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AMERESCO

WINSTON CHURCHILL THEATRE

PLANT NOISE ASSESSMENT

29 AUGUST 2023

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AMERESCO
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PLANT NOISE ASSESSMENT

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REVIEW AND AUTHORISATION			
Authored and approved by Adrian Finn	**Position** Director	**Signature**	**Date** 29/08/2023
Reviewed by Daniel Flood	**Position** Senior Consultant	**Signature**	**Date** 29/08/2023

AMENDMENT HISTORY			
Issue	**Status**	**Description**	**Date**
01	Draft	Report issued	29/08/2023

CONTENTS **PAGE NO.**

1. INTRODUCTION

1.1.1 Ameresco has commissioned AF Acoustics Ltd. to undertake a plant noise assessment for the proposed installation of three air to water heat pumps to be installed at the Winston Churchill Theatre, Ruislip.

1.2 Brief and Scope

1.2.1 The brief is to undertake a plant noise assessment for the proposed plant to be installed at the Winston Churchill Theatre and to calculate the level of noise impact at the nearest residential receptor. If the proposed plant creates an adverse impact, or the noise levels at the nearest residential receptor do not meet the local authority guidance then recommendations will be given to reduce the noise from the plant, so that the plant produces a low impact in accordance with BS 4142:2014 and meets local authority guidance.

2. SITE DESCRIPTION

2.1 Location

2.1.1 The proposed plant is to be located at the side of the Winston Churchill Theatre. The proposed location is shown in Figure 2.1.

2.1.2 The Winston Churchill Theatre is located in a mainly residential area with a large open green space surrounding most of the theatre. To the north and east of the theatre is a large park and open space. Further to the east are residential properties. To the south are Manor House stables and to the west are the nearest residential receptors on Bury Street.

2.1.3 The noise profile at the Winston Churchill Theatre consisted mainly of noise from local road traffic.

FIGURE 2.1: LOCATION MAP

3. GUIDANCE

3.1 British Standard 4142:2014

3.1.1 BS 4142:2014 'Methods for rating and assessing industrial and commercial sound' describes methods for rating and assessing sound from "fixed installations which comprise mechanical and electrical plant and equipment", amongst other sources of noise.

3.1.2 The methodology contained within BS 4142:2014 uses outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

3.1.3 A summary of the approach set out within BS 4142:2014 is set out below:

- establish the specific sound level of the source(s);
- measure the representative background sound level, typically by measurement close to the receptor location;
- rate the specific sound level to account for any distinguishing characteristics;
- estimate the impact by subtracting the background sound level from the rating level; and
- consider the initial estimate of impact, in the context of the noise and its environment.

3.1.4 An initial estimate of the impact of the specific sound is obtained by subtracting the background sound level from the rating level. Using this approach, BS 4142 states:

> "Typically, the greater this 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 on the context*
> A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
> The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source 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 on the context."

3.1.5 Certain acoustic features can increase the significance of the impact over that expected from a basic comparison between specific sound level and the background sound level. These features include tonality and impulsivity, as well as additional characteristics and intermittency of the sound.

3.1.6 If appropriate, a subjective assessment of the plant features can be adopted. Where the plant noise contains tonal elements, the following corrections can be made depending on how perceptible the tone is at the noise receptor.

3.1.7 The specific sound level is rated to account for distinguishing characteristics by using the penalties below:

- 0 dB where the tone is not perceptible
- 2 dB where the tone is just perceptible
- 4 dB where the tone is clearly perceptible
- 6 dB where the tone is highly perceptible

3.1.8 Where the plant noise is impulsive, the following corrections can be made depending on how perceptible the impulsivity is at the noise receptor.

- 0 dB where the impulse is not perceptible
- 3 dB where the impulse is just perceptible
- 6 dB where the impulse is clearly perceptible
- 9 dB where the impulse is highly perceptible

3.1.9 For noise which is equally both impulsive and tonal, then both features can be taken into account by linearly summing the corrections for both characteristics.

3.1.10 If the plant has other distinctive characteristics, such as intermittency, then a 3 dB correction can be made.

3.1.11 If a subjective assessment is not appropriate then an objective assessment can be made. A noise source is deemed to be tonal if the time averaged sound pressure level in a one-third octave band exceeds the level in adjacent one-third octave bands by the level differences given below:

- 15 dB in the low frequency one-third octave bands (25 Hz to 125 Hz)
- 8 dB in the mid frequency one-third octave bands (160 Hz to 400 Hz)
- 5 dB in the high frequency one-third octave bands (500 Hz to 10000 Hz)

3.1.12 If an objective assessment identifies the plant noise to be tonal then a 6 dB correction must be made.

3.2 Local authority Guidance – Hillingdon

3.2.1 The London Borough of Hillingdon's guidance on plant noise states, 'The rating level of noise emitted from the plant and/or machinery hereby approved shall be at least 5dB below the existing background noise level. The noise levels shall be determined at the nearest residential property. The measurements and assessment shall be made in accordance with British Standard 4142.'

4. NOISE SURVEY AND MEASUREMENTS

4.1 Unattended Noise Survey

4.1.1 An unattended noise survey was undertaken by Adrian Finn of AF Acoustics with the sound level meter located at the side of the Winston Churchill Theatre. It was not possible to measure closer to the nearest residential receptors due to safety concerns for the equipment. The measurement position is considered representative of the noise levels affecting the nearest noise sensitive receptors.

4.1.2 The duration of the survey was between 11:45 on 9 August and 12:45 on 10 August 2023. This measurement location is labelled as LT1 in Figure 4.1. The measured noise levels are considered free field noise levels. The microphone was protected with a windshield during the noise survey. Measurements were carried out in accordance with the requirements of BS 7445-2:1991 and ISO 1996-2:1987.

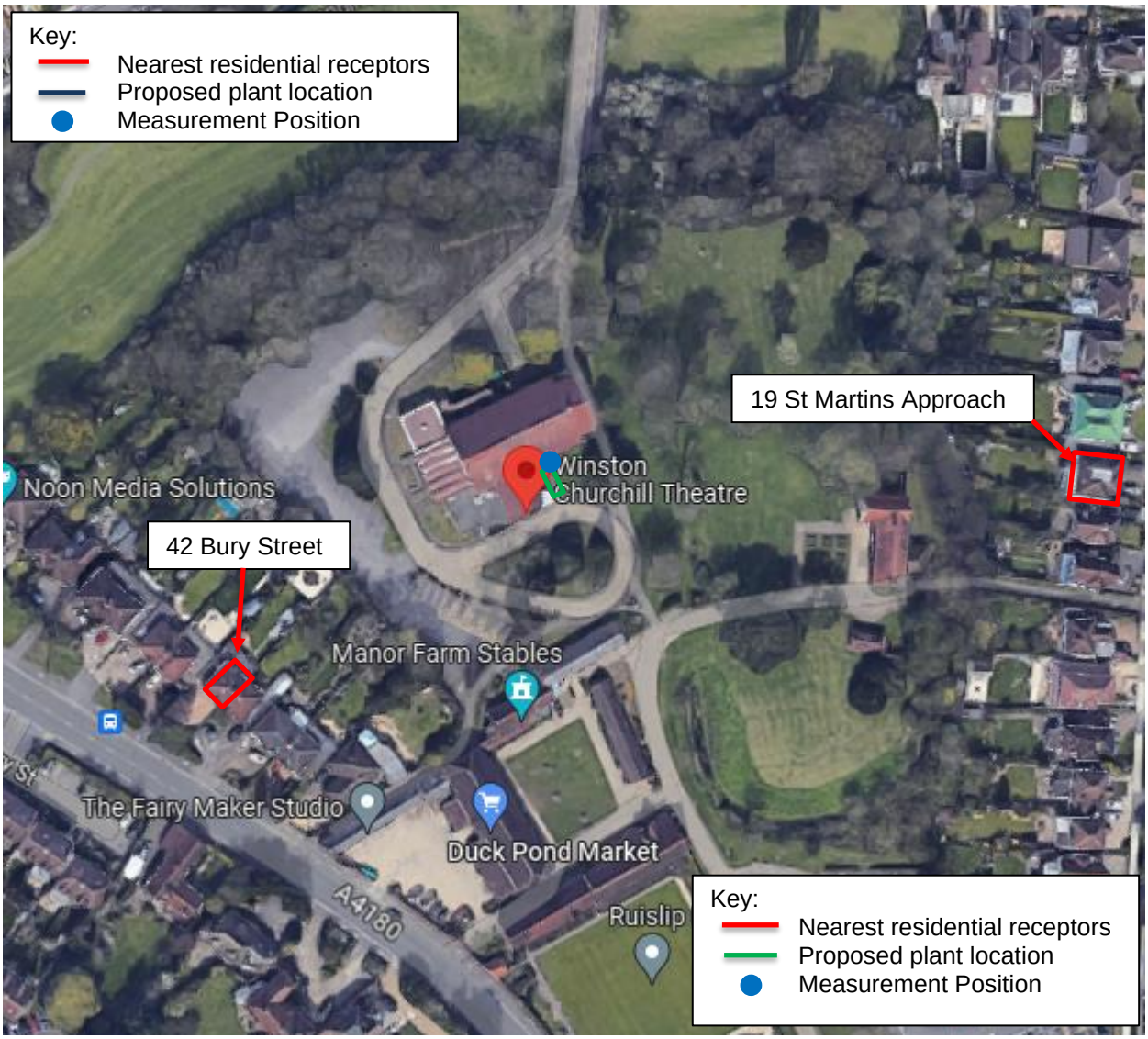

FIGURE 4.1: MEASUREMENT LOCATION

4.1.3 The sound level meter had calibration checks before and after the measurement surveys to generate a calibration level of 114 dB at 1 kHz. The equipment calibration was verified

before and after the survey and no calibration drift was observed. The microphone was fitted with a windshield.

4.1.4 The equipment used is shown in Table 4.1.

Location	Name	Serial Number	Last Calibrated
LT1	NTI Audio XL2-TA Class 1 Sound Level Meter	A2A-18530-E0	January 2023
LT1	NTI Audio MA220 Pre-amplifier	9566	January 2023
LT1	NTI Audio MC230A Microphone	A19842	January 2023
LT1	Norsonic 1251 Calibrator	30900	July 2023

TABLE 4.1: MEASUREMENT EQUIPMENT

4.2 Measurement Weather Conditions

4.2.1 The weather during the measurements was mainly dry and clear. The temperature ranged from 12 to 26°C. Average wind speeds remained below 3 ms^{-1}. The weather is deemed to have caused no significant effect during the measurement period.

4.3 Results

4.3.1 The results of the continuous noise monitoring survey are presented in graphical form in Figure A1 of Appendix A and summarised in Table 4.2.

4.3.2 The L_{A90} background noise level has been derived considering the most commonly occurring 1 hour period during the day and 15 minute period at night, whilst the $L_{Amax,F}$ maximum noise level is the 90th percentile of the measured maximum noise levels.

Time period	Measured Noise Levels (dB re 2.0 x 10^{-5} Pa)		
	$L_{Amax,F}$	$L_{Aeq,T}$	Typical $L_{A90,T}$
Daytime (07:00 – 23:00)	68	45	38
Night time (23:00 – 07:00)	62	10	31

TABLE 4.2: SUMMARY OF UNATTENDED NOISE MEASUREMENTS, LT1

5. PLANT NOISE ASSESSMENT

5.1 Noise Rating Limit

5.1.1 The table below presents the maximum noise rating level which must not be exceeded at the noise sensitive receptor.

Measurement Period	Assessed Background Noise Level dB L_{A90}	Noise Rating Level Design Criteria	Plant Noise Rating Level Limit dB $L_{Ar,Tr}$
24 hour	31	5dB below the background noise level	26

TABLE 5.1: TARGET BACKGROUND NOISE LEVEL

5.2 Plant Noise Levels

5.2.1 It is proposed to install three MasterThem air to water heat pumps at the side of the Winston Churchill Theatre.

5.2.2 The manufacturer's noise levels are presented in Table 5.2.

Plant	Parameter	Sound Level (dB) at Octave Band Centre Frequency						
		125	250	500	1000	2000	4000	8000
MasterTherm ASHP	L_w	78	65	62	59	55	51	42

TABLE 5.2: PLANT NOISE LEVEL

5.3 Calculated Noise Levels

5.3.1 Table 5.3 provides a summary of the calculated plant noise at the nearest receptor, 42 Bury Street, a distance of approximately 90m from the plant. The Bury Street receptor is screened from the plant by the theatre itself. In addition a calculation to 19 St Martins Approach, approx. 127m from the plant, has also been undertaken. The calculation sheets are presented in Appendix B.

Property	Assessment Period	Target Plant Noise Rating Level dB $L_{Ar,Tr}$	Plant Specific Sound Level dB $L_{Aeq,Tr}$	Actual Noise Rating Level dB $L_{Ar,Tr}$
42 Bury Street	24 hour	26	5	5
19 St Martins Approach	24 hour	26	21	21

TABLE 5.3: PREDICTED NOISE AT NEAREST RESIDENTIAL RECEPTORS

5.3.2 No correction factors have been added in accordance with BS4142:2014. There are no tones or other acoustic characteristics present from the proposed plant.

5.3.3 As per the semantics of BS4142:2014, the assessment indicates little likelihood of adverse impact. The proposed plant meets the London Borough of Hillingdon's requirement that the plant is 5 dB below the background noise level at the nearest residential receptor.

6. CONCLUSION

6.1.1 Ameresco has commissioned AF Acoustics Ltd. to undertake a plant noise assessment for the proposed installation of three air to water heat pump at the Winston Churchill Theatre.

6.1.2 A noise survey was undertaken with the sound level meter located at the side of the Winston Churchill Theatre. The measurement position is considered representative of the noise levels affecting the nearest noise sensitive receptor. The representative noise levels measured at this location was used to establish the prevailing environmental noise climate.

6.1.3 Plant noise emission criteria have been set at the nearest receptor based on the results of the noise survey and in conjunction with the national guidance.

6.1.4 Noise calculations based on the plant data was undertaken to the nearest noise sensitive receptors.

6.1.5 As per the semantics of BS4142:2014, the assessment indicates little likelihood of adverse impact. The proposed plant meets the London Borough of Hillingdon's requirement that the plant is 5dB below the background noise level at the nearest residential receptors.

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APPENDIX A: FIGURES

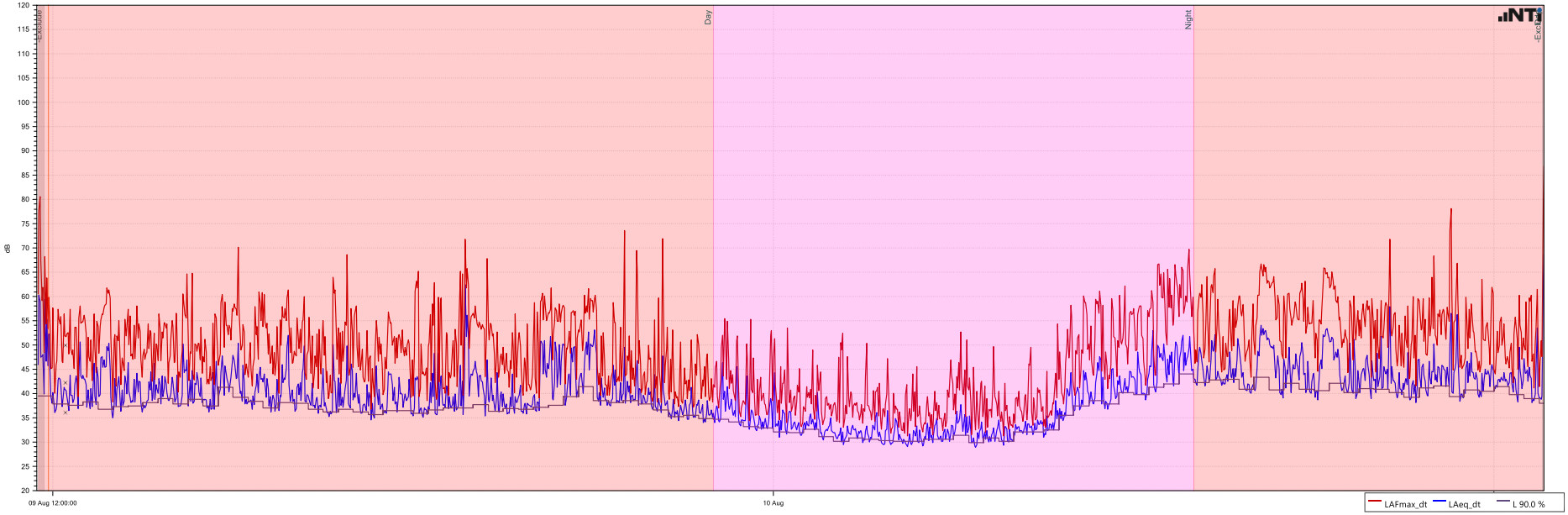

FIGURE A1: NOISE MEASUREMENT RESULTS – WINSTON CHURCHILL THEATRE

APPENDIX B: TABLES

Job No.	Job Title			
1953	Winston Churchill Theatre			
Date Created	By	Date Revised	Rev	Sheet
08 Aug 2023	AF	25 Aug 2023	11	4
Date Reviewed	By	Review Type	Review Status	
25 Aug 2023	AF	Self Check	No Comments	

Plant Noise Calculation - Winston Churchill Theatre

Item / Description		Rating/Broadband/Input Rating	dB	dB(A)	Octave Band Centre Frequency, Hz 31.5	63	125	250	500	1k	2k	4k	8k
Mastertherm	Lw						78.0	65.0	62.0	59.0	55.0	51.0	42.0
Number of Sources Correction		3 x		4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Point Source Propagation Loss		80.0 m	3.0 dB		-46.1	-46.1	-46.1	-46.1	-46.1	-46.1	-46.1	-46.1	-46.1
Barrier Attenuation - Theory: Maekawa, Source Height: 1 m, Receiver Height: 3.5 m	Barrier caused by theatre	5.6 m	1.5 m	80.0 m		-13.9	-16.9	-19.9	-22.9	-25.0	-25.0	-25.0	-25.0
Sum at receptor				5 (A)		-55.2	19.8	3.8	-2.2	-7.3	-11.3	-15.3	-24.3

TABLE B1: CALCULATIONS – TO 42 BURY STREET

Job No.	Job Title			
1953	Winston Churchill Theatre			
Date Created	By	Date Revised	Rev	Sheet
08 Aug 2023	AF	29 Aug 2023	2	5
Date Reviewed	By	Review Type	Review Status	
25 Aug 2023	AF	Self Check	No Comments	

Plant Noise Calculation - Winston Churchill Theatre to 19 St Martins Approach

Item / Description		Rating/Broadband/Input Rating	dB	dB(A)	Octave Band Centre Frequency, Hz 31.5	63	125	250	500	1k	2k	4k	8k
Mastertherm	Lw						78.0	65.0	62.0	59.0	55.0	51.0	42.0
Number of Sources Correction		3 x		4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Point Source Propagation Loss		127.0 m	3.0 dB		-50.1	-50.1	-50.1	-50.1	-50.1	-50.1	-50.1	-50.1	-50.1
Sum at receptor				21 (A)		-45.3	32.7	19.7	16.7	13.7	9.7	5.7	-3.3

TABLE B2: CALCULATIONS – TO 19 ST MARTINS APPROACH

APPENDIX C: TERMINOLOGY RELATING TO NOISE

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level	The sound level is the sound pressure relative to a standard reference pressure of 20_{μ}Pa ($20x10^{-6}$ Pascals) on a decibel scale.
Sound Power Level (Lw)	is the total amount of sound energy inherent in a particular sound source, independent of its environment. It is a logarithmic measure of the sound power in comparison to a specified reference level (usually 10^{-12} W).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by 20 $\log_{10}$ (s_1 / s_2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20_{μ}Pa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
$L_{Aeq,T}$	Equivalent continuous A-weighted sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound
$L_{90,T}$	L_{90} is the noise level exceeded for 90% of the period T (i.e. the quietest 10% of the measurement) and is often used to describe the background noise level.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
Specific Noise	The noise source under investigation for assessing the likelihood of complaints.
Rating Level	The specific noise level plus any adjustment for the characteristic features of the noise.
Free field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m.
Façade	At a distance of 1m in front of a large sound reflecting object such as a building façade.

APPENDIX D: LIMITATIONS TO THE REPORT

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