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DRAWING TITLE

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REPORT AS8175.161027.E.2

UCLH PHASE 4 AND PROTON BEAM THERAPY (PBT) UNIT

DEVELOPED ARCHITECTURAL ACOUSTIC DESIGN
STAGE E
100%

Prepared: 22 December 2016

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List of Attachments

1.0 INTRODUCTION

This report is intended to convey the fundamental architectural acoustic design principles to be adopted within the development of the UCLH Phase 4 PBT Unit at the Rosenheim Building and Former Odeon site on Grafton Way, London, WC1E 6DB.

A number of planning conditions relate to the acoustic performance of the building. Several of these are addressed in this report

2.0 ACOUSTIC CRITERIA

The project brief seeks the award of Building Research Establishment Environmental Assessment Measurement [BREEAM] credits, understood to be assessed under BREEAM New Construction Non-Domestic Buildings Technical Manual SD5073-3.0:2011.

Issue Hea 05 of the BREEAM document requires acoustic design and commissioning in accordance with the requirements of Health and Technical Memorandum (HTM) 08-01: *Acoustics* [HTM 08-01]. Pol 05 requires assessment of environmental noise emissions, although these requirements are less onerous than those of the London Borough of Camden [LBC].

2.1 INTERNAL NOISE LEVELS

Ambient internal noise levels required from external sources and internal building services for typical room types, as required by HTM 08-01, are shown in Table 2.1.

Room Type	External Noise Intrusion, $L_{Aeq,1h}$ (dB)	Building Services, NR
Private offices	40	35
Treatment rooms		
Consulting rooms		
Interview Rooms		
Single bed ward	40 daytime (7am – 11pm) 35 night-time (11pm – 7am)*	30
Open clinical areas	45	40
Operating theatres	40**	40
Recovery rooms	-	35
Large meeting rooms, seminar rooms and board rooms (>35m^2 floor area)	35	30
Small meeting rooms, seminar rooms and board rooms (≤35m^2 floor area)	40	35
Laboratories	45	40 (no fume cupboards) 60 (at 1m from fume cupboard with open sash)
Small food preparation areas	50	40
WCs/bathrooms	55	45
Circulation, atria	55	40
Dining areas, waiting areas and playrooms	50	45
All occupied areas (emergency conditions)	N/A	50

* $L_{Amax,fast}$ at night from regularly-occurring events should not exceed 45dB

** Maximum value of 50dB L_{Amax} from intermittent events

Table 2.1 - Internal noise criteria (ref. HTM08-01) **[dB ref. 20µPa]**

2.2 EXTERNAL ENVIRONMENT

2.2.1 Internal Noise Breakout (Condition 25)

Planning condition no. 25 requires control of noise emanating from within the building affecting adjoining premises and the area generally.

2.2.2 *Drop-Off Zone/Service Yard (Condition 33)*

The drop-off zone and service yard will be fully covered and so risk increased levels of reverberant noise.

Assessment of typical impulsive noise sources, such as door slams and noise from vehicle engines, has shown that their effect on receptors on Grafton Way and Huntley Street is likely to be of negligible significance.

It is recommended, however, that UCLH implements a noise management policy for activity in the service yard in order to minimise adverse effects.

2.3 INTERNAL SOUND INSULATION - WALLS

Internal walls should be designed and constructed to ensure that airborne sound insulation complies with the requirements of HTM 08-01.

Aspects of this element of the design are discussed in more detail below.

2.4 INTERNAL SOUND INSULATION - FLOORS

Internal floors should be designed and constructed to ensure that airborne and impact sound insulation complies with the requirements of HTM 08-01.

The highest airborne sound insulation required under HTM 08-01 is $D_{nT,w}$ 57dB. In the courtyard building, the highest airborne sound insulation requirement is $D_{nT,w}$ 42dB.

The document also considers an impact sound level of $L'_{nT,w}$ 65dB (or lower) to be reasonable.

These values are to be adopted for the Phase 4/PBT development.

2.5 SOUND REDUCTION - DOORS

HTM 08-01 provides the following advice on doors.

> *Doors are inevitably a weakness in a partition and will reduce the overall acoustic performance of most constructions.*
>
> *Reasonable acoustic performance cannot be achieved without seals around the whole door perimeter, including threshold and meeting stiles. It is recognised that there can be significant restrictions on the use of door seals; therefore, doors should be sealed as far as practically possible.*
>
> *Possible conflicts with the desired acoustic performance include opening force (including under emergency conditions), infection control, patient safety (for example if double-swing*

doors are required) and ventilation regimes. Designers should make an informed decision about the provision of door seals when the other restrictions are considered.

The Trust's Infection Control has confirmed that, whilst fitting of door seals to the head and jambs is acceptable, no door seals can be fitted at door bottoms.

As such, moderate privacy levels can be achieved between wards, consultation and examination rooms and adjoining waiting areas or corridors where ambient noise is maintained at, or as close as possible to, the levels shown in Table 2.1.

Airborne sound insulation between adjoining rooms where doors are closely aligned will also be limited as a result of sound transfer beneath doors.

2.6 SOUND REDUCTION – MOVABLE/FOLDING PARTITIONS

The following advice is given in HTM 08-01:

Movable/folding partitions may be beneficial for operational reasons, but the acoustic performance of these partitions is limited. They are not recommended where speech privacy is required and/or where it will not be acceptable to have any noise disturbance from one room to another.

The Client should, therefore, review the instances of this type of partition. Where speech privacy is deemed critical, the option of using fixed partitions should be considered or the costs of suitable systems ascertained to ensure adequate allowance is made in the building budget.

2.7 ROOM ACOUSTICS

HTM 08-01 generally advises that:

Sound-absorbent treatment should be provided in all areas (including all corridors), except acoustically unimportant rooms (for example storerooms etc), where cleaning, infection-control, patient-safety, clinical and maintenance requirements allow.

The absorbent treatment will normally be a ceiling. However, floor finishes (for example carpet) or wall panels may also be considered.

Washable, acoustically-absorbent materials will be required in some areas within the infection-control regime.

Acoustically-absorbent materials should have a minimum absorption area equivalent to a Class C absorber (as defined in BS EN ISO 11654:1997) covering at least 80% of the area of the floor, in addition to the absorption that may be provided by the building materials normally used. If a Class A or B absorbent material is used, less surface area is needed.

Within atria, the following is also stated;

> *Acoustic absorption is likely to be needed in large open spaces such as atria, particularly in localised areas within it (for example reception areas and cafeterias). A reverberation-time criterion should be agreed depending on the specific requirements for use of the space.*

Atria should strike a balance between controlled reverberation levels and the visually perceived/expected character of the space. The following criterion is recommended as an optimum.

	Reverberation Time, secs (average of values in 500Hz, 1kHz and 2kHz octave bands)
Atrium	2 - 2.5

Table 2.2 - Reverberation time criteria

3.0 ARCHITECTURAL DESIGN REVIEW & RECOMMENDATIONS

Scott Tallon Walker's drawings and information provided by other members of the design team have been used to inform the following review.

3.1 CURTAIN WALLING SPECIFICATION

3.1.1 Sound Insulation

All proprietary glazing elements of the building fabric shall be tested in accordance with BS EN ISO 10140-2:2010 in a UKAS accredited laboratory.

The quoted minimum sound reduction specifications apply to the panels and windows, including frames, seals, etc. Glass performance is not an acceptable means of demonstrating compliance with the specification for window performance.

This will involve testing in 1/3rd octaves from at least 100Hz to 3150Hz inclusive. The test samples must be representative of the design proposals for the relevant façades as set out in the specifications below. This shall include glass, framing, seals, opening lights, etc. The results from the tests should be converted into octave band values by the method approved in the above test document.

The following minimum sound reduction indices shall be achieved:

Sound Reduction Index dB	Octave Band Centre Frequency (Hz)						R_w
	125	250	500	1k	2k	4k	
External Façades							
Type A.1	38	43	46	50	50	47	49
Type A.2	34	40	43	47	47	44	46
Type B	32	38	41	45	45	42	44
Type C	30	36	39	43	43	40	42
Type D	20	24	27	31	34	33	31
Atrium Façades							
Type E	N/A						41
Type F	No Acoustic Rating						

Table 3.1 – Facades – Preliminary acoustic requirements [dB ref. 20µPa]

The general locations of these system types are indicated on the marked up façade sketches provided in Appendix A and summarised in the following table:

Elevation	Floor	Glazing type required
Double Aspect Room on TCR & Grafton Way	1-3	Type A.1
Tottenham Court Road	1-3	Type A.2
Grafton Way – TCR side	1-3	Type B
Grafton Way – Huntley St. side	1-5	Type C
TCR & Grafton Way	4-5	Type C
Huntley Street	All	Type D
University Street	All	Type D
Courtyards / Atrium Extension	All	Type D
Atrium to Sensitive Rooms	Ground – 5th	Type E
Atrium to Circulation Areas	Ground – 5th	Type F

Table 3.2 - Placement of glazing types

Type A.1 glazing system occurs in the limited scenario of a bedroom at the corner of Tottenham Court Road (TCR) and Grafton Way facades being exposed on both aspects. An appropriate secondary glazing unit, internal to the primary façade system, is expected to provide acceptable acoustic performance in this scenario.

Type A.2 glazing system is required for bedrooms on the TCR Façade having a single aspect. The requisite performance is expected to be provided by a suitably selected double or triple glazed unit and framing system.

Type B glazing system is required for bedrooms on the Grafton Way Façade with an open view of TCR. The request performance is expected to be provided by a suitably selected double or triple glazed unit and framing system.

Type C glazing system is required for bedrooms on Grafton Way that benefit from an increased distance from TCR and non-sensitive rooms on the TCR and Grafton Way facade. The requisite performance is expected to be provided by a suitably selected double or triple glazed unit and framing system.

Type D glazing system is required for all used on facades without an open view of TCR and Grafton Way. The requisite acoustic performance is typically provided by a standard double or triple glazed curtain wall system.

Type E glazing system is required on sensitive rooms backing onto the main atrium. The requisite performance is expected to be provided by a suitably selected double glazed unit and framing system.

Type F glazing system is specified for rooms backing onto the atrium that do not have a requirement for acoustic separation.

3.1.2 Mullions or Cellular Partition Lines

Where appropriate, to control the flanking of partitions by cladding/mullions, the construction forming part of the external cladding shall be tested in accordance with BS EN ISO 10848-2:2006: *Acoustics - Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms - Part 2: Application to light elements when the junction has a small influence*, in a UKAS accredited, or international equivalent, laboratory. This will involve testing in one third octave bands from at least 100Hz to 3150Hz inclusive.

Using the method set out in ISO 717-1: 1996: *Rating of sound insulation in buildings and building elements Part 1: Airborne Sound Insulation*, the measured performance of the mullion adjusted for the floor to ceiling heights shall be not less than $D_{nF,w}$ 57dB.

Where acceptable to the Trust, the flanking sound insulation of mullions in agreed areas may be relaxed such that the flanking sound insulation, $D_{nF,w}$, is no less than 10dB greater than the sound insulation, as $D_{nT,w}$, of the abutting partition.

3.1.3 Floor Edge Detail

Where appropriate, in order to ensure that the flanking transmission for the joint between the external cladding and the concrete floor slabs maintains the required level of sound insulation between floors above and below, a typical proposed joint arrangement shall be tested in accordance with BS EN ISO 10848-2:2006: *Acoustics - Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms - Part 2: Application to light elements when*

the junction has a small influence, in a UKAS accredited, or international equivalent, laboratory. This will involve testing in one third octave bands from at least 100Hz to 3150Hz inclusive.

Using the method set out in ISO 717-1: 1996: *Rating of sound insulation in buildings and building elements Part 1: Airborne Sound Insulation*, the measured performance, corrected for site set-out shall not be less than $D_{nF,w}$ 60dB.

This requirement would be expected to be achieved where a concrete floor slab interrupts the internal lining of the external façade, and the movement gap at the slab edge is packed with a fire-stopping material. Nevertheless, the façade supplier should be required to provide tested evidence of a compliant design.

3.1.4 Noise Breakout (Planning Condition 25)

Parts of the building in which elevated levels of noise are expected, such as plantrooms, beam unit, etc., are located below ground and, as such would not produce significant levels of noise externally.

Internal areas on the facades are generally occupied and so will not generate exceptional levels of noise. The specification of the facades to control external noise intrusion will be capable of reducing these noise sources to levels of inaudibility externally.

An exception to this is the MRI scanner room located at ground level at the rear of the building. Scanner operation can produce internal noise levels of up to around 80dB(A) during some procedures. The Type 'D' building envelope in this zone is acoustically specified at R_w ≥31dB although, in order to achieve all technical requirements, the actual performance achieved is likely to be greater.

Calculations show that, on the basis of a typical façade system achieving sound reduction of R_w 31dB, noise levels at the nearest affected windows of the Paramount Court apartments due to MRI operation will be less than 30dB(A). This is significantly lower than the background noise level typical of this area and so would not be audible.

3.1.5 Drop-Off Zone (Planning Condition 33)

The drop-off zone will be used by private vehicles, taxis and ambulance transport to bring patients to the unit during daytime hours only. Emergency vehicles will not use the drop-off zone, which will not normally be used at night. The anticipated sources of noise within the drop-off zone, such as vehicle engines, door slams and speech, are within the context of other activity on Grafton Way.

Acoustic modelling of the zone assuming a fully acoustically-reflecting soffit has shown that maximum noise levels from car/ambulance transport door slams will be around 20dB lower than those from Grafton Way street activity, when assessed at Maple House. As such, this noise is not expected to adversely affect occupants of other nearby buildings.

Acoustically-absorbing finishes within the drop-off zone are not expected to be required on this basis.

Some absorption may be beneficial for the general comfort of people in the drop-off zone. This could, however, be achieved with a porous road surface.

3.2 PARTITIONS

The marked up plans provided in Appendix B show the in-situ acoustic ratings for internal partitions (indicated as $D_{nT,w}$ values) as prescribed by HTM 08-01 and required to achieve the relevant BREEAM credits.

Partition systems shall be reviewed against corresponding laboratory measured sound insulation (R_w) which would be expected to achieve the target $D_{nT,w}$ values.

Achieving the target specification between spaces relies on both the partition system and all flanking details, including doors and edge details providing compliant sound insulation performance. The following notes are made:

- As a minimum, all acoustic rated partitions are to extend from slab to soffit. It is possible that the performance of $D_{nT,w}$ 37dB partitions may be achieved with a floor to ceiling partition and appropriate ceiling void barriers, but this is considered a high risk approach and is not recommended where avoidable.

- The interface with structural columns and curtain walling details must be considered to avoid gaps or bridging of the two skins of partitions.

- Infill panels between columns and external flanking walls / mullions are a common point of acoustic failure and should be of equivalent construction to the remainder of the partition.

- Glass viewing panels between rooms should ideally have a comparable R_w value as the adjoining partition. For the higher rated partitions, this will necessitate double glazed screens with split frames and wide cavities with acoustic-lined reveals.

- Partitions that include a door to corridors are not rated under HTM 08-01. Speech privacy should be considered however, particularly where potentially sensitive rooms open out to waiting areas or operating theatres open out to recovery areas. Refer to Section 3.5.

- Services such as transfer grilles and pressure release flaps have the potential to limit the sound insulation to corridors. Refer to Section 3.6.

- It is good acoustic practice when using lightweight walls to ensure that back-to-back sockets and switches, etc. are avoided and are, ideally, located in adjacent stud bays. Use of backing boxes or ‘putty pad’ type liners may be suitable if off-setting is not possible.

- It is recommended that installers consult with system suppliers on the detailing of junctions and movement joints/deflection heads so as to minimise risk of degradation in sound insulation. Some example details are shown in Appendix C by way of illustration.

- Where no particular acoustic rating is required, selected partition types should be capable of achieving minimum sound reduction value R_w 40dB under laboratory testing.

As a guide to the builder, Table 3.3 shows the corresponding laboratory-determined sound reduction indices required of candidate partition systems based upon guidance contained within HTM 08-01. System suppliers should be consulted as to the validity of this in relation to their test data.

Room	Sound Insulation, dB $D_{nT,w}$	Laboratory Sound Reduction, dB R_w
Single Bed Wards	≥47	≥55
Multi-Bed Wards	≥37	≥42
Consultation/Examination/Consent	≥47	≥57
Operating Theatres	≥47	≥56
Recovery	≥47	≥54
Imaging	≥47	≥56
Change	≥42	≥54
Seminar Rooms	≥47	≥54
Offices	≥37	≥46
Meeting Rooms	≥42	≥50
Waiting Room	≥42	≥50

Table 3.3 – Common Partition Acoustic Ratings

Elsewhere, it is suggested that partition systems are selected using the following adjustments.

Room depth (normal to dividing wall), m	Laboratory Sound Reduction, dB R_w
≤3	$D_{nT,w}$ + 11
3 - 4	$D_{nT,w}$ + 9
4 - 5	$D_{nT,w}$ + 8
>5	$D_{nT,w}$ + 7

Table 3.4 – Other Partition Acoustic Ratings

It should be noted that acoustic framing and resilient bar systems are heavily reliant on correct installation and are easily compromised if screws are too long or incorrectly positioned such that they make contact with the central portion of the stud section.

3.2.1 Integrated Plumbing Systems

Integrated plumbing systems (IPS) are proposed to be incorporated within partitions in many areas. It is expected that, where the design of the IPS can be made to incorporate a high density acoustic laminate product[1] and minimum 25mm acoustic absorbent, the sound reduction index of the panels would exceed R_w 50dB. As can be seen from Table 3.5, inclusion of these panels could risk degradation of sound insulation between areas.

Calculations of possible degradation are summarised below.

Room	No IPS panels in partition	Effect on Sound Insulation, dB
Single Bed Ward	1	Negligible
	2	-1
Consultation/Examination	1	-1

Table 3.5 – Effect of IPS (assumed at R_w ≥50dB)

Where located within acoustically critical partitions, therefore, the partition selection may need to be reselected to one providing higher sound reduction to account for this effect.

Where a single IPS panel is present in a partition, the use of the basic form, i.e. incorporating insulation and two layers of 12.5mm plasterboard, would be tolerable where the required sound insulation is $D_{nT,w}$ 42dB or lower. Acoustic laminate is recommended where the required sound insulation is above $D_{nT,w}$ 42dB.

Where two IPS panels are present in a partition, the use of acoustic laminate is recommended where the required sound insulation is $D_{nT,w}$ 39dB or above.

In addition, it must be ensured that all services penetrations through the IPS panel fascia are fully sealed.

3.3 MOVEABLE WALLS

Folding partitions are required to achieve acoustic ratings (≥$D_{nT,w}$ 47dB and 42dB). Experience suggests that, due to the additional flanking paths present in folding partitions, a higher rating should be specified in order to achieve the targeted in-situ performance. It is recommended that the folding partitions are specified as ≥R_w 55dB. These are likely to incur a significant cost and communication with potential suppliers at an early stage is important to ensure that a suitable structure is provided within which to fix the partition.

The movable wall must be capable of achieving the required sound reduction performance as a complete assembly. This must include seals, tracks, etc. The relevant test standard BS EN ISO 10140-2:2010 *Acoustics - Laboratory measurement of sound insulation of building elements -- Part 2: Measurement of airborne sound insulation* (and its predecessors) advises that:

[1] Siderise FIP (R_w 46dB at 31mm thickness) or similar

> *Preferably install the test partition in a manner as similar as possible to the actual construction with a careful simulation of normal connections and sealing conditions at the perimeter and at joints within the partition. The mounting conditions shall be stated in the test report.*

and that

> *If the test specimen is intended to be readily openable, it shall be installed for test so that it can be opened and closed in the normal manner. It shall be opened and closed at least five times immediately before testing.*

3.4 INTERNAL FLOORS

It is understood that internal floors within the main development are to comprise minimum 400mm thick structural concrete slabs with vinyl or linoleum flooring surface.

All floors are, consequently, expected to achieve the highest airborne sound insulation required under HTM 08-01 irrespective of the ceiling fitted beneath and will, therefore, satisfy the requirements of the project.

Above-ground floors within the courtyard building are to be based on a re-entrant profiled metal deck with overall 150mm thickness of concrete and vinyl or linoleum flooring surface. With a plasterboard ceiling suspended below, sound insulation values in excess of $D_{nT,w}$ 42dB are expected.

The impact sound insulation is expected to be compliant with the requirements of HTM 08-01 where a ceiling is hung below the slab.

3.5 INTERNAL DOORS

HTM08-01 (paragraphs 2.75 and 2.76) provides the following advice regarding the provision and specification of acoustic ratings for doorsets.

> *Solid-core door blanks (minimum 21 kg/m^2) should be used for access from corridors, and these are capable of achieving an acoustic performance in the range R_w 30-35 dB. …. If seals are not to be provided, the overall performance of the doorset will be in the range R_w 20-25 dB.*
>
> *Doorsets should be designed so that air gaps between the door blank and the frame are closed (for example by using stops on the door frame).*

Allowance should be made for solid-core door blanks (minimum superficial density 21kg/m^2, as recommended by HTM 08-01) in close-fitting rebated frames. Double doorsets should have a rebated meeting stile.

Rebates should be fitted with acoustic compression seals, e.g. of 'batwing' type, to the head and jambs. Gaps at door bottoms should be reduced as far as practicable.

Where adjacent rooms have doorsets to the corridor in close proximity to each other, sound flanking beneath doors will still limit the sound insulation performance between rooms. Flanking through single doorsets via corridors might be expected to compromise $D_{nT,w}$ 47dB and higher partitions. Double, swinging doorsets might be expected to compromise $D_{nT,w}$ 42dB and higher partitions.

3.6 PRESSURE RELIEF/AIR TRANSFER

Where door undercuts are insufficient for make-up air transfer between rooms, it is proposed to use 'up and over' transfer ducts within the ceiling space.

Where these are located above an acoustically-critical door or partition, sound attenuation should be incorporated to control crosstalk.

Connection of the grille/plenum to rigid ductwork within the ceiling void is to be by means of flexible ductwork. Where this ductwork is of an insulated acoustic type, such as Lindab Tecsonic 400s, additional attenuation is unlikely to be required.

Otherwise crosstalk attenuation will be required, either as a bespoke silencer or an acoustic insert, such as Hotchkiss Soundpac.

3.7 INTERNAL FINISHES

The preferred design involves clinical areas and wards having a skimmed and painted plasterboard ceiling. This does not meet the requirements of HTM 08-01, which requires that 80% of the ceiling area is fitted with an alternative finish providing at least Class C absorption. This equates to a reverberation time of around 0.6 seconds.

Smaller areas of more efficient absorbers, i.e. Class A or B, can provide the same amount of effective sound absorption.

3.7.1 Wards

The Trust has accepted Class C perforated plasterboard ceilings within wards at the required 80% coverage.

3.7.2 *Corridors*

Corridor areas are proposed with a central band of perforated metal tiles (SAS System 150 or equivalent), and additional Class C perforated plasterboard with acoustic fleece backing above staff bases. Compliant levels of sound absorption are achieved where the metal tile coverage is at least 50% of the floor area.

3.7.3 *Office Areas / Imaging*

Office areas and imaging areas are generally indicated as having a perforated metal or mineral fibre ceiling tile. Such tiles are typically rated as Class C, or better, absorbers.

3.7.4 *Reception / Atrium*

The undersides of balconies are currently indicated as a PPC Aluminium System. This should be made to be an absorptive finish with Class A performance, such as SAS perforated tile with 40mm acoustic pad at the rear.

Solid areas of the atrium ceiling should be formed of a similar Class A absorber.

Furniture and other contents within the atrium are expected to control reverberation to within the target range.

3.8 DETAILING GENERALLY

3.8.1 *Junctions*

Junctions between acoustically-critical partitions and flanking constructions must ensure that sound insulation is not compromised significantly. The sketches shown in Appendix B have been taken from HTM 08-01 in order to illustrate these requirements.

3.8.2 *Services Penetrations*

Typical details are shown in Appendix C.

4.0 SPECIFIC CASES

4.1 BEAM THERAPY UNIT

The Proton Beam Therapy (PBT) unit is located at Basement Level 4. It is expected that the beam unit will be highly sensitive to structural vibration. The structural engineering drawings, however, show the supporting slab to be 2m thick. This is likely to prevent the beam unit from being subjected to significant levels of vibration from the nearby LUL tunnels.

Other than the mazes, the beam unit walls and 'lid' are formed of 2m thick concrete. Any noise generated by the beam unit is unlikely to be audible from within the adjoining areas other than the restricted corridor and that leading to the maze access.

4.2 MRI SCANNER

The proposed MRI scanners are shown on at ground floor level. The MRI scanning process typically generates high levels of noise, ranging from a 'ringing' through 'chattering' to rapid impulses, often likened to gunshots. These can be transmitted into adjoining areas as airborne noise from the space generally and/or structure-borne noise due to scanner vibration.

Potential issues might, therefore, arise in the following locations;

- between the MRI room and the adjoining Ultra Sound room
- between the MRI room and the theatres below.

The latter issue would be avoided where the scanner and patient table can be effectively isolated from the structure. Scanner suppliers generally provide isolation pads which, when installed correctly beneath the unit, would be expected to adequately control transfer of vibration into the structure.

4.3 BASEMENT LEVEL 1 RECOVERY AREAS

These areas are effectively open to each other and surrounding corridors. As such, it will not be possible to achieve significant levels of sound insulation between them. The acoustic design will, therefore, consider these areas as a multi-bed ward.

4.4 HYDRAULIC AND WASTE SYSTEMS

In order to minimise risk of audible and intrusive noise from hydraulic and waste systems, all reasonable controls should be adopted and relevant guidance issued by the Institute of Plumbing and Heating Engineers should be observed.

The following are given as examples.

- Wherever possible, avoid horizontal offsets above noise-sensitive spaces such as wards and consulting/examination rooms;
- Minimise risk of water hammer by lowering operating pressures and/or through use of pressure snubbers. Regulate water pressure to the minimum satisfactory working pressure and, in any case, do not exceed 350 kPa;
- Adjust cistern fill times, particularly in toilets adjacent to quiet areas, to approximately 90 to 120 seconds;

- Avoid hard grouting and chasing of water pipes in masonry walls, particularly where walls are common with noise sensitive areas;
- In noise sensitive areas, support pipes with clamps having a soft neoprene sleeve;
- Provide cast iron or acoustically-treated plastic soil and waste pipes, e.g. Geberit dB20, in preference to lightweight pipes such as standard plastic and copper in sensitive areas unless acoustic wrappings/enclosures are used;
- Do not support pipework from lightweight constructions.

Horizontal offsetting pipework is to be formed of acoustically-enhanced plastic, such as Gerberit Silent dB20. Vertical stacks are to be of cast iron.

Where offsetting of wastes/SVP occurs above ward areas, it is recommended that additional acoustic lagging (min 50mm thick, 10kg/m^2 superficial density) is applied to the upstream bend and the following 1m of horizontal pipe.

5.0 CONCLUSIONS

The acoustic design criteria for the proposed development of the Phase 4 PBT at the Rosenheim Building and former Odeon site on Grafton Way, London, WC1E 6DB have been determined and confirmed.

Advice is given as to how these may be achieved within the general architectural and building services design.

Matt Sugden MIOA
CLARKE SAUNDERS ASSOCIATES

AS8175 UCLH PHASE 4 PBT

APPENDIX A

GLAZING SPECIFICATION

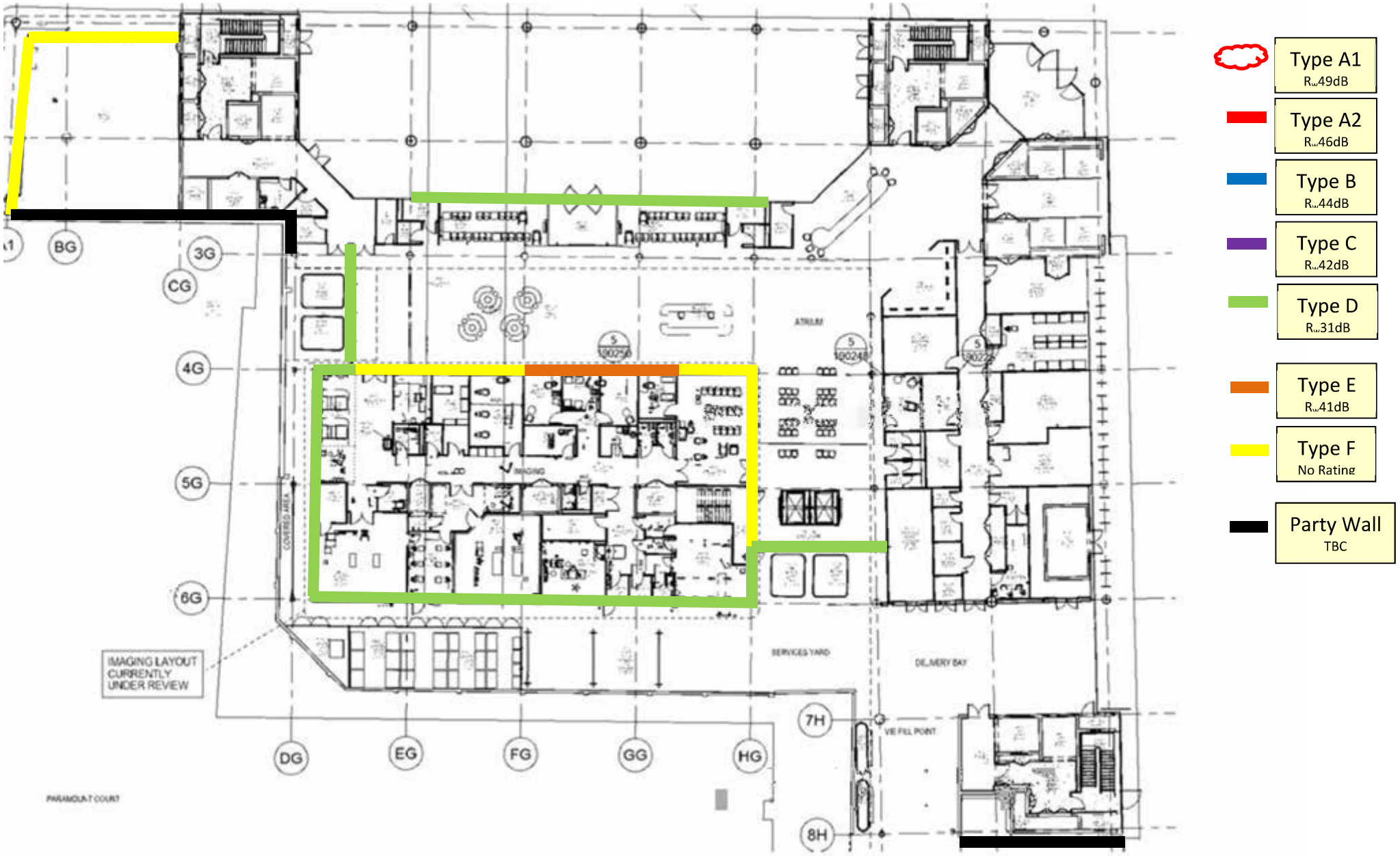


Figure AS8175/GS1

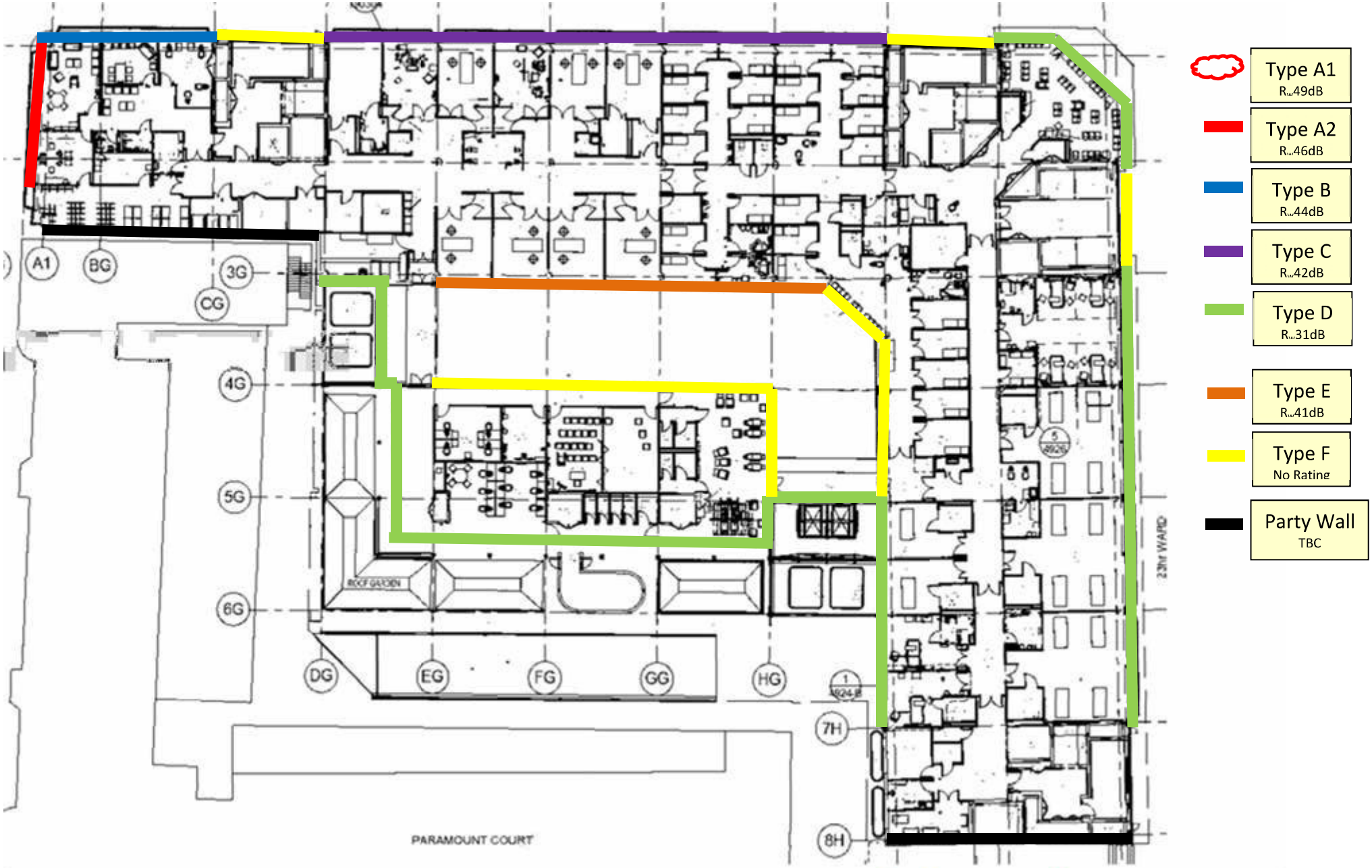
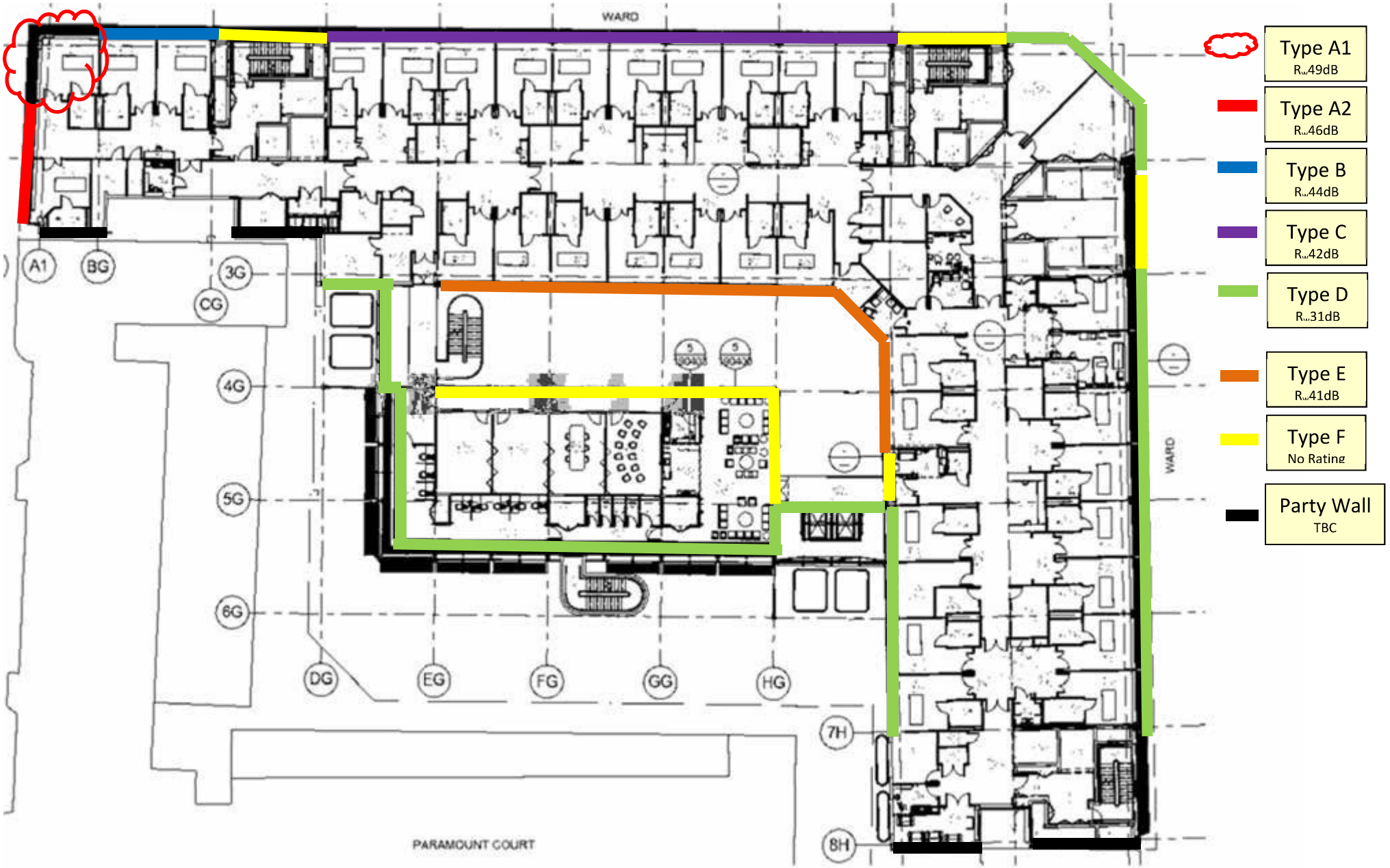


Figure AS8175/GS2



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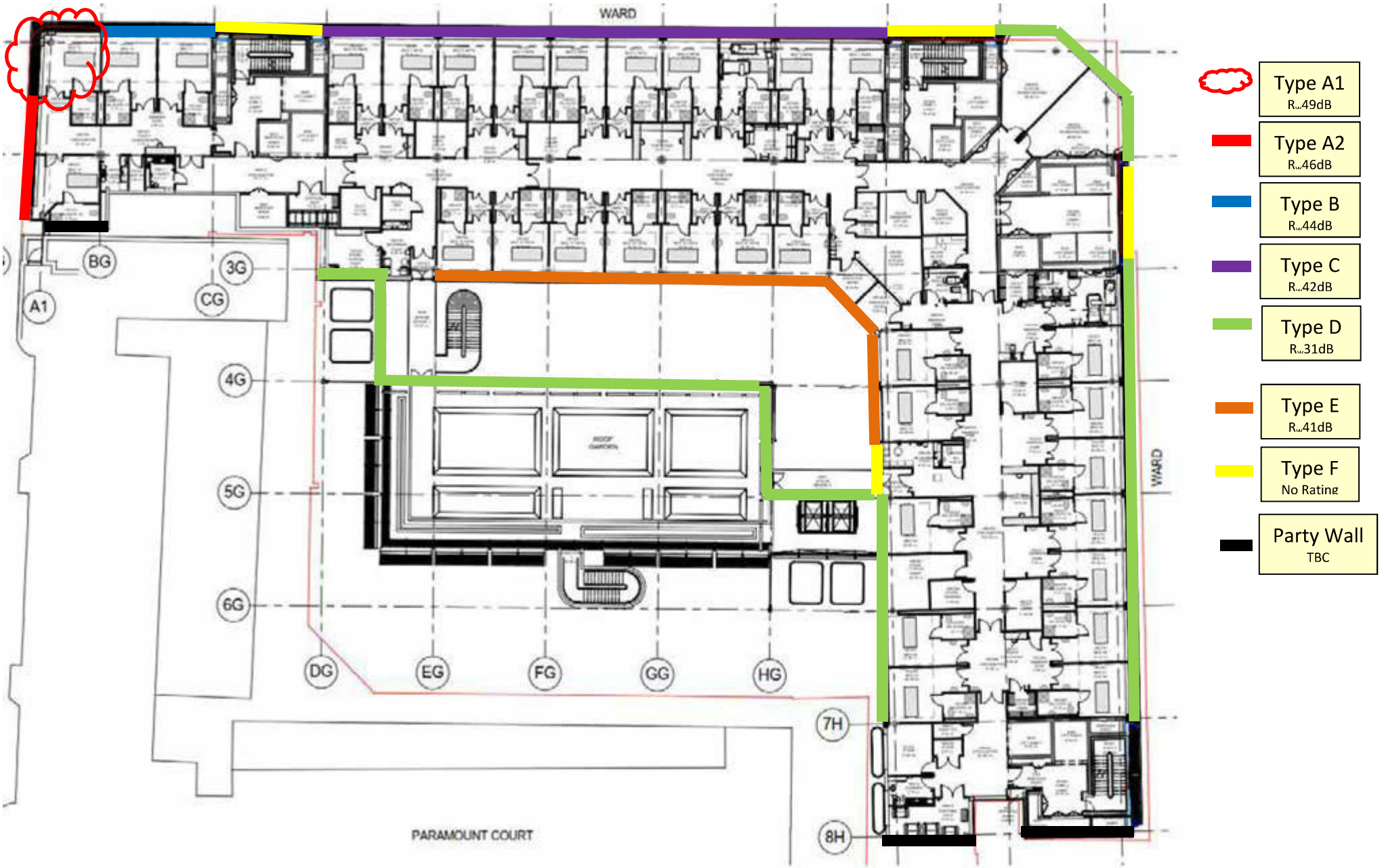


Figure AS8175/GS4

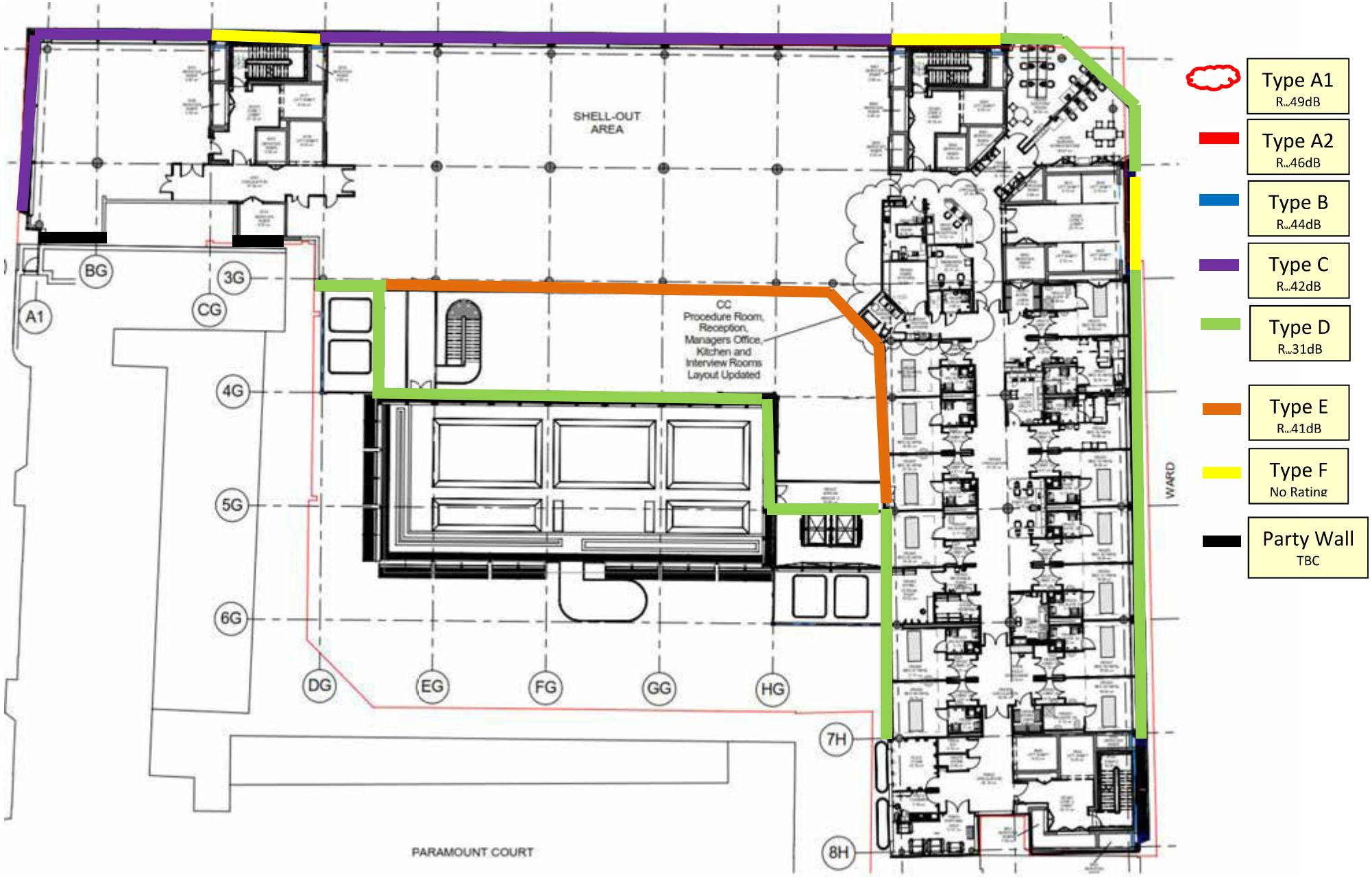


Figure AS8175/GS5

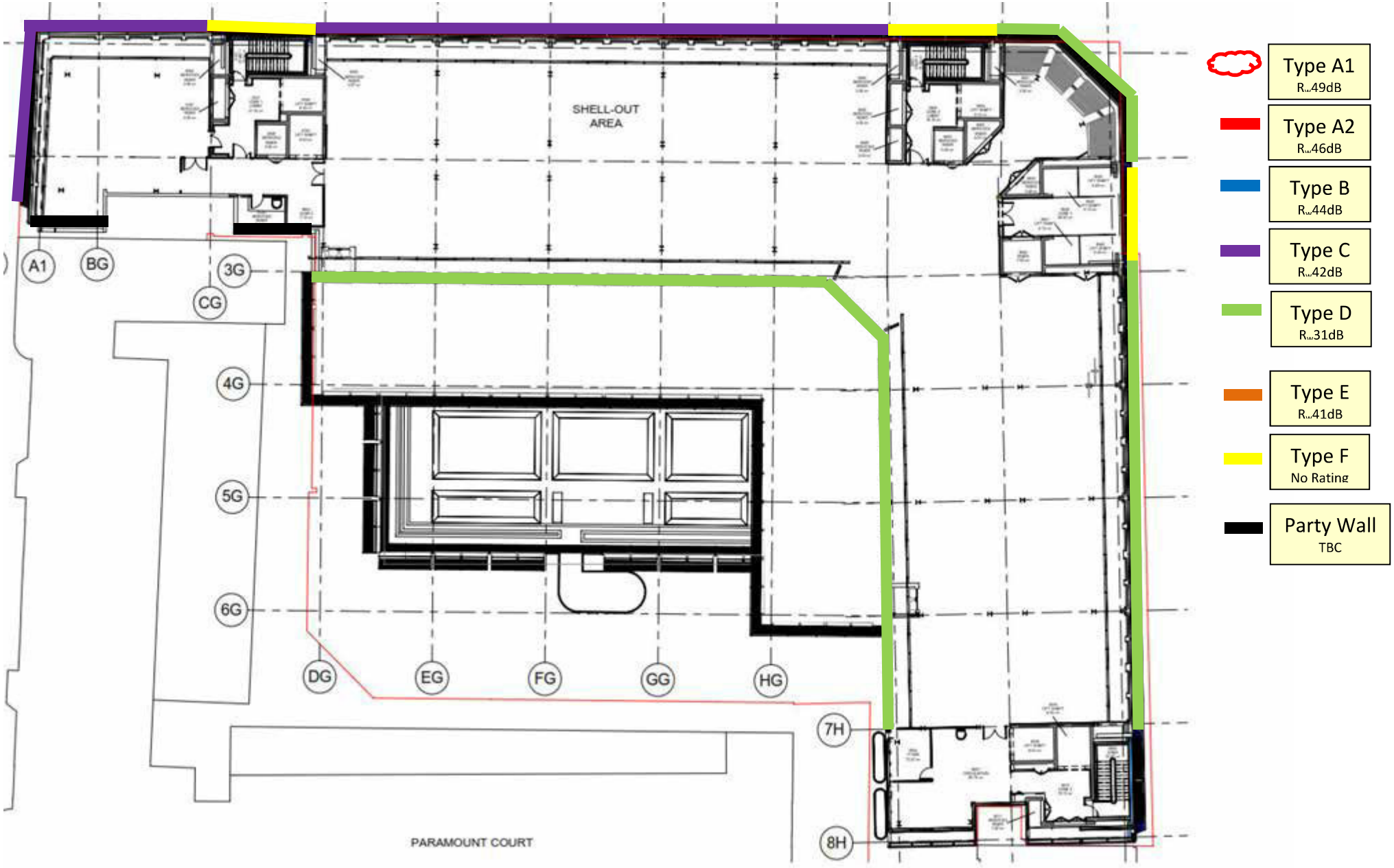
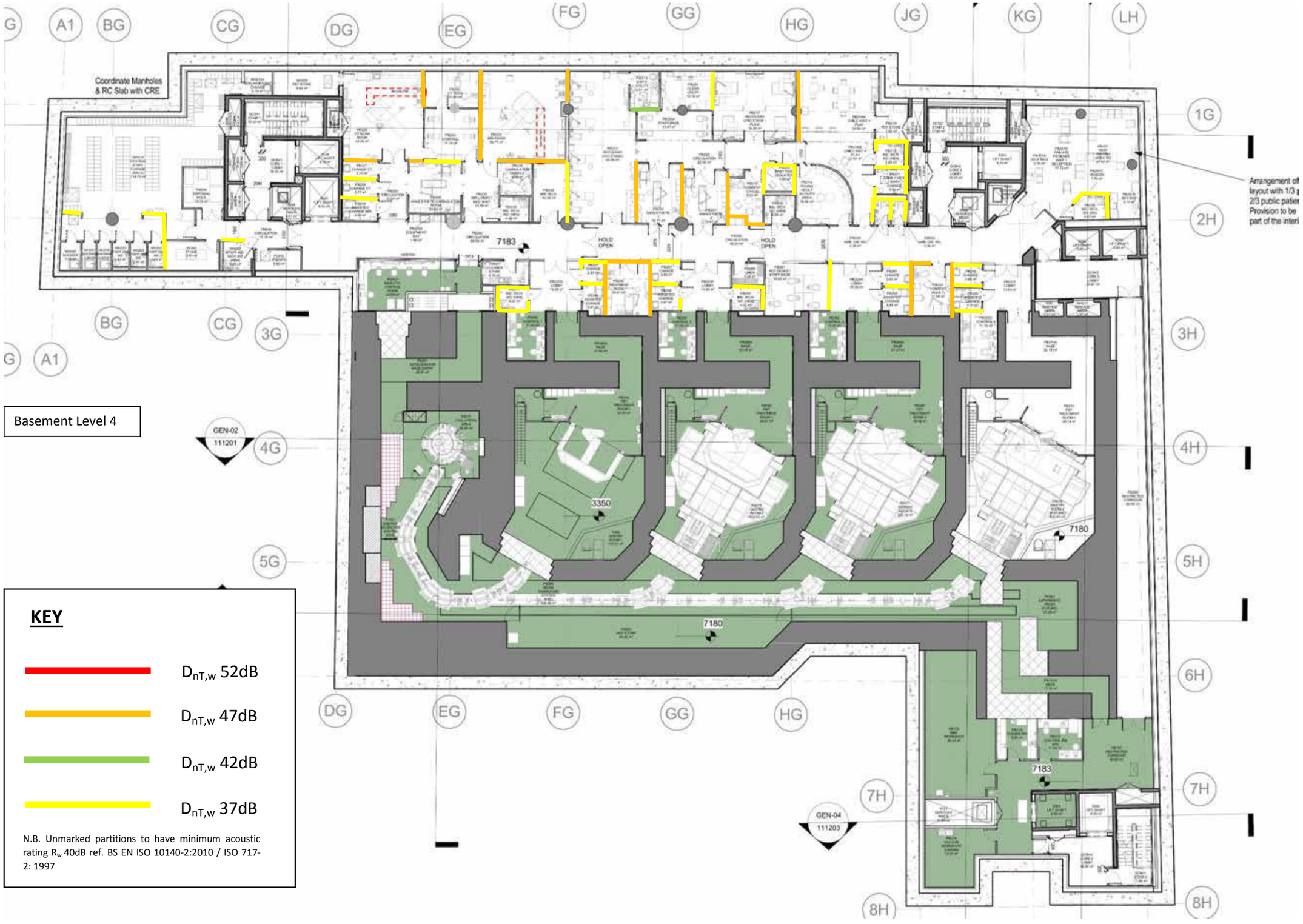


Figure AS8175/GS6

AS8175 UCLH PHASE 4 PBT

APPENDIX B

INTERNAL SOUND INSULATION PLANS



Basement Level 4

KEY

- $D_{nT,w}$ 52dB
- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

Basement Level 3

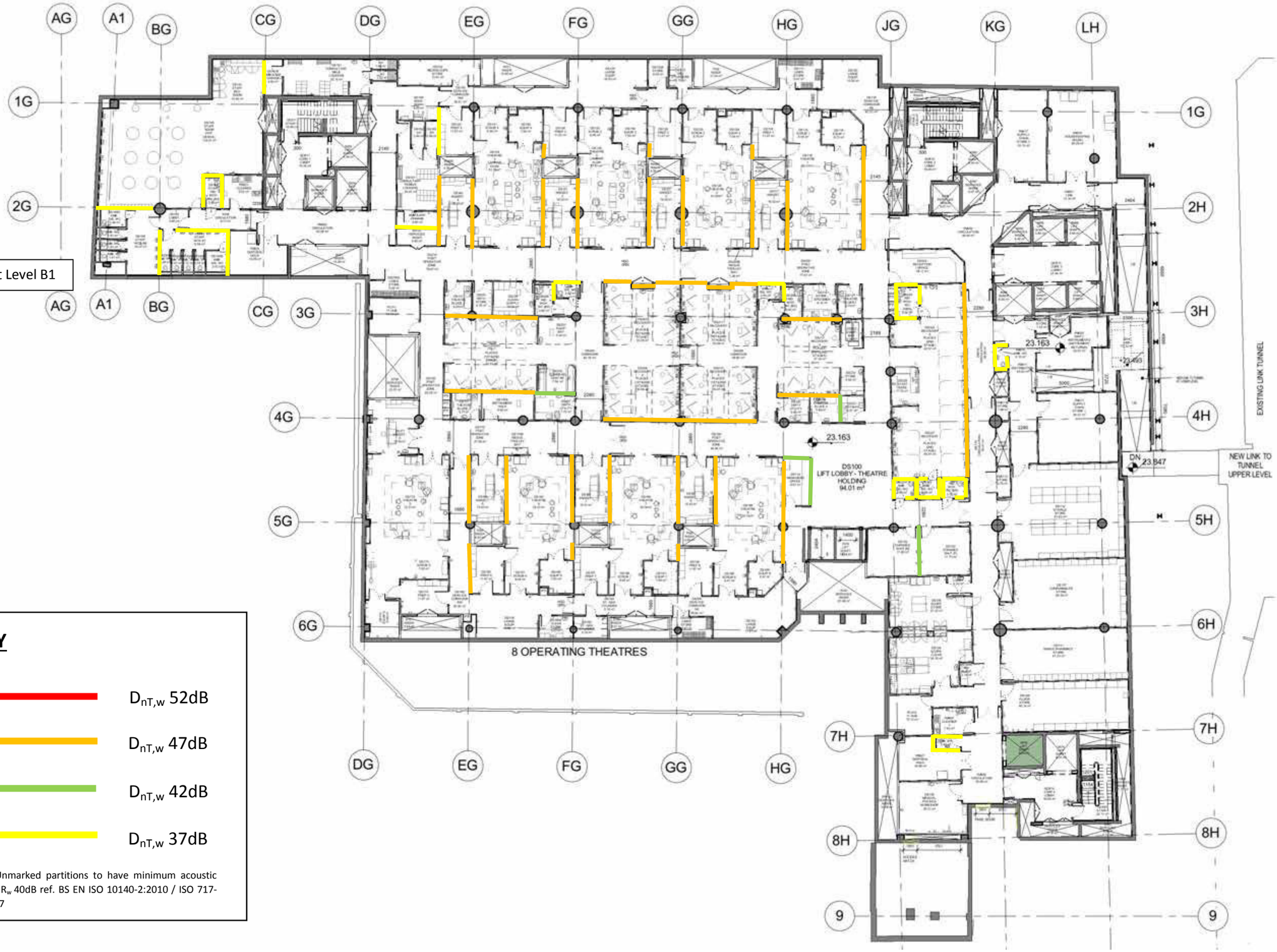
KEY

- $D_{nT,w}$ 52dB
- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

ics

Basement Level B1



KEY

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- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

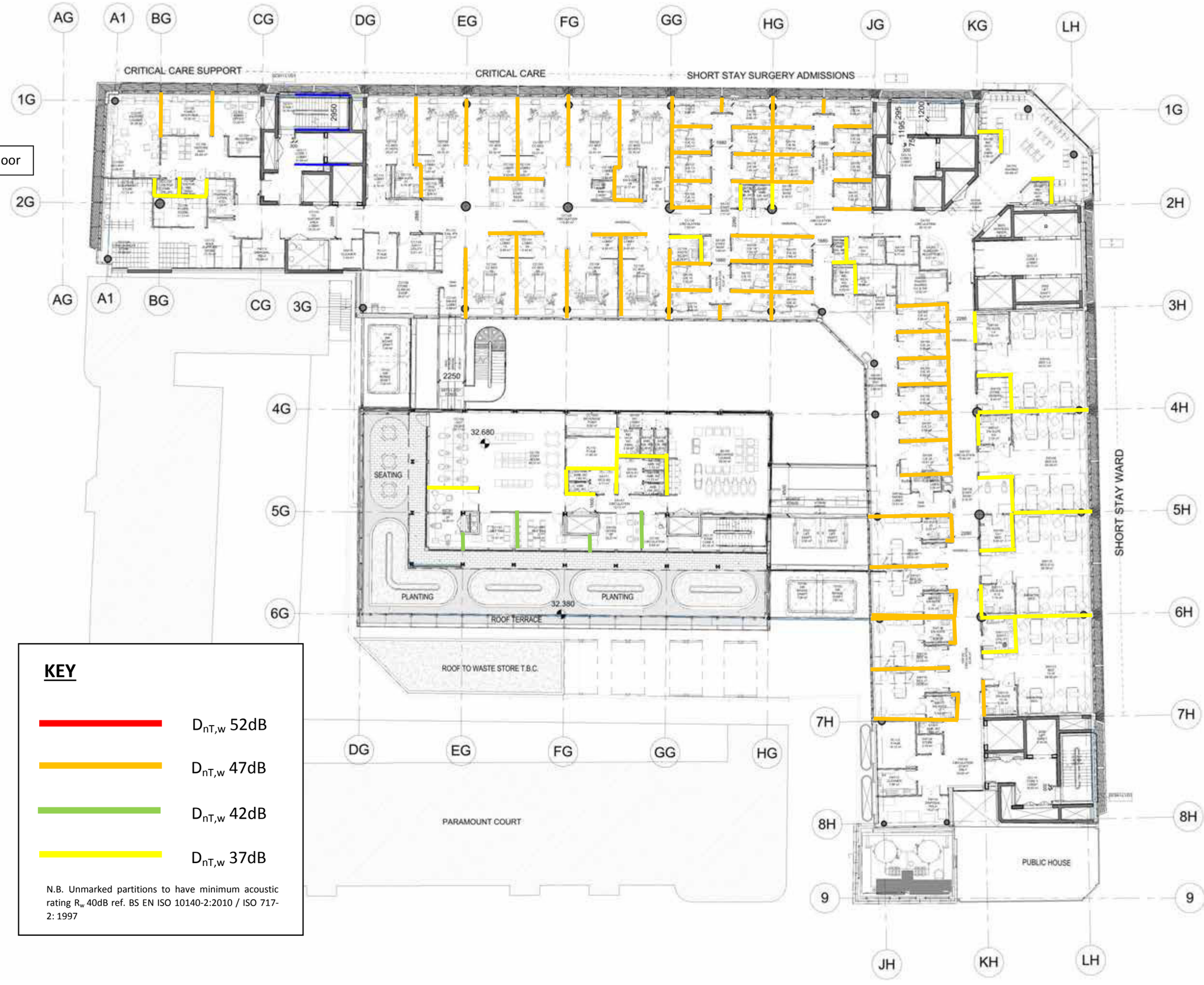
Ground Floor

KEY

- $D_{nT,w}$ 52dB
- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

First Floor

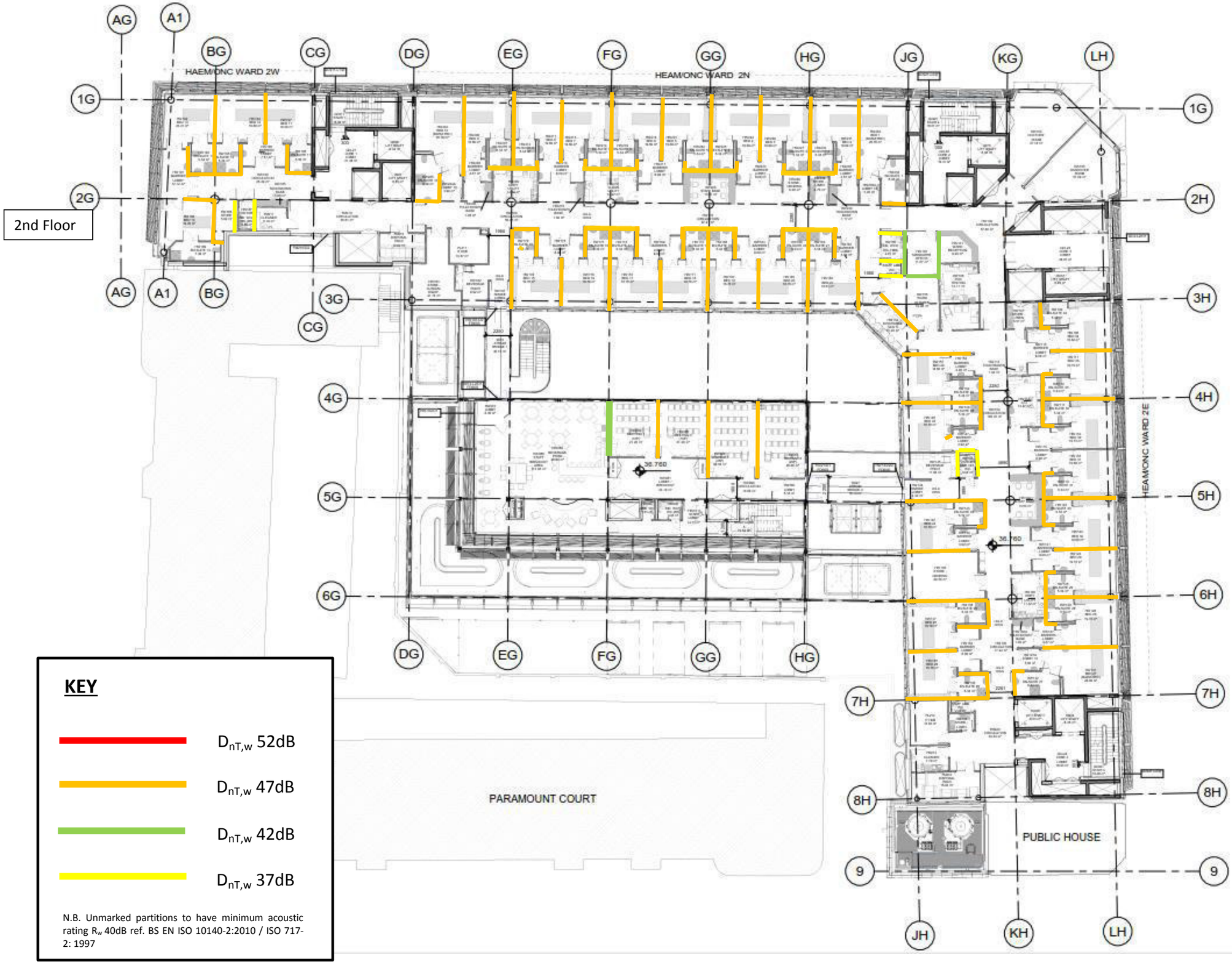


KEY

- $D_{nT,w}$ 52dB
- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

2nd Floor



KEY

$D_{nT,w}$ 52dB

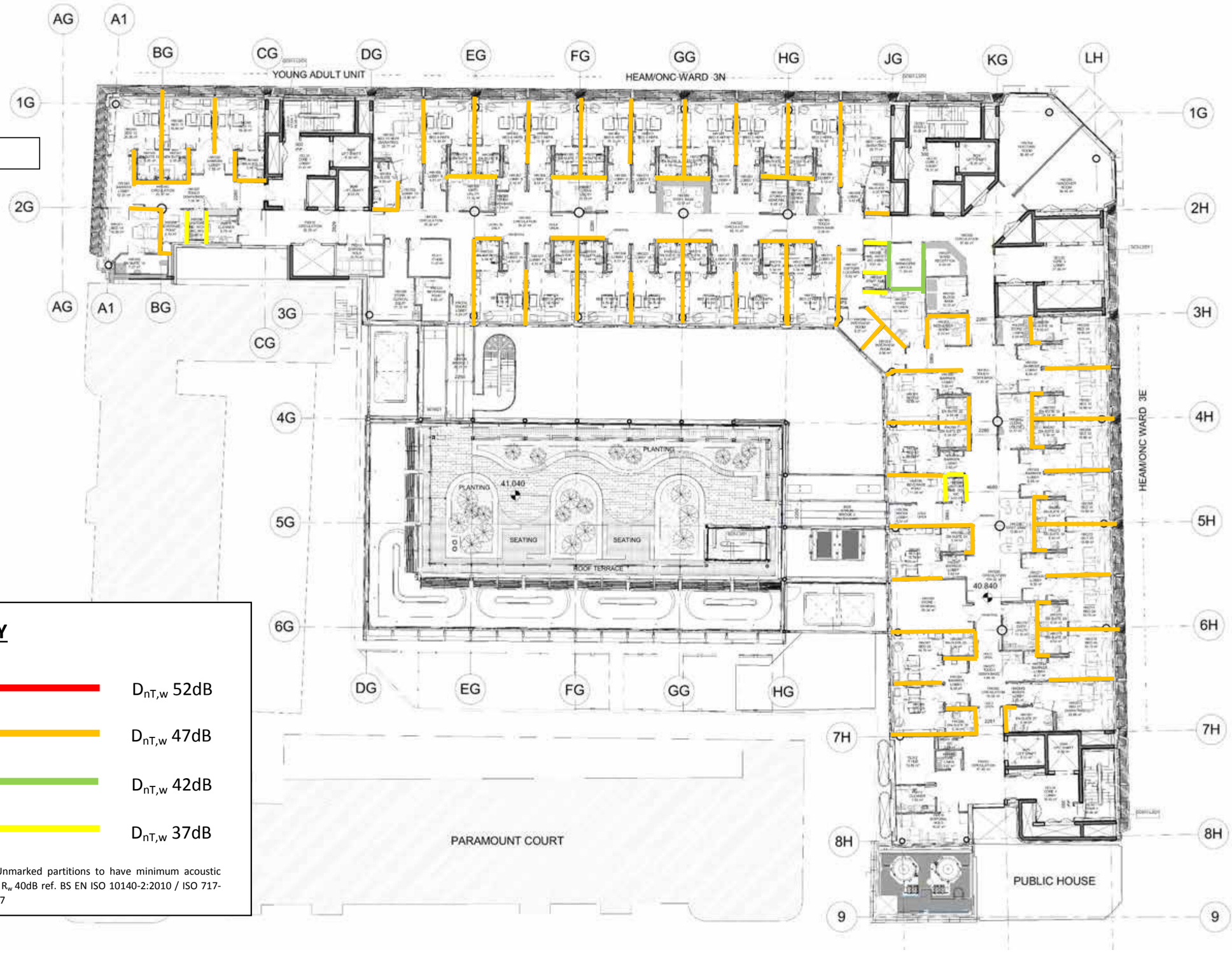
$D_{nT,w}$ 47dB

$D_{nT,w}$ 42dB

$D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

3rd Floor

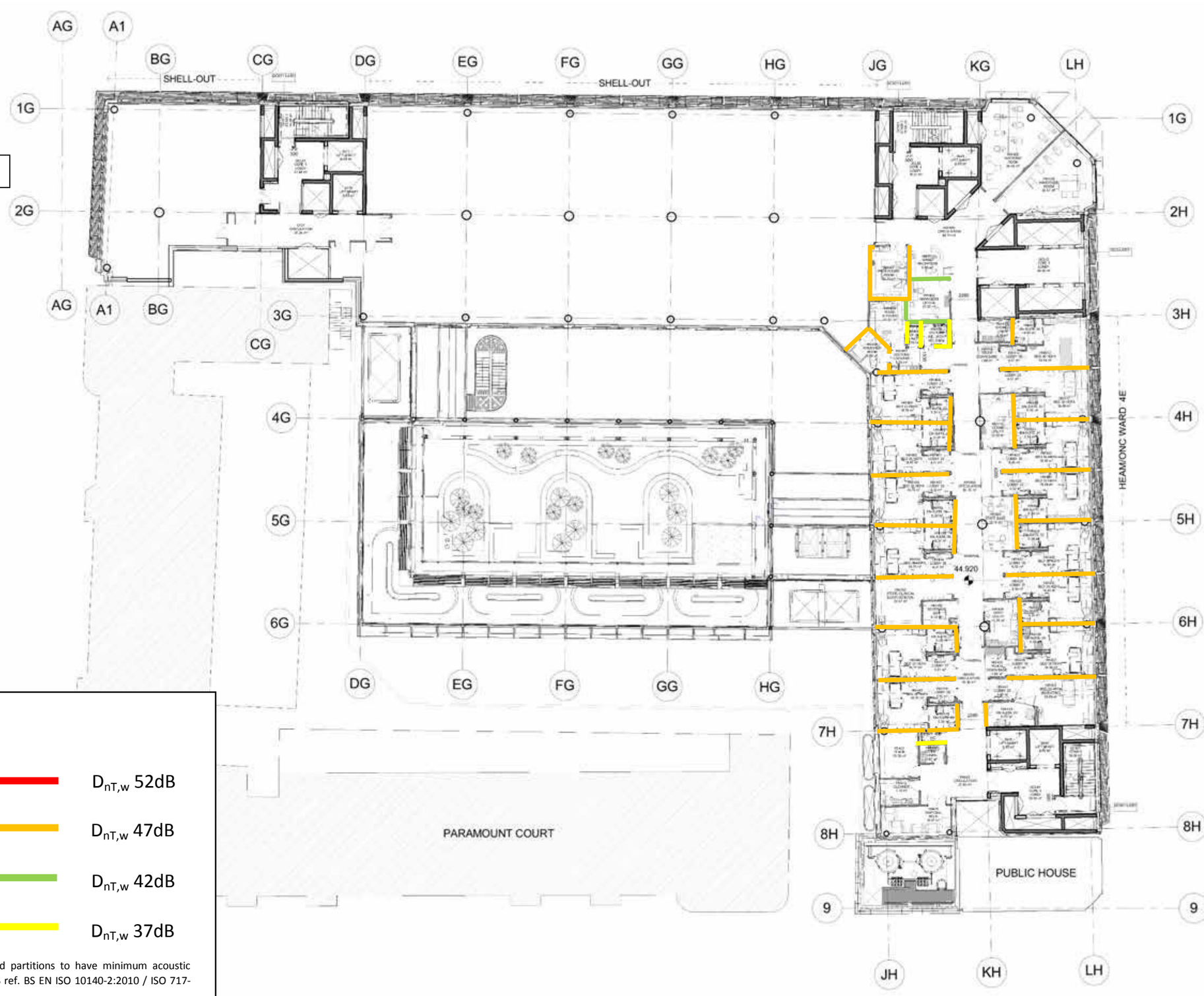


KEY

- $D_{nT,w}$ 52dB
- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

4th Floor



KEY

- $D_{nT,w}$ 52dB
- $D_{nT,w}$ 47dB
- $D_{nT,w}$ 42dB
- $D_{nT,w}$ 37dB

N.B. Unmarked partitions to have minimum acoustic rating R_w 40dB ref. BS EN ISO 10140-2:2010 / ISO 717-2: 1997

AS7143 UCLH PHASE 4 AND PROTON BEAM THERAPY UNIT

APPENDIX C

INDICATIVE PARTITION JUNCTION DETAILS (SOURCE: HTM 08-01)

Figure 2 Schematic of partition meeting cladding panel

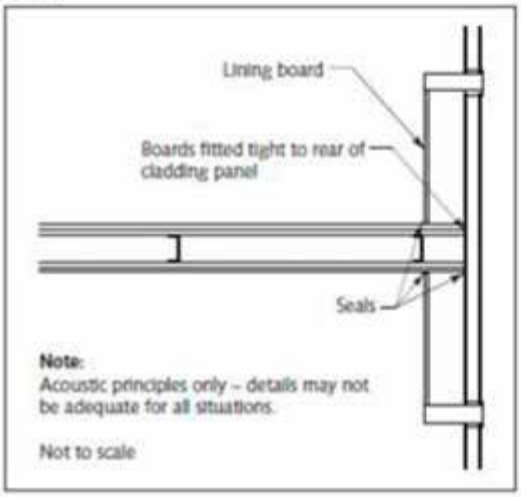


Figure 3 Typical schematic detail at junction of acoustic partitions with corridor walls (preferred)

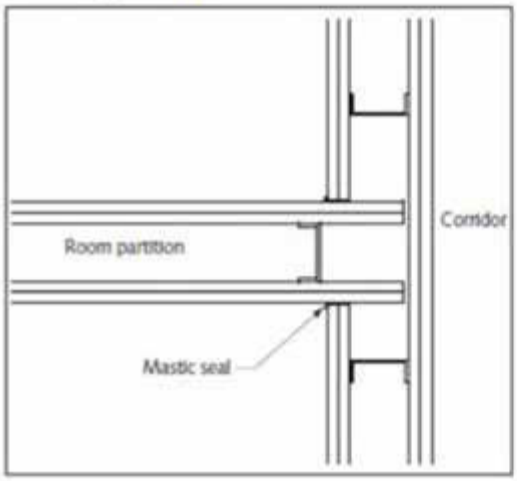
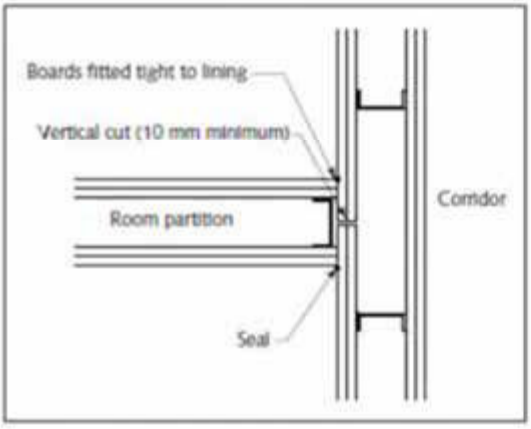


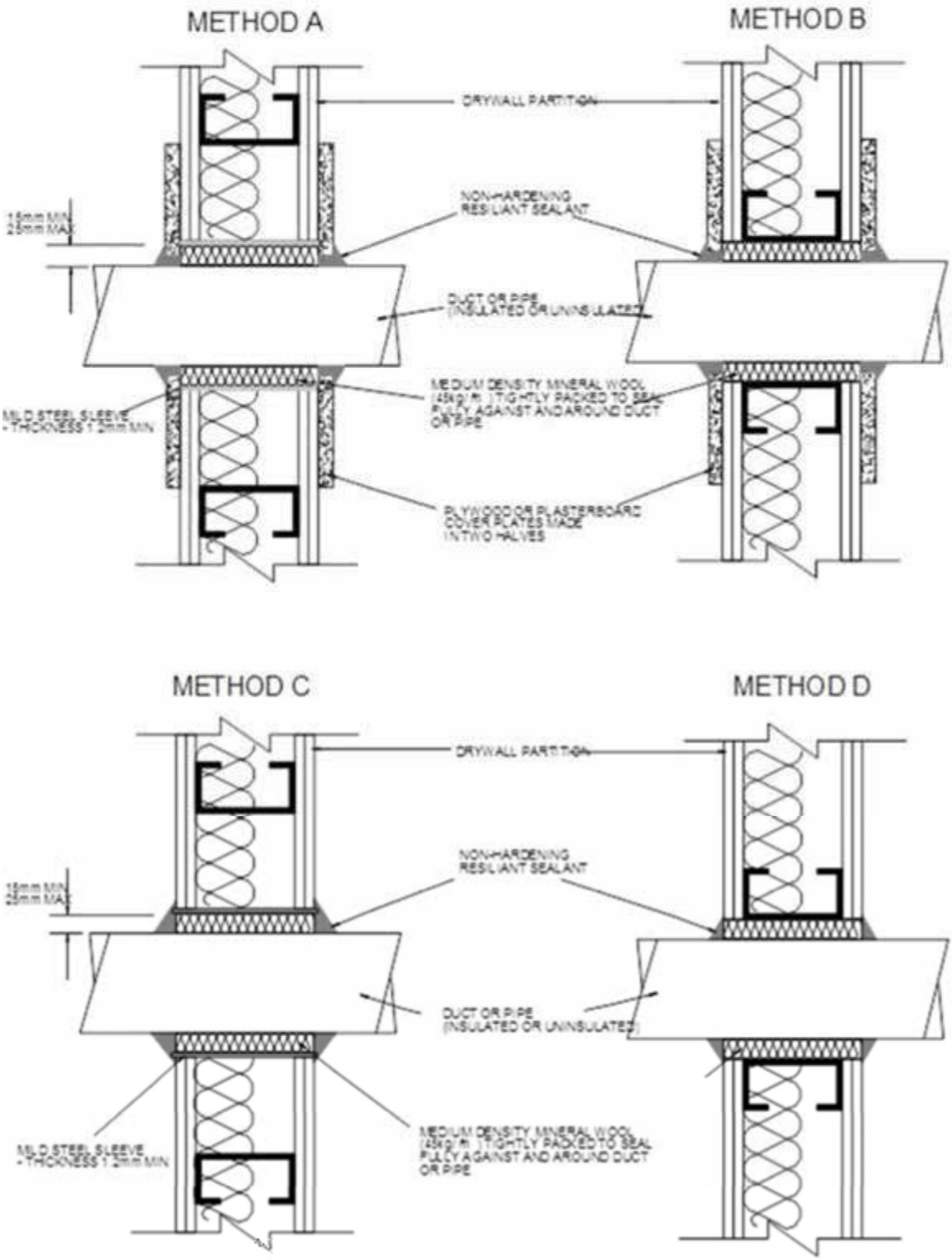
Figure 4 Typical schematic detail at junction of acoustic partitions with corridor walls (alternative)



AS7143 UCLH PHASE 4 AND PROTON BEAM THERAPY UNIT

APPENDIX D

INDICATIVE PARTITION PENETRATION DETAILS



clarke saunders | acoustics
specialist consultants

REPORT AS8175.161108.E.2

UCLH PHASE 4 AND PROTON BEAM THERAPY (PBT) UNIT

BUILDING SERVICES ACOUSTIC DESIGN
STAGE E
100%

Prepared: 17 January 2017

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CONTENTS

List of Attachments

1.0 INTRODUCTION

This report is intended to convey the fundamental internal acoustic design principles to be adopted within the development of building services systems to be installed within the UCLH Phase 4 PBT Unit at the Rosenheim Building and Former Odeon site on Grafton Way, London, WC1E 6DB.

Environmental noise and ground-borne vibration surveys have been undertaken at the site in order to establish the acoustic requirements of the shell and core design and for building services noise emissions.

A number of planning conditions relate to the acoustic performance of the building services. Several of these are addressed in this report

2.0 PLANNING REQUIREMENTS

Planning Permission for the development includes the following conditions:

22. *Prior to the commencement of development, other than site clearance, the detailed design on drawings scale 1:50 as well as supporting details of any ground floor air extraction vents and well as any other extraction vents located elsewhere including those relating the CHP as well as any associated filtering and/or attenuation devices, shall be submitted to and approved in writing by the council. The details approved shall be installed prior to first occupation and maintained thereafter.*

24. *Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (LA90), expressed in dB(A) when all plant/equipment (or any part of it) is in operation unless the plant/equipment hereby permitted will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps), then the noise levels from that piece of plant/equipment at any sensitive façade shall be at least 10dB(A) below the LA90, expressed in dB(A).*

28. *Prior to the installation of any plant (except for the vacuum insulated evaporator and the stand by generator) an acoustic report shall be submitted to and approved by the Local Planning Authority detailing how the required noise criteria as outlined within condition 24 will be met for each item of plant installed. Any attenuation measures detailed within the acoustic report approved by the Local Planning Authority shall be installed prior to occupation and remain in place for the lifetime of the development.*

    On commissioning the machinery and prior to the building being occupied a noise survey shall be carried out to ascertain the above noise criteria from the machinery are being

met. An acoustic report shall be submitted for the approval of the Local Planning Authority. The Acoustic Report shall clearly contain map/plan showing all measurements locations, tabulated and graphically raw data, calculations /façade corrections /assumptions made, time date, etc.

(ii) All plant and machinery, and ventilation ducting shall be installed so as to prevent the transmission of noise and vibration within or at the boundary of any noise sensitive premises either attached to or in the vicinity of the premises to which this application refers.

30. *Prior to the installation of the stand by generator, an acoustic report shall be submitted to and approved by the Local Planning Authority detailing how the required noise criteria as outlined within condition 24 will be met. Any attenuation measures detailed within the acoustic report approved by the Local Planning Authority shall be installed prior to occupation and remain in place for the lifetime of the development.*

On commissioning the machinery and prior to the building being occupied a noise survey shall be carried out to ascertain the above noise levels criteria from the machinery are being met. An acoustic report shall be submitted for the approval of the Local Planning Authority. The Acoustic Report shall clearly contain map/plan showing all measurements locations, tabulated and graphically raw data, calculations /façade corrections /assumptions made, time date, etc.

(ii) All plant and machinery shall be installed so as to prevent the transmission of noise and vibration within or at the boundary of any noise sensitive premises either attached to or in the vicinity of the premises to which this application refers.

3.0 ACOUSTIC CRITERIA

The project brief seeks the award of Building Research Establishment Environmental Assessment Measurement [BREEAM] credits, understood to be assessed under BREEAM New Construction Non-Domestic Buildings Technical Manual SD5073-3.0:2011.

Issue Hea 05 of the BREEAM document requires acoustic design and commissioning in accordance with the requirements of Health and Technical Memorandum (HTM) 08-01: *Acoustics* [HTM 08-01]. Pol 05 requires assessment of environmental noise emissions, although these requirements are less onerous than those of the London Borough of Camden [LBC].

3.1 EXTERNAL NOISE LIMITS

3.1.1 Normally-Operating Plant

From the background noise data collected, the criteria for control of building services plant noise emissions, as required by the London Borough of Camden under Condition 24 are as follows:

	Plant noise emissions at 1m from nearest window	
	Rear of building (apartments)	Grafton Way/Huntley Street
Daytime (07:00 - 23:00)	≤45	≤50
Night (23:00 – 07:00)	≤43	≤47

Table 3.1 - Plant noise emissions limits, dB L_{Aeq}

The limits advised at the front of the mentioned buildings have been set to ensure that there is no significant increase in noise in the vicinity of the building.

3.1.2 Emergency Plant

Emergency plant would typically be exempt from restrictions such as those given in Conditions 30 and 24, instead being considered on a specific basis.

The generator will not run under normal conditions, instead providing a life-safety function to patients within the building. The scheme detailed in this report targets a noise level of 50dB(A) at the closest receptor, in order to avoid giving rise to adverse impact under BS4142:2014 *Methods for rating and assessing industrial and commercial sound*. This approach will require acceptance by Camden.

Specifications are given for atmospheric-side attenuation of smoke fans to maintain environmental noise levels at 10dB above background during emergency operation. Although this plant is not covered by the planning consent, such limits are typically applied by Camden. These attenuators could be removed from the scheme if deemed unnecessary by the Client.

3.2 INTERNAL NOISE LEVELS

Internal noise levels required from internal building services for typical room types, as required by HTM 08-01, are shown in Table 3.2.

Room Type	Building Services, NR
Private offices	35
Treatment rooms	
Consulting rooms	
Interview Rooms	
Single bed ward	30
Open clinical areas	40
Operating theatres	40
Recovery rooms	35
Large meeting rooms, seminar rooms and board rooms (>35m^2 floor area)	30
Small meeting rooms, seminar rooms and board rooms (≤35m^2 floor area)	35
Laboratories	40
Small food preparation areas	40
WCs/bathrooms	45
Circulation, atria	40
Dining areas, waiting areas and playrooms	45
All occupied areas (emergency conditions)	50

Table 3.2 - Internal noise criteria (ref. HTM08-01) **[dB ref. 20µPa]**

HTM 08-01 does not provide noise criteria for shared offices. A target value of NR40 is proposed in order for room noise levels to lie in the range 45- 50dB(A) as advised for open plan offices in BS8233: 2014 *Guidance on sound insulation and noise reduction for buildings*.

4.0 BUILDING SERVICES DESIGN REVIEW

Stage E review of internal and external building services systems and plant will be undertaken once layouts and equipment schedules are confirmed. The review will check for compliance with the criteria set in Section 2.0.

4.1 EXTERNAL ROOFTOP PLANT

Major cooling plant, some ventilation plant and ancillary items will be located at roof level. Air cooled chillers will be located on the Grafton Way wing, with CHP, boiler plant and generators on the Huntley Street building.

The roof plant enclosures will be open-top, with sides formed by imperforate screens of PV arrays interspersed with louvres.

It is anticipated that louvres to the Grafton Way plantrooms will be of an acoustically-attenuating system providing minimum sound reduction as follows:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Sound Reduction	7	7	10	17	29	30	27	21

Table 4.1 Acoustic Louvre Sound Reduction, dB ref. BS EN ISO 10140-2:2010

As a minimum, the screens would be of sufficient height to prevent sight-lines between plant items and the Paramount Court and Maple House windows.

Louvres to the Huntley Street plantrooms can be of a standard, architectural design.

Items of medical gas plant will be installed within a separate enclosure close to Core 1, i.e. western end of Grafton Way.

Technical acoustic schedules relevant to this section are enclosed.

4.1.2 Normally-Operating Plant (Conditions 22 & 28)

Calculations have been undertaken of noise emissions from chiller plant based upon the advised selections, confirmed below.

Chiller Ref.	Chiller Type	Sound Pressure, dB(A) at 10m
CH1, CH2, CH3	To be confirmed	≤61
CH4, CH5	To be confirmed	≤66

Table 4.2 Chiller Types and Noise Levels **[dB ref. 20µPa]**

Not more than four chillers will run at any time. Ideally, preference should be given to operating one of either CH4 or CH5 at any one time.

Although not necessary to meet the planning and BREEAM requirements, noise emissions at receptor premises will be minimised where it is possible to relocate CH4 and CH5 to the eastern end of the Grafton Way plantroom toward the rear edge of the roof.

Air handling units will be fitted with integral attenuator sections, such that fresh air intake and casing-radiated noise levels noise levels on the roof will be controlled.

Selections for a small number of AHU bypass and other dual mode extract systems are yet to be made. For the purpose of analysis, it is assumed that these plant items will be designed, installed and fitted with atmospheric attenuators to ensure that the following noise limits are not exceeded, to include any jet efflux noise. These targets have been derived to ensure compliance with Camden's conditions.

Fan Type	Sound Pressure Level @ 3m	
	Roof Level Fans	Louvres at Lower Level
All normally-operating extract fans	≤54dB(A)	≤54dB(A)

Table 4.3 Extract Fan Limiting Sound Level **[dB ref. 20µPa]**

Refer to the enclosed schedule AS8175/PNS-1 for more details.

Otherwise fans will be fitted with attenuators as shown in schedule AS8175/ASS-1, in order to achieve the above targets.

Boilers will be located within a louvred plantroom. Burners should be fitted with acoustic shrouds to control noise levels as shown below:

	Sound Pressure Level @ 1m
Boiler burner	65dB(A)

Table 4.4 Boiler Noise Level **[dB ref. 20µPa]**

The Combined Heat & Power unit (CHP) will be provided with its own enclosure, but will also generate noise from mechanical ventilation and engine exhaust. Enclosure and exhaust noise levels for the scheduled unit are shown below. Also shown is a noise level limit for the enclosure ventilation system.

	Sound Pressure Level @ 3m		
	Enclosure Lp @ 1m, dB(A)	Exhaust Lp @ 1m, dB(A)	Ventilation Lp @ 1m
CHP noise level	≤65dB(A)	≤64dB(A)	≤65dB(A)

Table 4.5 CHP Noise Level **[dB ref. 20µPa]**

A 24-hour heat pump with advised free-field noise level of 65dB(A) at 10m is proposed for installation on the roof in the vicinity of Core 1. Without further enclosure, this item is expected to generate noise levels in excess of 54dB(A) at the closest windows in Paramount Court and around 34dB(A) at Maple House. It will, therefore, require a full or partial enclosure to provide at

least 19dB(A) noise reduction, with any necessary ventilation system. It may be preferable to relocate this unit to the B2 basement level.

Medical gas plant (anaesthetic gas scavenging, medical air plant, vacuum pump, etc.) will also be located close to Core 1 at the western end of the Grafton Way building. It is understood that some of the plant will run at night. Manufacturer's noise levels are given as below, which are assumed to be sound pressure level at 1m.

Item	Sound Pressure, dB(A) at 1m
Anaesthetic gas scavenging system	≤70
Medical air plant (compressors) – 24h operation	62
Vacuum pump – 24h operation	67

Table 4.6 Medical Gas Plant Noise Levels **[dB ref. 20µPa]**

This plant will require enclosure to provide a minimum of 20dB(A) noise reduction at Paramount Court. Maple House is slightly more tolerant of noise, being exposed to higher background noise levels. An alternative strategy of relocating this plant closer to Grafton Way may be viable.

4.1.3 Emergency Plant (Condition 30)

The two emergency generators will be located within an acoustic enclosure on the Huntley Street building, with air intake in the northern end and vertical ventilation air discharge.

The proposed generator installation will be designed to a limit of 70dB(A) at 1m from any point of the enclosure. It is expected that this will control noise levels to 50dB(A) or lower at the noise-sensitive windows of Paramount Court or the Cruciform Building.

Whilst above the noise criteria set for normally-operating plant, this level is lower than the 55dB(A) *Interim Target* advised by the World Health Organisation for night-time noise[1]. Given the unlikely operation of this plant, other than for daytime testing, it is suggested that this is an appropriate level of noise.

Smoke fans will be fitted with atmospheric-side attenuators as shown in schedule AS8175/ASS-1to control noise levels to the following:

Item	Sound Pressure, dB(A) at 3m – Full duty
Smoke Fans	68

Table 4.7 Smoke Fan Noise Levels **[dB ref. 20µPa]**

At lower speed, environmental mode, operation, noise levels will be around 20dB lower and, hence, compliant with the criteria for normally-operating plant.

[1] *Night Noise Guidelines for Europe*, WHO 2009

4.2 BASEMENT B2 AHU ATMOSPHERIC LOUVRES

Other than items AHU14 and AHU15, AHUs to be located at B2 basement level, with fresh air louvres located at Level 4 and exhaust louvres at ground level on Grafton Way and Level 1 on Huntley Street.

Analysis of the sound power level unit data for the scheduled AHUs, with integral attenuation, shows that atmospheric noise levels will be comfortably within the planning noise limits at Paramount Court, Maple House and The Cruciform Building.

Air velocities through louvres should be maintained at suitably low ranges (typically ≤2m/s face) to ensure no significant levels of regenerated noise.

4.3 INTERNALLY TRANSMITTED NOISE

The specification of plant and design of noise control measures should target the criteria listed in Table 2.2.

4.3.1 AHU Supply/Return Systems

Analysis of the sound power level unit data for the scheduled AHUs, with integral attenuation, shows that roomside noise levels will be comfortably within the HTM 08-01 criteria.

4.3.2 Fan Extraction Systems

The schedule of roomside attenuators AS8175/RSS-1 has been developed from sound power level unit data for the scheduled fans (AS8175/PNS-1) in order to maintain internal noise levels in line with the HTM 08-01 criteria.

4.3.3 Constant Volume Boxes

Analysis of manufacturer's data for the TVR constant volume boxes, as per the CCRD/Harley Haddow schedule, shows that the HTM 08-01 room noise criteria would be achieved with the proposed 1000mm long attenuators (type CA or better) having 100mm insulation thickness.

The TVJ type constant volume boxes fitted in the theatre ventilation systems risk generating excessive levels of airflow noise at high differential pressure (based on data stated at 150Pa), and would require additional silencer units where such settings are expected during normal operation.

4.3.4 Fan Coil Units

Fan coil units should be selected and installed with all necessary sound attenuation to achieve limiting sound power levels as tabulated below.

Suppliers' data should be provided from testing conducted in accordance with BS 4856-4:1997 *Methods for testing and rating fan coil units, unit heaters and unit coolers. Determination of sound power levels of fan coil units, unit heaters and unit coolers using reverberating rooms* or equal and equivalent.

Frequency (Hz)		63	125	250	500	1k	2k	4k	8k
Offices	Supply (in-duct) L_w, dB	71	56	46	40	37	35	32	31
	Casing/intake (radiated) L_w, dB	69	60	54	53	53	51	48	47
Small Seminar/ Meeting Rooms (NR35)	Supply (in-duct) L_w, dB	73	58	52	47	42	37	35	33
	Casing/intake (radiated) L_w, dB	65	56	50	48	48	45	43	41
Large Seminar/ Meeting Rooms (NR30)	Supply (in-duct) L_w, dB	69	54	48	42	37	32	29	28
	Casing/intake (radiated) L_w, dB	61	52	45	43	43	40	38	36

Table 4.8 Fan Coil Unit Limiting Sound Power Level **[dB ref. 10pW]**

4.3.5 *Emergency Systems*

Smoke fans will require attenuation on the roomside connection where serving escape routes in which it is necessary to maintain intelligibility of voice-activated alarm systems. Refer to schedule AS8175/RSS-1.

4.3.6 *Crosstalk*

Connections between ductwork and grilles are typically made with sections of flexible ductwork. Where these are a minimum of 500mm in axial length and of an acoustically-attenuating product, such as Tecsonic 400s[2], Trox type CF[3] or Regaduct Acoustic[4], sound insulation values of up to $D_{nT,w}$ 42dB are expected to be maintained between rooms without the need for crosstalk attenuators. It is assumed that all en-suite extract connections will be made using such products.

Where no such connections are provided and/or higher levels of sound insulation are required between rooms served by the same ductwork system, crosstalk attenuators will be necessary. Each crosstalk path should incorporate two attenuators having the following minimum insertion losses:

[2] http://www.lindab.com/uk/pro/products/pages/ts400s.aspx
[3] http://web.trox.de/xpool/download/en/technical_documents/attenuators/leaflets/index.php
[4] http://www.rega-uk.com/duct.html

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Type 1 $D_{nT,w}$ 42dB sound insulation	1	3	8	18	18	11	7	6
Type 2 $D_{nT,w}$ 47dB sound insulation (grille on each side)	2	5	11	25	29	18	11	8

Table 4.9 Crosstalk Attenuator Insertion Losses, dB

A review of CCRD ductwork layouts has identified locations crosstalk attenuators are required. These are given in Appendix A. Where there is a grille on one side of the partition only, a single attenuator should be used, located as close as possible to the partition.

4.3.7 Plantrooms

Plantrooms are located at B2 basement level and on the roof.

Internal structural slabs are to be of in-situ concrete, typically 400mm in thickness. The Level 5 roof is understood to be of a profiled metal deck with concrete. The mass of the slabs are expected to be capable of controlling airborne sound transfer to the spaces above and below.

4.4 GENERAL CONSIDERATIONS

In order to control regenerated noise from ductwork systems and fittings, e.g. dampers, grilles and diffusers, the following airflow velocity limits should be observed.

Room Noise Criterion	*NR40+*	*NR35*	*NR30*
Main Branch	6	5[1]	4[1]
Grille	3	2.5	2
Diffuser	3	2	1.5
Return air stub duct in ceiling	4	3	2

[1] Higher velocities can be tolerated where ducts can be stiffened and/or acoustically wrapped, e.g. in Muftilag or similar, and where additional attenuation, e.g. in the form of acoustic flexi-duct, can be fitted behind grilles.

[2] Where ductwork can be kept within 3:1 aspect ratio, velocities up to 4 m/s would be acceptable, provided that they can be reduced as necessary behind the grilles.

Table 4.10 - Maximum Airflow Velocity (m/s)

As far as is reasonably practicable, system design should follow good practice guidance to minimise airflow noise regeneration.

4.5 HYDRAULIC AND WASTE SYSTEMS

In order to minimise risk of audible and intrusive noise from hydraulic and waste systems, all reasonable controls should be adopted and relevant guidance issued by the Institute of Plumbing and Heating Engineers should be observed.

The following are given for information.

- Wherever possible, avoid horizontal offsets above noise-sensitive spaces such as wards and consulting/examination rooms;
- Minimise risk of water hammer by lowering operating pressures and/or through use of pressure snubbers. Regulate water pressure to the minimum satisfactory working pressure and, in any case, do not exceed 350kPa;
- Adjust cistern fill times, particularly in toilets adjacent to quiet areas, to approximately 90 to 120 seconds;
- Avoid hard grouting and chasing of water pipes in masonry walls, particularly where walls are common with noise sensitive areas;
- In noise sensitive areas, support pipes with clamps having a soft neoprene sleeve;
- Provide cast iron or acoustically-treated plastic soil and waste pipes, e.g. Geberit dB20, in preference to lightweight pipes such as standard plastic and copper in sensitive areas unless acoustic wrappings/enclosures are used;
- Do not support pipework, WCs or cisterns from lightweight constructions.

From research conducted on various pipework configurations, it is suggested that fluid velocities in pipework, i.e. supply systems, are controlled to 1.25 m/s or less within NR25 areas provided that:

- Elbows and tees are avoided within low noise areas, i.e. use of bends recommended, and;
- Pipework is fixed to heavy structures, i.e. concrete/masonry with soft-sleeved clamps

Velocities of 1.5 m/s would be acceptable elsewhere.

Stacks are proposed of cast iron pipework, with offsets formed of enhanced plastic pipework, such as Geberit Silent dB20. Where offsets occur above acoustically-critical spaces, such as wards, it is recommended that bends and the following 750mm (minimum) of pipework is wrapped in a proprietary acoustic lagging material, comprising minimum 25mm insulation layer with minimum 5kg/m^2 mass barrier.

4.6 LIFTS

In-Car Lift Vibration (Passenger Lifts Only)

The following limits will apply at the centre of the floor at any time during a complete cycle, in any 1/3 octave band in the frequency range specified:

Horizontal Vibration

1 - 25 Hz inclusive: The maximum rms acceleration level should not exceed 0.1m/s^2

26 - 80Hz inclusive: The maximum rms acceleration level should not exceed 0.5m/s^2

Vertical Vibration

At maximum speed, the maximum rms acceleration level in any 1/3 octave band should not exceed 0.1m/s^2 in the frequency range 1-80Hz.

During acceleration/deceleration and start/stop periods, the maximum rms in any 1/3 octave band should not exceed 0.15m/s^2 in the frequency range 1-80Hz.

Acceleration/Deceleration

Acceleration/deceleration rates of the car should not exceed 1.5m/s^2 at any time during a complete cycle, and should preferably be below 1.2m/s^2.

Jerk

The rate of change of acceleration/deceleration of the car should not exceed 2m/s^3 at any time during the cycle for lifts having a speed above 2m/s. Jerk for low speed geared lifts should not exceed 3.5m/s^3.

Vibration in Structure

At no time during the lift cycle should vibration levels within the floor of an area accessible to residents exceed Curve 1 as shown in BS6472:1992 'Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)', when measured in any of three mutually perpendicular axes corresponding to the vertical and two horizontal directions.

In-Car Noise Levels (Passenger Lifts Only)

Door noise, when measured with a precision grade sound level meter set to "fast" meter response at 1.5m from the floor and 1m from the door face, should not exceed 55dB(A).

Noise levels in the car at the maximum car velocity in the cycle should not exceed 60dB(A) when measured as described above.

In-car announcements should not exceed 65dB(A) when measured as described above.

Noise in Lift Lobbies (ward levels only)

Lift noise, when measured with a precision grade sound level meter set to "fast" response at 1.5m from the floor and 1m from the door face, should generally not exceed 50dB(A) at any time during

the lift cycle. This does not include lift arrival indication sounders, which should operate at a level generally below 65dB(A).

Noise in Adjacent Areas

At no time during the cycle should noise levels due to lift movements exceed a maximum value of 35dB(A) within adjoining noise-sensitive spaces.

4.7 VIBRATION ISOLATION

In order to control structure-borne noise and vibration transfer from plant operation, all plant and connected pipework should be supported by means of appropriately selected vibration isolating mountings.

Details of typical requirements are shown in the attached schedule.

4.8 PENETRATIONS

Penetration of services through partitions should be sealed as per the general details shown in Appendix A.

Where possible, sockets, switches, medical-gas outlets, integrated plumbing system/integrated services (IPS/IS) panels etc. should not be located back-to-back in partitions. A minimum of one stud bay separation is recommended. Stood-off IS panels and surface mounted sockets and switches are preferable from an acoustic perspective.

Where unavoidable, as in the case of IS panels, penetrations in adjoining rooms will occur in the same studwork bay, use of Putty Pads, or similar, backing boxes or through internal division of the bay (to separate the services runs) should be used to minimise sound leakage. Care must be taken to avoid bridging of the acoustic studs in achieving this.

Matt Sugden

Matt Sugden MIOA

CLARKE SAUNDERS ASSOCIATES

ANTI-VIBRATION MOUNTINGS SCHEDULE

UCLH Phase 4 PBT

Ref:	A8175/AVM- 1	Revision:	*0*	Date:	8-Nov-16	Engineer	*MS*	No. of per set	No. of sets
AVM Ref.	**Plant Description**	**Location**		**Mounting Code**	**Base Code**	**Unit Weight (kg)**	**Static Deflection (mm)**		
1	Chillers	Roof		A	A/B	-	≥25mm	Supplier design	5
2	CHP	Roof		A/B	A/B	-	≥40mm	Supplier design	1
3	AHU[i]	Roof		D	A	-	≥4mm	As required	2
4	Pumps/pressurisation units[ii]	Roof		A/B	C	-	≥25mm	As required	As required
5	Emergency Generators	Roof		Manufacturer design to achieve 98% isolation efficiency					
6	SEF08A/08B, SEF 09A/09B	Roof		B/E	-	-	≥20mm	As required	4
7	Smoke fans	Roof		B/E	-	-	≥15mm	As required	As required
8	Heat Pumps/Medical Gas Plant	Roof		C	-		≥10mm	As required	As required
9	Boilers	Roof		D	-	-	≥3mm	As required	2
10	AHU[iii]	B2/M2		D	A	-	≥4mm	As required	As required
11	CHW pumps[ii]	B2/M2		B	C	-	≥20mm	As required	As required
11	Booster pumps[ii]	B2/M2		B	C	-	≥25mm	As required	As required
12	Compressors	B2/M2		C	A/B	-	≥10mm	As required	As required
13	Fans	B2/M2		B/E	-	-	≥15mm	As required	As required

[i] Minimum 20mm deflection steel spring isolators fitted internally to fan by supplier
[ii] Pipework will require flexible connectors and be supported from 25mm deflection hangers (with rubber 'noise-stop' pads) for minimum distance of 100 pipe diameters from pumps.
[iii] Minimum 15mm deflection steel spring isolators fitted internally to fan by supplier

Mounting Code and Description
A : Caged steel spring
B : Open steel spring
C : Neoprene-in-shear
D : Neoprene Pad
E : Hangers with steel springs
F : Hangers with neoprene springs
/R: Restraining or positioning device

Base Code and Description
A : A.V. Rails
B : Steel frame base
C : Concrete inertia base (steel springs)
D : Concrete inertia base (neoprene pads or mounts)

PLANT NOISE SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof and B2/M2

Ref:	AS8175/PNS-1	Revision:	0	Date:		14-Dec-16	Engineer	MS					
Plant Ref.	Description	Make & Model		Duty Vol. @ Ext Static Pa		Octave Band Mid Frequency (Hz)							dB(A)
				l/s	Pa	63	125	250	500	1k	2k	4k	8k	
AHU1	As per CCRD/Harley Haddow Schedule P4PBT-CCR-ALL-SL-REP-A73-710022 rev. B													
AHU2														
AHU3														
AHU4														
AHU5														
AHU6														
AHU7A/B														
AHU8														
AHU9														
AHU10														
AHU11														
AHU12														
AHU13														
AHU14														
AHU15														
SEF01A/ SEF01B[1]	AHU4 Smoke Exhaust (Duty/ Standby)	Systemair AXC1000		7500	500	77	87	96	100	101	98	94	86	106
SEF02A/ SEF02B[1]	AHU5 Smoke Exhaust (Duty/ Standby	Systemair AXC1000		5350	500	77	87	95	100	100	97	93	86	105
SEF03A/ SEF03B[1]	AHU6 Smoke Exhaust (Duty/ Standby)	Systemair AXC1000		5250	500	77	87	95	100	100	97	93	86	105
SEF04A/B[1]	AHU6 Smoke Exhaust (Duty/ Standby)	Systemair AXC450		1390	400	70	80	88	93	93	90	86	79	98

Notes:	All values correspond to induct sound power, dB re. 10pW
1	Spectral values are A-weighted

PLANT NOISE SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof and B2/M2

Ref:	AS8175/PNS-1	Revision:	0	Date:		14-Dec-16	Engineer	MS					
Plant Ref.	Description	Make & Model		Duty Vol. @ Ext Static Pa		Octave Band Mid Frequency (Hz)							dB(A)
				l/s	Pa	63	125	250	500	1k	2k	4k	8k	
SEF05A/B[1]	AHU9 Smoke Exhaust (Duty/ Standby)	Systemair AXC450		1530	400	70	80	89	93	93	91	86	79	98
SEF06A/B[1]	AHU10 Smoke Exhaust (Duty/ Standby)	Systemair AXC500		1940	400	74	84	92	97	97	94	90	83	102
SEF07A/B[1]	AHU11 Smoke Exhaust (Duty/ Standby)	Systemair AXC500		1820	400	73	83	91	96	96	93	89	82	101
SEF08A/B[1]	AHU7A Exhaust	Systemair AXC1000		5819	600	77	87	95	100	100	97	93	86	105
SEF09A/B[1]	AHU7B Smoke Exhaust (Duty/ Standby)	Systemair AXC630		10834	600	76	86	95	99	99	97	92	85	104
SEF10A/B	Core 1 Lobby Smoke Extract (Duty Standby) Exhaust.	EF599230		4000	400	99	96	99	94	92	90	87	84	-
	Intake					96	96	97	93	92	89	86	83	-
SEF11A/B	Core 2 Lobby Smoke Extract (Duty Standby)	EF599230		4000	400	99	96	99	94	92	90	87	84	-
	Intake					96	96	97	93	92	89	86	83	-
SEF12A/B	Core 4 Lobby Smoke Extract (Duty Standby)	EF599230		4000	400	99	96	99	94	92	90	87	84	-
	Intake					96	96	97	93	92	89	86	83	-
SEF 13 – SEF 18	Atrium Exhaust			8500	300	97	94	98	95	91	90	86	80	-
	Atrium Extract					95	89	94	91	89	87	85	79	-
SEF19A/B, SEF19C/D & SEF20E/F[1]	B2/M2 Plantroom	Systemair AXC560		3730 (Emergency)/ 750 (Normal)	300 (Emergency)/ 100 (Normal)	76	86	94	99	99	96	92	85	104
SEF20A/B[1]	UPS Areas 1/3, 2/3 & 3/3	Systemair AXC400		370 (Emergency)) / 189 (Normal)	300 (Emergency)/ 100 (Normal)	66	76	85	89	90	87	83	76	95
SEF21A/B[1]	E1 Transformer/Switchroom Area	Systemair AXC400		472 (Emergency)/	300 (Emergency)/	66	76	85	89	89	86	82	75	94

Notes:	All values correspond to induct sound power, dB re. 10pW
1	Spectral values are A-weighted

PLANT NOISE SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof and B2/M2

Ref:	AS8175/PNS-1	Revision:	0	Date:		14-Dec-16	Engineer	MS					
Plant Ref.	Description	Make & Model		Duty Vol. @ Ext Static Pa		Octave Band Mid Frequency (Hz)							dB(A)
				l/s	Pa	63	125	250	500	1k	2k	4k	8k	
				188 (Norma)	125 (Normal)									
SEF22A/B[1]	N1 Transformer/Switchroom Area	Systemair AXC400		475 (Emergency) / 187 (Normal)	300 (Emergency)/ 125 (Normal)	66	76	85	89	89	86	82	75	94
SEF23A/B[1]	T3 Transformer/Switchroom Area	Systemair AXC315		193 (Emergency)/ 70 (Normal)	300 (Emergency)/ 125 (Normal)	61	71	80	84	84	82	77	70	89
SEF24A/B[1]	PBT Transfomer/UPS Area	Systemair AXC400		853 (Emergency) / 231 (Normal)	300 (Emergency) / 125 (Normal)	67	77	85	90	90	87	83	76	95
SEF25A/B[1]	PB237 IT Room	Systemair AXC355		736 (Emergency)/ 147 (Normal)	300 (Emergency) / 125 (Normal)	64	74	82	87	87	84	80	73	92
SEF26A/B[1]	8157 Comms Room	Systemair AXC355		801 (Emergency)/ 160 (Normal)	300 (Emergency)/ 75 (Normal)	64	74	82	87	87	84	80	73	92
SEF27A/B[1]	8158 Oil Tank Room	Systemair AXC355		798 (Emergency)/ 160 (Normal)	300 (Emergency)/ 75 (Normal)	64	74	82	87	87	84	80	73	92
SEF28A/B[1]	6167 Plant Room	Systemair AXC450		1613 (Emergency) / 340 (Normal)	300 (Emergency)/ 100 (Normal)	70	80	89	93	93	90	86	79	98
SEF29A/B[1]	6245 Sprinkler Tank Room	Systemair AXC560		3438 (Emergency) / 690 (Normal)	300 (Emergency)/ 110 (Normal)	75	85	94	98	98	95	91	84	103
SEF30A/B[1]	8165 Water Tank Room	Systemair AXC450		1640 (Emergency) /	300 (Emergency)/	70	80	89	93	93	90	86	79	98

Notes:	All values correspond to induct sound power, dB re. 10pW
1	Spectral values are A-weighted

PLANT NOISE SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof and B2/M2

Ref:	AS8175/PNS-1	Revision:	0	Date:		14-Dec-16	Engineer	MS					
Plant Ref.	Description	Make & Model		Duty Vol. @ Ext Static Pa		Octave Band Mid Frequency (Hz)							dB(A)
				l/s	Pa	63	125	250	500	1k	2k	4k	8k	
				330 (Normal)	110 (Normal)									
EF12A/B	AHU12 Exhaust (Isolation Room) Outlet	TBC Limiting Induct Sound Power Levels Given		1418	600	90	77	69	62	58	55	53	52	-
	Inlet					87	78	74	68	67	68	62	60	-
EF13A/B	AHU13 Exhaust (Isolation Room) Outlet			1471	600	90	77	69	62	58	55	53	52	-
	Inlet					87	78	74	68	67	68	62	60	-
EF14A/B	AHU14 Exhaust (Isolation Room) Outlet			1311	600	90	77	69	62	58	55	53	52	-
	Inlet					87	78	74	68	67	68	62	60	-
EF15A/B	AHU15 Exhaust (Isolation Room) Outlet			1258	600	90	77	69	62	58	55	53	52	-
	Inlet					87	78	74	68	67	68	62	60	-
SF 01 & SF-02	B2/M2 Plantroom Outlet	TBC Limiting Induct Sound Power Levels Given		1120	125	101	91	84	79	76	74	72	70	-
	Intake					102	89	82	75	71	67	65	63	-
TGF01/ TGF02	PBT Technical Gases Extract Outlet	TBC Limiting Induct Sound Power Levels Given		290 (Emergency) / 90 (Normal)	400 (Emergency) / 150 (Normal)	101	90	82	76	72	70	68	66	-
LPF01A/B	Core 1 Goods Lift Pressurisation Outlet	LCS071L2-A3/18		1800	TBC by specialist	97	97	107	104	99	97	93	90	-
	Inlet					97	98	108	106	100	98	94	89	-
LPF02A/2B	Core 4 Goods Lift Pressurisation Outlet	LCS071L2-A3/18		1800	TBC by specialist	98	97	94	103	106	106	102	97	-
	Inlet					96	97	97	102	107	107	103	98	

Notes:	All values correspond to induct sound power, dB re. 10pW
1	Spectral values are A-weighted

ATMOSPHERE SIDE SILENCER SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof & B2/M2

Ref:	AS 8175/ ASS- 1	Revision:	0	Date:	18 January 2017		Engineer	MS							
Silencer Ref.	Description	Dimensions (mm)			Volume duty	Pressure drop	Octave Band Mid Frequency (Hz)							
		W	H	L	l/s	Pa	63	125	250	500	1k	2k	4k	8k
SEF01A/B	M2, exhaust	TBC		600	7500	50	1	2	7	10	11	9	8	7
SEF02A/B	M2, exhaust	TBC		900	5350	50	2	4	9	15	17	14	10	8
SEF03A/B	M2, exhaust	TBC		600	5250	50	1	2	7	10	11	9	8	7
SEF04A/B	M2, exhaust	TBC		600	1390	50	1	2	7	10	11	9	8	7
SEF05A/B	M2, exhaust	TBC		600	1530	50	1	2	7	10	11	9	8	7
SEF06A/B	M2, exhaust	TBC		900	1940	50	2	4	9	15	17	14	10	6
SEF07A/B	M2, exhaust	TBC		900	1820	50	2	4	9	15	17	14	10	6
SEF08A/B	6th floor roof, exhaust	500	Dia.	900	5819	50	4	8	14	21	27	27	21	16
SEF09A/B	M2, exhaust	TBC		600	10834	50	1	2	7	10	11	9	8	7
SEF10A/B	6th floor roof, exhaust	560	Dia	900	4000	50	4	9	17	26	31	30	23	16
SEF11A/B	6th floor roof, exhaust	560	Dia	900	4000	50	4	9	17	26	31	30	23	16
SEF12A/B	6th floor roof, exhaust	560	Dia	900	4000	50	4	9	17	26	31	30	23	16
SEF 13	4th floor roof, exhaust	560	Dia	900	8500	50	4	7	13	19	23	23	16	13
SEF 14	4th floor roof, exhaust	560	Dia	900	8500	50	4	7	13	19	23	23	16	13
SEF 15	4th floor roof, exhaust	560	Dia	900	8500	50	4	7	13	19	23	23	16	13
SEF 16	4th floor roof, exhaust	560	Dia	900	8500	50	4	7	13	19	23	23	16	13
SEF 17	4th floor roof, exhaust	560	Dia	900	8500	50	4	7	13	19	23	23	16	13
SEF 18	4th floor roof, exhaust	560	Dia	900	8500	50	4	7	13	19	23	23	16	13
SEF19A/B, SEF19C/D & SEF20E/F	M2, exhaust	TBC		900	3730 (Emergency) / 750 (Normal)	50	2	4	9	15	17	14	10	8

Notes:

ATMOSPHERE SIDE SILENCER SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof & B2/M2

Ref:	AS 8175/ ASS- 1	Revision:	0	Date:	18 January 2017		Engineer	MS					
Silencer Ref.	Description	Dimensions (mm)			Volume duty	Pressure drop	Octave Band Mid Frequency (Hz)						
		W	H	L	l/s	Pa	63	125	250	500	1k	2k	4k	8k
SEF20A/B	M2, exhaust	TBC		600	370 (Emergency)/ 189 (Normal)	50	1	2	7	10	11	9	8	7
SEF21A/B	B2, exhaust	TBC		600	472 (Emergency) / 188 (Normal)	50	1	2	7	10	11	9	8	7
SEF22A/B	B2, exhaust	TBC		600	475 Emergency) / 187 (Normal)	50	1	2	7	10	11	9	8	7
SEF23A/B	B2, exhaust	TBC		600	193 (Emergency) / 70 (Normal)	50	1	2	7	10	11	9	8	7
SEF24A/B	B2, exhaust	TBC		600	853 (Emergency) / 231 (Normal)	50	1	2	7	10	11	9	8	7
SEF25A/B	B2, exhaust	TBC		600	736 (Emergency) / 147 (Normal)	50	1	2	7	10	11	9	8	7
SEF26A/B	M2, exhaust	TBC		600	801 (Emergency) / 160 (Normal)	50	1	2	7	10	11	9	8	7
SEF27A/B	M2, exhaust	TBC		600	798 (Emergency) / 160 (Normal)	50	1	2	7	10	11	9	8	7
SEF28A/B	B2, exhaust	TBC		600	1613 (Emergency) / 340 (Normal)	50	2	4	8	12	13	13	9	8

Notes:

ATMOSPHERE SIDE SILENCER SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof & B2/M2

Ref:	AS 8175/ ASS- 1	Revision:	0	Date:	18 January 2017		Engineer	MS							
Silencer Ref.	Description	Dimensions (mm)			Volume duty	Pressure drop	Octave Band Mid Frequency (Hz)							
		W	H	L	l/s	Pa	63	125	250	500	1k	2k	4k	8k
SEF29A/B	M2, exhaust	TBC		600	3438 (Emergency) / 690 (Normal)	50	1	2	7	10	11	9	8	7
SEF30A/B	M2, exhaust	TBC		900	1640 Emergency) / 330 (Normal)	50	2	5	11	17	20	19	12	10
EF12A/B	Roof	-	-	-	1418	50	See Plant Noise Schedule							
EF13A/B	Roof	-	-	-	1471	50	See Plant Noise Schedule							
EF14A/B	Roof	-	-	-	1311	50	See Plant Noise Schedule							
EF15A/B	Roof	-	-	-	1258	50	See Plant Noise Schedule							
SF 01 & SF 02	B2/M2	-	-	-	1120	50	See Plant Noise Schedule							
TGF01/2	Roof	-	-	-	290 (Emergency) / 90 (Normal)	50	See Plant Noise Schedule							
LPF01A/ LPF01B	6th floor roof, exhaust	TBC		1500	1800	50	5	11	21	33	37	44	43	30
LPF02A/ LPF02B	6th floor roof, exhaust	TBC		1500	1800	50	5	11	21	33	37	44	43	30

Notes:

ROOMSIDE SILENCER SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof & B2/M2

Ref:	AS8175/RSS-1	Revision:	0	Date:	18 Jan 17		Engineer	MS						
Fan Ref.	Description	Dimensions (mm)			Volume duty	Pressure drop	Octave Band Mid Frequency (Hz)							
		W	H	L	l/s	Pa	63	125	250	500	1k	2k	4k	8k
SEF01A/B	M2, inlet	TBC		900	7500	50	2	4	9	15	17	14	10	8
SEF02A/B	M2, inlet	TBC		600	5350	50	1	2	7	10	11	9	8	7
SEF03A/B	M2, exhaust	TBC		600	5250	50	1	2	7	10	11	9	8	7
SEF04A/B	M2, exhaust	TBC		1200	1390	50	2	6	11	20	23	19	12	9
SEF05A/B	M2, exhaust	TBC		1200	1530	50	2	6	11	20	23	19	12	9
SEF06A/B	M2, exhaust	TBC		1200	1940	50	2	6	11	20	23	19	12	9
SEF07A/B	M2, exhaust	TBC		1200	1820	50	2	6	11	20	23	19	12	9
SEF08A/B	6th floor roof, exhaust						None required							
SEF09A/B	M2, exhaust	TBC	600		10834	50	2	6	11	20	23	29	12	9
SEF10A/B	6th floor roof, exhaust	560	Dia	800	4000	50	4	7	11	19	27	30	25	18
SEF11A/B	6th floor roof, exhaust	560	Dia	800	4000	50	4	7	11	19	27	30	25	18
SEF12A/B	6th floor roof, exhaust	560	Dia	800	4000	50	4	7	11	19	27	30	25	18
SEF 13	4th floor roof, exhaust	560	Dia	1000	8500	50	5	8	12	21	29	25	21	15
SEF 14	4th floor roof, exhaust	560	Dia	1000	8500	50	5	8	12	21	29	25	21	15
SEF 15	4th floor roof, exhaust	560	Dia	1000	8500	50	5	8	12	21	29	25	21	15
SEF 16	4th floor roof, exhaust	560	Dia	1000	8500	50	5	8	12	21	29	25	21	15
SEF 17	4th floor roof, exhaust	560	Dia	1000	8500	50	5	8	12	21	29	25	21	15
SEF 18	4th floor roof, exhaust	560	Dia	1000	8500	50	5	8	12	21	29	25	21	15
SEF19A/B, SEF19C/D & SEF20E/F	M2, exhaust						None required							

Notes:

ROOMSIDE SILENCER SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof & B2/M2

Ref:	AS8175/RSS-1	Revision:	0	Date:	18 Jan 17		Engineer	MS							
Fan Ref.	Description	Dimensions (mm)			Volume duty	Pressure drop	Octave Band Mid Frequency (Hz)								
		W	H	L	l/s	Pa	63	125	250	500	1k	2k	4k	8k	
SEF20A/B	UPS Areas 1/3, 2/3 & 3/3						None required								
SEF21A/B	E1 Transformer/Switchroom Area						None required								
SEF22A/B	N1 Transformer/ Switchroom Area						None required								
SEF23A/B	T3 Transformer/ Switchroom Area						None required								
SEF24A/B	PBT Transfomer/UPS Area						None required								
SEF25A/B	PB237 IT Room						None required								
SEF26A/B	8157 Comms Room						None required								
SEF27A/B	8158 Oil Tank Room						None required								
SEF28A/B	6167 Plant Room						None required								
SEF29A/B	6245 Sprinkler Tank Room						None required								
SEF30A/B	8165 Water Tank Room						None required								
EF12A/B	Roof	-	-	-	-	-	Refer to schedule AS8175/PNS-1								
EF13A/B	Roof	-	-	-	-	-	Refer to schedule AS8175/PNS-1								
EF14A/B	Roof	-	-	-	-	-	Refer to schedule AS8175/PNS-1								
EF15A/B	Roof	-	-	-	-	-	Refer to schedule AS8175/PNS-1								

Notes:

ROOMSIDE SILENCER SCHEDULE

UCLH PHASE 4 PROTON BEAM THERAPY UNIT

Roof & B2/M2

Ref:	AS8175/RSS-1	Revision:	0	Date:	18 Jan 17		Engineer	MS							
Fan Ref.	Description	Dimensions (mm)			Volume duty	Pressure drop	Octave Band Mid Frequency (Hz)							
		W	H	L	l/s	Pa	63	125	250	500	1k	2k	4k	8k
SF 01 & SF 02	B2/M2	-	-	-	-	-	None required							
TGF01/2	Roof	TBC	TBC	TBC	-	290 (Emergency) / 90 (Normal)	TBC							
LPF01A/B	6th floor roof, outlet	710	Dia	1100	1800	50	4	7	11	19	27	30	25	18
LPF02A/B	6th floor roof, outlet	710	Dia	1100	1800	50	4	7	11	19	27	30	25	18

Notes:

AS8175 UCLH PHASE 4 PBT

APPENDIX A

LOCATIONS REQUIRING DUCT-MOUNTED CROSSTALK ATTENUATION

	Location	Attenuator type
Level 2	Extract from HW086 Seminar	2
	Extract from HW087 Seminar	2
	Extract from HW085 Meeting	2
	Extract from HW084 Meeting	2
	EG/2/1/43	1
	SG2/1/14	1
	Extracts from SA150 Lounge	1
	Branch to EG1/5/11 & 12	1
	EG1/5/10	1
	EG1/5/13	1
	EG1/5/15	1
Level 1	Branch to EG1/5/16 to 18	1
	Branch to EG1/5/19 & 20	1
	EG1/5/21	1
	Extract from C154 Meeting Room	2
	Extract from C153 Meeting Room	2
	Extract from C151 Office	1
	Extract from C156 Hot Desks	1
	EGG/4/30	1
	EGG/4/34	1
Ground	Extract from XR124 View/Report	1
	Extract from XR111 Super Radiog.	1
	Extract from XR116 Office	1
	Extract from XR104 Counsel	2
	EGB1/10/12	1
	EGB1/10/14	1
Level B1	EGB1/10/18	1
	EGB1/11/12	1
	EGB1/11/14	1

Cont.

	EGB3/6/27	1
	EGB3/6/28	1
	EGB3/6/29	1
	EGB3/6/30	1
	EGB3/6/31	1
	Extract ducts within PB122 MDT/Group Room	2
	Extract ducts within PB125 staff lounge	1
Level B3	Extract ducts within PB123/124 meeting rooms	2
	EGB3/6/26	1
	Branch to EGB3/6/24 & 25	1
	EGB3/6/20	1
	Branch to EGB3/6/21, 22 & 23	1
	EGB3/6/45 and 48	1
	SGB3/6/36	1
	SGB3/6/37	1
	Between EGB4/6/13 and EGB4/6/12	1
Level B4	EGB4/6/2	1
	EGB4/6/1	1
	EGB4/620 - 22	1

AS7143 UCLH PHASE 4 AND PROTON BEAM THERAPY UNIT

APPENDIX B

INDICATIVE PARTITION PENETRATION DETAILS