

SHARPS REDMORE

ACOUSTIC CONSULTANTS ▪ Established 1990



Report 2

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BREEAM 2018 Hea 05
Acoustic Specification
Radcliffe Hub

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Revision Register

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This report has been prepared with all reasonable skill, care and diligence commensurate with an acoustic consultancy practice under the terms and brief agreed with our client at that time. Sharps Redmore provides no duty or responsibility whatsoever to any third party who relies upon its content, recommendations or conclusions.

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1.0 Executive Summary

- 1.1 This report presents the acoustic performance criteria required to achieve the BREEAM 2018 New Construction standards described by Hea 05 for the proposed Radcliffe Hub.
- 1.2 It is understood that three BREEAM credits are being sought in the performance areas of *Sound Insulation*, *Internal Indoor Ambient Noise Level*, and *Reverberation*. A single credit is available for each.
- 1.3 Criteria are provided in accordance with the guidance of BREEAM, BS 8233:2014 *Guidance on sound insulation and noise reduction for buildings* and the Sports England guidance. Criteria described within CIBSE Guide A has been considered for the specification regarding noise from building services.
- 1.4 Sound insulation mark-ups are provided in Appendix B.
- 1.5 Drawings accessed from the Viewpoint for Projects document cloud on 26th May 2022 were reviewed to inform our understanding of the project.
- 1.6 The project is at RIBA Stage 3 and as such some details will be developed and evaluated in due course.
- 1.7 Acoustic surveys were carried out by Sharps Redmore between the 13th and 18th January 2022 to determine the existing sound levels at the development site. The results of the survey are used to advise performance specifications for the building envelope to control sound ingress. Survey time-history charts are included in Appendix A.
- 1.8 BREEAM require that acoustic assessments are carried out by a suitably qualified acoustician, or 'SQA'. This report has been prepared by Andrew Newell who has nine years' experience as an acoustic consultant, holds a Post-Graduate Diploma in Acoustics and Noise Control and is a corporate member of the Institute of Acoustics (MIOA). The author therefore meets BREEAM prerequisites for an SQA.

2.0 Introduction

- 2.1 Sharps Redmore (SR) has been appointed to provide acoustic advice regarding the Radcliffe Hub development with a view to achieving sustainability credits in accordance with the British Research Establishment Environmental Assessment Method (BREEAM) 2018.
- 2.2 Three credits are being targeted for meeting the standards specified by Hea 05 *Acoustic Performance*.
- 2.3 The development comprises the demolition of existing buildings and the construction of a new Hub. The Hub building will include a swimming pool, gym, fitness studios, library, clip and climb, office/admin spaces, meeting rooms and welfare facilities.
- 2.4 The site is situated in the centre of the market town of Radcliffe next to the existing market hall by the River Irwell. A Lidl store is located to the south-west and the Bridge Tavern to the north-east. The land use is mixed predominantly with retail /commercial, leisure and some residential.

3.0 Acoustic Standards and Guidance

BREEAM Hea 05 Acoustic Performance

- 3.1 BREEAM sets out the manner in which credits may be achieved for meeting standards to ensure the building is capable of providing an appropriate acoustic environment to provide comfort for building users. Performance requirements are specified in the following areas:

- Sound insulation
- Internal indoor ambient noise levels
- Room acoustics

- 3.2 All three BREEAM credits are being targeted and a description of performance requirements for each area are provided below. Specific criteria are identified in Sections 5.0, 6.0 and 7.0.

- 3.3 A programme of pre-completion testing is required to demonstrate compliance with the criteria set out for the performance areas above.

First Credit – Sound Insulation

- 3.4 One credit can be awarded where the sound insulation between rooms and other occupied areas complies with the performance criteria given in Section 7 of BS 8233:2014. Alternatively, propose performance standard based on demonstrably best practice.

- 3.5 An occupied area is defined as “A room or space within the assessed building that is likely to be occupied for 30 minutes or more by a building user.”

Second Credit – Internal Ambient Noise Levels

- 3.6 One credit can be awarded where the internal indoor ambient noise levels comply with the design ranges given in Section 7 of BS 8233:2014.

Third credit – Reverberation

- 3.7 One credit can be awarded for meeting the requirements of Section 7 of BS 8233:2014 relating to sound absorption and reverberation times, where applicable.

Suitably Qualified Acoustician

- 3.8 An individual who has achieved the following requirements can be considered to be ‘suitably qualified’ for the purposes of a BREEAM assessment:

1. Has a minimum of three years relevant experience (within the last five years). Such experience must clearly demonstrate a practical understanding of factors affecting acoustics in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for suitable acoustic performance levels and mitigation measures.
2. An individual who holds a recognised acoustic qualification and membership of an appropriate professional body. The primary professional body for acoustics in the UK is the Institute of Acoustics.

- 3.9 Where an SQA is verifying the acoustic measurements or calculations carried out by another acoustician who does not meet the SQA requirements, they must, as a minimum have read and reviewed the report and confirm in writing that they have found it to:

- Represent sound industry practice
- Is appropriate given the building being assessed and scope of works proposed
- Avoid invalid, biased or exaggerated recommendations.

- 3.10 Additionally, written confirmation from the third-party verifier that they comply with the definition of an SQA is required.

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings

- 3.11 BS 8233:2014¹ provides information for the design of buildings that have internal acoustic environments appropriate to their function, and provides general guidance for many types of buildings.
- 3.12 Section 7.7.6 offers guidance for offices and refers to the British Council for Offices Guide to Specification. In relation to offices BS 8233:2014 provides specific guidance relating to acoustic privacy, sound insulation, noise in open-plan offices, and indoor ambient noise levels.

Sport England

- 3.13 Sport England provide broad guidance regarding sports facilities in England, which includes advice for controlling reverberation and appropriate noise level criteria.

¹ *BS 8233_2014_Guidance on sound insulation and noise reduction for buildings, BSI, 2014*

4.0 Acoustic Survey

- 4.1 Sharps Redmore carried out an environmental survey to determine the current acoustic climate at the site and at nearby noise-sensitive locations. The results of the survey will be used to determine suitable sound insulation requirements for the building envelope. Criteria for fixed external building services plant have been provided in the BREEAM Pol05 specification.
- 4.2 The survey was undertaken between the 13th and 18th January 2022 such that sufficient data was obtained to represent the daytime and night-time periods, weekdays and weekends, and days which were or were not market days.
- 4.3 A single sound level meter was left unattended to record measurements over the six-day survey period.
- 4.4 Sound level meters are laboratory calibrated to national standards, and field-calibrated before and after the survey. No significant calibration drift was observed. Equipment details are shown in Table 4.1 below; calibration certificates are available on request.

Table 4.1 Measurement equipment

Equipment	Description	Serial Number
Cirrus CR:515	Class 1 sound level meter	65605
Cirrus MK:224	Microphone	213337D
Cirrus CR:515	Calibrator (integral to meter)	65605

- 4.5 The measurement location was chosen to be representative of the closest-noise sensitive locations above the Bridge Tavern and River Court, whilst being safe and secure to leave monitoring equipment unattended. The meter was positioned protruding a first-floor window at the Market Chambers. The measurement position is shown in Figure 4.1 and Figure 4.2.

Figure 4.1 Unattended survey position

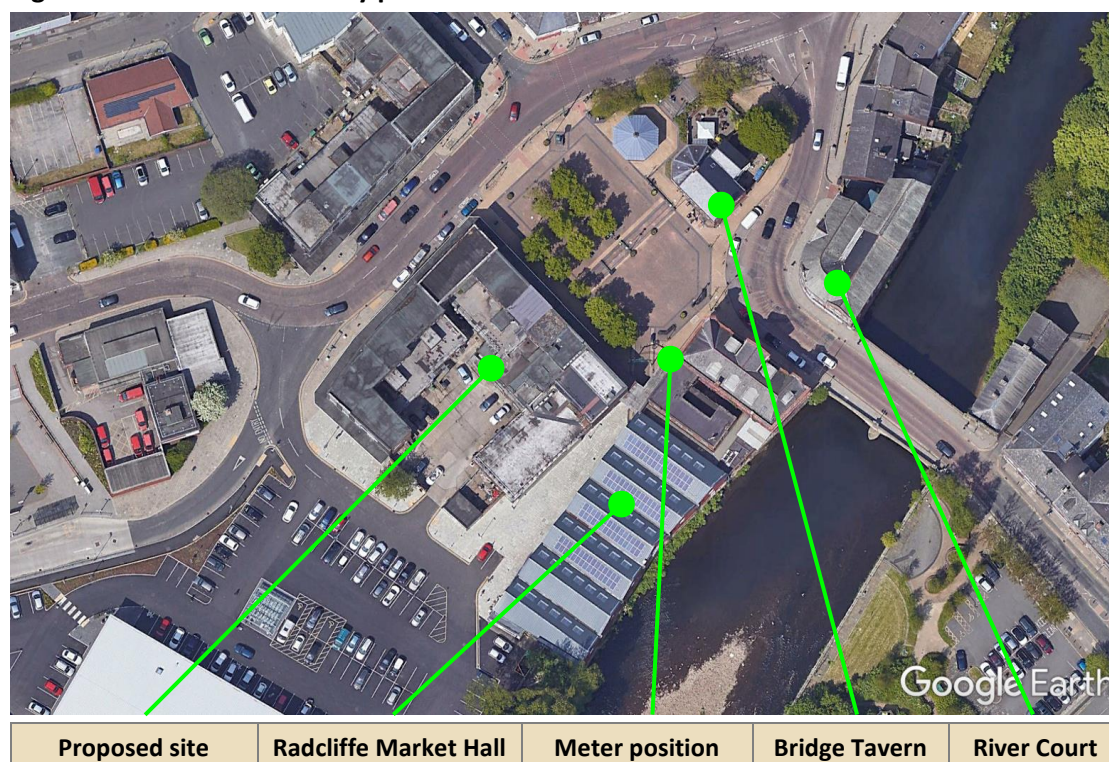


Figure 4.2 Meter location



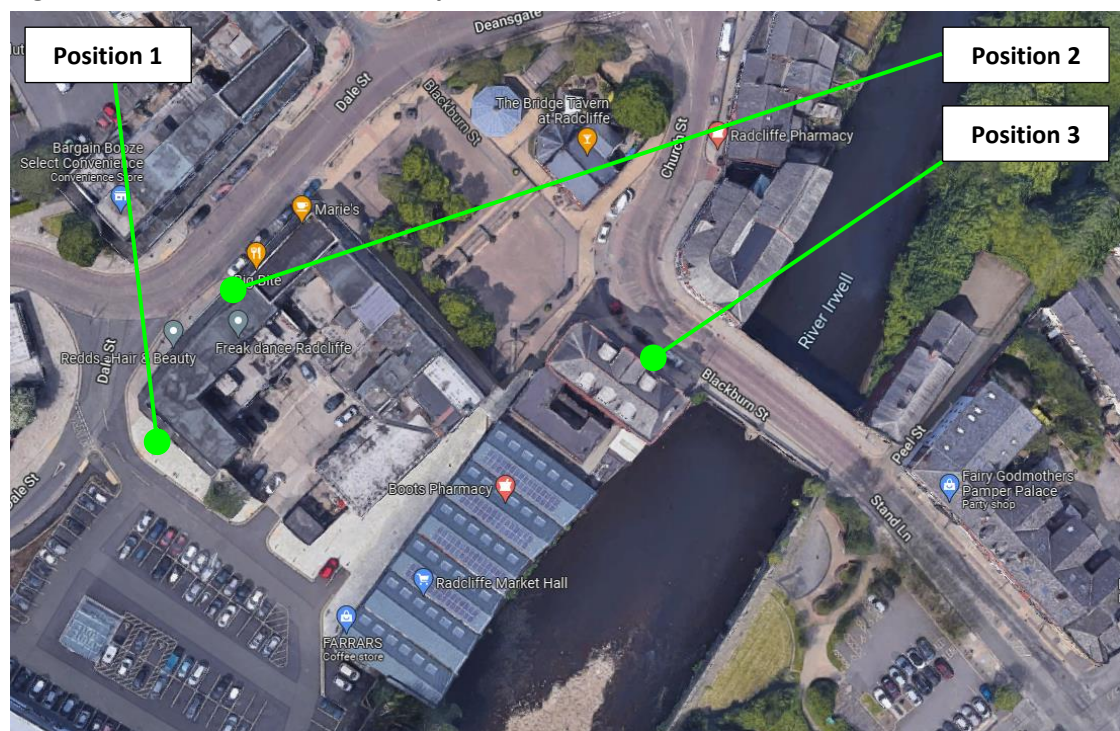
- 4.6 Multiple parameters were recorded in 5-minute measurement periods, including the following:
- equivalent sound pressure level ($L_{eq,T}$)
 - maximum sound pressure level (L_{Fmax})
 - background sound pressure level ($L_{90,T}$)
 - the tenth percentile sound pressure level ($L_{10,T}$)
- 4.7 Measurements are recorded in one-third-octave frequency bands, which are adjusted in each frequency band by an 'A' weighting, before summing logarithmically to obtain a single-figure A-weighted value, denoted by the 'A' subscript. The A-weighting represents a normal human's response to sound pressure levels.
- The A-weighted equivalent sound pressure level ($L_{Aeq,T}$) represents an 'average' continuous sound level over a given period T .
 - The A-weighted maximum sound pressure level (L_{AFmax}) is the highest sound pressure level measured with a 'fast' time constant, which is a rise and fall time of 125 milliseconds.
 - The background sound level ($L_{A90,T}$) is the level which is exceeded by 90% of measurements over a given period. As the name suggests this represents a background level of sound without the influence of significant transient sound events.
 - The A-weighted tenth percentile sound pressure level ($L_{A10,T}$) is commonly used to represent traffic noise.

- 4.8 The weather conditions during the survey have been sourced from www.wunderground.com for the weather station IBURY44 located at 53.566° N, 2.293° W. The data is presented on the survey history charts in Appendix A.
- 4.9 In summary, temperatures ranged between -2°C and 8°C during the daytime and between -2°C and 6°C during the night-time. Wind speeds were low and not considered to have significantly affected measurements. There was a very small amount of precipitation during the survey, and roads may have been damp during some periods, though this is in keeping with typical meteorological conditions at the site.
- 4.10 The dominant noise sources at the site was road traffic from nearby highways, and pedestrians walking through square which contributed noise from footfall and from talking. In addition, there was some noise contributions from people visiting shops and other commercial premises. The survey data indicates some noise due to night-time economy activities, such as the nearby Bridge Tavern.
- 4.11 The results of the survey are presented in the time history charts in Appendix A; detailed measured data are available on request.

Attended Survey

- 4.12 Attended measurements were undertaken on the 18th January 2022 to obtain representative sound spectra at key positions at the site. The positions are intended to represent noise levels at key positions surrounding the development.
- 4.13 The attended survey positions are shown in Figure 4.3. The sound level meter was positioned approximately 1.3 metres above ground level and at a minimum distance of 3 from reflective surfaces, other than the ground.

Figure 4.3 Attended measurement positions



- 4.14 The dominant noise source at all positions was road traffic noise, although other sources were significant at each of the positions, as follows:

- Position 1 – Road traffic noise and from vehicles accessing the Lidl car park. There was frequent pedestrian activity including talking.
- Position 2 – Road traffic noise from Dale Street and Deansgate. There was constant pedestrian activity and occasional beeping from the pedestrian crossing.
- Position 3 – Road traffic noise from Church Street and Blackburn Street, along with noise from passing pedestrians.

4.15 The results of the attended measurement are presented in the tables below. The measurement duration T for each measurement in Table 4.2 is 15 minutes. For Table 4.3 the duration T is the total measurement duration of 45 minutes.

Table 4.2 Summary of attended survey measurements

Position	Date + time	Duration	$L_{Aeq,T}$ (dB)	$L_{Amax,F}$ (dB)	$L_{A01,T}$ (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)
1	18/01/2022 11:02	15 min.	62	82	70	65	57
1	18/01/2022 12:01	15 min.	62	84	69	65	57
1	18/01/2022 13:01	15 min.	61	83	69	64	56
2	18/01/2022 11:18	15 min.	67	78	74	71	57
2	18/01/2022 12:19	15 min.	68	86	75	72	58
2	18/01/2022 13:19	15 min.	67	83	73	71	57
3	18/01/2022 11:37	15 min.	69	80	76	73	58
3	18/01/2022 12:37	15 min.	70	83	77	73	59
3	18/01/2022 13:37	15 min.	70	89	78	73	57

Table 4.3 Attended measurements: equivalent sound pressure level spectra (L_{eq})

Position	Octave-band equivalent sound pressure level, $L_{eq,T}$ (dB)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	dBA
1	69	62	60	58	58	54	48	62
2	71	64	64	61	64	60	54	67
3	74	66	67	65	67	61	53	69

5.0 Indoor Ambient Noise Levels

- 5.1 Criteria for the indoor ambient noise level are specified according to the guidance of BS 8233:2014 and Sports England. Criteria specified as noise rating (NR) levels are approximately equivalent to 6 dB less than a continuous L_{Aeq} in the absence of strong low frequency contributions.

BS 8233:2014

- 5.2 BS 8233:2014 provides criteria for indoor ambient noise levels, including for offices and meeting rooms. Each are expressed as a design range, with the intention to provide sufficient background noise to aid privacy, but without being excessive so as to adversely affect speech intelligibility.
- 5.3 The criteria include noise contributions from steady noise sources, such as external traffic noise ingress, internal mechanical services noise, or continuously running plant but not including noise from occupants and their activities.

Table 5.1 BS 8233:2014 internal ambient noise level design ranges

Objective	Typical Situations	Design Range, $L_{Aeq,T}$ (dB)
Typical noise levels for acoustic privacy in shared areas	Open plan office	45 – 50

Table 5.2 BS 8233:2014 typical noise levels in non-domestic buildings when unoccupied

Activity	Location	Design Range, $L_{Aeq,T}$ (dB)
Speech or telephone communications	Cafeteria, canteen, kitchen	50 – 55
	Corridor, circulation space	45 – 55
Study and work requiring concentration	Library	40 – 50
	Staff/meeting room, training room	35 – 45
	Executive office	35 – 40

- 5.4 For other large spaces where speech intelligibility may be important, such as the Studios and Fitness Suite where instruction could be given, it is recommended that the indoor ambient noise level does not exceed 40 dB $L_{Aeq,30mins}$ when unoccupied.

Pool Hall

- 5.5 Sports England specify that noise from building services (heating, ventilation and electrical) and external break-in noise should be limited to NR 40 dB $L_{eq,30mins}$ in pool halls.

Building Services Noise

- 5.6 It is recommended that noise due to building services do not exceed the levels given below in Table 5.3. These criteria are generally as specified by CIBSE Guide A² and are compatible with the criteria shown in Tables 5.1 and 5.2 above.

² CIBSE Guide A Environmental design, Chartered Institution of Building Services Engineers, 2015

Table 5.3 Criteria for building services noise

Room	Criteria
Pool hall	NR 40 L_{eq}
Community rooms	NR 35 L_{eq}
Meeting rooms	NR 30 L_{eq}
Cellular offices	NR 30 L_{eq}
Multi-occupancy offices	NR 35 L_{eq}
Consultation rooms	NR 30 L_{eq}
Library	NR 30 – 35 L_{eq}

Plant Rooms

- 5.7 Noise from plant rooms must be designed to suit the adjacent occupied areas and to comply with Noise at Work Regulations to protect occupants/employees from hearing damage. It is recommended that noise levels do not exceed the Lower Exposure Action Value of 80 dBA for daily personal exposure, $L_{EP,d}$, or weekly personal exposure, $L_{EP,w}$. Hearing protection is not required to be offered by the employer below these noise levels. Peak sound pressure levels must not exceed 137 dB L_{Cpeak} at any time.
- 5.8 It is acceptable for noise levels to exceed 80 dBA if the exposure time is less than the daily reference period of 8 hours. Table 5.6 presents the daily personal exposure limits for shortened time periods.

Table 5.4 Daily personal exposure limits for shortened time periods

Exposure period, T (hours)	Exposure limit $L_{EP,T}$ (dBA)	Personal daily exposure, $L_{EP,d}$ (dBA)
1	89	80
2	86	80
3	84	80
4	83	80
5	82	80
6	81	80
7	81	80
8	80	80

- 5.9 A risk assessment must be undertaken in accordance with the Noise Regulations to assess the risks associated with noise exposure to employees. If the any of the following apply it is likely that measures to control the noise risk to occupants/employees will be required:
- Noise is intrusive – for example, as noisy as a busy road, a vacuum cleaner or a crowded restaurant – or worse than intrusive, for most of the working day.
 - Occupants/employees have to raise their voices to carry out a normal conversation when about 2 m apart for at least part of the day.
 - Occupants/employees use noisy equipment, such as loud sound systems for music playback, for more than half an hour during the day.

- 5.10 Where plant poses a risk of transmitting noise and/vibration to the structure of the building, the plant must incorporate anti-vibration/noise measures, such as resilient fixings, anti-vibration springs, mounts, mats or an inertia base, for example, and physical connections to the plant must include flexible connectors.
- 5.11 Sound insulation calculations and the subsequent acoustic performance specification for partitions between plant rooms and occupied rooms have been based on plant room noise levels no greater than 80 dB L_{Aeq} .

Plant Room Noise Transfer

- 5.12 Some noise-sensitive spaces are directly adjoining the plant room including the Flexi Hall stage at ground floor level, and dressing rooms and technical areas on the first floor directly above the plant room.
- 5.13 The acoustic performance of separating walls and floors can be reviewed once plant room information is available.
- 5.14 All plant generating noise and/or vibration must incorporate appropriate acoustically resilient fixings, mountings and/or connectors to minimise structural noise/vibration transmission.

6.0 Sound Insulation

Airborne Sound Insulation

- 6.1 Section 7.5 of BS 8233:2014 offers an example sound insulation matrix to determine suitable levels of sound insulation to control noise between adjacent spaces. The level of sound insulation is dependent on the activity noise of the source room, the noise sensitivity of the receiving room and the overall privacy requirement. The assessment is carried out in both directions with the most onerous requirement taking precedence. The example matrix is reproduced in the following table.

Table 6.1 BS 8233:2014 Example sound insulation matrix (dB $D_{nT,w}$)

Privacy requirement	Activity noise of source room	Noise sensitivity of receiving rooms		
		Low	Medium	Sensitive
Confidential	Very high	47	52	57
	High	47	47	52
	Typical	47	47	47
	Low	47	42	47
Moderate	Very high	47	52	57
	High	37	42	47
	Typical	37	37	42
	Low	No rating	No rating	37
Not private	Very high	47	52	57
	High	37	42	47
	Typical	No rating	37	42
	Low	No rating	No rating	37

- 6.2 The sound insulation criteria is specified as the weighted standardised level difference ($D_{nT,w}$) where T is the receiving room reverberation time. The $D_{nT,w}$ parameter describes the in-situ performance which must be achieved and does not take into account allowances for construction defects or flanking noise transmission.
- 6.3 The sound insulation performance of building elements (e.g. partitions, doors, glazing) is typically specified in terms of the weighted sound reduction index R_w , the calculation for which includes allowances for construction defects, flanking noise transmission, room geometry and room acoustics. In general, an allowance of +7 dB is adequate for these considerations.
- 6.4 For office spaces, BS 8233:2014 specifies that the minimum sound insulation needs to be approximately 38 dB D_w in order to achieve unintelligible speech between offices, or between an office and an occupied space. Where privacy is important, the minimum sound insulation should be 48 dB D_w .
- 6.5 The equivalent $D_{nT,w}$ values (where the reverberation time is ≤ 0.8 seconds when furnished) is 40 dB $D_{nT,w}$ to achieve unintelligible speech between offices, or 50 dB $D_{nT,w}$ where privacy is important.
- 6.6 In practice 48 dB D_w or 50 dB $D_{nT,w}$ is difficult to achieve without a well-performing partition, careful consideration of detailing, a ceiling, non-continuous floor and excellent workmanship.

- 6.7 To provide a reasonable level of sound insulation between occupied spaces and ancillary areas and, such as toilets and circulation spaces, it is proposed that separating partitions achieve at least 40 dB R_w .
- 6.8 Table 6.2 presents example constructions capable of achieving sound insulation performance criteria for internal partitions.

Table 6.2 Example partition constructions

Required specification	Description	Laboratory tested sound insulation performance
40 dB R_w	One layer of 12.5 mm standard plasterboard (8.0 kg/m ²) to both sides of 70 mm 'C' stud at 600 mm centres, with 25 mm acoustic partition roll in cavity.	42 dB R_w
45 dB R_w	One layer 15 mm standard plasterboard (8.0 kg/m ²) to both sides 70 mm 'C' stud at 600 mm centres, with 50 mm acoustic partition roll in the cavity, with plaster skim.	45 dB R_w
37 dB $D_{nT,w}$	One layer 15 mm standard plasterboard (8.0 kg/m ²) to both sides 70 mm 'C' stud at 600 mm centres, with 50 mm acoustic partition roll in the cavity.	44 dB R_w
42 dB $D_{nT,w}$	Two layers 12.5 mm standard plasterboard (8.0 kg/m ²) to both sides of 70 mm 'C' stud at 600 mm centres, with 25 mm acoustic partition roll in the cavity.	49 dB R_w
47 dB $D_{nT,w}$	Two layers 15 mm dense plasterboard (12.6 kg/m ²) to both sides of 70 mm 'C' stud at 600 mm centres, with 25 mm acoustic partition roll in the cavity.	54 dB R_w
52 dB $D_{nT,w}$	Two layers 15 mm dense plasterboard (12.6 kg/m ²) and a plaster skim to each side of independent staggered 70 mm 'I' studs at 300 mm centres, with 50 mm acoustic partition roll in the cavity.	59 dB R_w

- 6.9 Mark-ups showing the minimum sound insulation performance for internal partitions and doors are presented in Appendix B.
- 6.10 Moderate background noise is critical to mask intruding speech and is generally provided by building services noise which should be designed to meet the ranges for the indoor ambient noise level identified in Section 5.0.

Internal glazing and glazed screens

- 6.11 Acoustically important partitions which contain glazed sections, or which are fully glazed, must also meet the minimum sound required insulation performance as a whole.

Corridor walls and doors

- 6.12 Doors are normally the weakest element where included in a partition and the overall performance of the partition will be limited by the performance of the door, frame and door furniture.
- 6.13 Walls which contain doors between corridors and acoustically sensitive rooms should be rated at ≥ 40 dB R_w , or ≥ 45 dB R_w where privacy is important.
- 6.14 Doors to acoustically sensitive rooms (e.g. offices, meetings rooms) should be rated at ≥ 30 dB R_w . Where privacy is important doors should be rated at ≥ 35 dB R_w .

- 6.15 Typically, with good workmanship and detailing a 44 mm timber solid-core door can achieve up to 30 dB R_w and a 54 mm timber solid-core door can achieve up to 35 dB R_w with the appropriate seals and door furniture.
- 6.16 To maximise the acoustic performance of a door-set the gap between the frame and surrounding wall must not exceed 10 mm with all gaps packed with mineral wool and sealed with a non-hardening sealant. The door must be well-fitting within a rebated stop (generally around 15 mm) and incorporate seals around the full perimeter of the door including a drop-down or wipe type threshold seal at the bottom.

Folding Partitions

- 6.17 The folding partition which separates the ground floor Community Rooms, and the folding partition which splits Studio 2 should ideally achieve at least 42 dB $D_{nT,w}$.
- 6.18 To achieve this performance, the partition and surrounding detailing must be rated at least 10-15 dB higher in terms of the laboratory performance, i.e. ≥ 52 -57 dB R_w . The supplier of the folding partition will normally be able to advise a suitable product in their range.

Airborne Sound Insulation of Floors

- 6.19 Separating floor constructions must achieve a minimum sound insulation performance of 42 dB $D_{nT,w}$, with the exception of the floor between the Library and Prayer Room which must achieve a performance of 47 dB $D_{nT,w}$.
- 6.20 The above criteria may be achieved with floor constructions rated at around 52 dB R_w . A concrete slab (min. density 2400 kg/m³) of depth 130 mm is capable of achieving this requirement. Other constructions can be reviewed by the acoustician as required.

Impact Sound Insulation

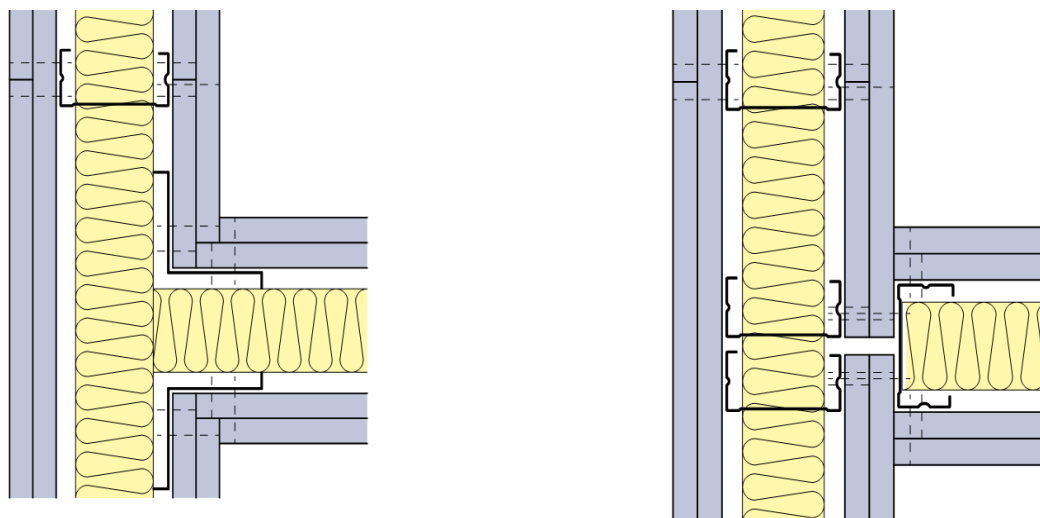
- 6.21 Impact noise within the Library due to footfall above should be controlled to not exceed 60 dB $L_{nT,w}$.
- 6.22 Typically, a carpet tile floor finish in rooms above, plus an acoustic suspended ceiling in the Library would be sufficient.

Flanking and detailing: Further guidance

- 6.23 Flanking is noise transmitted via indirect noise paths such as through the cavity within a wall, via screeds under a partition, along structural members and through elements of curtain walling, for example. It is imperative to minimise flanking noise as it is likely to limit the sound insulation between spaces. Flanking noise transmission is controlled by careful consideration and design of building elements, as well as excellent standards of construction.
- 6.24 Acoustic walls should be built from slab to soffit and according to the manufacturer's specifications to be capable of achieving the required criteria. Gaps around the perimeter of the partition must be filled and sealed. Where detailing is required to accommodate movement, such as deflection heads, these must be designed to maintain the acoustic integrity of the partition.
- 6.25 Where an acoustically rated partition meets another partition lining (such as perpendicular to corridor walls) the linings must not be continuous across the acoustically rated partition. A break must be incorporated into the lining, and the partition should ideally cut into the lining,

as shown in Figure 6.1 below. This is also applicable where a partition meets an external wall lining.

Figure 6.1 Example junction details to optimise acoustic performance and reduce flanking sound transmission



- 6.26 It is common for walls to be built from a screed which is continuous between spaces. A continuous screed is likely to limit the performance of a separating partition to around 40 dB $D_{nT,w}$, and increasing the performance of the partition will not significantly improve the overall sound insulation.
- 6.27 Where partitions are rated at 50 dB R_w or above, the screed or floating floor must not be continuous. Breaks can be achieved by either building partitions directly from the base slab and pouring the screed after partitions are built, or by incorporating shuttering or timber battens under the locations of the partition floor channel. Construction details can be reviewed by the acoustician as necessary.
- 6.28 Partitions rated ≤ 45 dB R_w may be built from a raised access floor where the gap under the floor is fully closed. Intumescent fire pillows, for example, can be useful to fill gaps around cable trays running under raised access floors. Non-acoustic partitions or those rated ≤ 40 dB R_w can be built directly from a raised access floor.
- 6.29 Services should not penetrate partitions directly between acoustically sensitive spaces. Services would ideally be routed along circulation routes and penetrate into rooms from there. Where services must penetrate a partition between acoustically sensitive spaces the penetration must be appropriately designed and ventilation ductwork is likely to require a cross-talk attenuator.
- 6.30 Where services pass through an acoustically rated partition, the penetration opening must be minimised, ideally scribing or cutting the plasterboard lining as close to the services as possible. Gaps must be packed with mineral wool and sealed with flexible acoustic mastic. For gaps around service of more than 25 mm, additional layers of plasterboard must be cut/scribed and overlaid to within 10 mm of the services, again with all gaps packed with mineral wool and sealed.
- 6.31 It is recommended that any soil or rainwater pipes which pass through sensitive areas should be lagged with 25 mm unfaced mineral wool and should be within an enclosure of minimum surface mass 15 kg/m², this being equivalent to two layers of standard plasterboard.

- 6.32 Risers which open directly to sensitive areas may require particular consideration. If these are open vertically (at the floor slab) then the most straightforward method of maintaining the sound insulation performance between floors would be to install a floor in the riser and effectively close off the vertical path. Alternatively, acoustic door-sets can be installed to the risers themselves with performance at least 45 dB R_w including seals and frame.
- 6.33 Where recessed back boxes are used in acoustically-rated walls they should not be located back-to-back, no closer than 450 mm, and enclosed at the rear with the same lining as is being penetrated. Prefabricated acoustic socket boxes and putty liners are also suitable.

7.0 Reverberation

- 7.1 The control of reverberation is critical to providing a suitable acoustic environment to enable clear speech communication and listening conditions, and to reduce the build-up of noise in rooms and transfer of noise to other areas. Excessive reverberation will contribute to increased noise levels and a reduction in speech intelligibility.
- 7.2 It is particularly important to consider the effects of reduced speech intelligibility for voice alarms systems.
- 7.3 It is recommended that a Class A ceiling is implemented in the Open Office Space covering all areas except lights, grilles and plasterboard margins. The use of hard flooring as a final floor finish in offices should be avoided.
- 7.4 For cellular offices and meeting rooms, the reverberation time criteria shown in Table 7.1 are specified.

Table 7.1 Reverberation time criteria

Room type	Reverberation criteria, T_{mf} (seconds)
Cellular offices	≤ 0.8
Meeting rooms / consultation rooms	≤ 1.0
Co-working / multi-occupation offices	≤ 1.2
Prayer room	≤ 0.8

- 7.5 The Library should achieve a reverberation time of no greater than 1.0 seconds T_{mf} . An absorbent Class A ceiling tile is recommended.
- 7.6 For other large spaces where speech intelligibility may be important, such as the Studios and Fitness Suite where instruction would be given, it is recommended that a reverberation time of between 1.5 and 2.0 seconds T_{mf} is achieved.
- 7.7 Criteria are presented as T_{mf} , which is the mean average of the reverberation time in the 500 Hz, 1kHz and 2 kHz octave frequency bands.

Pool Hall

- 7.8 Sports England Guidance suggest that the pool hall construction should provide control of the reverberation time to achieve between 1.5 and 2.0 seconds in the 500 Hz octave band.
- 7.9 An absorbent perforated ceiling liner tray would contribute to these requirements, but additional acoustic wall panels are typically also required.
- 7.10 On the basis of a Class A (according to BS EN ISO 11654³) absorbent liner tray to 90% of the ceiling area, it is calculated an additional 140 to m² of wall panels would be necessary to achieve 1.5 seconds.
- 7.11 Wall panels should be distributed evenly around the space. Additional advice will be provided as the design develops.

³ BS EN ISO 11654. Acoustics. Sound absorbers. Rating of sound absorption coefficients, BSI, 2017

8.0 Fitness Suite Noise and Vibration

- 8.1 Gyms can typically transmit significant levels of low frequency noise and vibration through the structure of the building if not properly controlled. Structural noise can be transmitted some distance, and not solely to adjacent spaces. Dropping of weights is the primary cause of low frequency noise.
- 8.2 Airborne sound can also be transmitted directly through separating elements, such as perimeter walls. Airborne sound includes music and noise from general gym activities.
- 8.3 Typical gym activities may include:
- Cardiovascular equipment, such as treadmills and exercise bikes,
 - Free-weights,
 - Pin-loaded weights machines,
 - Functional activity equipment.
- 8.4 There are a number of methods of providing structural isolation between the Fitness Suite floor slab and the rest of the building. These include:
- Acoustic isolating pads between the structure supporting the Fitness Suite slab and surrounding building structure. The Fitness Suite slab would not touch the surrounding structure, incorporating perimeter isolation strips. Twin stud partition constructions would separate the Fitness Suite from adjacent spaces.
 - Additional floating floor construction, typically comprising a 100 mm concrete base slab supported by isolating springs and 100 mm void underneath, with mineral wool (density between 22 kg/m³ and 45 kg/m³) placed in the void. The floating floor would need to be isolated around the edges by incorporating perimeter isolation strips.
- 8.5 The isolating floor systems should be designed to have a natural frequency no greater than 12 Hz.
- 8.6 In addition to the above isolated floor, acoustic floor coverings would be required in any area which may experience the dropping of weights. General traffic areas would benefit from a resilient rubber floor finish.
- 8.7 Individual gym equipment should incorporate shock absorbers and/or acoustic isolators to reduce impact noise transmitted from equipment to the floor.

9.0 Vibration

- 9.1 Vibration-generating plant must incorporate measures to control transmission of noise/vibration to the building structure and to achieve the above criterion, such as resilient fixings and/or mounts, for example. Ductwork and/or connecting services should include flexible connections to vibration generating plant.
- 9.2 Vibration-generating equipment should not be fixed directly to partitions where there is an adjacent sensitive room use.

10.0 Building Envelope

External Noise Ingress

- 10.1 Initial external noise ingress calculations have been undertaken based on the drawings and information currently available.
- 10.2 It is calculated that standard thermal double-glazed windows (e.g. 4 mm/12 mm/6 mm) are capable of achieving the criteria specified in Section 5.0. Calculations assume no passive façade openings for ventilation and the recommended reverberation time criteria from Section 7.0. Predicted internal levels for a selection of rooms based on the measured site noise levels are given in Table 10.1 below.

Table 10.1 Predicted noise ingress levels

Room	Criteria	Calculated noise ingress
Pool Hall	NR 40 dB $L_{eq,30mins}$	NR 27 L_{eq}
Community Rooms	40 dB $L_{Aeq,30mins}$	19 dB L_{Aeq}
Library	40 – 50 dB $L_{Aeq,T}$	35 dB L_{Aeq}
Consultation Room 2	35 – 45 dB $L_{Aeq,T}$	36 dB L_{Aeq}
Meeting Room 2	35 – 45 dB $L_{Aeq,T}$	39 dB L_{Aeq}

- 10.3 The calculated internal levels allow for some further noise contributions from building services, which should not exceed the levels given in Table 5.3.
- 10.4 The acoustic performance of the standard thermal double-glazed window used in calculations is given below.

Table 10.2 Example acoustic performance for windows

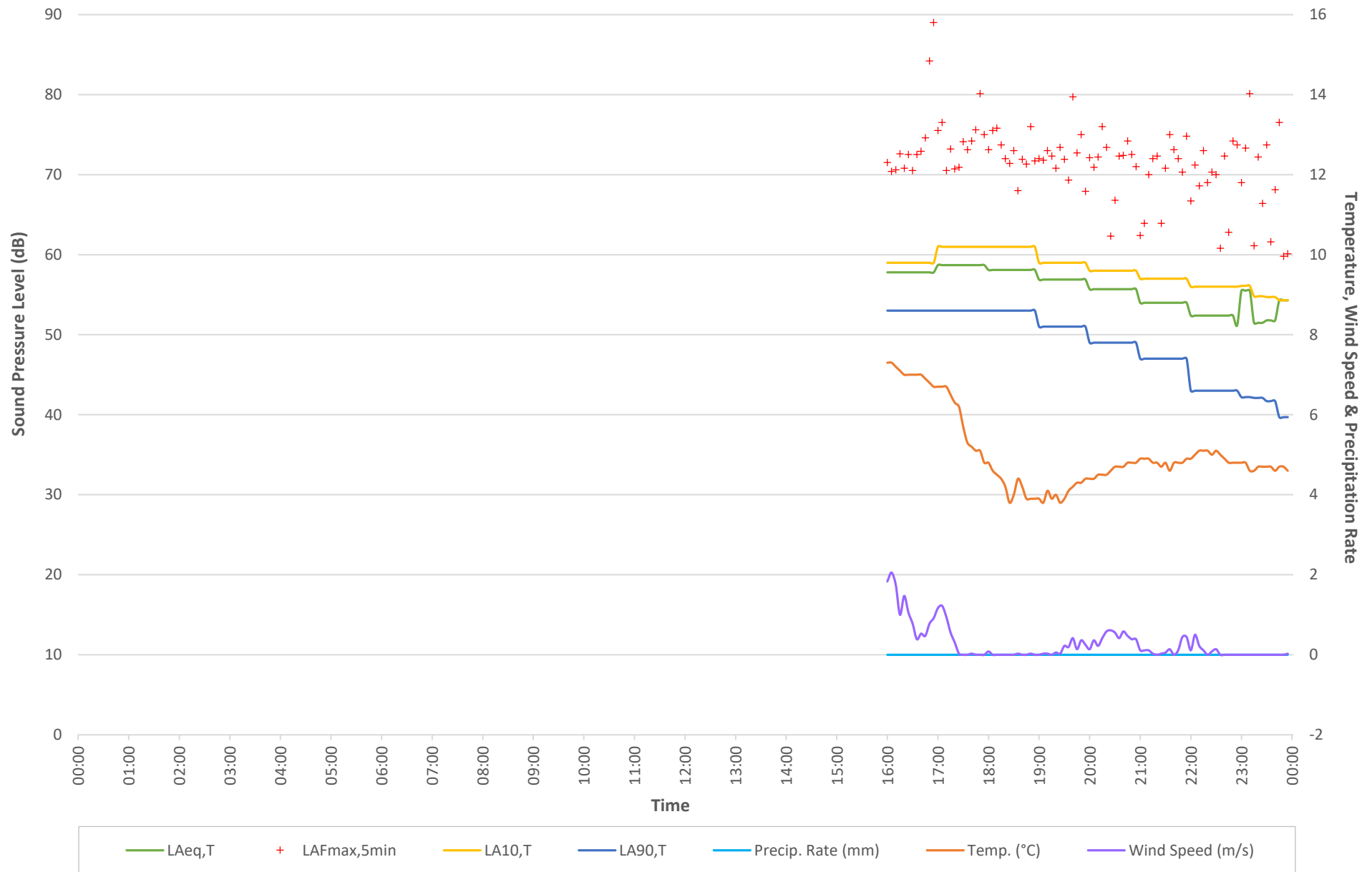
Description	Octave-band sound reduction index, SRI (dB)						
	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	R_w
4 (12) 6 mm window unit	27	23	27	39	40	41	33

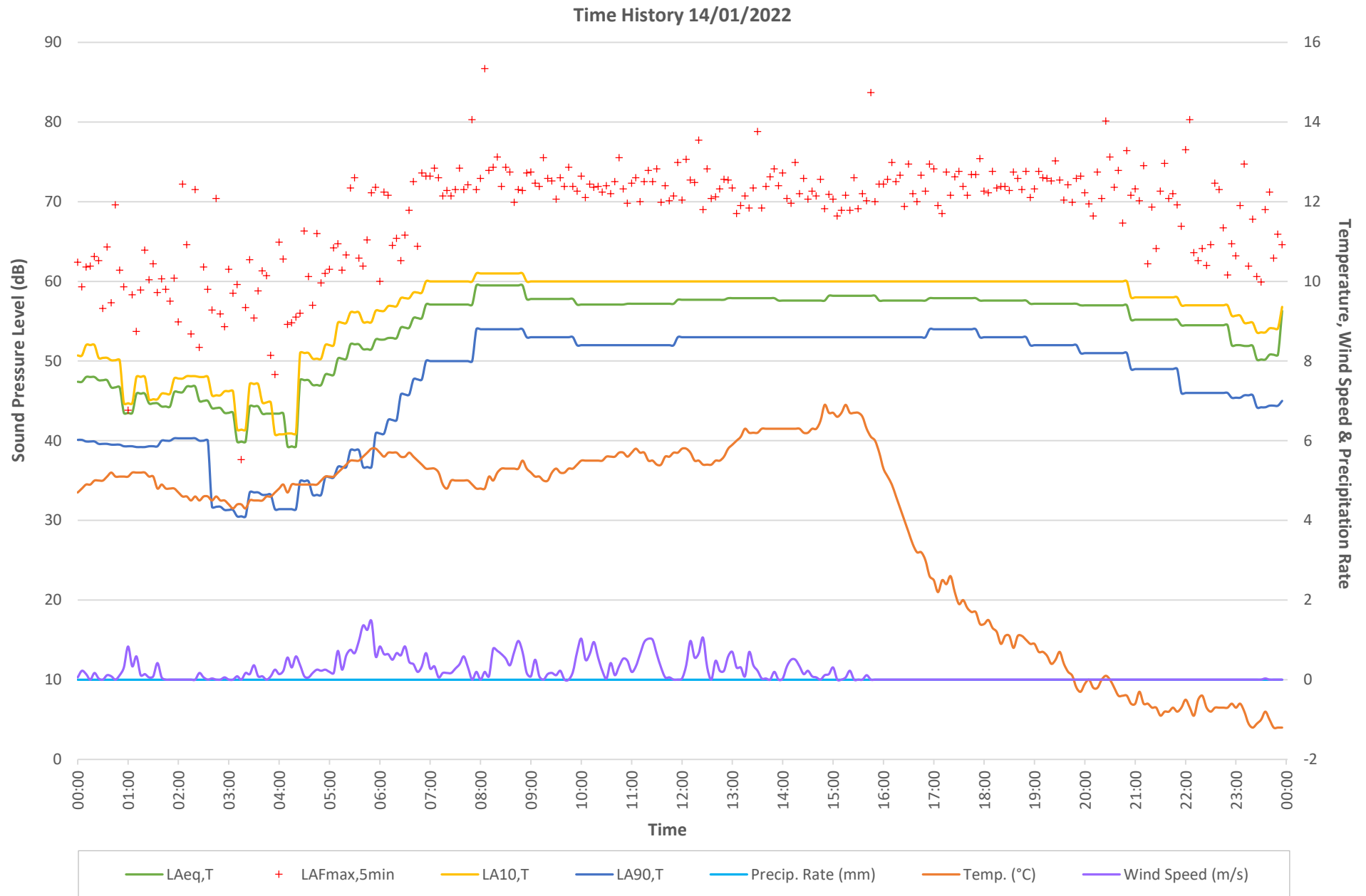
- 10.5 The acoustic performance must be achieved by the window unit as a whole, including glazing, frame, seals and any opening mechanisms. Other façade elements, such as external walls, ventilators and the roof, would need to perform significantly better than the windows.
- 10.6 The acoustic performance of façades will need to be reviewed as the design develops, particularly to take into account ventilation requirements, and the external wall build-up.

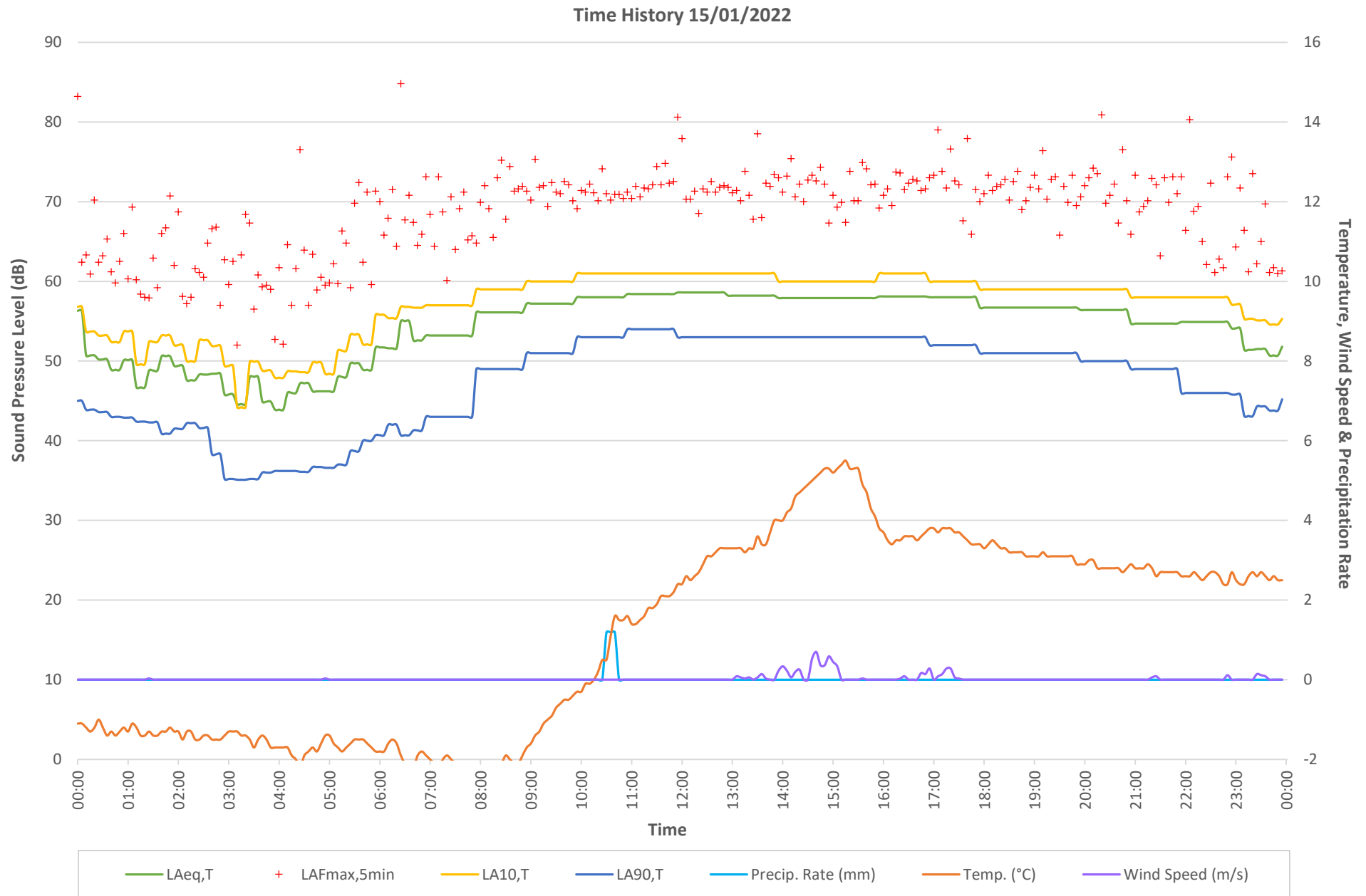
APPENDIX A

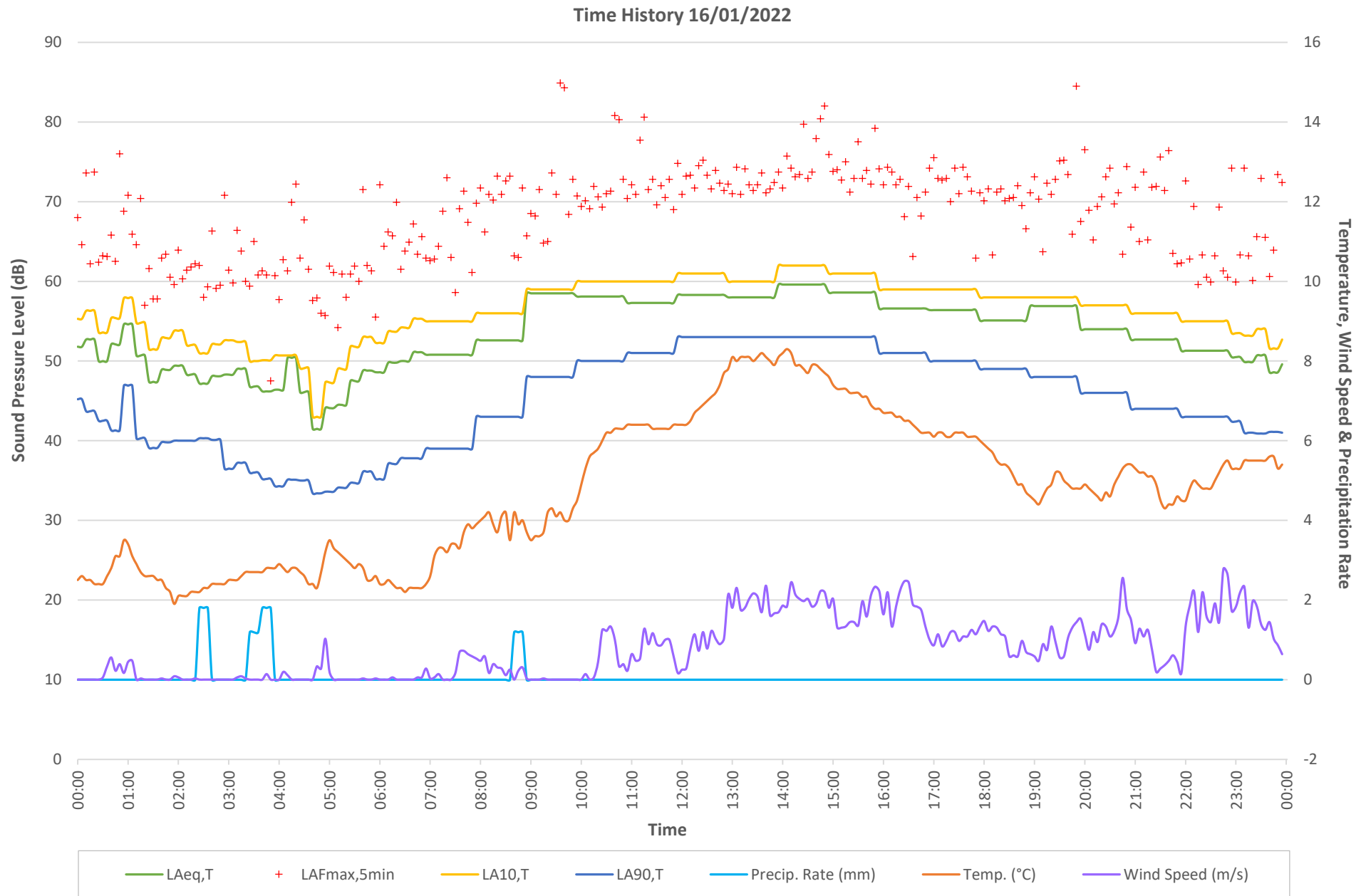
Survey Time-History Charts

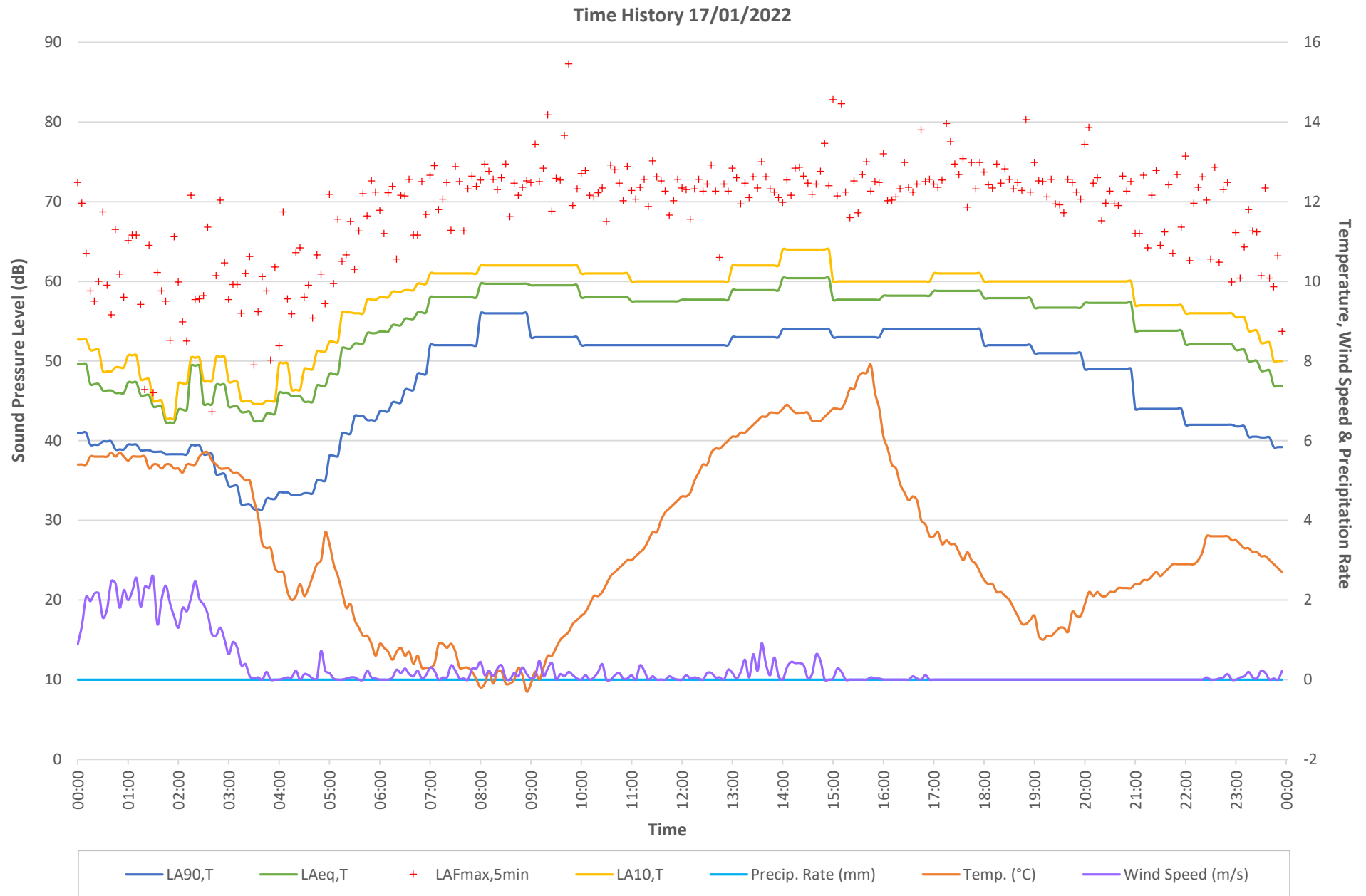
Time History 13/01/2022



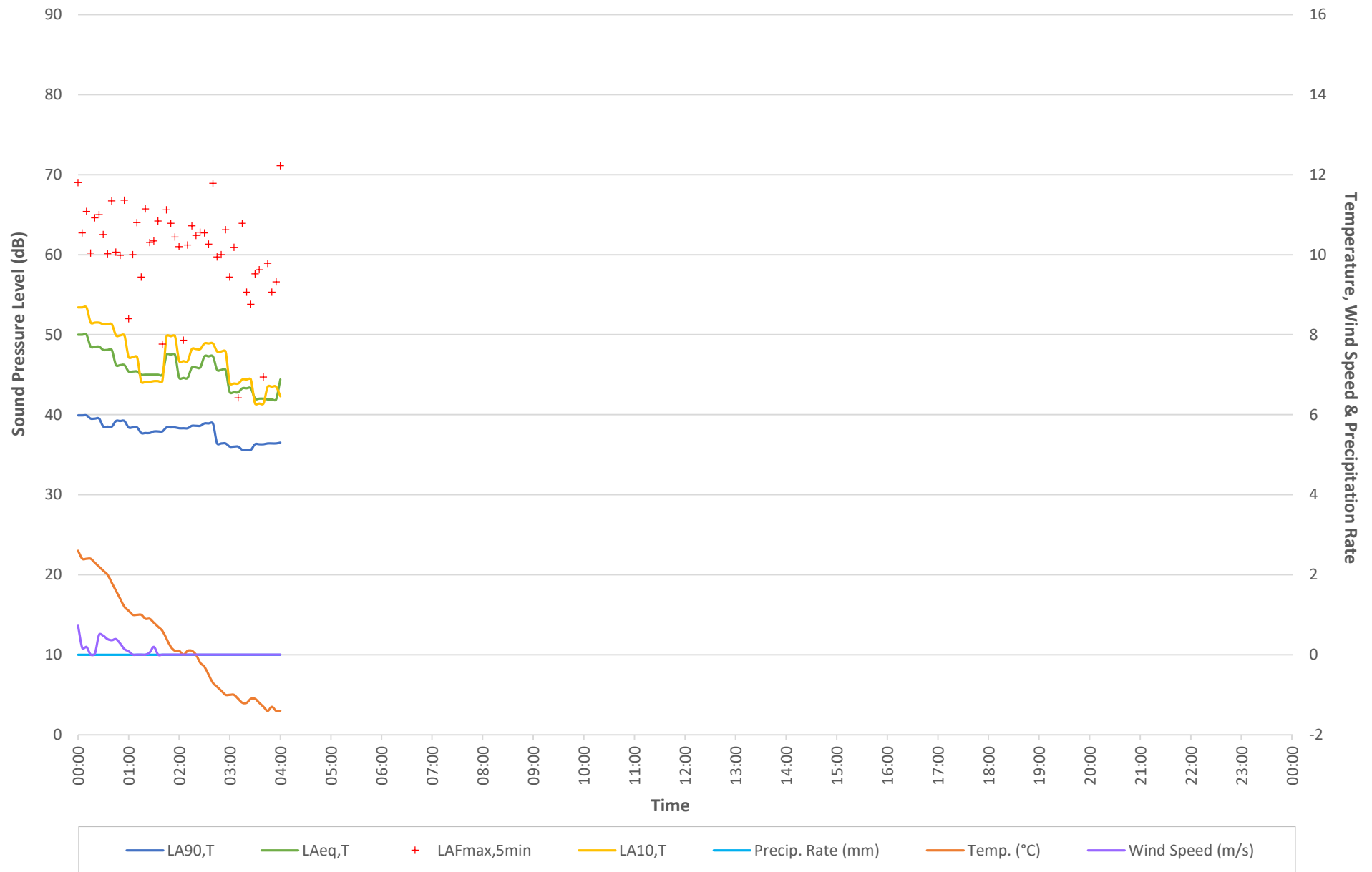








Time History 18/01/2022



APPENDIX B

MARK-UPS: Sound Insulation Performance

PROJECT:

Radcliffe Hub

PROJECT No:

2120733

DWG TITLE:

Acoustics: Internal partitions and doors

UPPER GROUND FLOOR

DRAWN BY:

AJN

CHECKED BY:

REVISION:

A

DATE:

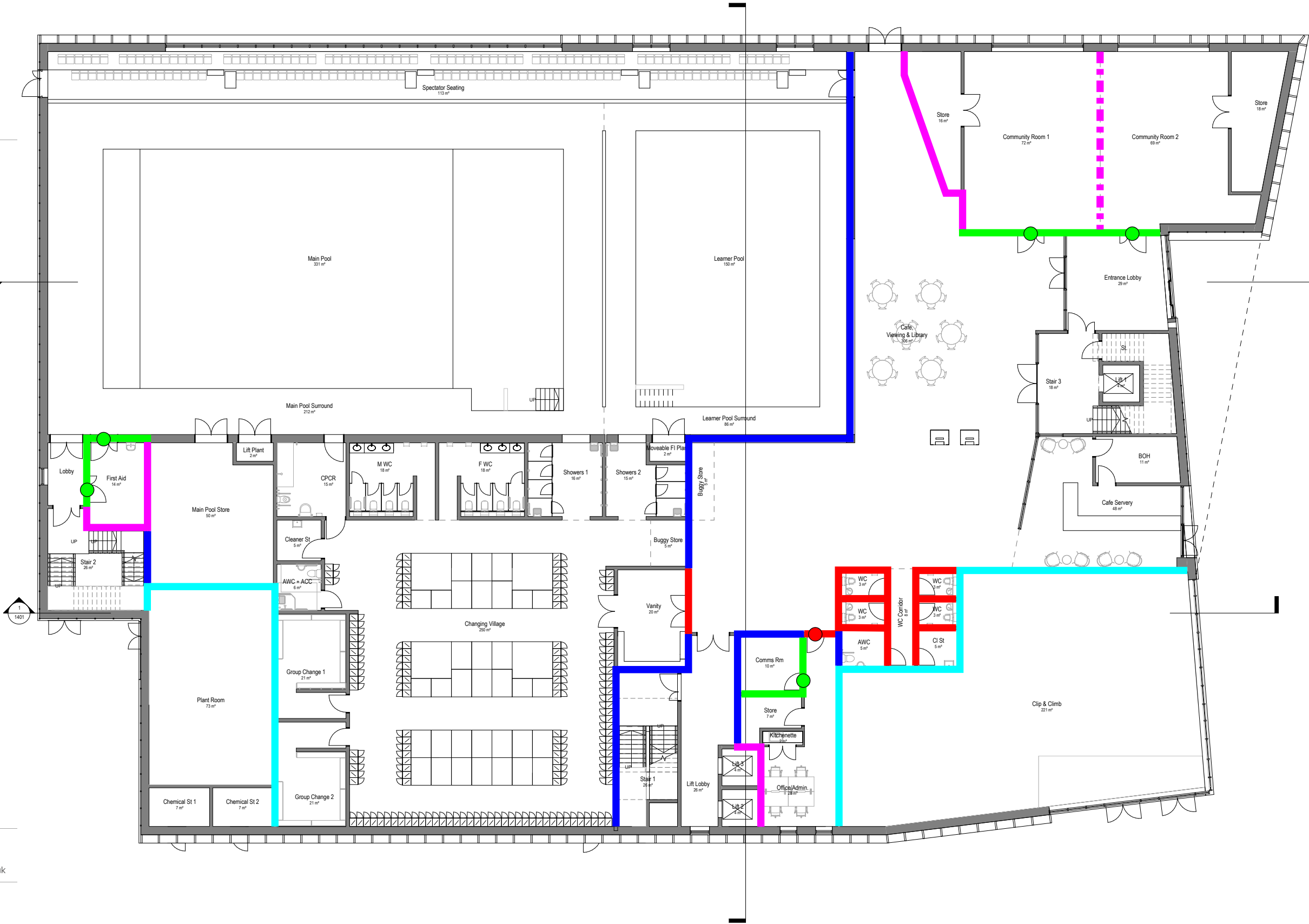
27-05-2022

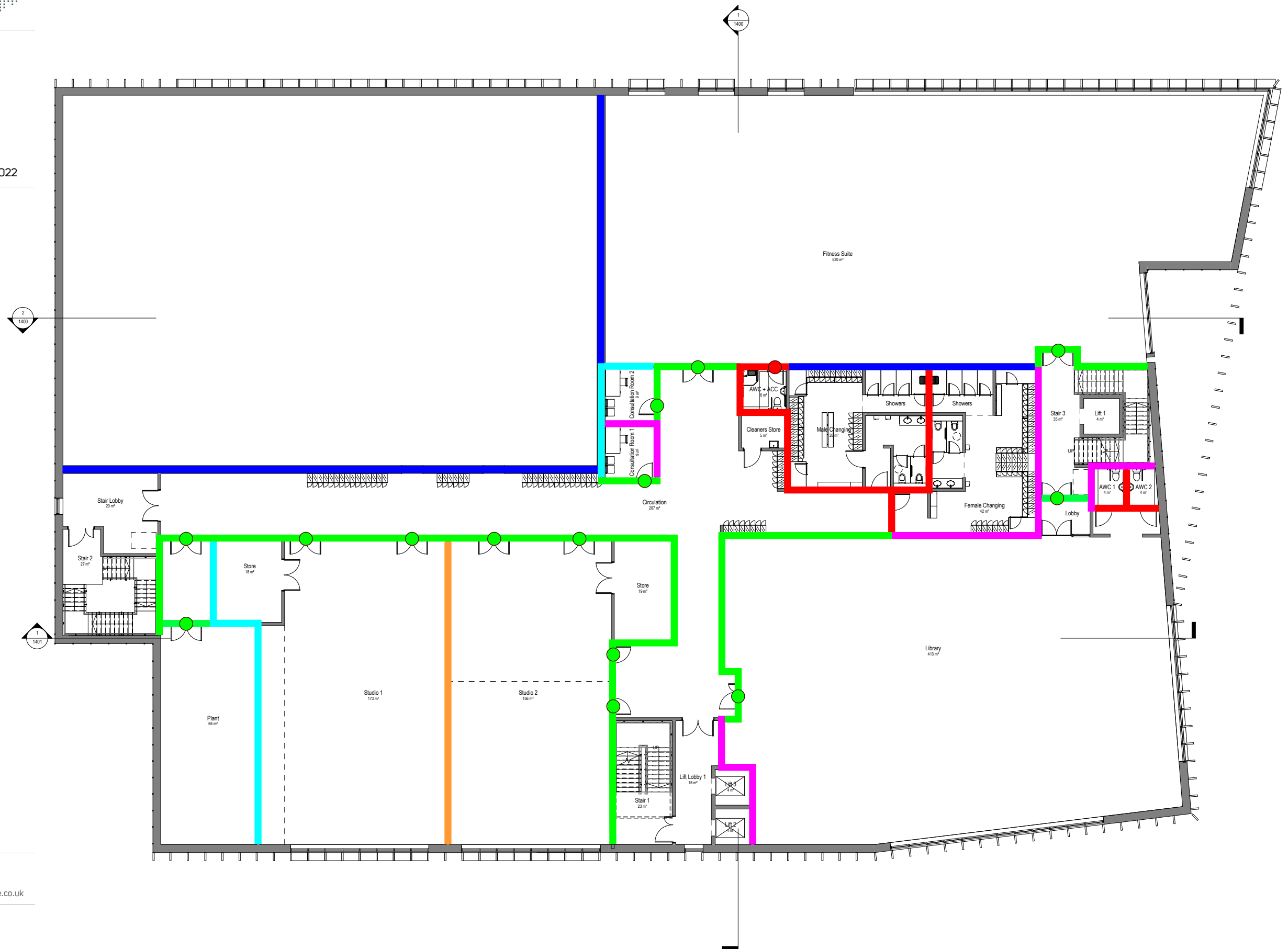
INTERNAL PARTITIONS

- 40 dB R_w
- 45 dB R_w
- 37 dB $D_{nT,w}$
- 42 dB $D_{nT,w}$
- 47 dB $D_{nT,w}$
- 52 dB $D_{nT,w}$
- 57 dB $D_{nT,w}$

INTERNAL DOORS

- 30 dB R_w
- 35 dB R_w





PROJECT:

Radcliffe Hub

PROJECT No:

2120733

DWG TITLE:

Acoustics: Internal partitions and doors

SECOND FLOOR

DRAWN BY:

AJN

CHECKED BY:

REVISION:

A

DATE:

27-05-2022

INTERNAL PARTITIONS

- 40 dB R_w
- 45 dB R_w
- 37 dB $D_{nT,w}$
- 42 dB $D_{nT,w}$
- 47 dB $D_{nT,w}$
- 52 dB $D_{nT,w}$
- 57 dB $D_{nT,w}$

INTERNAL DOORS

- 30 dB R_w
- 35 dB R_w

