMU Business School development site 8th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
03:55	56.5	70.9	67.9	59.8	46.7	44.5	43.6
04:00	53.1	67.9	64.1	56.7	41.6	39.5	38.7
04:05	54.2	66.5	62.9	57.8	46.4	42.4	41.0
04:10	54.6	70.1	66.1	58.0	43.6	41.0	40.3
04:15	55.0	70.6	64.8	58.1	45.6	43.6	42.9
04:20	54.7	67.7	64.9	58.3	45.3	42.0	41.4
04:25	54.5	67.9	63.8	57.8	45.0	43.0	41.6
04:30	55.4	68.4	65.0	59.2	45.0	41.1	39.4
04:35	55.4	67.7	64.9	58.9	47.3	45.0	43.6
04:40	55.5	67.4	65.0	59.2	47.1	45.4	44.8
04:45	54.9	67.5	64.4	59.1	46.5	44.3	43.1
04:50	56.9	68.2	65.7	60.8	47.2	44.1	42.9
04:55	55.7	67.4	64.0	59.4	47.4	44.2	43.3
05:00	56.4	68.1	65.3	59.8	48.5	44.8	43.5
05:05	56.9	69.4	65.2	60.0	49.0	46.6	45.5
05:10	55.8	66.2	63.8	58.9	46.1	41.7	40.7
05:15	56.2	67.6	63.7	59.7	48.2	43.2	42.4
05:20	58.1	66.5	64.9	61.5	51.5	48.9	47.5
05:25	58.6	65.8	64.2	61.7	52.9	49.2	47.9

Table D7: Full measurement results for continuous noise measurement located on MMU Business School development site 8th April 2008

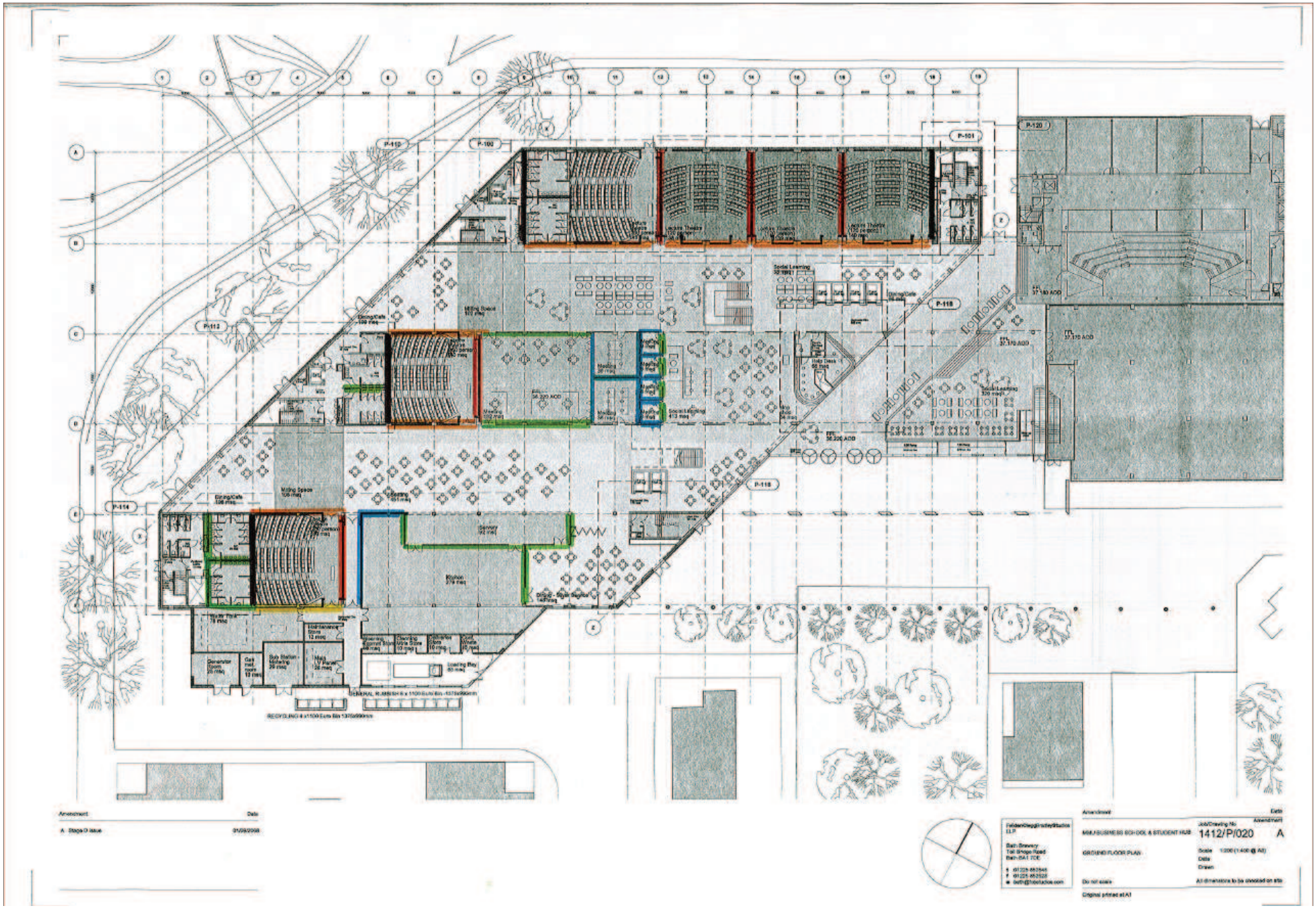
Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
05:30	59.2	69.0	66.3	62.3	52.9	50.1	49.1
05:35	58.2	65.7	63.7	61.4	51.8	46.9	45.7
05:40	59.4	69.7	65.1	62.6	54.4	49.1	47.4
05:45	61.0	69.6	66.2	63.5	55.9	52.6	50.2
05:50	59.8	68.6	66.3	63.1	54.8	52.2	50.5
05:55	60.7	68.4	65.9	63.6	54.8	51.9	51.0
06:00	59.3	70.0	66.5	62.2	53.8	49.7	48.5
06:05	60.6	70.3	67.0	64.0	54.6	51.4	50.3
06:10	62.7	72.1	69.0	66.0	57.4	55.3	51.5
06:15	62.3	71.1	68.3	64.7	57.3	54.5	53.3
06:20	62.8	73.0	68.8	65.3	57.8	54.4	53.2
06:25	62.5	67.7	66.3	64.8	59.0	56.5	55.7
06:30	63.2	69.7	66.7	65.2	59.8	57.5	56.2
06:35	64.5	72.4	68.8	66.2	61.9	60.1	58.3
06:40	64.9	70.6	69.0	66.9	61.6	59.1	58.3
06:45	66.1	71.9	69.5	67.4	64.4	63.2	62.3
06:50	65.7	69.6	68.5	67.1	64.0	62.9	62.0
06:55	64.8	69.9	68.2	66.6	62.2	60.6	59.8
07:00	71.0	83.3	81.6	74.7	63.3	60.8	59.7

Table D8: Full measurement results for continuous noise measurement located on MMU Business School development site 8th April 2008

Start Time	L_{Aeq}	L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
07:05	72.0	84.8	82.6	72.0	66.7	64.5	63.3
07:10	69.1	78.0	73.8	71.3	66.5	65.5	64.7
07:15	69.0	74.4	72.5	70.9	66.4	65.1	64.4
07:20	69.3	77.3	74.2	71.4	66.4	65.2	64.1
07:25	69.0	78.5	73.8	71.5	65.3	63.8	62.7
07:30	65.6	76.4	70.1	67.1	63.2	62.3	61.8
07:35	63.9	72.0	67.6	65.7	61.9	60.8	60.3
07:40	63.1	71.5	66.6	64.0	61.6	60.5	59.7
07:45	66.1	77.3	71.8	69.2	61.8	60.9	60.1
07:50	67.6	75.9	73.0	70.6	64.3	63.1	62.0
07:55	68.5	83.2	75.8	70.8	64.9	63.4	62.3
08:00	66.4	79.0	74.3	69.9	61.5	60.9	60.4
08:05	68.6	80.6	77.4	72.1	63.9	62.1	61.0
08:10	66.3	72.5	69.4	67.7	64.4	62.5	62.0
08:15	64.6	70.8	68.6	66.7	62.2	61.5	61.1
08:20	65.8	73.8	68.9	67.2	63.7	63.0	62.3
08:25	64.7	78.1	68.6	66.6	62.3	61.5	60.9
08:30	72.5	95.8	84.4	70.7	64.0	63.0	62.2
-	-	-	-	-	-	-	-

Table D9: Full measurement results for continuous noise measurement located on MMU Business School development site 8th April 2008

Appendix E: Marked-up Plans Detailing Required Sound Insulation Performance for Partition Walls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Kitchen 219 max
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Social Learning 413 max
Social Learning 320 max
Help Desk 65 max
Meeting 30 max
Meeting 30 max
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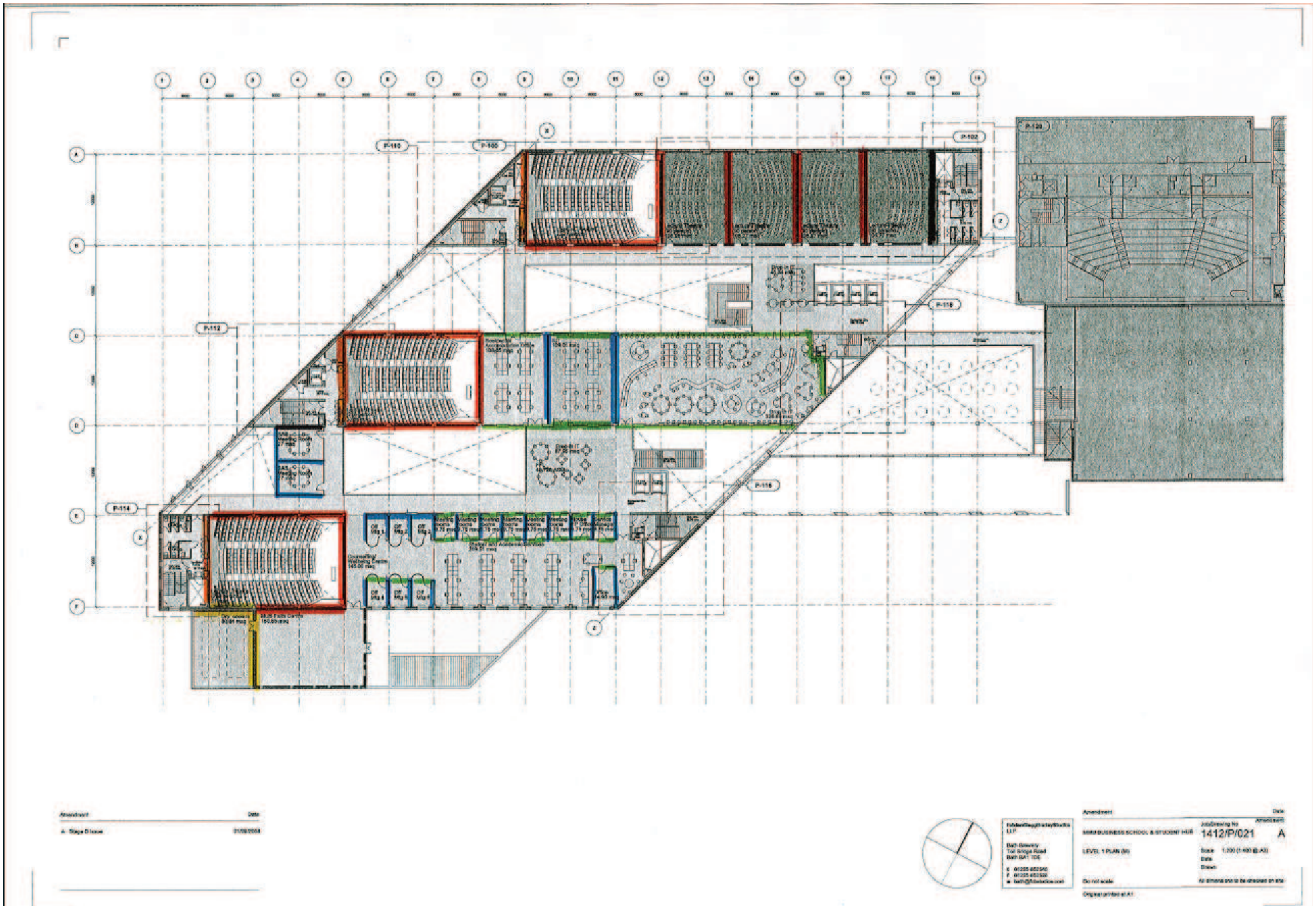
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Scale
Date
Drawn
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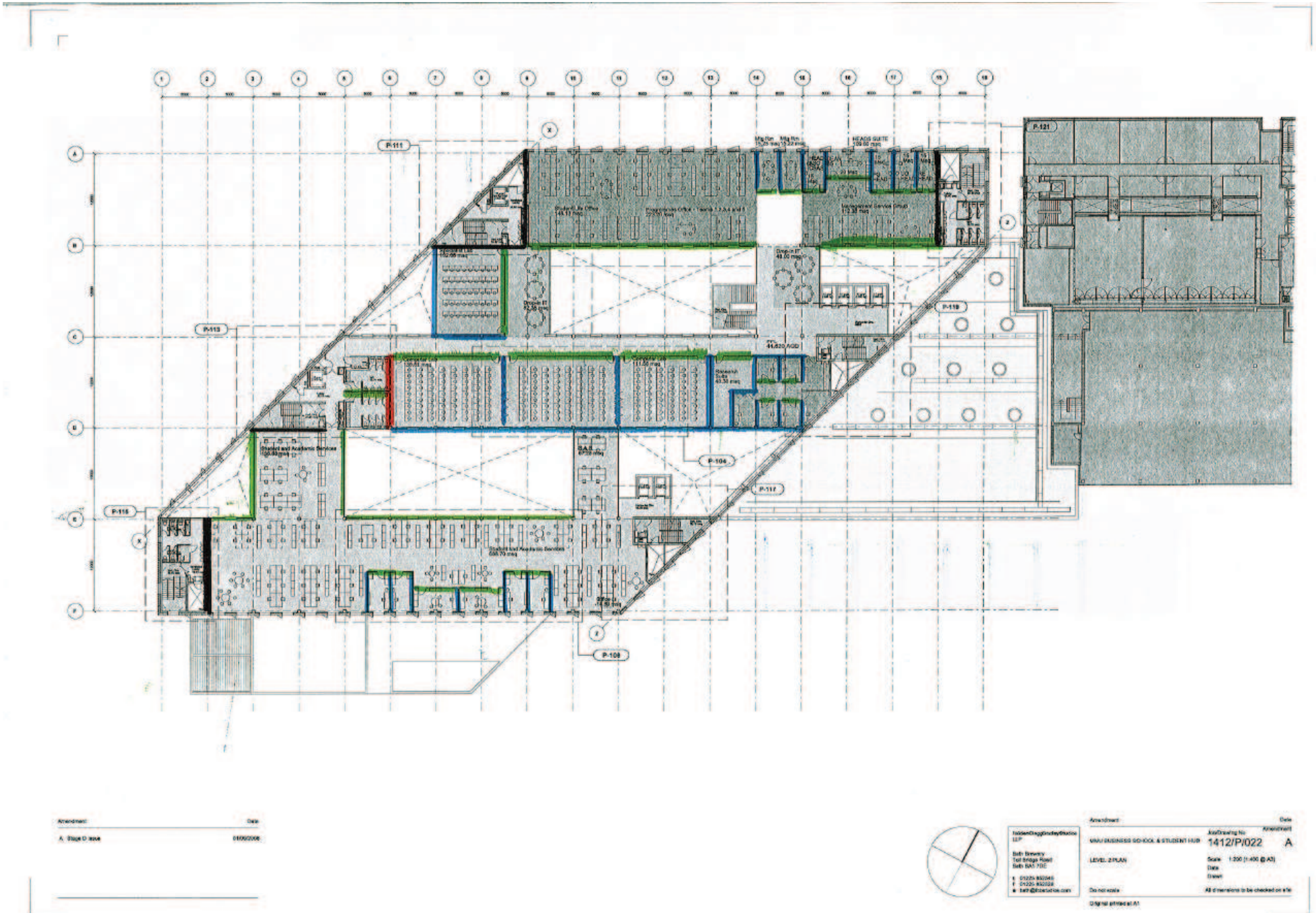
Original printed at A1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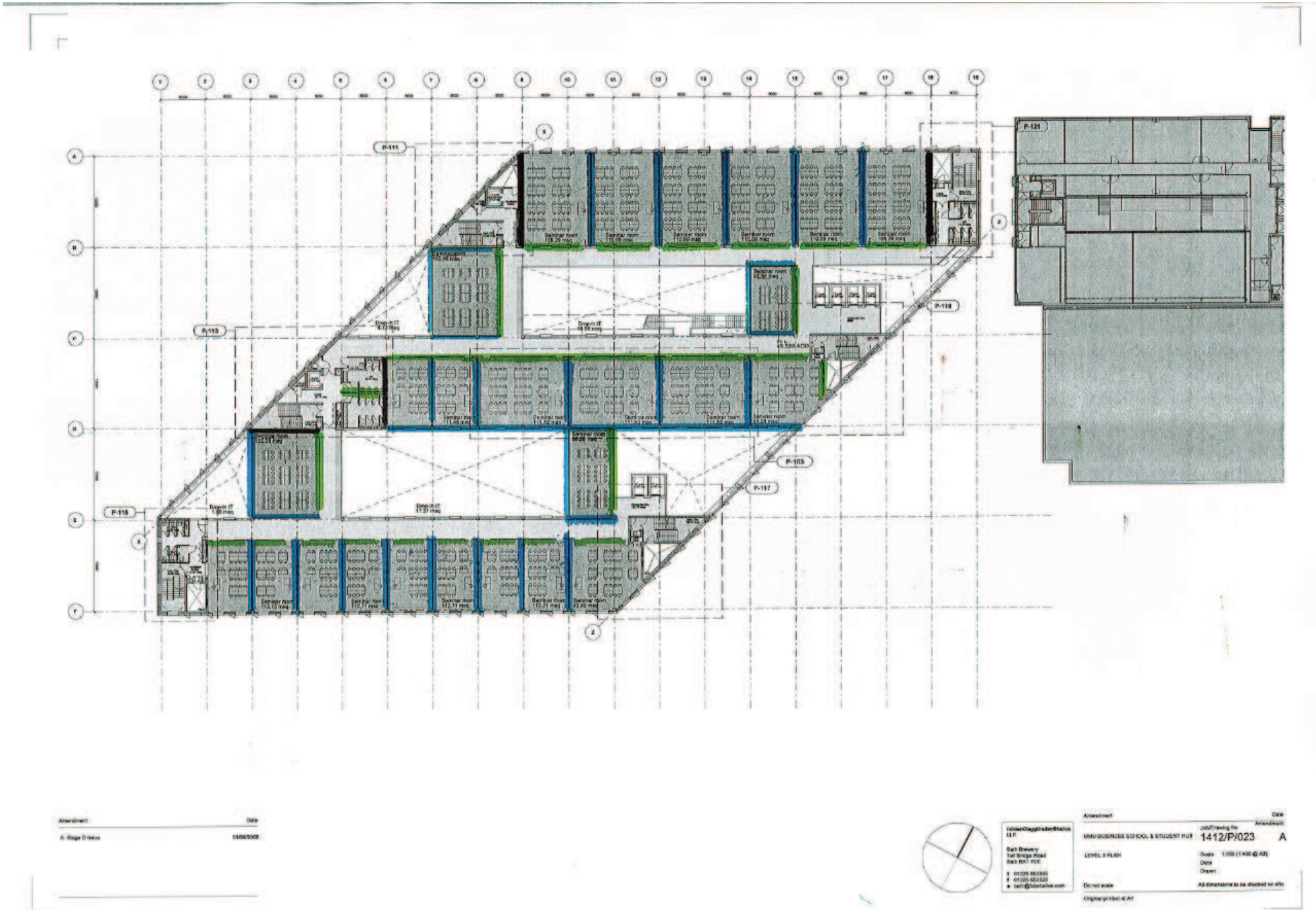
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Job/Drawing No
1412/P/023
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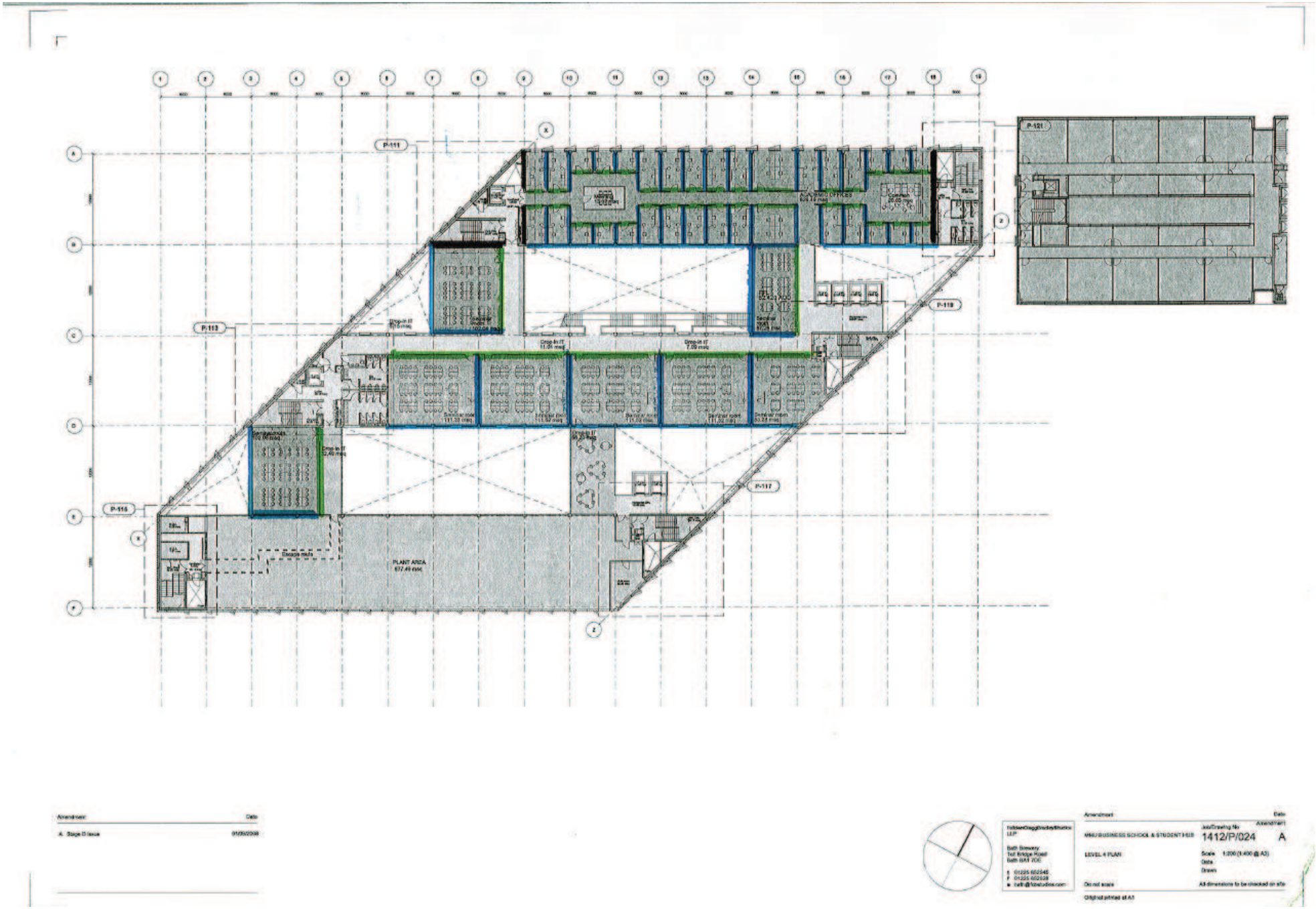
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Job/Drawing No
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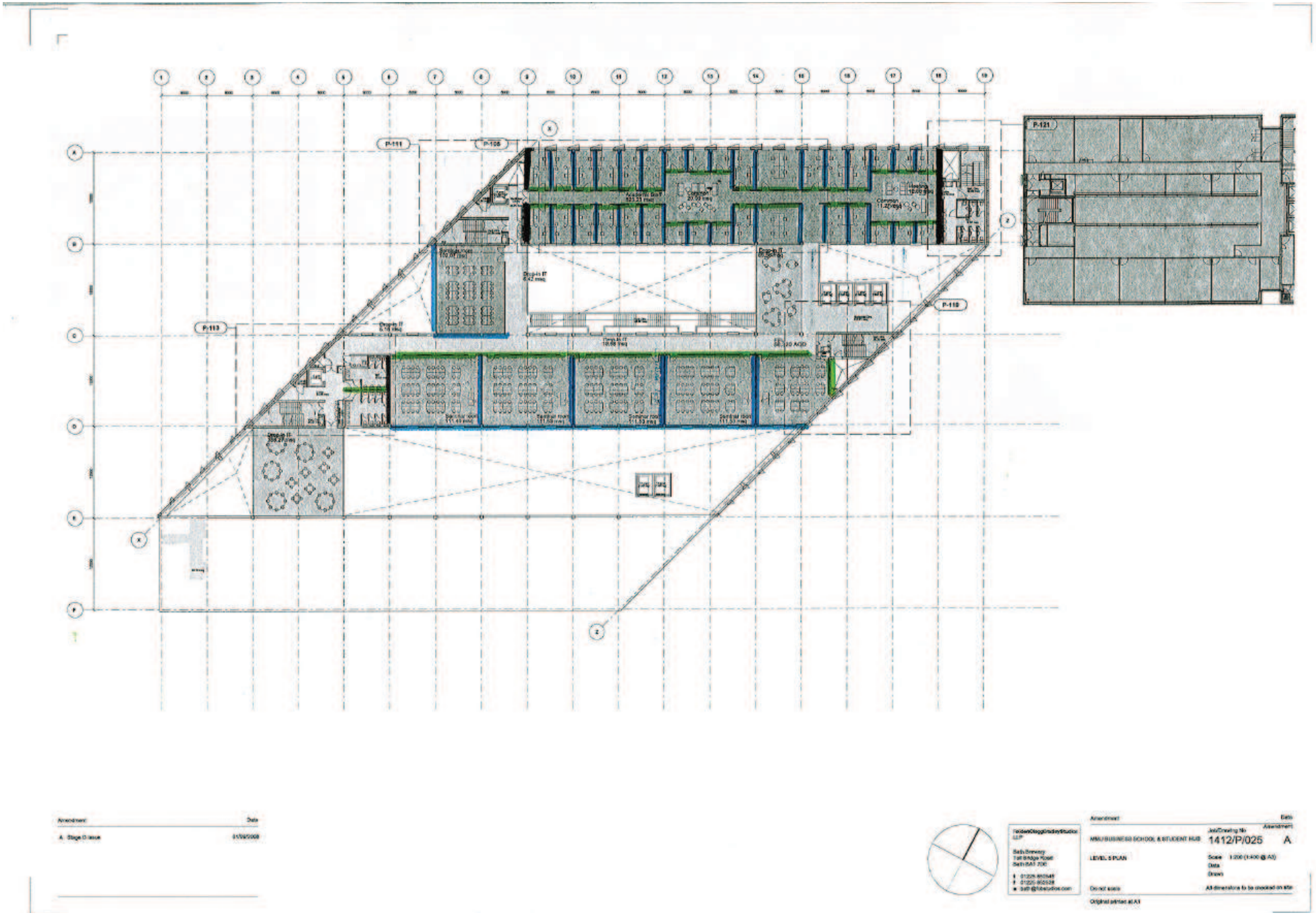
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Date
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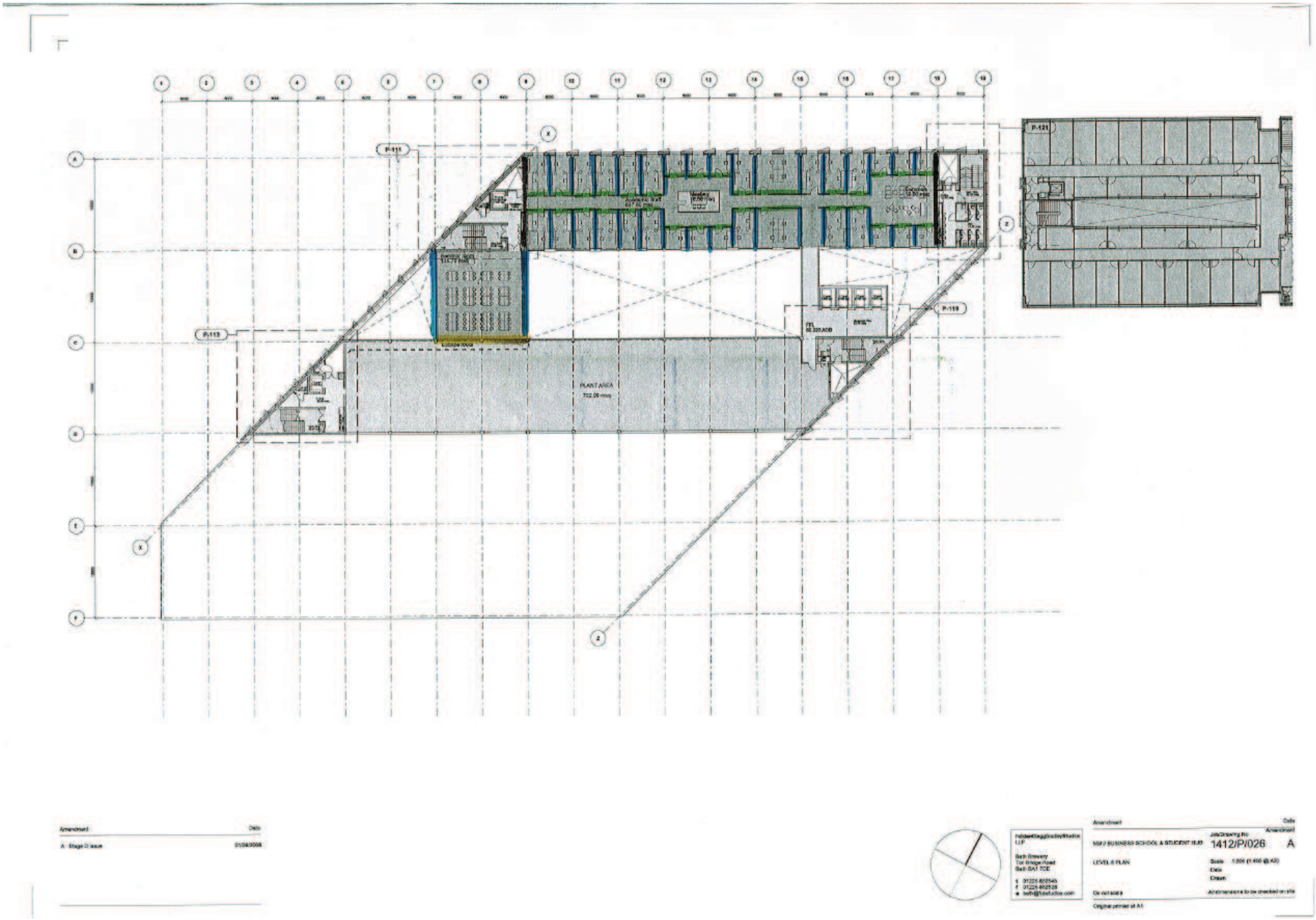
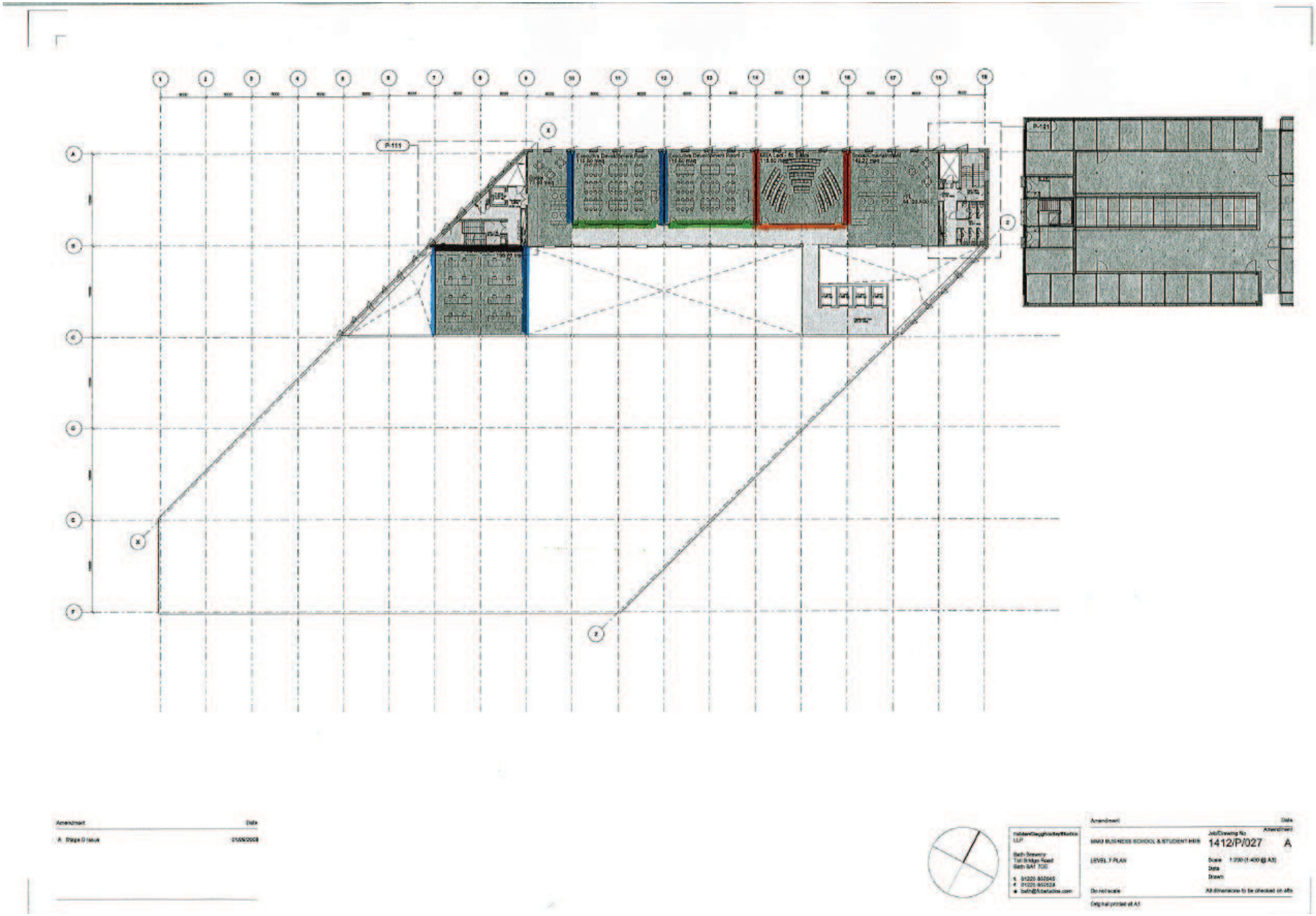
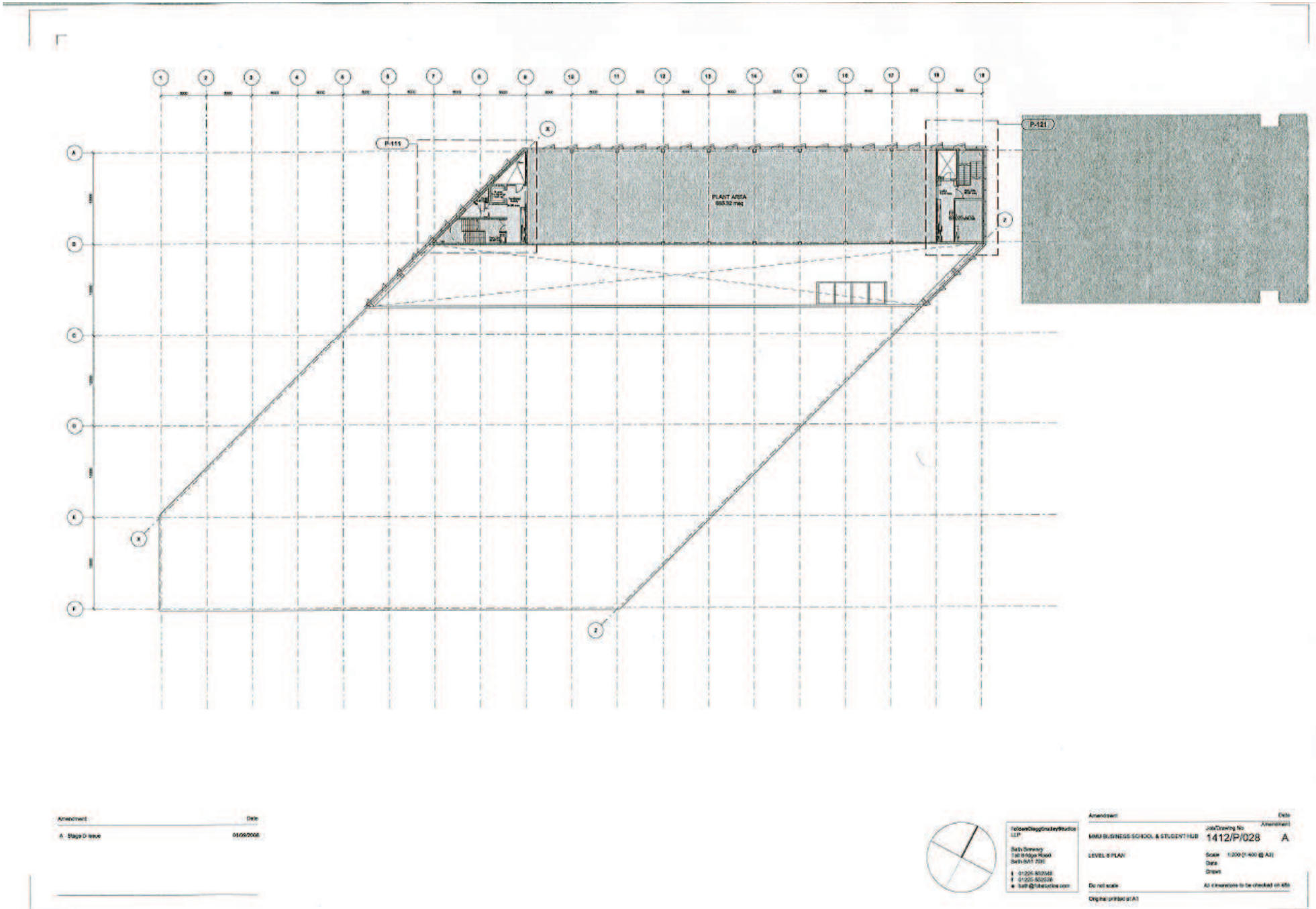
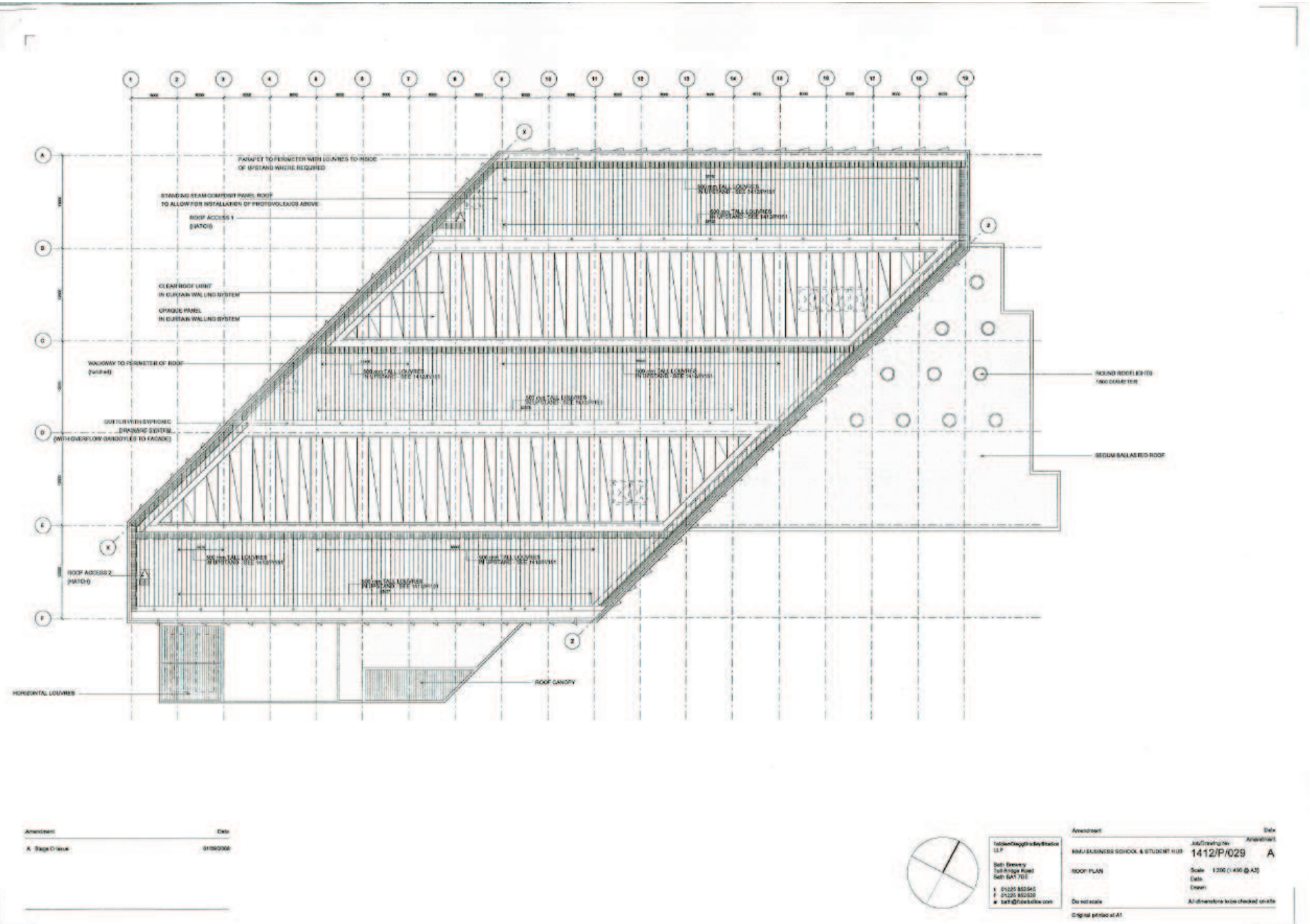
1412/P/025
A
LEVEL 5 PLAN
Scale 1:200 (1:400 @ A3)
Date
Drawn
Do not scale
All dimensions to be checked on site
Original printed at A1

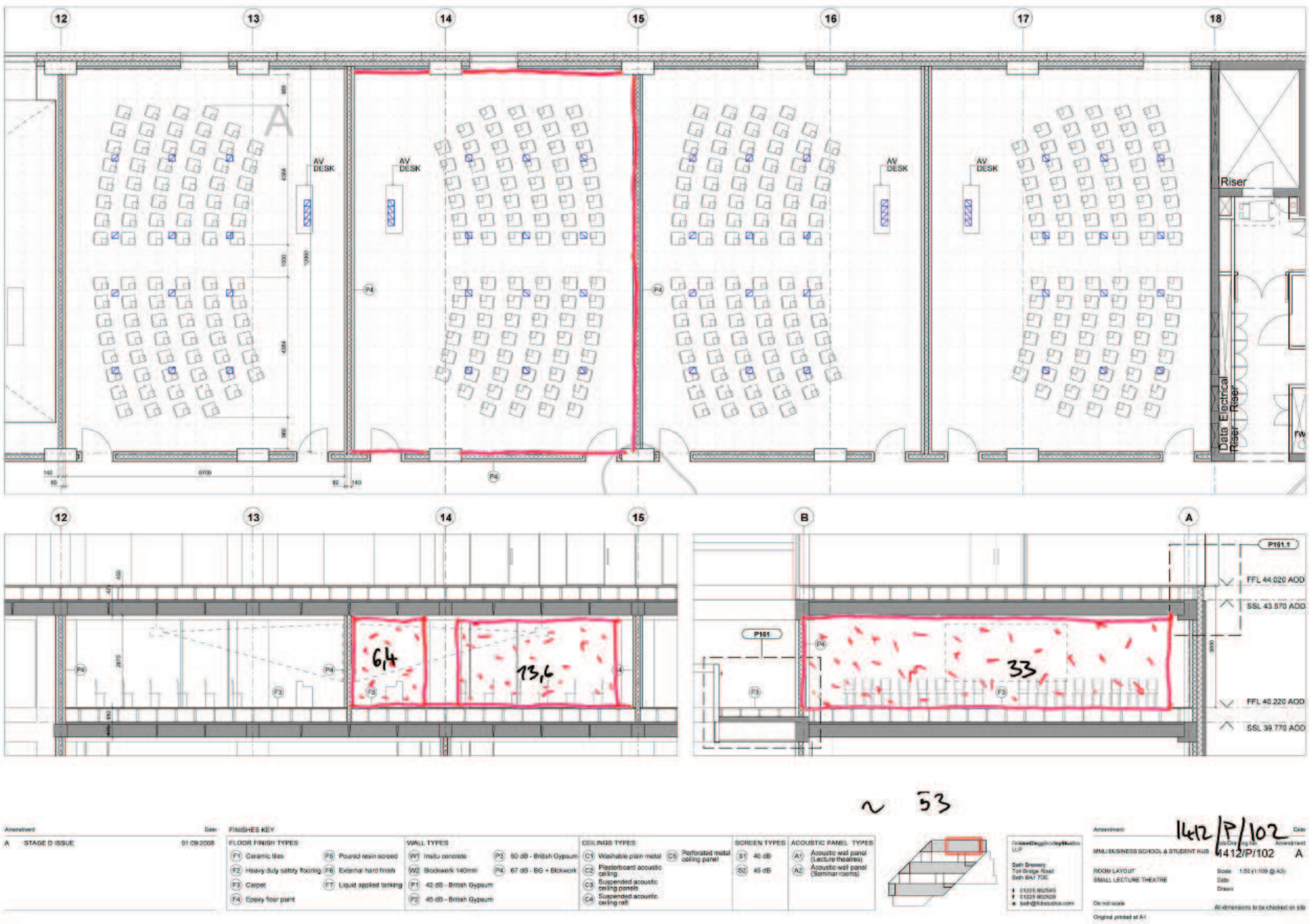

P-111
P-113
P-119
P-121
PLANT AREA
Amendment
Date
A Stage D issue
Amendment
Date
MMU BUSINESS SCHOOL & STUDENT HUB
Job/Drawing No
1412/P/026
A
LEVEL 6 PLAN
Scale
Date
Drawn
Do not scale
Original printed at A1

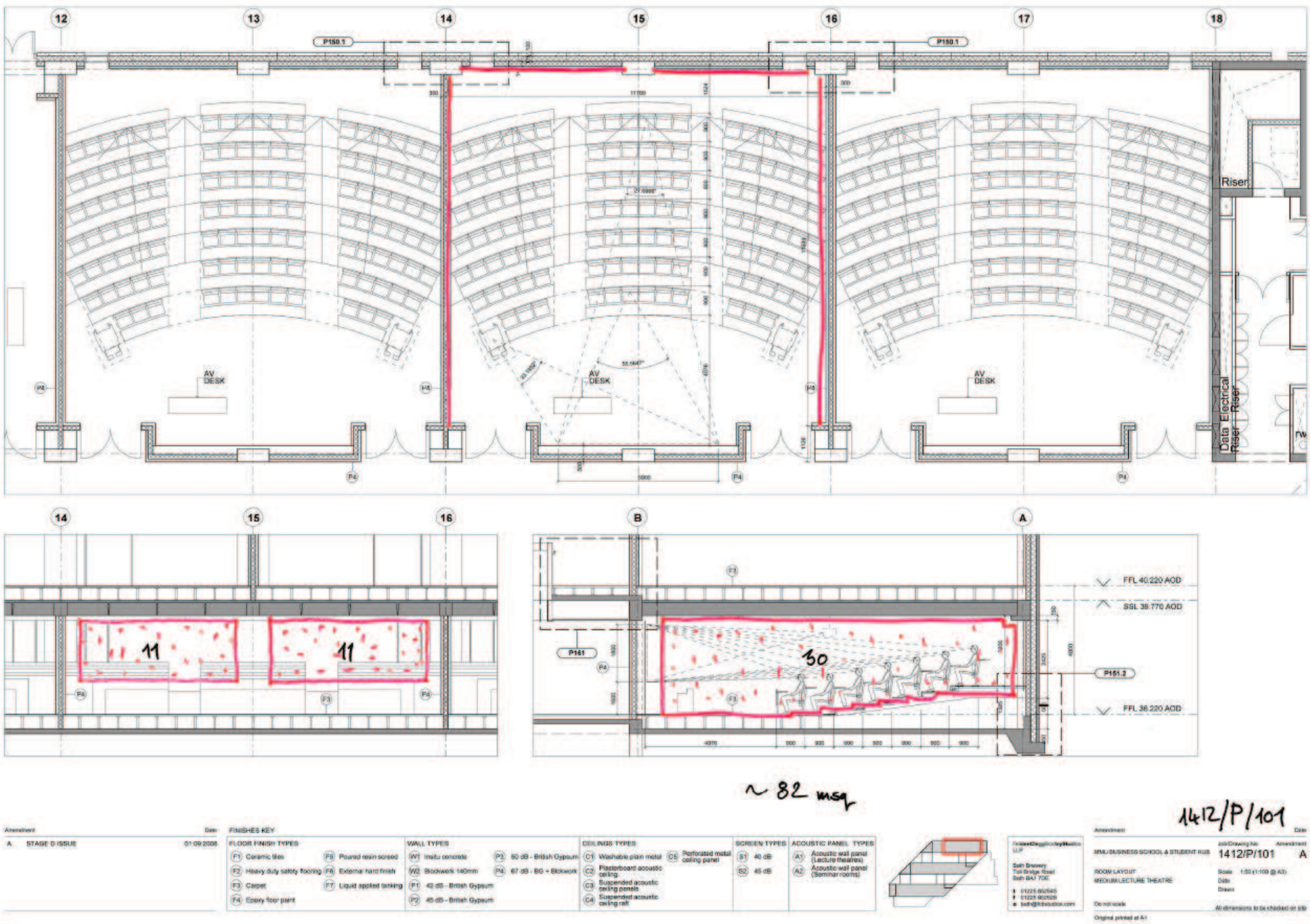

P-111
P-121
Amendment
Date
A Stage D Issue
Amendment
Date
MMU BUSINESS SCHOOL & STUDENT HUB
Job/Drawing No
1412/P/027
A
LEVEL 7 PLAN
Scale
Date
Drawn
Do not scale
All dimensions to be checked on site
Original printed at A1

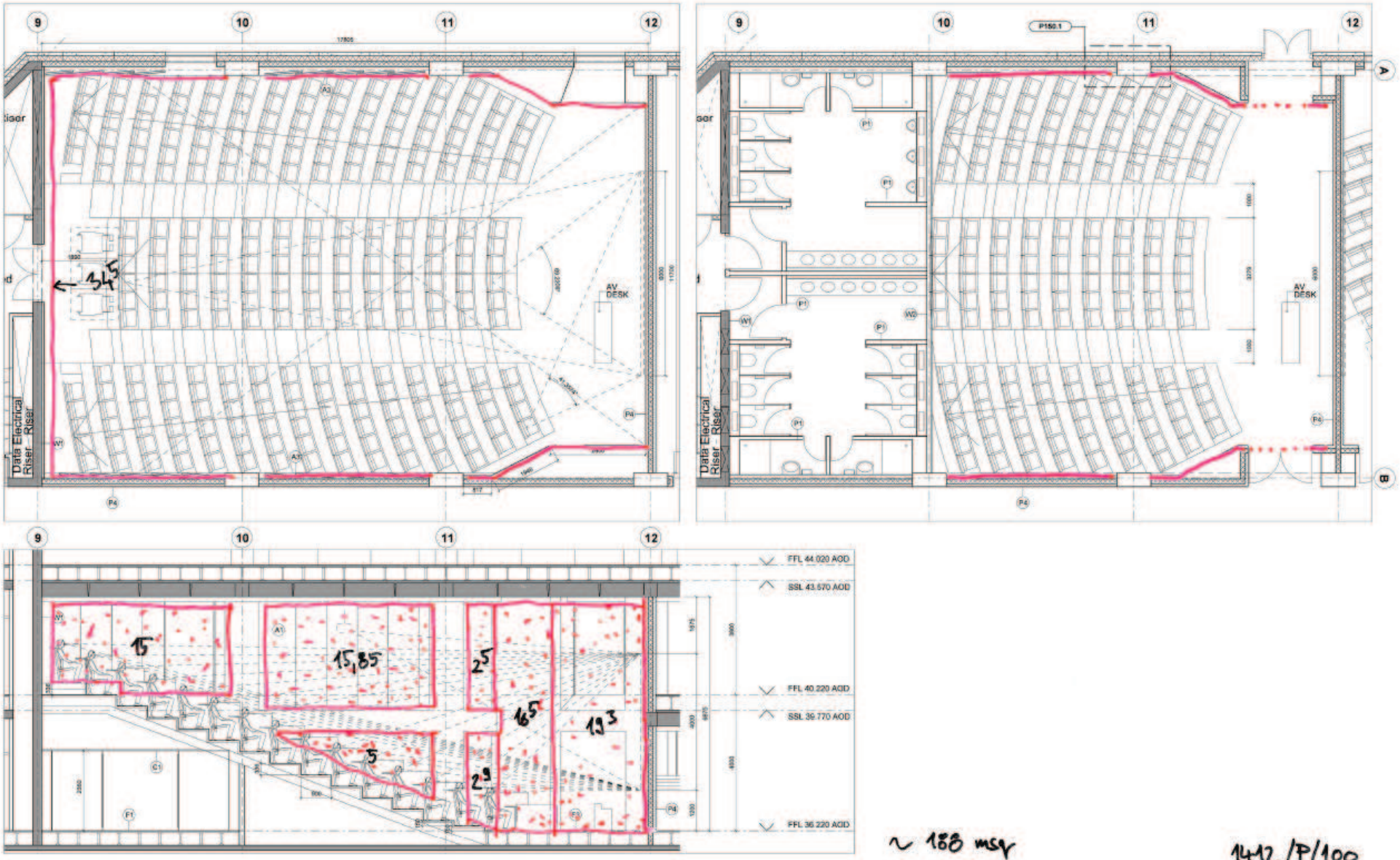

P-111
P-121
PLANT AREA
Amendment
Date
A Stage D Issue
Amendment
Job/Drawing No
1412/P/028
A
LEVEL 8 PLAN
Scale
Date
Drawn
Do not scale
Original printed at A1


PARAPET TO PERIMETER WITH LOUVRES TO INSIDE OF UPSTAND WHERE REQUIRED
STANDING SEAM COMPOSIT PANEL ROOF TO ALLOW FOR INSTALLATION OF PHOTOVOLTAICS ABOVE
ROOF ACCESS 1 (HATCH)
CLEAR ROOF LIGHT IN CURTAIN WALLING SYSTEM
OPAQUE PANEL IN CURTAIN WALLING SYSTEM
WALKWAY TO PERIMETER OF ROOF
GUTTER WITH SYPHONIC DRAINAGE SYSTEM (WITH OVERFLOW GARGOYLES TO FACADE)
ROOF ACCESS 2 (HATCH)
HORIZONTAL LOUVRES
ROOF CANOPY
ROUND ROOFLIGHTS
SEDUM BALLASTED ROOF
Amendment
Date
A Stage D Issue
Amendment
Date
Job/Drawing No
Amendment
1412/P/029
A
ROOF PLAN
Scale 1:200 (1:400 @ A3)
Date
Drawn
Do not scale
All dimensions to be checked on site
Original printed at A1

Appendix F: Surfaces Available For Acoustic Treatment in Lecture Theatres


12
13
14
15
16
17
18
A
AV DESK
AV DESK
AV DESK
AV DESK
Riser
Data Electrical Riser
Riser
P4
6,4
13,6
B
A
P161.1
P161
FFL 44.020 AOD
SSL 43.570 AOD
FFL 40.220 AOD
SSL 39.770 AOD
33
~ 53
Amendment
Date
A STAGE D ISSUE 01.09.2008
FINISHES KEY
FLOOR FINISH TYPES
F1 Ceramic tiles
F2 Heavy duty safety flooring
F3 Carpet
F4 Epoxy floor paint
F5 Poured resin screed
F6 External hard finish
F7 Liquid applied tanking
WALL TYPES
W1 Insitu concrete
W2 Blockwork 140mm
P1 42 dB - British Gypsum
P2 45 dB - British Gypsum
P3 50 dB - British Gypsum
P4 67 dB - BG + Blckwork
CEILINGS TYPES
C1 Washable plain metal
C2 Plasterboard acoustic ceiling.
C3 Suspended acoustic ceiling panels
C4 Suspended acoustic ceiling raft
C5 Perforated metal ceiling panel
SCREEN TYPES
S1 40 dB
S2 45 dB
ACOUSTIC PANEL TYPES
A1 Acoustic wall panel (Lecture theatres)
A2 Acoustic wall panel (Seminar rooms)
Amendment
Date
1412/P/102
MMU BUSINESS SCHOOL & STUDENT HUB
1412/P/102
A
ROOM LAYOUT
SMALL LECTURE THEATRE
Scale 1:50 (1:100 @ A3)
Date
Drawn
Do not scale
All dimensions to be checked on site
Original printed at A1


12
13
14
15
16
17
18
P150.1
P150.1
Riser
AV DESK
AV DESK
AV DESK
Data Electrical Riser
Riser
P4
P4
P4
P4
14
15
16
B
A
11
11
30
P161
P151.2
FFL 40.220 AOD
SSL 38.770 AOD
FFL 36.220 AOD
~ 82 msq
1412/P/101
Amendment
Date
A STAGE D ISSUE 01.09.2008
FINISHES KEY
FLOOR FINISH TYPES
F1 Ceramic tiles
F2 Heavy duty safety flooring
F3 Carpet
F4 Epoxy floor paint
F5 Poured resin screed
F6 External hard finish
F7 Liquid applied tanking
WALL TYPES
W1 Insitu concrete
W2 Blockwork 140mm
P1 42 dB - British Gypsum
P2 45 dB - British Gypsum
P3 50 dB - British Gypsum
P4 67 dB - BG + Blckwork
CEILINGS TYPES
C1 Washable plain metal
C2 Plasterboard acoustic ceiling
C3 Suspended acoustic ceiling panels
C4 Suspended acoustic ceiling raft
C5 Perforated metal ceiling panel
SCREEN TYPES
S1 40 dB
S2 45 dB
ACOUSTIC PANEL TYPES
A1 Acoustic wall panel (Lecture theatres)
A2 Acoustic wall panel (Seminar rooms)
Amendment
Date
MMU BUSINESS SCHOOL & STUDENT HUB
ROOM LAYOUT
MEDIUM LECTURE THEATRE
Job/Drawing No
1412/P/101
Amendment
A
Scale 1:50 (1:100 @ A3)
Date
Drawn
Do not scale
All dimensions to be checked on site
Original printed at A1


9
10
11
12
AV DESK
Data Electrical Riser - Riser
P150.1
FFL 44.020 AOD
SSL 43.570 AOD
FFL 40.220 AOD
SSL 39.770 AOD
FFL 36.220 AOD
~ 188 m²
1412/P/100
FINISHES KEY
FLOOR FINISH TYPES
WALL TYPES
CEILINGS TYPES
SCREEN TYPES
ACOUSTIC PANEL TYPES
STAGE D ISSUE
MMU BUSINESS SCHOOL & STUDENT HUB
LARGE LECTURE THEATRE
ROOM LAYOUT