

REF: L1662.2 V2

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2nd July 2024

**RE: SEVEN SISTERS INDUSTRIAL UNITS, NEATH PORT TALBOT
STAGE 3 ACOUSTIC DESIGN REVIEW**

Dear Mr Davies,

I am writing following your request to undertake a review of the acoustic design of the proposed industrial units at Seven Sisters.

The proposal includes the construction of new single storey industrial building comprising 6 independent units, each providing a workshop-type facility, an office and associated ancillary facilities.

We have considered relevant design guidance and standards for this type of accommodation, and we have assessed the proposed building form to derive an acoustic performance specification for the main elements of the building.

1.0 ACOUSTIC PERFORMANCE CRITERIA...

1.1 Design Strategy

The acoustic design of office buildings is not dictated by statutory requirements, and there is only general guidance which can be applied. The following documents have been considered in defining the acoustic performance specification for the project.

British Standard 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

This document provides guidance for the control of noise in and around buildings. It is applicable to the design of new and refurbished buildings.

British Council for Office Guide to Specification 2014

This document provides design criteria which are commonly used in contractual specifications for office designs and fit-outs.

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British Council for Office Guide to Fit Out 2011

This document provides design criteria which are commonly used in contractual specifications for office designs and fit-outs.

Building Bulletin 93 BB93

This document provides design criteria for the purpose of school design. Whilst not explicitly relevant for this project, it provides useful guidance notes.

We note that the proposed building and facilities within are likely to be operational prior to 09:00. However, it is likely that during the night-time period (23:00 to 07:00) there would be reduced function and therefore typical daytime operational hours are considered the most relevant in which to base this assessment.

1.2 Indoor Noise Level Standards

The guidance given in the various guidance for maximum and minimum internal noise levels are as follows for office spaces, and it should be noted that the minimum values are just as important as the upper values in achieving suitable privacy.

BS8233:2014

Meeting Room	35-45 dB(A) $L_{Aeq,T}$
Open Plan Offices	45-50 dB(A) $L_{Aeq,T}$
Executive Office	35-40 dB(A) $L_{Aeq,T}$
Concourse	45-55 dB(A) $L_{Aeq,T}$
Laboratory	50-55 dB(A) $L_{Aeq,T}$

where T is defined as a typical working day 09:00 to 17:00

BCO

<i>Open Plan Office:</i>	<i>NR40 Leq (taken from 2014 guide) approx. 46 dB(A)</i>
<i>Cellular Office</i>	<i>NR35 (Leq) approx. 41 dB(A)</i>
<i>Toilets :</i>	<i>NR45 Leq (taken from 2014 guide) approx. 51 dB(A)</i>

The above criteria primarily relate to office buildings, rather than a workshop with an ancillary office. We are of the opinion that the proposed facilities are less sensitive to noise and, on the basis that the office and workshop in each unit are likely to operate as an open plan space with an interconnecting door, we proposed less onerous design criteria than that of a typical office in an office building i.e. an upper indoor noise limit of 50 dB(A) $L_{Aeq,T}$ for the office and 55 dB(A) $L_{Aeq,T}$ for the workshop.

The dB(A) level is approximated in BS8233 as 6 dB higher than the equivalent NR (Noise Rating) level used for designing building services provided there are no significant low frequency components.

We are not involved with the design or specification of the building services and cannot therefore confirm the design achieves these values at this stage.

1.3 Sound Insulation Performance Standards

We have considered the criteria set out in the BCO Guide. In this instance, however, the criteria set out in BS8233:2014 is considered most relevant and we have therefore based our assessment of separating constructions on the guidance provided in British Standard BS8233:2014 (Table 3 of Section 7.5):

*Office to Workshop: Non-private, very high noise, medium sensitivity
A minimum sound level difference at CAT A fit out of 52 dB $D_{nT,w}$*

*Workshop to Workshop: Non-private, very high noise, low sensitivity
A minimum sound level difference at CAT A fit out of 47 dB $D_{nT,w}$*

*Office to Tea Room: Moderate privacy, typical noise, medium sensitivity
A minimum sound level difference at CAT A fit out of 37 dB $D_{nT,w}$*

The $D_{nT,w}$ is the “weighted standardised sound level difference” which uses a reference reverberation time of 0.5 seconds.

Where a wall includes a door, there is no specific guidance. However, the achieved level of separation will be dominated by sound that passes through the door. Where such a situation occurs, it is recommended that the partition performance exceeds the door performance by at least 10 dB, (see also section 3.1). Achievement of this performance implies the sound that passes through the wall sections will have a minimal effect on the overall separation.

The impact sound insulation of the floor is not defined in BS8233. However, the building is single storey, and the impact sound implications are therefore not relevant.

1.4 Control of Reverberation

There is no quantitative guidance in BS8233:2014 for reverberation times. We have, however, considered the guidance for reverberation times in unoccupied rooms used for speech within the superseded version of the document BS8233: 1999 for the relevant performance criteria.

Other documents which provide guidance for office spaces include Building Bulletin 93 *Acoustic Design of Schools: Performance Standards, 2014*. This document suggests an arithmetic average reverberation time at mid-frequency of less than or equal to 1.0 second is appropriate in an office. Mid-frequency is defined as the 500 Hz, 1k Hz and 2k Hz 1/1 octave bands.

We propose achievement of an overall reverberation time of less than 1.0 second at mid frequency within the office spaces and less than 1.5 second at mid frequency within workshops, and to follow the guidance on location of treatment in the British Standard which states:

BS8233:2014, Clause 7.7.10.5 Committee/Meeting Rooms

Seats may be arranged in a circle or oval, rather than in parallel rows facing each other. The ceiling may be acoustically hard and low (not more than 3 m), at least over the table area, to reflect speech. A resilient floor covering minimizes noise from chair and foot movements, and reverberation should be controlled by absorbent materials on the walls. Noise from chair/table movement can also be controlled by rubber feet/castors. Appropriate wall treatments should be used to control the effects of flutter echo.

It is worth noting that we have interpreted the guidance to represent a maximum value, therefore reverberation times below the target are to be deemed suitable. However, it is also important to note the reverberation time of a room has a direct effect on the noise within that room from either internal or external sources.

2.0 DESIGN ASSESSMENT...

2.1 Internal Noise Levels

In predicting the level of noise internally to compare with the criteria we have followed the methodology set out in BS EN 12354-3:2000 *Building Acoustics – Estimation of Acoustic Performance of Buildings from the Performance of Elements Part 3: Airborne Sound Insulation Against Outdoor Sound*. The accuracy of the adopted method for estimation of level difference is stated within the standard to be “on average correct”, with the single number ratings displaying a standard deviation of about 1.5 dB while for individual octave bands the deviation will be larger up to 3 dB.

Within the method, it is also possible to include an allowance for flanking and on-site degrade of performance. However, it is rare to have data which is reliable for doing so. It is common practice therefore to include a 3 dB degrade for façade elements to perform differently to their predicted or laboratory measured performance. We have based our assessment on this principle.

It is our understanding that during operational hours, the roller doors are to remain open, and that the office accommodation is to be ventilated using an open window strategy.

2.1.1 Site Noise Exposure

We have undertaken a survey of the existing noise levels at site. More details of the survey are provided in the appendix, and it was undertaken in full accordance with BS 7445.

We have reduced the measured data into design cases to match the criteria from section 1.0 and this is summarised in Table 1.

Typical Location	1/1 Octave Band Sound Pressure Levels $L_{Aeq,T}$ dB								dB(A)
	63	125	250	500	1000	2000	4000	8000	
All Facades	65	59	54	51	49	47	44	38	55

TABLE 1: EXTERNAL SOUND PRESSURE LEVEL USED FOR ASSESSMENT (FREE-FIELD)

The survey measured sound pressure levels in a free-field and therefore within our assessment a correction of 3 dB is to be added to provide the level at the façade.

2.1.2 Proposed Building Envelope

The proposed construction of the external envelope is understood to be as follows:

External Walls	Facing brick / block cavity wall (lower) and European Profile Powder coated insulated wall cladding (upper)
External Windows	Double glazed PPC aluminium Part L compliant windows.
Roof	European Profile powder coated insulated roofing sheets with European Profile translucent rooflights.
Ventilation	The building is to be ventilated using openable windows.

2.1.3 Assessment of External Noise Ingress

The windows are openable to allow the occupants choice over the level of ventilation. It should be recognised that opening the window (and indeed the roller shutter) will result in an increase of the internal noise level.

The reduction in external sound passing through an open window has been based on the WHO guidelines which states the reduction to be between 10-15 dB(A) from the level measured 2 m from the façade. Napier University has conducted extensive research into the effects of window openings and concluded a similar level of attenuation, with dependencies on the type of opening, of between 12-18 dB(A) to traffic noise. We have used a value of 10 dB(A) reduction from the façade level for the purposes of this assessment, representing a worst-case scenario.

Table 2 shows the predicted noise ingress levels, due to external sound, against the design requirements without the contribution of any building services noise.

Elevation	Room Type	Maximum IANL (dB $L_{Aeq,30min}$)	Expected IANL From External Sources (dB $L_{Aeq,30min}$)	Compliant Y/N
All	Office	50	48	Y
	Workshop	55	48	Y

TABLE 2: PREDICTED INTERNAL LEVELS DUE TO EXTERNAL SOURCES

2.1.4 Noise Limits for Mechanical Services

We understand the building is to be naturally ventilated. However, should it transpire that building services are to be included in the form of NVHR or MVHR units, the following noise limits would be relevant.

We have based our assessment of the building on achievement of the following indoor noise levels which result from the normal external sources affecting the building (e.g. road traffic etc) but exclude sporadic sources such as rain noise.

The total indoor noise level is anticipated to be a combination of external sources and mechanical plant such as ventilation and other services.

The criteria considered for assessment of the building design are summarised in Table 3.

Room Use	Total Noise Level (dB(A) $L_{Aeq,T}^{-1}$)	Contribution From External Sources (dB(A) $L_{Aeq,T}^{-1}$)	Max Contribution from Mechanical Plant (NR ²)
Office	≤ 50	≤ 48	NR40
Workshop	≤ 55	≤ 48	NR48

TABLE 3: SUMMARY OF NOISE LEVEL OBJECTIVES UNDER NORMAL VENTILATION CONDITIONS

{Note 1} The time base used for assessment of average noise levels is proposed to be 1 hour during the day.

{Note 2} An approximate conversion of the noise limit from dB(A) to the Noise Rating level has been provided. This is an approximate relationship provided in BS8233 which assumes there are no strong low frequency components.

2.1.5 Internal Noise Conclusions

We expect the target internal noise levels to be achieved without needing to specify the acoustic performance of the building envelope other than the glazing described above. The derived performance requirements are not overly onerous and are expected to be readily achieved with standard building materials.

The building services noise is expected to contribute the internal noise levels, and we recommend the building services designer be made aware of the necessity for both minimum and maximum noise levels to be achieved.

2.2 Separating Constructions

2.2.1 Assessment Method and Specifications

To achieve the desired level of sound insulation between adjacent rooms we have considered the room sizes and common areas of each partition, and converted the on-site $D_{nT,w}$ value into a laboratory measured sound reduction index value R_w .

The sound reduction index is a more commonly used variable for specification of constructions and can be readily compared with manufacturer's data. We have followed the method described in BS EN ISO 12354:2000 Part 1 *Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements – Airborne Sound Insulation Between Rooms*.

We have based our calculations on the basis the rooms achieve our predicted mid-frequency reverberation times.

2.2.2 Proposed Separating Constructions

The transfer of sound between rooms will be a combination of the energy passing directly through the separating structure, with contributions of energy that have taken other routes.

Our understanding of the constructions of the separating walls is summarised in Table 4.

The separating walls have been assessed based on generic drywall systems available from British Gypsum as an example. Other manufacturers such as Siniat and Knauf will likely offer similar performance for similar constructions, but any changes should be reviewed.

We have also provided an option for a solid masonry wall for each wall type.

Wall Type Ref.	Construction Description	Min Laboratory Performance R_w (dB)	Expected Performance R_w (dB)	Substantiation Reference
1	Gypframe 70 S 50 C studs at 600 mm cts, 1 x 15 mm Gyproc DuraLine board to both sides	40	40	Q606062
	Or 100 mm medium density concrete block (minimum density 1400kg/m ²)		45	Estimate
2	Gypframe 70 S 50 C studs at 600 mm cts, 1 x 15 mm Gyproc DuraLine board to both sides, 25 mm Modular Roll in the cavity	45	45	Q606063
	Or 140 mm medium density concrete block (minimum density 1400kg/m ²)		47	Estimate
3	Gypframe 70 S 50 C studs at 600 mm cts, 1 x 15 mm Gyproc DuraLine board to both sides, 80 mm Modular Roll in the cavity	48	49	Q606065
	Or 100 mm medium density concrete block, 50 mm cavity, 100 mm medium density concrete block (minimum density 1400kg/m ²)		60	Estimate

TABLE 4: CONSTRUCTION PERFORMANCES – WALLS

2.2.3 Assessment of Separating Structures

Our assessment of the acceptability of the proposed walls, against the derived performance targets is summarised in Table 5.

Room 1	Room 2	Approx. Partition Area (m ²)	Minimum On-site Separation (dB $D_{nT(0.5s),w}$)	Minimum Laboratory Sound Insulation (dB R_w)	Wall Type	Pass / Fail
Ground Floor						
Office	Workshop	14	52 ^{1}	45	2	Pass
Office	Tea Room	6	37	45	2	Pass
Tea Room	WC	6	n/a	n/a	1	n/a
Workshop	Workshop	45	47	48	3	Pass

TABLE 5: SUMMARY OF MINIMUM SOUND INSULATION SPECIFICATION (WALLS)

{Note 1} The separation between these rooms contains a connecting door. A door will limit the acoustic separation. To maintain a reasonable separation with a functional door we recommend these doors have an acoustic rating of at least 35 dB R_w and the wall a rating of a minimum 45 dB R_w .

The most onerous performance requirement derived for separating walls is for a minimum sound reduction index of 48 dB R_w .

Comparing the expected performance of the proposed construction against the derived minimum performances, we have concluded the proposals for the walls to be acceptable.

2.2.4 Separating Construction Conclusions

The design of the separating walls is compliant with the acoustic performance objectives derived.

2.3 Control of Reverberation

2.3.1 Assessment Method

We have based our assessment on achievement of a global reverberation time within an enclosed space, using the Sabine method, and sensible placement of such treatment to minimise undesirable room effects.

2.3.2 Design Assessment

At this stage, we understand the ceilings within the office spaces are to be formed using a Class C suspended ceiling covering 100% of the available area, and the ceilings within the workshops are to be formed by the underside of the Euroclad Roof system i.e. exposed metal.

The floors are understood to be hard floor finish in all rooms i.e. vinyl in the offices and exposed concrete in the workshops.

We have undertaken the reverberation time calculations on the basis that the internal walls are to be formed from unpainted concrete blocks.

We have reviewed the reverberation time for the specific rooms including the ceiling and floor finishes described above. The expected reverberation times have been compared against the derived target summarised in section 1.4.

Room Type	Approx. Room Volume (m ³)	Target Reverberation Time (T _{mf})	Floor Finish	Ceiling Finish	Calculated Rev Time (T _{mf})	Pass / Fail
Office	14	1.0	Vinyl	Suspended Ceiling	0.5	Pass
Workshop	245	1.5	Exposed concrete	Exposed Metal	2.6	Fail

TABLE 6: SUMMARY OF ESTIMATED REVERBERATION TIMES

It can be seen in the above table that the overall amount of acoustically absorptive materials within each of the spaces as proposed is expected to achieve the target reverberation times in the offices, but not in the workshops.

We therefore recommend that additional absorption is included in the form of 35 m² of Class A wall panels. With the inclusion of such a provision, we expected the reverberation time in the workshop to be reduced to 1.5 s and therefore achieve the derived target levels.

Alternatively, it would also be an option to install vertical baffles suspended from the ceiling in the workshop. We have modelled the provision of 48 No Optima baffles (400mm, 1000mm ODS, 450mm spacing with a 600 mm void) and the calculated reverberation time within each workshop is expected to achieve the derived target levels.

It is also possible to combine the provision of baffles and wall panels to achieve the desired outcome. For example, the provision of 25 No Optima baffles described above and 17 m² of Class A wall panels is expected to achieve the derived target level.

There are numerous products available in this respect and we recommend a review of product selection is undertaken prior to procurement.

It is alluded to in BS8233 that wall treatments are advisable to control flutter echo (when sound bounces back and forth between parallel walls). This can be achieved without adding significantly to the absorption within the room, by introducing scattering objects, such as shelves or bookcases, or 3D artwork or even proprietary diffusors.

When considering the placement of wall treatments, they would ideally be placed on two adjacent sides of the room (i.e. so that both pairs of parallel walls are treated).

Where it is not acceptable to accommodate the depth of a scattering object additional absorptive materials can be used but it should be noted that this will further reduce the reverberation time, and an ISO Class C rated absorber would be sufficient to control flutter at speech frequencies.

3.0 OTHER ACOUSTIC DESIGN ISSUES...

3.1 Doors

No performance specification is provided in the available guidance documents for the performance of a door in an office environment. A reasonable level of privacy can be achieved by installing doors with a minimum laboratory tested sound reduction index of 30 dB R_w.

Higher performance door sets are available. However, in our experience they are more cumbersome to operate and require ongoing maintenance. A value of 40 dB R_w is considered to be an upper limit for very private situations without the design needing to have a door lobby arrangement.

We propose the doors in walls serving non-sensitive rooms (door Type 1) are procured with a laboratory tested performance of 30 dB R_w to offer a reasonable balance between function and operability, with an upgraded door of 35 dB R_w for doors which connect occupied rooms.

Double doors are recommended to have a performance specification that is at least 3 dB greater than that of a single door. This enhancement would also apply to 1.5 width doors.

Door Type Ref	Minimum Requirement R _w (dB)	Typical Construction Description (Example only)
1	30	30 dB R _w laboratory tested door set, typically a 45 mm solid core door set (23 kg m ⁻²) with smoke seals
2	35	35 dB R _w laboratory tested door set, typically 45 mm solid core door set (door leaf mass of min 38 kg m ⁻²) with perimeter acoustic/smoke seals

TABLE 7: TYPICAL CONSTRUCTIONS FOR DOORS

The proposed door products have not been confirmed. However, the performance is readily achievable with standard products, and compliance with desired targets is expected subject to our recommendations.

4.0 COMPLIANCE WITH THE DESIGN OBJECTIVES...

We have undertaken an assessment of the proposed industrial workshops in Seven Sisters against relevant design criteria for the acoustic performance.

The design of the building can be demonstrated to achieve the acoustic performance requirements subject to the design recommendations stated.

Please feel free to contact me if you require any further clarification.

Yours sincerely,
For Red Twin Limited



Dr Ashley Punter BEng (Hons) EngD MSc MRTPI MIOA

APPENDIX A – SURVEY DETAILS...

Address: Seven Sisters Industrial Units, Neath Port Talbot, SA10 9EY

Date: 11th – 12th April 2024

Measurement Location

Location 1 The monitoring equipment was set up 140 m to the South of the proposed site at a location considered representative of the proposed building location and nearest noise sensitive receivers. The microphone was pole mounted at 2 m above local ground level and in free-field conditions as indicated in Figure 1.

Equipment (Blue)

Brüel & Kjær 2250 hand held analyser, serial No 265348, with a Brüel & Kjær Type 4189 Microphone, serial No 2676519. The microphone was fitted with a UA-1650 windshield. The hand-held analyser and microphone were laboratory calibrated on 16th June 2022 (Certificate No. U41288) and the calibrator was laboratory calibrated on 16th June 2022 (Certificate No. U41287). The hand-held analyser sensitivity was checked before and after the measurements using the calibrator and a drift of 0.03 dB was observed, which is not significant and no adjustments to the measurements have been made to the data.

Personnel

The survey was set up and managed by Dr Ashley Punter of Red Twin Limited.

Weather

The weather was suitable for noise measurement with overcast conditions. There was precipitation at the start of the survey period but remained dry for the majority of the survey and the wet conditions are excluded accordingly. Wind speeds were moderately low c. 5 m s⁻¹ and were suitable for noise surveying.

Conditions were acceptable for noise measurement work and in full accordance with BS7445.

Survey Comments

The background and ambient sound at site are dominated by existing industrial noise, other fixed plant in the area, passing pedestrians and vehicular traffic.

Location	Start Time	Duration	Parameter dB(A)		
			LAeq	LA1	LA90
Day 1					
1	14:15:14	00:44:36	56	65	48
	15:00:00	01:00:00	54	62	46
	16:00:00	01:00:00	53	62	47
	17:00:00	01:00:00	52	61	47
	18:00:00	01:00:00	52	61	45
	19:00:00	01:00:00	48	57	43
	20:00:00	01:00:00	46	56	43
	21:00:00	01:00:00	45	53	43
	22:00:00	01:00:00	45	53	43
Day 2					
1	07:00:00	01:00:00	57	65	50
	08:00:00	01:00:00	55	63	50
	09:00:00	01:00:00	53	60	49
	10:00:00	01:00:00	54	63	49

	11:00:00	01:00:00	53	61	50
	12:00:00	00:30:00	52	61	50

TABLE 8: MEASURED NOISE DATA – LOCATION 1 (FREE-FIELD) DAY TIME

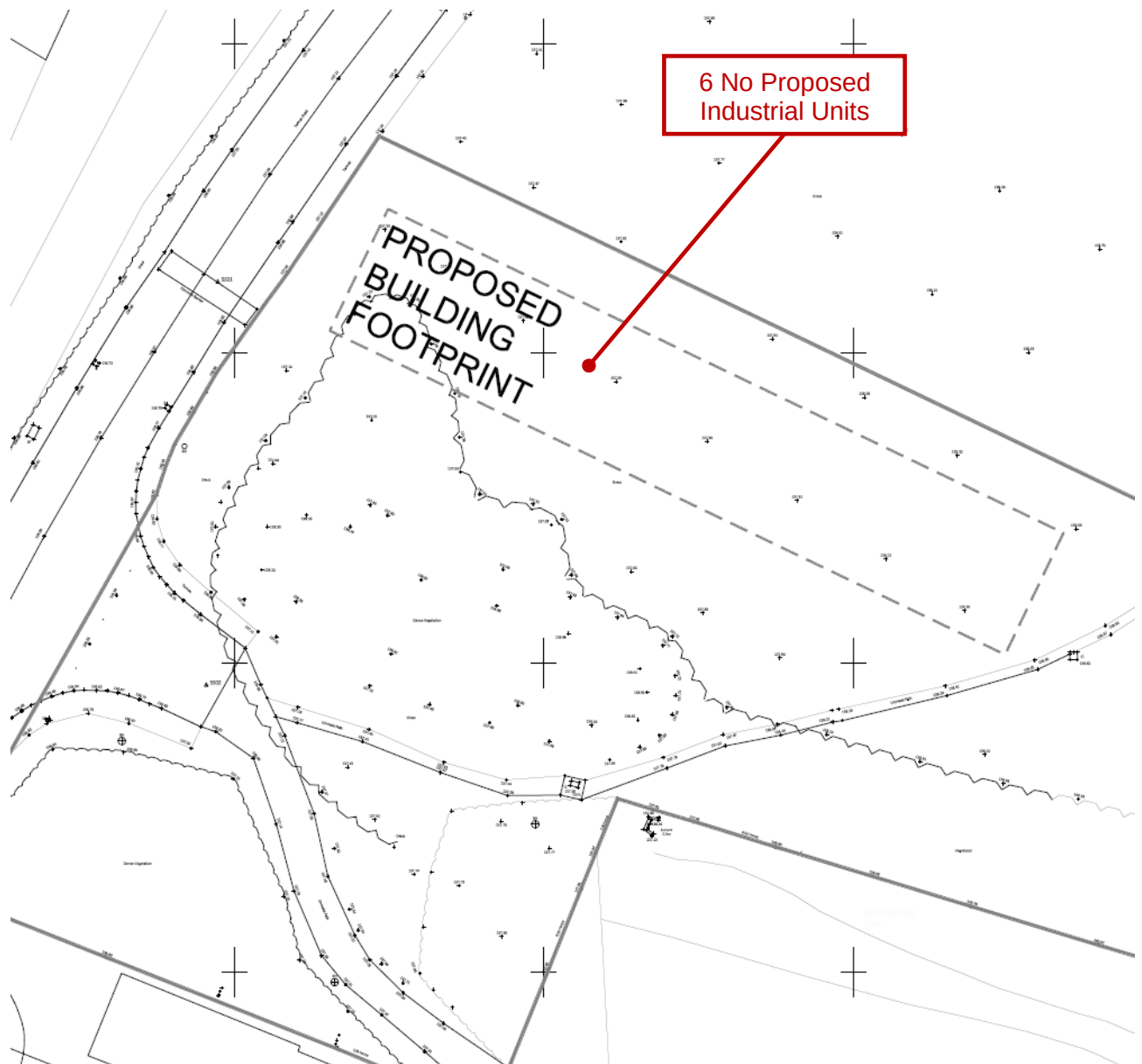
The data in red has been excluded from the assessment on the basis that the local weather conditions were unsuitable for survey inclusion.

Location	Start Time	Duration	Parameter dB(A)		
			LAeq	LA1	LA90
1	23:00:00	00:15:00	45	52	43
	23:15:00	00:15:00	47	56	43
	23:30:00	00:15:00	47	57	43
	23:45:00	00:15:00	47	56	43
	00:00:00	00:15:00	45	54	43
	00:15:00	00:15:00	43	48	42
	00:30:00	00:15:00	43	47	42
	00:45:00	00:15:00	44	50	42
	01:00:00	00:15:00	45	54	42
	01:15:00	00:15:00	45	53	42
	01:30:00	00:15:00	45	55	42
	01:45:00	00:15:00	50	62	41
	02:00:00	00:15:00	54	67	41
	02:15:00	00:15:00	50	63	41
	02:30:00	00:15:00	52	67	41
	02:45:00	00:15:00	50	63	41
	03:00:00	00:15:00	47	59	41
	03:15:00	00:15:00	50	63	41
	03:30:00	00:15:00	49	61	41
	03:45:00	00:15:00	46	55	41
	04:00:00	00:15:00	46	56	41
	04:15:00	00:15:00	48	57	42
	04:30:00	00:15:00	53	66	43
	04:45:00	00:15:00	51	58	46
	05:00:00	00:15:00	50	58	44
	05:15:00	00:15:00	47	55	43
	05:30:00	00:15:00	48	56	44
	05:45:00	00:15:00	52	57	48
	06:00:00	00:15:00	53	60	48
	06:15:00	00:15:00	52	61	48
	06:30:00	00:15:00	53	64	48
	06:45:00	00:15:00	53	59	50

TABLE 9: MEASURED NOISE DATA – LOCATION 1 (FREE-FIELD) NIGHT-TIME



FIGURE 1: PHOTOGRAPH OF SURVEY MEASUREMENT LOCATION NO 1

APPENDIX B – SITE LOCATION PLAN...**FIGURE 2: BLOCK PLAN (NOT TO SCALE)**

APPENDIX B – MARKED UP PLANS OF ACOUSTIC DESIGN INTENT...

Wall Type Ref.	Construction Description	Min Laboratory Performance R_w (dB)	Substantiation Reference
1	Gypframe 70 S 50 C studs at 600 mm cts, 1 x 15 mm Gyproc DuraLine board to both sides	40	Q606062
	Or 100 mm medium density concrete block (minimum density 1400kg/m ²)	45	Estimate
2	Gypframe 70 S 50 C studs at 600 mm cts, 1 x 15 mm Gyproc DuraLine board to both sides, 25 mm Modular Roll in the cavity	45	Q606063
	Or 140 mm medium density concrete block (minimum density 1400kg/m ²)	47	Estimate
3	Gypframe 70 S 50 C studs at 600 mm cts, 1 x 15 mm Gyproc DuraLine board to both sides, 80 mm Modular Roll in the cavity	48	Q606065
	Or 100 mm medium density concrete block, 50 mm cavity, 100 mm medium density concrete block (minimum density 1400kg/m ²)	60	Estimate

Door Type Ref	Dot Colour Key	Typical Construction Description	Minimum Laboratory Performance R_w (dB)
1	●	30 dB R_w laboratory tested riser door set, typically 45 mm solid core door set (door leaf mass of min 23 kg m ⁻²) with perimeter acoustic/smoke seals	30
2	●	35 dB R_w laboratory tested riser door set, typically 45 mm solid core door set (door leaf mass of min 38 kg m ⁻²) with perimeter acoustic/smoke seals	35

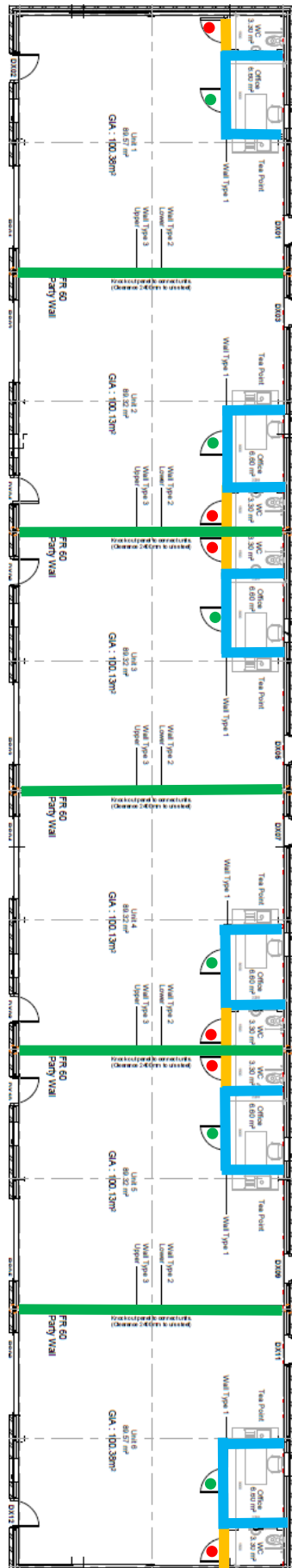


FIGURE 3: ACOUSTIC DESIGN INTENT FOR INTERNAL ELEMENTS