

Rolls-Royce Bristol

B150 Server Room

Sound Impact Assessment

Rolls-Royce plc

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Quality information

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1. Introduction

1.1 Purpose

Rolls-Royce plc is proposing to install a new server room within Building 150 on their Bristol site. This includes the installation of new condenser units, extract fan and air supply AHU on the roof of the building.

AECOM have been commissioned by Rolls-Royce plc to carry out an environmental noise assessment for this proposed new plant in support of the planning application.

The plant may operate at any time of day or night, although it is likely to operate at a lower load (and hence sound level) during the night time when ambient temperatures are lower. Hence, as a worst case, the assessment covers both the daytime and night-time period, and is based on the expected sound emission levels at full load.

A brief summary of noise terminology used within this report is provided in Appendix A.

1.2 Scope of Assessment

The assessment comprises the following items:

- Definition of applicable baseline sound levels at selected nearby sensitive receptors.
- Acoustic modelling work to quantify the cumulative impacts of this and other projects on the Rolls-Royce Bristol site to surrounding sensitive receptors.
- Noise assessment in accordance with the requirements of BS 4142:2014+A1:2019 and comparison with the rating level required by the Local Authority.
- Provision of a report detailing baseline sound measurements, acoustic modelling, calculations and assessment work, suitable for submission to the Local Authority.

1.3 The Bristol Site and Surroundings

The Rolls-Royce Bristol site is situated north of Bristol on the east side of the A38 between Filton and Almondsbury, two miles south of M5 junction 16.

Employing 3,000 people, Rolls-Royce Bristol is their principal defence site in the UK, and also specialises in both the aerospace and naval sectors. The Bristol site has benefitted from a £75 million investment designed to create a centre of excellence for the assembly, manufacture, test and overhaul of gas turbines for the defence sector.

The closest residential properties to Whittle House are located to the north west and to the east, at distances of approximately 350 metres from the nearest proposed new plant items. Further residential properties are located to the north and west at significantly greater distances.

2. Planning Policy and Guidance

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) was introduced in March 2018 and revised in June 2019[i]. The document sets out the Government's planning policies for England and how these are expected to be applied.

Applications for planning permission must be determined in accordance with the Local Authority development plan (which includes any local plan or neighbourhood plans which have been adopted for the area), unless material considerations indicate otherwise.

The planning system is required to contribute to and enhance the natural and local environment. Consequently, the aim is to prevent both new and existing development from contributing to or being put at unacceptable risk from or being adversely affected by unacceptable levels of noise pollution.

The NPPF states that planning policies and decisions should aim to:

- 'mitigate, and reduce to a minimum, potential adverse impacts resulting from noise from new development – and avoid noise from giving rise to significant adverse impacts on health and quality of life; and
- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason'.

With regards to 'adverse effects' and 'significant adverse effects' the NPPF refers to the Noise Policy Statement for England (NPSE) Explanatory Note [ii].

2.2 Noise Policy Statement for England

The statement sets out the long-term vision of the government's noise policy, which is to 'promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development'.

This long-term vision is supported by three aims:

- 'avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvements of health and quality of life.'

The long-term policy vision and aims are designed to enable decisions to be made regarding what is an acceptable noise burden to place on society.

The 'Explanatory Note' within the NPSE provides further guidance on defining 'significant adverse effects' and 'adverse effects' using the concepts:

- No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observable Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

The three aims can therefore be interpreted as follows:

- the first aim is to avoid noise levels above the SOAEL;
- the second aim considers situations where noise levels are between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and minimise the effects. However, this does not mean that such adverse effects cannot occur; and
- the third aim considers situations where reductions in noise levels can be sought through the pro-active management of noise.

The NPSE recognises that it is not possible to have single objective noise-based measures that define the SOAEL, LOAEL and NOEL that is applicable to all sources of noise in all situations. The levels are likely to be different for different noise sources, receptors and at different times of the day.

2.3 Planning Practice Guidance web-based resource

In March 2014, the Department for Communities and Local Government (DCLG) released its Planning Practice Guidance (PPG) web-based resource to support the NPPF, and this was last updated in July 2019[iii]. The guidance advises that local planning authorities should consider:

- whether or not a significant adverse effect is occurring or likely to occur;
- whether or not an adverse effect is occurring or likely to occur; and
- whether or not a good standard of amenity can be achieved.

This guidance introduced the additional concepts of NOAEL (No Observed Adverse Effect Level), and UAEL (Unacceptable Adverse Effect Level). Full details of the Planning Practice Guidance on effects are provided in Table 2.1.

Table 2.1 PPG Guidance

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

Factors to be considered in determining if noise is a concern are identified including the absolute noise level of the source, the existing ambient noise climate, time of day, frequency of occurrence, duration, character of the noise and cumulative impacts.

2.4 BS4142:2014+A1:2019

Response to sound is subjective and affected by many factors (acoustic and non-acoustic). In general, the likelihood of complaints in response to sound depends on factors including the margin by which it exceeds the background sound levels, its absolute level, character of the sound, time of day, change in the sound environment as well as local attitudes to the installation and the nature of the local area. The latest iteration of the standard used for assessing industrial sound and determining community reaction is British Standard BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' [iv]. According to the standard, it can be used for:

- “investigating complaints;
- assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and
- assessing sound at proposed new dwellings or premises used for residential purposes.”

The basis of BS 4142 is a comparison between the background sound level in the vicinity of residential locations and the rating level of the noise source under consideration. The relevant parameters in this instance are as follows:

- *Background Sound Level* – $L_{A90,T}$ – defined in the Standard as the ‘A’ weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels;
- *Specific Sound Level* – $L_{Aeq,T}$ – the equivalent continuous ‘A’ weighted sound pressure level produced by the specific sound source at the assessment location over a given time interval, T;
- *Residual Sound Level* – $L_{Aeq,T}$ – the equivalent continuous ‘A’ weighted sound pressure level at the assessment location in the absence of the specific sound source under consideration, over a given time interval, T; and
- *Rating Level* – $L_{Ar,T}$ – the specific sound level plus any adjustment made for the characteristic features of the noise such as tonality, impulsivity and intermittency.

When comparing the *Background Sound Level* and the *Rating Level*, the standard states that:

- “Typically, the greater the difference, the greater the magnitude of impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending upon the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending upon the context.
- The lower the *Rating Level* is to the measured *Background Sound Level*, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the *Rating Level* does not exceed the *Background Sound Level*, this is an indication of the specific sound source having a low impact, depending upon the context.”

Importantly, as indicated above, BS 4142:2014 requires that the rating level of the sound source under assessment be considered in the context of the environment when defining the overall significance of the impact. The standard suggests that in assessing the context, all pertinent factors should be taken into consideration, including the following:

- “The absolute level of sound;
- The character and level of the residual sound compared to the character and level of the specific sound; and
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.”

2.5 Discussions with Local Authority

The requirements of the various sound assessments completed for the Bristol Rolls-Royce site were discussed with Neil Higgs, Environmental Health Officer (EHO) at South Gloucestershire Council (SGC) [v] in October 2018.

The criteria for the BS 4142 assessment were discussed and SGC requested that the sound resulting from the operation of future proposed plant at the site is controlled to a *Rating Level* not exceeding the average *Background Sound Levels* measured in September 2018 at surrounding sensitive receptors. It was agreed that cumulative noise assessments would be carried out to include planning applications since the baseline measurements were completed in September 2018.

Given that a cumulative assessment is required, the calculations include for planning applications since the background measurements were completed in September 2018. These comprise:

- Marine Load Bank external to Building 131 (AECOM report reference: 60581568_Marine_01, dated 11th October 2018);
- Coolant Farm Extension (AECOM report reference: 60589549_Coolant Farm_01, dated 23rd October 2018);
- Oxygen Base and Chiller Base – Sound Impact Assessment (AECOM report reference: 60579633_Noise_01, dated 24th October 2018);
- AHU to CTAL (AECOM report reference: 60581568_AHU to CTAL_01, dated 4th December 2018);
- Canaveral 3 – Sound Impact Assessment (AECOM report reference: 60590766_Canaveral 3_1, dated 10th May 2019);
- B185 Gantry Heating System (AECOM report reference 60605936_GantryHeating_1, dated 21st May 2019);
- B188 Replacement Cooling System – Sound Impact Assessment (AECOM report reference 60605936_B188 Cooling System, dated 11th July 2019);
- Canaveral 3: Prep Clean LEV – Sound Impact Assessment (AECOM report reference 60590766, dated 3rd December 2019);
- ALM Area Transformation (AECOM report reference 60617369_B001.01, dated 28th June 2020);
- Ground Source Heating Extension (AECOM report reference 60624397 C001.01, dated 19th August 2020); and
- Whittle House AHUs (AECOM report reference 60624397.D001.01, dated 4th September 2020).

3. Methodology

3.1 Sound Measurements

Baseline sound monitoring undertaken by AECOM in 2018 has been used for this assessment, as discussed in Section 2.5 above. This baseline sound monitoring was carried out in accordance with measurement guidance in British Standard BS 7445: 2003 'Description and Measurement of Environmental Noise' [vi].

The sound level meters were programmed to measure the L_{Aeq} and L_{A90} parameters, logging in contiguous periods of 15 minutes. All sound measurements were taken at between 1.2 and 1.5 metres above ground level and located in free-field conditions (at least 3.5 metres from any vertical reflecting surfaces).

3.2 Calculations and Assessment

An acoustic model of the Bristol site, with the new plant associated with the Building 150 server room plant in place, has been developed using the SoundPLAN (v8.2) sound modelling software. The software implements the standard sound prediction methodology detailed in ISO 9613:1996 [vii].

The Ordnance Survey base mapping and the layout of the existing buildings on the site have been obtained from commercially available mapping [viii]. The site layout has been obtained from a combination of the Ordnance Survey mapping and Rolls-Royce data.

The model has been used to calculate sound levels at identified sensitive receptors resulting from the operation of the new plant associated with the Building 150 server room. The cumulative noise levels (new plant associated with the Building 150 server room + all developments referenced in section 2.5) have then been derived and an assessment carried out in accordance with BS 4142 to determine if the calculated *Rating Levels* meet the requirements of the Local Authority.

4. Baseline Conditions

4.1 Survey Monitoring Procedures

A survey of the background sound levels surrounding the Rolls-Royce site was carried out between Friday 14th September and Tuesday 25th September 2018.

Sound monitoring was carried out at three locations that represented the properties likely to be worst affected by operational plant at the Rolls-Royce site. These locations were:

- 17 Redfield Road (location M1, representative of receptors R1 and R1A);
- 7 Rossall Avenue (location M2, representative of receptors R2, R2A, R2B, R2C and R2D); and
- 102 Gloucester Road (location M3, representative of receptor R3, R3A and R4).

The sound monitoring locations are shown in Figure B.1, Appendix B. Details of the instrumentation employed are presented in Appendix C. All equipment was checked with a field calibrator before and after the measurements. No significant drift in calibration was noted ($> \pm 0.2\text{dB}$). Calibration certificates are available on request.

4.2 Meteorological Conditions

The weather during the monitoring period was largely overcast with average wind speeds less than 5 m/s. However, there were periods of rain and high winds ($> 5\text{m/s}$) and the corresponding data have been removed based on historic weather data from Timeanddate.com.

Further information is provided within Table C.1, Appendix C.

4.3 Survey Results

The measured data were processed to define representative background sound levels during the day (07:00 to 23:00) and night (23:00 to 07:00) periods. The results of the background sound analysis are presented in Table 4.1, and the time history plots are provided in Appendix C.

Table 4.1 Measured Background Sound Levels

Location	Derived Daytime and Night-Time Background Sound Levels L_{A90} dB	
	Day (07:00-23:00)	Night (23:00-07:00)
M1: Redfield Road	44	40
M2: Rossall Avenue	42	38
M3: Gloucester Road	49	40

5. Sound Assessment

5.1 Nearest Sensitive Receptors

The sensitive receptors included in the assessment, along with the derived limits for the *Rating Levels*, are detailed in Table 5.1 and shown in Figure B.1, Appendix B.

Receptors R2A, R2B, R2C and R2D are additional receptors to those employed previously for the cumulative assessments, included to fully account for the location of the previously assessed Ground Source Heating Extension (GSHE) and subsequent developments in the south eastern area of the site.

In the absence of background sound measurements at these additional locations, the noise limits for Receptor R2 have been employed. This is considered a reasonable worst-case as the background sound levels at R2C and R2D will likely be higher due to them being closer to the B4057 to the south.

Table 5.1 Nearest Receptors and Noise Limits

Receptor	Corresponding Monitoring Location	Noise Limit Daytime $L_{A,T,r}$ dB (07:00-23:00)	Noise Limit Night-Time $L_{A,T,r}$ dB (23:00-07:00)
R1 – 21 Redfield Road	M1 – 17 Redfield Road	44	40
R1A – 20 Ravenscourt Road		44	40
R2 – 18 Rossall Avenue	M2 – 7 Rossall Avenue	42	38
R2A – 18 Lawford Avenue		42	38
R2B – 10 Lawford Avenue		42	38
R2C – 6 Gifford Crescent		42	38
R2D – Bush Avenue		42	38
R3 – 92 Gloucester Road	M3 - 102 Gloucester Road	49	40
R3A – 120 Gloucester Road		49	40
R4 – 70 Gloucester Road		49	40

5.2 Plant Data for Acoustic Model

The new external plant to be installed associated with the new server room comprises:

- Roof mounted condenser units (x3, of which no more than 2 will operate simultaneously)
- Roof mounted air intake Air Handling Unit (AHU) (x1)
- Roof air exhaust fan (x1)

The acoustic data for the proposed new plant associated with the Building 150 server room employed within the acoustic model are provided in Table D.1, Appendix D and the locations of the proposed plant are shown in Figure B.1, Appendix B. These are based on information provided by the client.

5.3 Specific Sound Predictions

The acoustic model includes the ground topography, existing Rolls-Royce buildings and residential properties around the site.

Specific sound levels due to the operation of the new plant associated with the Building 150 server room during the daytime and night-time have been calculated at each of the identified sensitive receptors. The results of the calculations are provided in Table 5.2.

Table 5.2 Predicted Free-field Specific Sound Levels at Receptors

Receptor	Floor/Period	Specific Sound Level ($L_{Aeq,T}$ dB)
R1 – 21 Redfield Road	Ground Floor / Day	13
	First Floor / Night	17
R1A – 20 Ravenscourt Road	Ground Floor / Day	11
	First Floor / Night	14
R2 – 18 Rossall Avenue	Ground Floor / Day	16
	First Floor / Night	20
R2A – 18 Lawford Avenue	Ground Floor / Day	16
	First Floor / Night	19
R2B – 10 Lawford Avenue	Ground Floor / Day	18
	First Floor / Night	19
R2C – 6 Gifford Crescent	Ground Floor / Day	16
	First Floor / Night	18
R2D – Bush Avenue	Ground Floor / Day	15
	First Floor / Night	17
R3 – 92 Gloucester Road	Ground Floor / Day	15
	First Floor / Night	17
R3A – 120 Gloucester Road	Ground Floor / Day	7
	First Floor / Night	17
R4 – 70 Gloucester Road	Ground Floor / Day	20
	First Floor / Night	19

The specific sound levels for the new plant associated with the Building 150 server room have been summed with the cumulative specific sound levels for all previous developments (as defined in section 2.5) to provide revised cumulative sound levels, as shown in Table 5.3.

Table 5.3 Predicted Free-field Cumulative Specific Sound Levels at Receptors

Receptor	Floor/Period	Previous Cumulative Level ($L_{Aeq,Tr}$ dB)	Building 150 Server Room External Plant Level ($L_{Aeq,Tr}$ dB)	Revised Cumulative Level ($L_{Aeq,Tr}$ dB)
R1 – 21 Redfield Road	Ground Floor / Day	36	13	36
	First Floor / Night	40	17	40
R1A – 20 Ravenscourt Road	Ground Floor / Day	38	11	38
	First Floor / Night	40	14	40
R2 – 18 Rossall Avenue	Ground Floor / Day	31	16	31
	First Floor / Night	35	20	35
R2A – 18 Lawford Avenue	Ground Floor / Day	31	16	31
	First Floor / Night	35	19	35
R2B – 10 Lawford Avenue	Ground Floor / Day	31	18	31
	First Floor / Night	35	19	35
R2C – 6 Gifford Crescent	Ground Floor / Day	30	16	30
	First Floor / Night	34	18	34
R2D – Bush Avenue	Ground Floor / Day	30	15	30
	First Floor / Night	34	17	34
R3 – 92 Gloucester Road	Ground Floor / Day	38	15	38
	Ground Floor / Night	38	17	38
R3A – 120 Gloucester Road	Ground Floor / Day	36	7	36
	First Floor / Night	38	17	38
R4 – 70 Gloucester Road	Ground Floor / Day	28	20	29
	First Floor / Night	31	19	31

5.4 Assessment

The cumulative sound associated with operation of the plant is judged not to be tonal and no penalty has been applied.

There are no impulsive features associated with the plant and no penalty has been applied.

The plant will generally operate continuously, hence no penalty for intermittency is applicable.

Following the procedures outlined in BS4142, the cumulative *Rating Levels* have been compared to the *Background Sound Levels*, as shown in Table 5.4.

Table 5.4 Sound Assessment

Receptor	Specific Sound Level ($L_{Aeq,Tr}$ dB)	Rating Level ($L_{Ar,Tr}$ dB)	Background Level (L_{A90} dB)	Rating Level minus Background (dB)	Conclusion from BS 4142
Daytime					
R1	36	36	44	-8	Low impact, depending on context
R1A	38	38	44	-6	Low impact, depending on context
R2	31	31	42	-11	Low impact, depending on context
R2A	31	31	42	-11	Low impact, depending on context
R2B	31	31	42	-11	Low impact, depending on context
R2C	30	30	42	-12	Low impact, depending on context
R2D	30	30	42	-12	Low impact, depending on context
R3	38	38	49	-11	Low impact, depending on context
R3A	36	36	49	-13	Low impact, depending on context
R4	29	29	49	-20	Low impact, depending on context
Night-time					
R1	40	40	40	0	Low impact, depending on context
R1A	40	40	40	0	Low impact, depending on context
R2	35	35	38	-3	Low impact, depending on context
R2A	35	35	38	-3	Low impact, depending on context
R2B	35	35	38	-3	Low impact, depending on context
R2C	34	34	38	-4	Low impact, depending on context
R2D	34	34	38	-4	Low impact, depending on context
R3	38	38	40	-2	Low impact, depending on context
R3A	38	38	40	-2	Low impact, depending on context
R4	31	31	40	-9	Low impact, depending on context

Table 5.4 shows that the cumulative rating levels at the receptors are well below the background sound levels during the daytime period. At night, the cumulative rating levels at the receptors are equal to or below the background sound levels. The criterion applied by the Local Authority EHO at SGC is therefore met. The criterion is for a cumulative assessment to include all the sound sources from relevant planning applications since the background measurements were carried out in September 2018.

5.5 Context

The context is that new items of plant are to be installed within an existing industrial site with a large complement of existing operational fixed plant, and where the residual acoustic environment at surrounding sensitive receptors is at a higher level than that predicted for the new plant.

It is concluded that the operation of the proposed plant will result in a low impact at all surrounding receptors.

5.6 Uncertainty

Some uncertainty in the measured data and calculations is unavoidable. With regards to the measured data, this has been minimised as follows:

- undertaking 10 days of baseline sound monitoring. This enabled a comprehensive consideration of the baseline sound levels at the receptors, ensuring that the adopted background sound levels were representative of the relevant time periods;

- use of suitable Class 1 sound level meters which comply with the relevant standards and have been calibrated at a UKAS accredited laboratory within the previous year; and
- field calibration of the measurement system on site at the start and end of each monitoring period.

With regards to the calculations, uncertainties have been minimised as follows:

- The predictions have been completed using a reputable noise mapping software package (SoundPLAN) which implements a validated method of calculation (ISO 9613-2). This methodology predicts sound propagation under typical down-wind conditions, and hence presents a reasonable worst case in terms of sound levels at the receptor locations.
- Input data for the calculations have been derived from supplier data provided via the client.

The author and reviewer's qualifications and experience are provided in Appendix E.

6. Summary

Sound from the proposed new plant associated with the Building 150 server room at the Rolls-Royce Bristol site has been assessed.

The proposed plant will operate during the daytime and night-time. Therefore, the assessment has included for both periods.

The assessment has utilised the results of a baseline sound survey performed in September 2018 to define the background sound levels at the closest noise sensitive receptors to the site.

The predicted levels are cumulative and include for all proposed plant since the baseline noise monitoring in September 2018.

The rating levels at the receptors for the cumulative assessment are predicted to be at or below the background sound level during the day and night-time and therefore the requirements of SGC are met.

7. References

- i Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, MHCLG, London.
- ii Department for the Environment Food and Rural Affairs (2010) Noise Policy Statement for England, Defra.
- iii <https://www.gov.uk/guidance/noise--2>
- iv British Standard 4142: 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'. British Standards Institute. 2019
- v Email from Neil Higgs of SGC to Robert Colder of AECOM on 03.10.2018.
- vi BS 7445: 2003 'Description and Measurement of Environmental Noise'. British Standards Institution.
- vii International Organization for Standardization (1996) ISO 9613: 1996 Part 2 Attenuation of sound during propagation outdoors, ISO.
- viii [Ordnance.survey.co.uk/opendatadownload](https://ordnancesurvey.co.uk/opendatadownload)

Appendix A : Glossary of Terms

Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in sound pressure (measured in Pascals, Pa). Because of this wide range, a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB. The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB(A). Table A1 lists the sound pressure level in dB(A) for common situations.

Table A1: Noise Levels for Common Situations

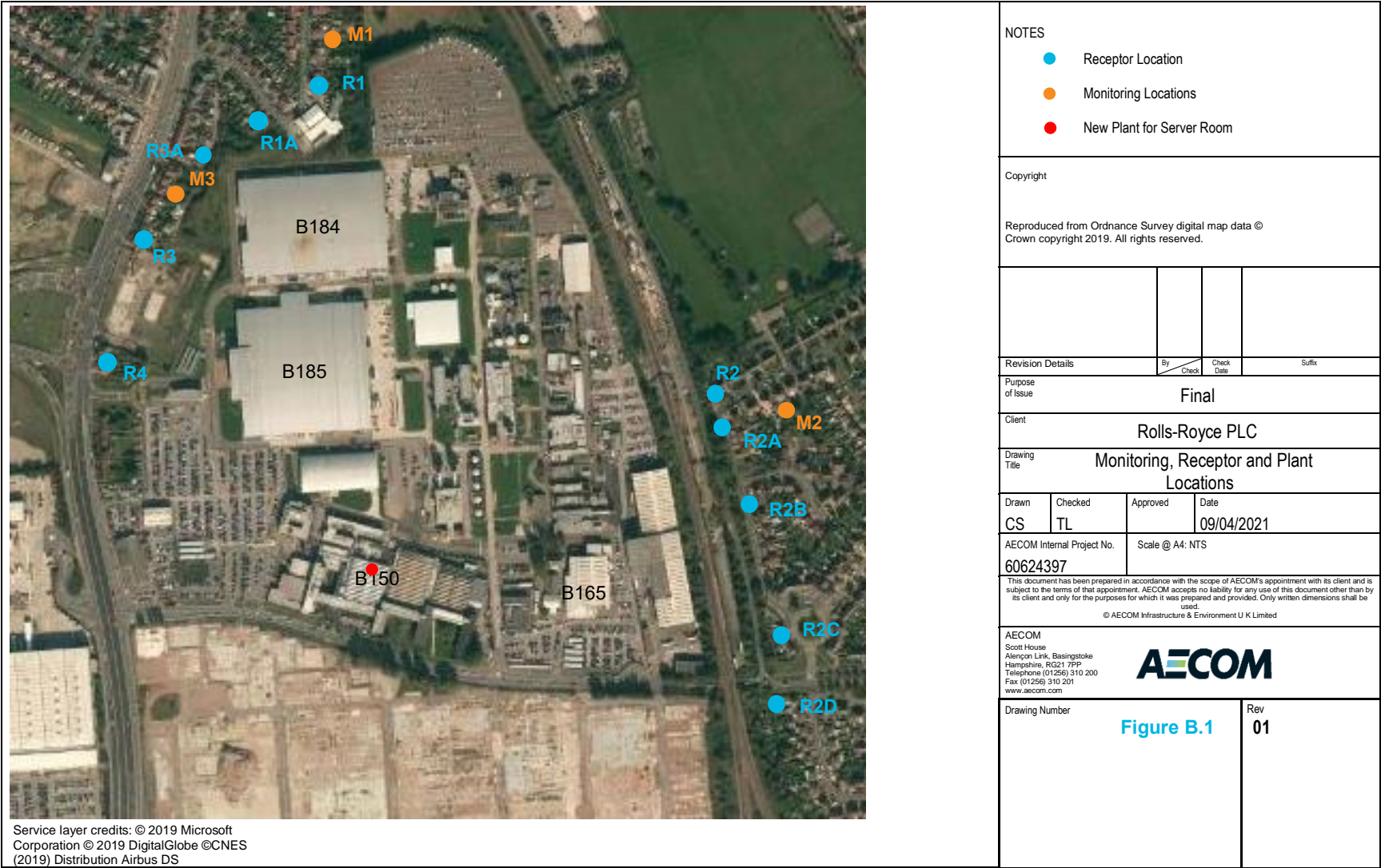
Approximate Sound Pressure Levels (dB(A))	Example
0	Threshold of hearing
30	Rural area at night
50	Quiet office, no machinery
80	General factory noise level
100	Pneumatic drill
140	Threshold of pain

The noise level at a measurement point is rarely steady, even in rural areas, and varies over a range dependent upon the effects of local noise sources. Close to a busy motorway, the noise level may vary over a range of 5 dB(A), whereas in a suburban area this variation may be up to 40 dB(A) and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.) and their variable operation. Furthermore, the range of night-time noise levels will often be smaller and the levels significantly reduced compared to daytime levels. When considering environmental noise, it is necessary to consider how to quantify the existing noise (the ambient noise) to account for these second to second variations.

A parameter that is widely accepted as reflecting human perception of the ambient noise is the background sound level, L_{A90} . This is the noise level exceeded for 90 % of the measurement period and generally reflects the noise level in the lulls between individual noise events. Over a one hour period, the L_{A90} will be the noise level exceeded for 54 minutes.

The equivalent continuous A-weighted sound pressure level, L_{Aeq} is the single number that represents the total sound energy measured over that period. L_{Aeq} is the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period.

Appendix B : Monitoring, Receptor and Plant Locations



Appendix C : Sound Monitoring Details

C.1 Sound Monitoring Equipment

The following equipment was used for the noise monitoring exercise:

- Location M1 - Rion NL-52 Class 1 integrating sound level meter, S/N: 00386762 (SLM 44).
- Location M2 - Rion NL-52 Class 1 integrating sound level meter, S/N: 00386764 (SLM 46).
- Location M3 - Rion NL-52 Class 1 integrating sound level meter, S/N: 00386763 (SLM 45).
- Rion NC-74 Field Calibrator, S/N: 34425539.

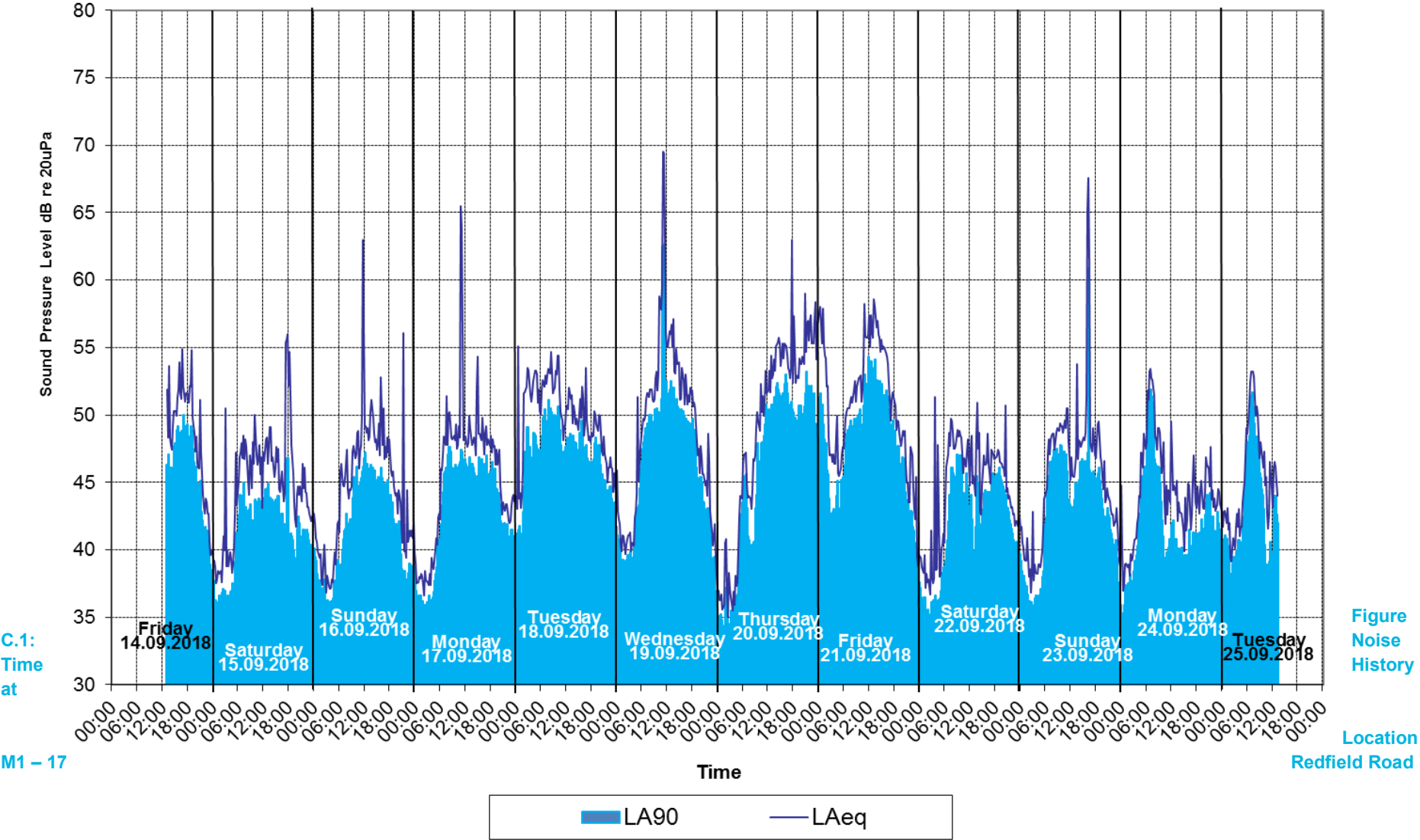
The microphones were protected at all times by appropriate outdoor enclosures. All measurements were taken 1.5 m above local ground level and were located more than 3.5 m from any vertical reflecting surfaces and as such can be considered to be free-field.

C.2 Weather Conditions

Table C.1: Weather Conditions

Date	Temperature °C Range	Wind Speed m/s	Precipitation
Friday 14/09/2018	11 to 16	<5m/s except 14:20 to 18:50	Periods of light rain
Saturday 15/09/2018	12 to 17	<5m/s except 00:00 to 02:20, 09:50 to 16:20, 21:20 to 00:00	No rain
Sunday 16/09/2018	13 to 19	<5m/s	No rain
Monday 17/09/2018	15 to 20	<5m/s except 19:20 to 20:20, 21:50 to 23:20	No rain
Tuesday 18/09/2018	15 to 19	<5m/s except 14:20 to 16:50	No rain
Wednesday 19/09/2018	12 to 21	<5m/s except 06:50 to 20:50	No rain
Thursday 20/09/2018	12 to 18	<5m/s except 05:20 to 06:20 and 09:20 to 00:00	Period of light rain
Friday 21/09/2018	8 to 15	<5m/s	No rain
Saturday 22/09/2018	9 to 11	<5m/s except 02:50 to 12:50	Light rain
Sunday 23/09/2018	9 to 14	<5m/s	Rain AM
Monday 24/09/2018	7 to 13	<5m/s	No rain
Tuesday 25/09/2018	3 to 17	<5m/s	No rain

Source: Time and Date, Bristol



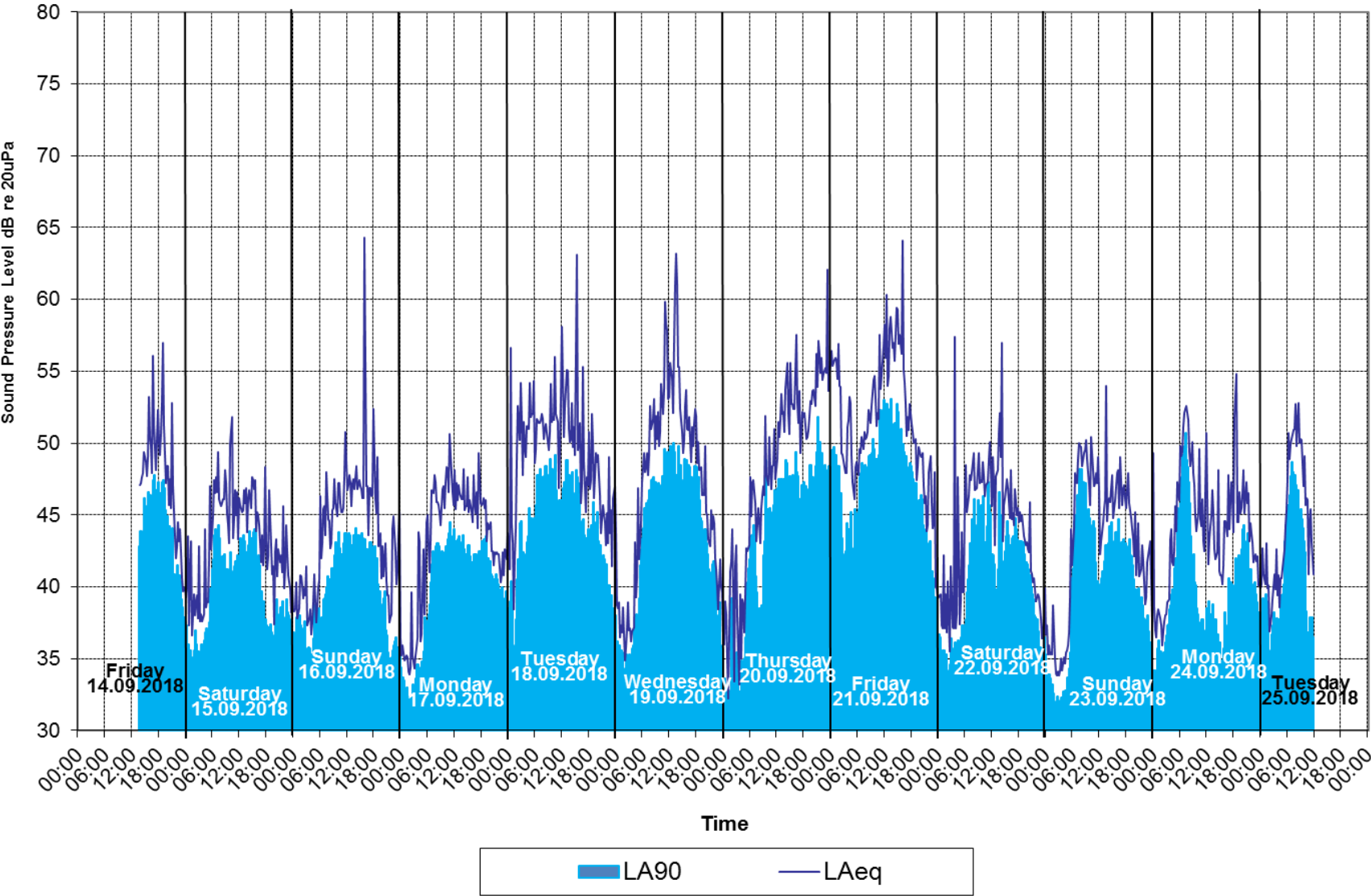


Figure C.2: Noise Time History at

Location

M2 – 7 Rossall Avenue

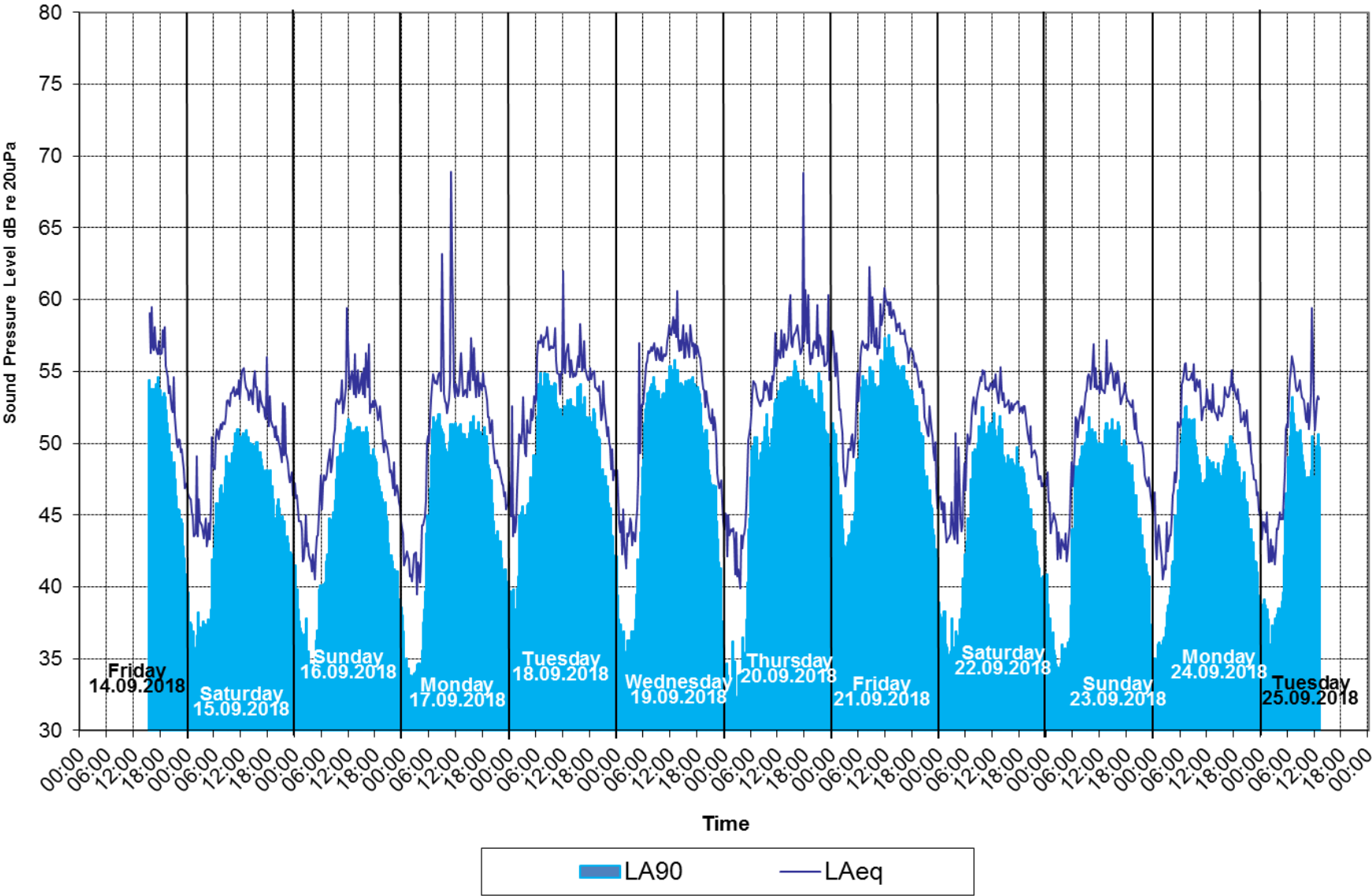


Figure C.3: Noise Time History at Location M3 – 102 Gloucester Road

Appendix D : Sound Model Details and Inputs

D.1 Data sources

OS mapping: Downloaded from [Ordnance.survey.co.uk/opendatadownload](https://ordnancesurvey.co.uk/opendatadownload)

Ground elevation data from environment.data.gov.uk/ds/survey#/

D.2 Modelling assumptions & parameters

Ground Absorption: 0 for site and nearby surroundings.

Ground Absorption: 0.5 at residential receptors.

(Note: Acoustically Soft = 1, Acoustically Hard = 0)

D.3 Other Settings

Order of Reflections = 3

ISO 9613 prediction methodologies

Receiver height = 1.5 metres for ground floor height

Receiver height = 4 metres for first floor height

D.4 Source Data

Condenser Units (x3) – 2 operational at any time:

- Sound Pressure Level 59 dB(A) at a distance of 5m
- Dimensions of unit: 2.6m x 1.3 m x 1.0 m

Air Intake AHU x1

- Inlet Sound Power Level 54 dB L_{WA}
- Breakout Sound Power Level 45 dB L_{WA}

Extract Fan

- Sound Pressure Level 50 dB(A) at a distance of 3m

Appendix E : Qualifications and Experience

Chris Skinner MSci MA MIOA – Assessment

Chris has spent 20 years working on noise and vibration related projects, including advising a wide range of clients on environmental noise impacts and noise control. Chris has also provided technical advice to Defra on environmental noise matters.

Chris is currently a regional manager, leading AECOM's acoustics team in the Midlands and is a Corporate Member of the Institute of Acoustics, and a highly experienced user of SoundPLAN noise modelling software, providing in-house support to SoundPLAN users.

Chris' technical experience includes undertaking detailed noise modelling and measurements exercises for a number of key industrial clients. He has worked with his clients to assess environmental noise emissions and provide detailed technical advice relating to the installation of new noise producing plant, control of existing noise sources and investigation of noise complaints.

Tom Lucas MSc MIOA – Review

Tom has over 13 years of acoustic consultancy experience providing advice and assessment on sound, noise and vibration to a wide range of public and private sector clients. He graduated in 2007 from the University of Derby with a 1st Class (Hons) BSc in Environmental Science and Environmental Management, and went on to complete the Institute of Acoustics Post-graduate Diploma in Acoustics and Noise Control and an MSc in Applied Acoustics, both also at the University of Derby.

Tom has gained substantial knowledge and experience in a variety of acoustic disciplines, including undertaking Environmental Impact Assessments (EIA) for various end uses and the assessment of industrial noise impacts.

Tom has worked on and project managed several large-scale projects, from development of the acoustic strategy and acoustic performance specifications through to project completion and final acoustic testing.

