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Feasibility assessment of noise issues

arising from a proposed data centre

at the former RAF mast site, Courtenay Road, Dunkirk

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1. INTRODUCTION

1.1 Planning permission was granted in November 2018 for the construction of a data centre at the former RAF mast site off Courtenay Road, Dunkirk, under Swale Borough Council planning reference 16/507586/FULL.

1.2 Condition 13 of the Decision Notice states: "*Prior to first use of the building details of noise mitigation measures based on the silencing system recommended in Appendix 4 of the Peter Moore Acoustics Ltd report dated 11 September 2017. (ref; 170102/3) shall be submitted to and approved by the Local Planning Authority. Upon approval the approved details shall be installed in the building before its first use and thereafter this system shall be maintained to meet the intended noise mitigation levels.*"

1.3 The acoustic report referenced by the planning condition provided a feasibility assessment of the noise issues. It was based on the proposal drawings 1078/102C, /103C, /104B and 105A by DF Johnston Architects, together with technical information from a conceptual design of the data centre prepared by Comms Room Services.

1.4 The 2018 planning permission has now expired without being implemented, and a new planning application is to be submitted for the same scheme. For the purposes of this new planning application, the acoustic report referenced in Condition 13 of the 2018 Decision Notice has been reviewed to take account of changes in the technical and planning guidelines.

1.5 This current version of the acoustic report is the result of that review. There have been changes to the NPPF and to British Standard BS 1442 which have taken place since the previous acoustic report. The text of this report has been updated to refer to the current versions of those documents. These changes have been found not to have any material effect on the technical analysis or the conclusions drawn from it, which therefore remain identical to before.

2. NATIONAL PLANNING POLICY

2.1 The July 2021 National Planning Policy Framework describes how noise should be taken into account when determining planning applications.

2.2 At paragraph 174(e) it states: *"Planning policies and decisions should contribute to and enhance the natural and local environment by … preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of … noise pollution."*

2.3 At paragraph 185(a) it states: *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life."*

2.4 For a definition of adverse impacts, the NPPF refers to the 2010 Noise Policy Statement for England. The NPSE utilises two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

- NOEL – No Observed Effect Level. Below this level, there is no detectable effect on health and quality of life due to the noise.
- LOAEL – Lowest Observed Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.

2.5 The NPSE extends these to the concept of a

- SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.

2.6 The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development. The NPSE states that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. The NPSE acknowledges that further research is required to increase understanding of what may constitute a significant adverse impact on health and quality of life from noise.

2.7 The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.

2.8 The adverse effect levels are described in more detail in the DCLG Planning Practice Guidance as follows:

At the lowest extreme, when noise is not noticeable, there is by definition no effect. As the noise exposure increases, it will cross the no observed effect level as it becomes noticeable. However, the noise has no adverse effect so long as the exposure is such that it does not cause any change in behaviour or attitude. The noise can slightly affect the acoustic character of an area but not to the extent there is a perceived change in quality of life. If the noise exposure is at this level no specific measures are required to manage the acoustic environment.

As the exposure increases further, it crosses the lowest observed adverse effect level boundary above which the noise starts to cause small changes in behaviour and attitude, for example, having to turn up the volume on the television or needing to speak more loudly to be heard. The noise therefore starts to have an adverse effect and consideration needs to be given to mitigating and minimising those effects (taking account of the economic and social benefits being derived from the activity causing the noise).

Increasing noise exposure will at some point cause the significant observed adverse effect level boundary to be crossed. Above this level the noise causes a material change in behaviour such *as keeping windows closed for most of the time or avoiding certain activities during periods when the noise is present. If the exposure is above this level the planning process should be used to avoid this effect occurring, by use of appropriate mitigation such as by altering the design and layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused.*

At the highest extreme, noise exposure would cause extensive and sustained changes in behaviour without an ability to mitigate the effect of noise. The impacts on health and quality of life are such that regardless of the benefits of the activity causing the noise, this situation should be prevented from occurring.

2.9 The DCLG Planning Practice Guidance provides the following table which summarises the noise exposure hierarchy, based on the likely average response.

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

3. BRITISH STANDARD BS 4142: 2014

3.1 The current version of British Standard BS 4142 was published in 2014, and was subsequently amended in 2019. It specifies methods for rating and assessing noise of an industrial and/or commercial nature affecting residential property. It uses outdoor noise levels to assess the likely effects of noise on people who might be inside or outside a dwelling.

3.2 The level of noise from the industrial or commercial source is evaluated in terms of its equivalent continuous noise level (L_{Aeq}) over a reference time interval of a one hour period during the day, and 15 minutes during the night. This is referred to as the "specific sound level".

3.3 The specific sound level is then adjusted according to whether it has any acoustically distinguishing characteristics, to arrive at a "rating level". These adjustments comprise:

- Tonality - a penalty of 2 dB is applied for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible
- Impulsivity - a penalty of 3 dB is applied for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible
- Other noise characteristics, such as intermittency - a 3 dB penalty can be applied if the characteristics are readily distinctive against the residual acoustic environment

3.4 The residual acoustic environment (i.e. in the absence of the industrial or commercial noise source that is being assessed) is evaluated by measurement of the background noise level L_{A90}, which is the noise level exceeded for 90% of the time.

3.5 The likely impact of the industrial or commercial noise is initially estimated by comparing the rating level with the residual background noise. A rating level that exceeds the background noise level by around 10 dB or more is likely to be an indication of a significant adverse impact, depending on the context. A rating level around 5 dB above the background noise is likely to be an indication of an adverse impact, depending on the context. Where the rating level does not exceed the background noise level, this is an indication of the noise source having a low impact, depending on the context.

4. BACKGROUND NOISE SURVEY

4.1 A survey of existing noise levels was carried out at the site between Tuesday 15th and Monday 20th February 2017. The survey established the background L_{A90} noise levels as required for the BS 4142 assessment. Ideally this would have been carried out at the residential locations likely to be affected by any noise from the proposed data centre, however this would have required obtaining permission from the relevant landowners. Although this could possibly have been arranged, it was decided instead to measure at a position on the application site as marked on Figure 1 which was judged to be representative of the background noise at the rear of the neighbouring dwellings.

4.2 The results of this survey are listed at Tables 1a to 1f. As well as the L_{A90} noise levels, other statistical noise levels are also listed together with the weather conditions as recorded on site throughout the survey. Details of the instrumentation used and its calibration are at Appendix 1.

4.3 From the data in Tables 1a to 1f it is concluded that a representative value of the background noise during the day is 44 dB L_{A90}, and at night it is 34 dB L_{A90}. It was mainly caused by distant road traffic. There was some variation from one day or night to another which was partly influenced by wind conditions. The lowest background noise in any single hour was 30.3 dB L_{A90} measured at 3 a.m. on the Saturday morning.

5. DATA CENTRE NOISE SOURCES

5.1 The main noise sources at the proposed data centre are anticipated to be the intake and extract fans associated with the evaporative cooling units which are to be located along the sides of the building, and the DRUPS (diesel rotary uninterruptible power supply) generator units at basement level.

5.2 The principle of operation of the evaporative cooling is shown in Figure 2. The proposed installation at Dunkirk may not be identical to the one shown in this diagram, for example there is unlikely to be a heating coil.

5.3 The data servers within the building may also generate noise, however this should be readily contained within the building structure and is not therefore considered an issue for noise reaching nearby houses for the purposes of this feasibility study. The sound insulation properties of the building will need to be checked as part of a detailed design.

5.4 The intake and extract fans have been selected in the Comms Room Services conceptual design as being Ziehl-Abegg type ZN080ZIL.GL.V7P3 which have a sound power level of 82 dB(A) on the suction side and 83 dB(A) on the discharge side according to the manufacturer's data. The manufacturer also provides the octave band frequency analysis of this noise from 63 Hz to 8 kHz inclusive. The data sheet for this fan is at Appendix 3.

5.5 Based on this information, a computer calculation model has been set up to predict the fan noise reaching the dwellings near the data centre. The calculation is based on the ISO 9613-2 method as implemented in Soundplan, which is a widely-used computer program for environmental noise calculations. The calculation takes into account the noise screening effects of intervening structures including the data centre building itself, the attenuation of sound over distance, and the absorption of sound by the air and by the ground surface.

5.6 The sound power levels of the fan intakes has been modelled as vertical area sources at the ground and first floor louvred openings along each side of the proposed building. There are 11 fans on each side at the ground floor, and 13 on each side at the first floor. The corresponding number of extract fans at ground and first floor have been modelled as a series of point noise sources along each side of the building.

5.7 The resulting calculated noise levels due to the ventilation intake and extract fans, without silencers, are shown in Figures 3 and 4 respectively. At the worst-case dwelling which is the bungalow at 7 Courtenay Road, the façade noise level is 53.2 dB L_{Aeq} from the intake fans and 55.1 dB L_{Aeq} from the extract fans.

5.8 There will be other noise sources such as water pumps within the evaporative cooling units. It is anticipated that these will be relatively quiet compared to the ventilation fans and could be adequately attenuated by the selection of appropriate acoustic grades of louvres at the sides of the building behind which the evaporative coolers will be situated.

5.9 Noise level data for the DRUPS generators has been provided by Comms Room Services from measurements at a similar installation in Vienna. There the internal noise level within the generator room was typically 99 dB(A) and outside the generator room it was 49 dB(A) at the air inlet, 54 dB(A) at the air outlet and 59 dB(A) at the diesel exhaust. Octave band frequency data for that installation was not reported. For the purposes of this Dunkirk feasibility study, manufacturer's octave band data for a comparable size of generator has been referenced.

5.10 The installation at Vienna must have had air inlet and outlet silencers although the details of those are not known. For the Dunkirk assessment the noise levels have been calculated using the Soundplan computer model, assuming a 1.5 metre long silencer (IAC type 5S) on the air inlet and a 1.8 metre long silencer (IAC type 6S) on the outlet. A data sheet for these silencers is at Appendix B. The silencer performance is calculated in Table 4 and is somewhat less than what is reported to have been achieved at Vienna. Possibly larger, more effective silencers were used there. The resulting noise levels reaching the nearby dwellings with one generator running are shown in Figure 5. At the worst-case dwelling which is the bungalow at 7 Courtenay Road, the façade noise level is 35.0 dB L_{Aeq}.

5.11 Assuming the diesel exhaust would be located at the rear of the data centre building it would be about 60 metres from the nearest houses. Over this distance the noise level from the Vienna measurements translates to 23 dB(A) from the diesel exhaust.

6. BS 4142 ASSESSMENT OF NOISE LEVELS – VENTILATION SYSTEM

6.1 The ventilation system for the data centre will run continuously throughout the day and night. The assessment of noise levels will be dictated by the night-time case since background noise levels then are lower than during the day. The survey found a typical background noise of 34 dB L_{A90} at night which could at times fall to just over 30 dB L_{A90}.

6.2 The fan noise sources at the data centre are likely to have some tonal character, which would attract a penalty in the BS 4142 assessment depending on how perceptible the tone is. For the purposes of this feasibility study it is assumed that the tonal character is clearly perceptible and warrants a penalty of 4 dB.

6.3 Therefore in order to achieve a situation where the noise from the data centre has a low impact it will need to be no higher than 4 dB below the background noise at night, which puts the design target at 30 dB L_{Aeq} based on typical night-time background noise or 26 dB LAeq based on the quietest measured background noise.

6.4 The calculated noise levels due to the ventilation intake and extract fans without silencers at the worst case dwelling are higher than this target at 53.2 dB L_{Aeq} from the intake fans and 55.1 dB L_{Aeq} from the extract fans so will need attenuation.

6.5 One method of attenuating these noise levels would be to include a silencer on the inlet of each intake fan (between the evaporative cooler outlet and the fan intake) and on the outlet of each extract fan (between the fan and atmosphere, before the take-off to the evaporative cooler). Calculations in Tables 2 and 3 show the effect of a silencer that could achieve the required attenuation. The example chosen is a type 7LFS Quiet-Duct Silencer from Industrial Acoustics Company. It is a splitter silencer of length 2.1 metres. A data sheet for this silencer is at Appendix 4. The resulting noise levels reaching the worst-case dwelling are 22.1 dB L_{Aeq} from the intake fans and 23.4 dB L_{Aeq} from the extract fans, which combine to a level of 25.8 dB L_{Aeq} so would be within the 26 or 30 dB L_{Aeq} design target.

6.6 If an acoustic grade of louvre is to be used for the sides of the data centre building then it will provide some attenuation on the fan inlet side, in which case a shorter silencer on the fan inlet may be adequate.

6.7 The final selection of all silencers will need to take into account the pressure drops through the silencers and the effect that this has on the performance of the fans. It would be prudent to test a prototype example of the proposed evaporative cooling unit with its silencers to verify its noise levels and airflow performance, before production of all the units is undertaken and before the length of the silencers is finalised, so that adjustments can be made if necessary.

7. BS 4142 ASSESSMENT OF NOISE LEVELS – DRUPS

7.1 The DRUPS generators will not normally be running. They will only be operated in response to a failure of the main electricity supply, or for routine testing. Routine testing would only take place during the daytime.

7.2 Calculations earlier in this report for the noise emitted through the air intake and outlet of the generator room found a level of 35 dB L_{Aeq} reaching the worst case dwelling with silencers fitted and one generator running. The sound is likely to have a distinctive and intermittent character for which a penalty of 3 dB applies in the BS 4142 assessment, and possibly some tonal character warranting a further 2 dB penalty, so the rating level with a single generator running would be 40 dB. This is 4 dB below the daytime background noise of 44 dB L_{A90} so would have a low impact during the day, i.e. if a generator was being run for test purposes. In the event that two generators were running, then the noise level would be 3 dB higher which would still be a low daytime impact. It is assumed that there is spare capacity and that all three would not be needed simultaneously.

7.3 If the generators were to run at night due to a failure of the electricity supply then with two running the BS 4142 rating level of 43 dB would be close to 10 dB above the typical night time background noise of 34 dB L_{A90} so would be approaching a significant adverse impact. However account needs to be taken of this being a very rare occurrence, and in that context this could well be regarded as acceptable. Nevertheless if there is concern about the possible impact of this scenario then there is scope to improve on the noise levels, for example the data for the installation at Vienna is some 15 dB better than is being assumed in this report.

8. UNCERTAINTY

8.1 BS 4142 requires a consideration of the level of uncertainty in the data and associated conclusions of an assessment. A summary of the more general issues is given at Appendix 2.

8.2 In a feasibility assessment such as this there are necessarily many uncertainties about how the detailed design will unfold. Those uncertainties can only be addressed as part of the detailed design and it would be premature if not impossible to consider them at this feasibility stage.

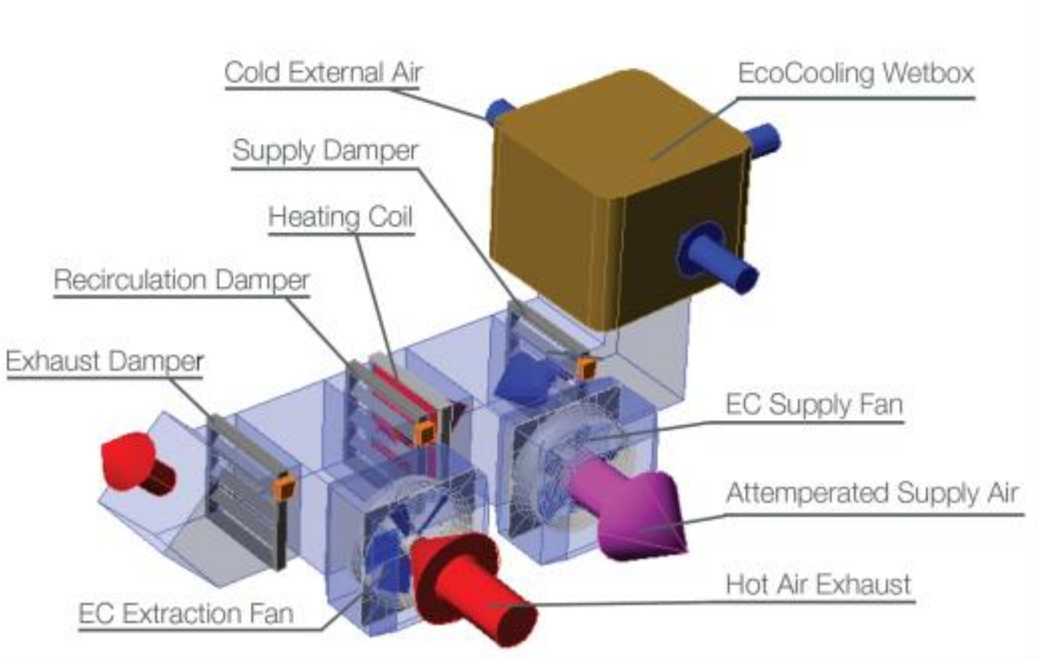
9. CONCLUSIONS

9.1 It is concluded that, from the noise control point of view, the proposed data centre is technically feasible in this location. A significant amount of noise control in the form of silencers to the ventilation system and the DRUPS generator units will be required.

9.2 This feasibility assessment is based on a conceptual design of the data centre, and the use of silencers from manufacturers' standard catalogues. Its purpose is to provide an indication of the amount of noise control work that will be required. It does not amount to a fully developed acoustic design, which will be needed as part of the detailed design of the data centre.

FIGURE 1: Background Noise Measurement Position

FIGURE 2: Evaporative Cooling principle of operation



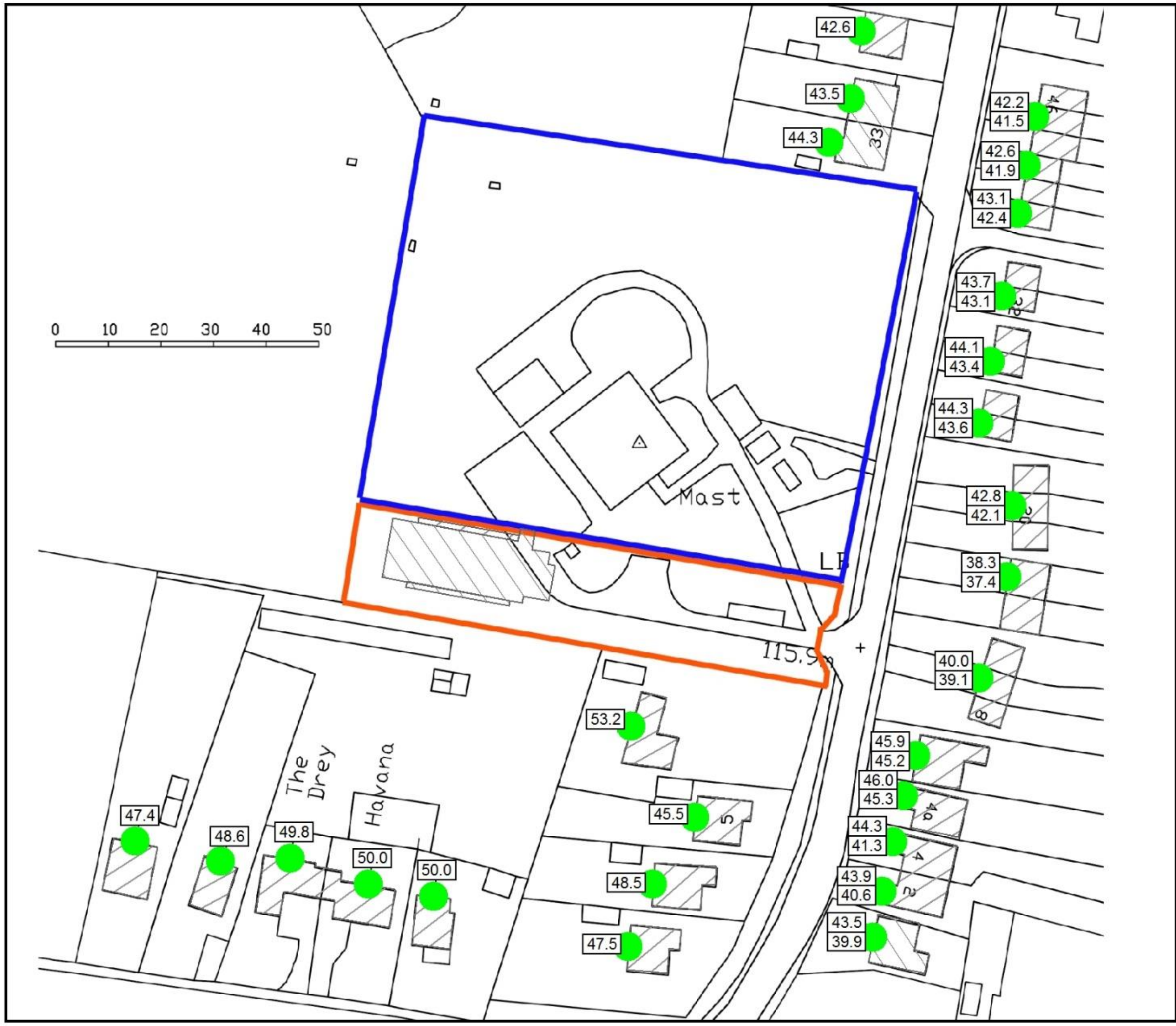


FIGURE 3: Noise levels due to air intake fans without silencers

Facade dB(A) noise levels at window centre-height, reaching nearby houses and bungalows

Signs and symbols

- Main building
- Receiver at building
- Ground and first floor noise levels

0 5 10 20 30 40 m

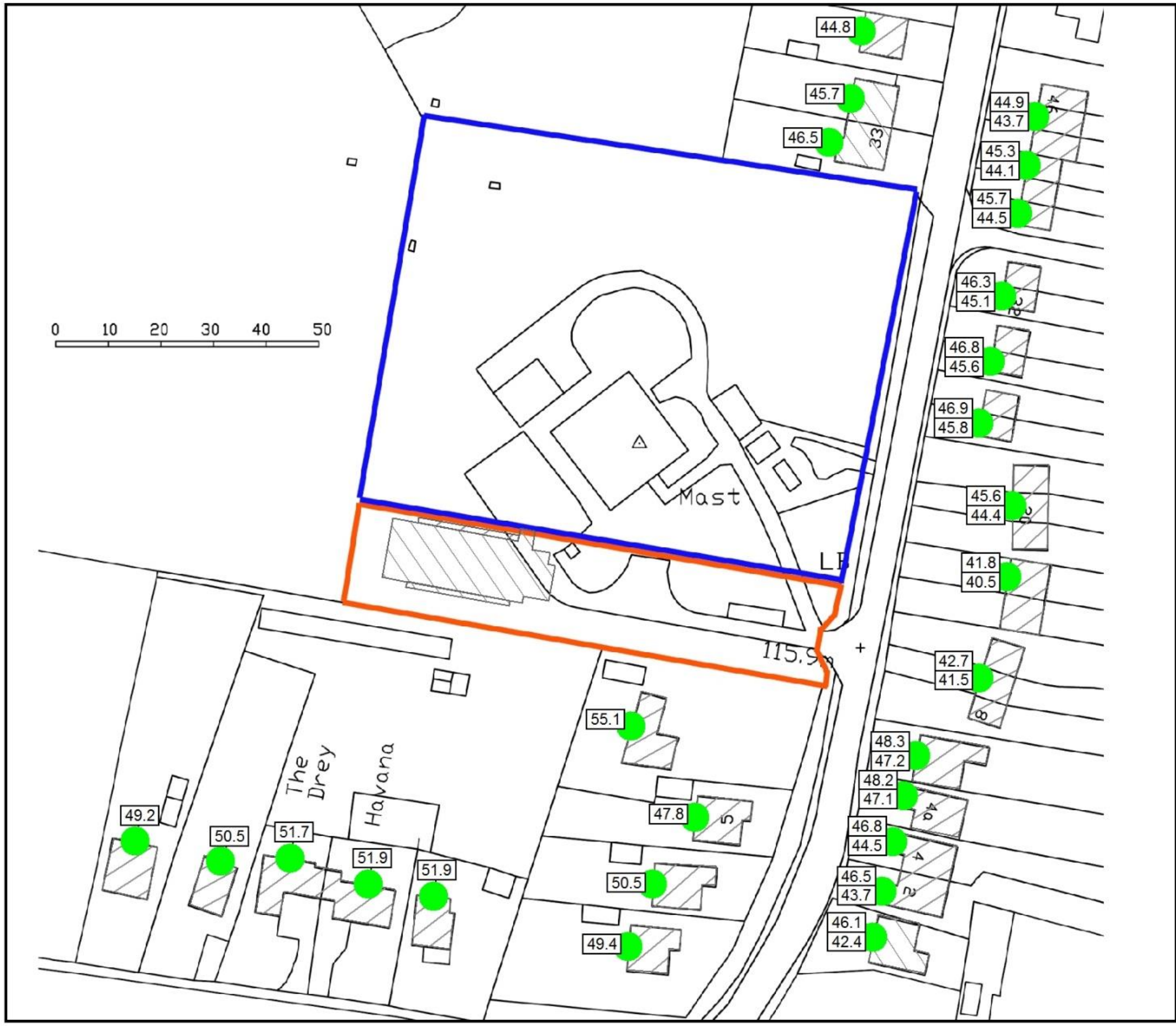


FIGURE 4: Noise levels due to air extract fans without silencers

Facade dB(A) noise levels at window centre-height, reaching nearby houses and bungalows

Signs and symbols

- Receiver at building
- Ground and first floor noise levels

0 5 10 20 30 40 m

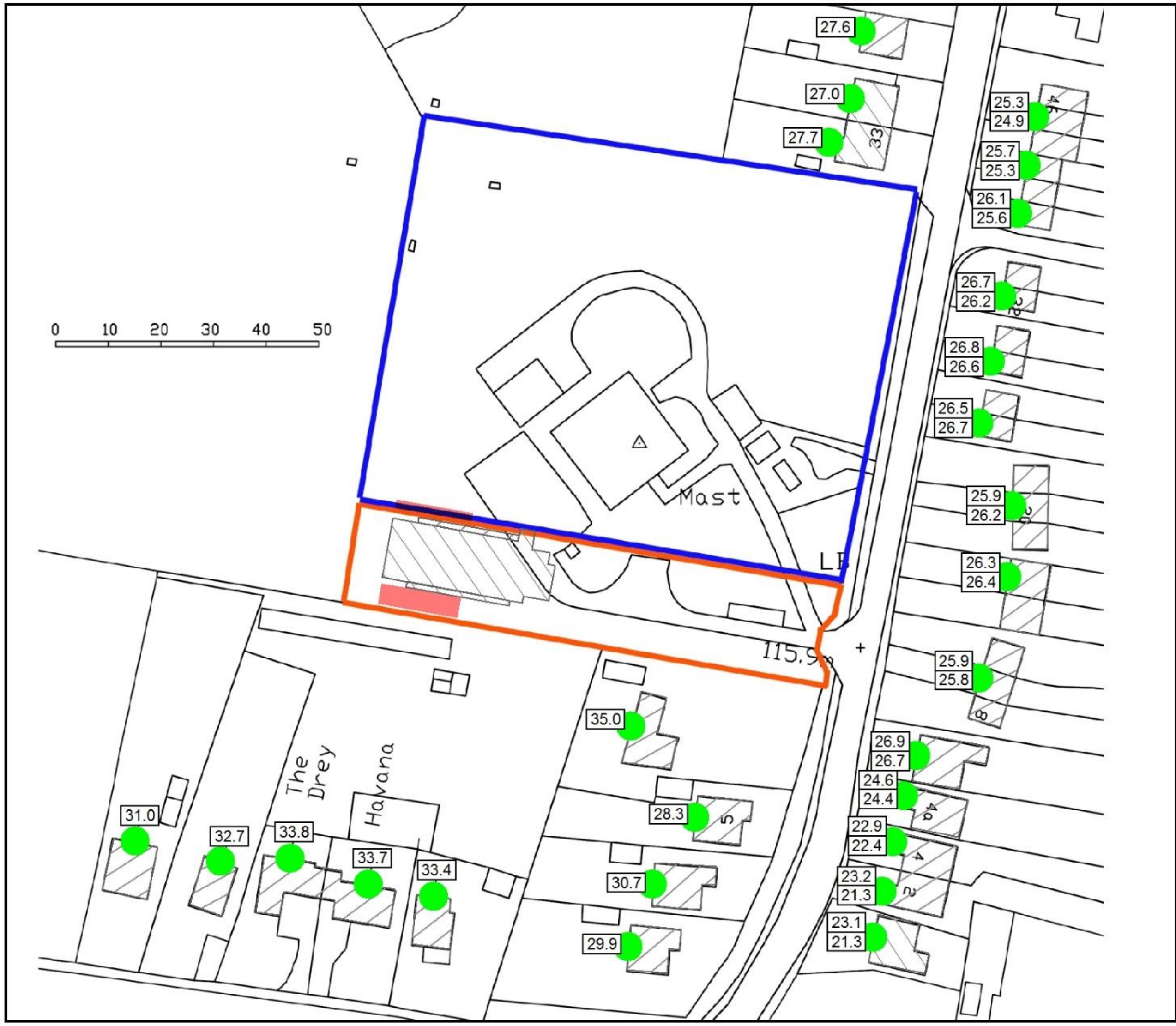


FIGURE 5: Noise levels due to DRUPS air intake and air outlet, with silencers

Facade dB(A) noise levels at window centre-height, reaching nearby houses and bungalows

Signs and symbols

- Main building
- Receiver at building
- Area source
- Ground and first floor noise levels

0 5 10 20 30 40 m

TABLE 1a: Survey of existing noise, Wednesday 15th February 2017

Date	Start time (hh:mm)	LAeq dB	LAmax dB	LA10 dB	LA50 dB	LA90 dB	Rain mm	Max wind speed mph	Wind direction
14-Feb-17	23:00	43.2	55.9	46.3	41.4	37.2	0	12	SSE
15-Feb-17	00:00	41.8	54.1	45.1	40.1	34.8	0	10	S
15-Feb-17	01:00	41.3	58.3	44.8	39.0	33.4	0	9	SSE
15-Feb-17	02:00	43.1	58.7	46.8	40.5	35.5	0	10	S
15-Feb-17	03:00	41.5	54.7	44.5	39.9	36.4	0	8	S
15-Feb-17	04:00	44.3	64.0	47.2	43.0	38.5	0	5	SSE
15-Feb-17	05:00	46.3	54.6	48.8	45.6	42.2	0	8	SSE
15-Feb-17	06:00	49.3	64.9	51.9	47.9	44.9	0	6	S
15-Feb-17	07:00	50.9	68.0	53.0	49.9	47.8	0	6	S
15-Feb-17	08:00	52.1	70.7	53.8	50.6	48.2	0	9	S
15-Feb-17	09:00	52.3	71.3	54.1	51.5	49.5	0	11	SSE
15-Feb-17	10:00	53.6	80.1	54.1	51.1	48.7	0	15	SSW
15-Feb-17	11:00	55.3	79.3	55.3	52.8	50.7	0	16	SSE
15-Feb-17	12:00	53.1	71.8	54.7	51.9	49.3	0	15	SSE
15-Feb-17	13:00	51.0	62.1	53.2	50.4	47.8	0	12	SSE
15-Feb-17	14:00	50.4	69.6	52.3	49.9	47.7	0	12	SSE
15-Feb-17	15:00	51.3	66.9	53.0	50.9	48.5	0.2	10	SSE
15-Feb-17	16:00	53.0	62.5	54.7	52.7	50.8	0	13	SSW
15-Feb-17	17:00	54.0	76.5	55.1	52.3	50.2	0	15	SW
15-Feb-17	18:00	51.9	62.3	53.8	51.5	49.2	0	13	SW
15-Feb-17	19:00	50.9	60.0	53.0	50.4	47.8	0	15	WNW
15-Feb-17	20:00	50.4	63.3	52.6	49.7	46.9	0	15	W
15-Feb-17	21:00	47.5	57.2	49.8	46.8	43.8	0	14	WSW
15-Feb-17	22:00	45.8	58.7	48.2	44.9	41.9	0	10	WSW

Overall LAeq values

Day	07:00 to 23:00	52.0
Night	23:00 to 07:00	44.7

TABLE 1b: Survey of existing noise, Thursday 16th February 2017

Date	Start time (hh:mm)	LAeq dB	LAmax dB	LA10 dB	LA50 dB	LA90 dB	Rain mm	Max wind speed mph	Wind direction
15-Feb-17	23:00	43.5	55.0	46.4	42.2	38.8	0	8	W
16-Feb-17	00:00	44.6	57.8	47.4	43.2	39.6	0	8	WSW
16-Feb-17	01:00	42.5	54.3	45.7	40.7	36.6	0	7	WSW
16-Feb-17	02:00	42.5	60.3	45.7	40.9	36.1	0	8	SSE
16-Feb-17	03:00	42.9	56.4	46.3	41.1	36.6	0	9	W
16-Feb-17	04:00	44.0	58.3	47.0	42.5	38.0	0	14	WSW
16-Feb-17	05:00	45.8	54.6	47.9	45.4	42.9	0	9	WSW
16-Feb-17	06:00	50.3	65.6	52.3	49.7	46.6	0	8	W
16-Feb-17	07:00	53.0	77.7	53.6	51.0	49.2	0	7	WSW
16-Feb-17	08:00	51.9	76.0	53.5	50.1	48.1	0	8	WSW
16-Feb-17	09:00	51.2	69.3	52.5	50.1	47.9	0	10	WSW
16-Feb-17	10:00	50.5	72.6	51.3	48.0	45.8	0	10	WSW
16-Feb-17	11:00	52.8	84.6	51.4	47.4	45.1	0	10	WSW
16-Feb-17	12:00	49.7	82.3	51.2	47.1	44.2	0	10	W
16-Feb-17	13:00	48.8	66.5	50.7	47.4	45.2	0	11	WSW
16-Feb-17	14:00	55.2	77.6	55.1	47.2	44.5	0	11	WSW
16-Feb-17	15:00	52.5	80.5	51.2	48.0	45.6	0	11	WSW
16-Feb-17	16:00	49.0	67.4	51.0	48.0	45.8	0	9	WSW
16-Feb-17	17:00	49.8	72.6	51.6	48.5	46.6	0	8	W
16-Feb-17	18:00	48.9	62.8	50.3	48.3	46.6	0	8	WSW
16-Feb-17	19:00	47.6	62.9	49.2	46.9	45.1	0	8	WSW
16-Feb-17	20:00	46.4	56.0	48.3	45.9	44.1	0	9	WSW
16-Feb-17	21:00	46.8	58.4	48.8	46.2	43.9	0	9	WSW
16-Feb-17	22:00	45.0	60.8	46.9	43.7	41.3	0	8	W

Overall LAeq values

Day	07:00 to 23:00	50.7
Night	23:00 to 07:00	45.4

TABLE 1c: Survey of existing noise, Friday 17th February 2017

Date	Start time (hh:mm)	LAeq dB	LAmax dB	LA10 dB	LA50 dB	LA90 dB	Rain mm	Max wind speed mph	Wind direction
16-Feb-17	23:00	43.9	60.9	45.8	42.5	39.8	0	10	W
17-Feb-17	00:00	41.9	64.1	43.7	40.0	37.4	0	9	WSW
17-Feb-17	01:00	39.8	53.9	42.9	38.1	34.1	0	8	WSW
17-Feb-17	02:00	39.9	57.6	42.2	38.3	34.8	0	8	W
17-Feb-17	03:00	39.4	54.6	42.3	37.8	34.6	0	6	W
17-Feb-17	04:00	41.9	62.6	44.1	40.6	37.6	0	5	WSW
17-Feb-17	05:00	43.9	55.4	45.5	43.6	41.5	0	6	WSW
17-Feb-17	06:00	49.1	71.8	51.6	48.0	44.3	0	4	WSW
17-Feb-17	07:00	51.4	67.7	53.5	50.2	48.2	0	4	WSW
17-Feb-17	08:00	51.4	71.0	53.0	49.9	47.9	0	6	W
17-Feb-17	09:00	49.6	69.7	51.6	47.4	45.0	0	6	W
17-Feb-17	10:00	48.8	72.0	50.7	45.7	42.7	0	6	W
17-Feb-17	11:00	46.4	67.3	48.4	44.1	40.9	0	8	WSW
17-Feb-17	12:00	48.8	75.2	49.4	44.1	40.5	0	5	NNW
17-Feb-17	13:00	56.0	86.5	50.0	44.5	40.4	0	3	WNW
17-Feb-17	14:00	49.8	76.1	51.4	45.0	40.6	0	3	NW
17-Feb-17	15:00	51.1	71.2	53.3	44.5	39.4	0	2	NNW
17-Feb-17	16:00	48.7	76.0	49.9	45.1	41.8	0	3	S
17-Feb-17	17:00	49.6	69.5	52.4	46.3	42.8	0	3	S
17-Feb-17	18:00	45.0	58.3	47.6	44.0	41.1	0	5	SSE
17-Feb-17	19:00	44.9	56.4	47.2	44.1	41.3	0	5	S
17-Feb-17	20:00	43.1	56.5	45.7	42.1	39.3	0	6	S
17-Feb-17	21:00	44.6	58.7	47.3	43.5	40.1	0	7	W
17-Feb-17	22:00	43.8	55.7	46.7	42.6	39.0	0	10	S

Overall LAeq values

Day	07:00 to 23:00	49.7
Night	23:00 to 07:00	43.7

TABLE 1d: Survey of existing noise, Saturday 18th February 2017

Date	Start time (hh:mm)	LAeq dB	LAmax dB	LA10 dB	LA50 dB	LA90 dB	Rain mm	Max wind speed mph	Wind direction
17-Feb-17	23:00	42.5	57.1	45.8	40.5	35.5	0	10	S
18-Feb-17	00:00	43.0	55.9	46.3	41.2	36.6	0	10	S
18-Feb-17	01:00	41.0	55.8	44.8	38.1	33.4	0	5	SSW
18-Feb-17	02:00	39.3	54.0	42.5	37.5	33.1	0	4	SSE
18-Feb-17	03:00	38.1	51.9	41.2	36.5	30.3	0	5	SSE
18-Feb-17	04:00	37.4	57.0	40.3	35.2	30.5	0	5	SSE
18-Feb-17	05:00	40.6	55.2	43.8	39.0	34.4	0	7	SSE
18-Feb-17	06:00	47.7	68.7	50.5	43.6	39.8	0	5	SSE
18-Feb-17	07:00	48.0	77.1	50.0	44.2	40.9	0	4	S
18-Feb-17	08:00	48.0	75.5	50.3	46.0	42.8	0	7	SSE
18-Feb-17	09:00	49.7	72.4	51.7	48.1	45.4	0	13	S
18-Feb-17	10:00	49.5	69.0	51.3	48.3	45.8	0	10	SSE
18-Feb-17	11:00	49.9	67.9	51.9	48.2	45.7	0	8	S
18-Feb-17	12:00	48.3	73.2	50.2	47.1	44.4	0	9	SE
18-Feb-17	13:00	48.2	63.8	50.6	47.0	44.4	0	7	S
18-Feb-17	14:00	51.0	81.5	51.8	47.9	45.1	0	10	S
18-Feb-17	15:00	50.9	69.8	52.6	49.4	46.9	0	8	SSE
18-Feb-17	16:00	50.3	68.8	52.2	49.5	47.3	0	9	SSE
18-Feb-17	17:00	51.7	68.0	53.8	50.6	48.5	0	9	SSE
18-Feb-17	18:00	49.9	62.4	51.9	49.4	46.9	0	11	SSE
18-Feb-17	19:00	48.3	58.1	50.6	47.7	45.0	0	9	SSE
18-Feb-17	20:00	47.2	55.8	49.4	46.6	44.0	0	7	WSW
18-Feb-17	21:00	48.2	58.0	50.5	47.7	44.5	0	8	SE
18-Feb-17	22:00	46.7	57.9	49.0	46.1	42.9	0	8	SSW

Overall LAeq values

Day	07:00 to 23:00	49.3
Night	23:00 to 07:00	42.5

TABLE 1e: Survey of existing noise, Sunday 19th February 2017

Date	Start time (hh:mm)	LAeq dB	LAmax dB	LA10 dB	LA50 dB	LA90 dB	Rain mm	Max wind speed mph	Wind direction
18-Feb-17	23:00	45.9	55.6	48.9	44.7	40.7	0	9	WSW
19-Feb-17	00:00	44.4	57.2	48.0	42.7	35.6	0	11	S
19-Feb-17	01:00	43.8	56.8	46.3	42.8	39.5	0	10	WSW
19-Feb-17	02:00	42.4	54.7	45.0	41.2	37.6	0	9	WSW
19-Feb-17	03:00	41.6	53.1	44.6	40.0	36.3	0	9	SSW
19-Feb-17	04:00	40.2	53.6	42.6	39.2	35.9	0	10	SW
19-Feb-17	05:00	42.7	59.0	45.3	41.4	38.2	0	8	W
19-Feb-17	06:00	48.1	62.9	51.2	45.8	42.6	0	8	WSW
19-Feb-17	07:00	50.7	77.8	51.2	47.3	44.8	0	9	WSW
19-Feb-17	08:00	50.1	70.0	51.2	47.5	45.3	0	12	WSW
19-Feb-17	09:00	51.7	73.6	52.4	47.5	45.0	0	10	W
19-Feb-17	10:00	50.0	79.4	51.5	47.6	45.0	0	10	WSW
19-Feb-17	11:00	47.6	70.2	49.6	46.3	44.0	0	13	W
19-Feb-17	12:00	48.1	72.0	50.2	46.7	44.2	0	10	NNW
19-Feb-17	13:00	49.3	72.2	51.0	46.7	43.4	0	10	WSW
19-Feb-17	14:00	48.5	65.6	50.3	47.0	44.7	0	9	WSW
19-Feb-17	15:00	48.3	64.1	50.7	47.1	44.5	0	8	W
19-Feb-17	16:00	47.0	69.9	49.0	45.2	42.9	0	8	W
19-Feb-17	17:00	51.6	80.8	51.9	45.9	43.3	0	6	W
19-Feb-17	18:00	47.3	70.4	48.1	45.7	43.5	0	6	WSW
19-Feb-17	19:00	45.5	58.9	47.4	44.8	42.9	0	8	WSW
19-Feb-17	20:00	44.3	64.7	46.0	43.4	41.2	0	8	WSW
19-Feb-17	21:00	43.5	64.0	45.3	42.5	40.3	0	7	W
19-Feb-17	22:00	41.7	56.3	43.8	40.8	38.5	0	8	W

Overall LAeq values

Day	07:00 to 23:00	48.6
Night	23:00 to 07:00	44.3

TABLE 1f: Survey of existing noise, Monday 20th February 2017

Date	Start time (hh:mm)	LAeq dB	LAmax dB	LA10 dB	LA50 dB	LA90 dB	Rain mm	Max wind speed mph	Wind direction
19-Feb-17	23:00	40.4	52.0	42.8	39.5	36.5	0	11	W
20-Feb-17	00:00	39.3	50.9	42.3	38.1	34.0	0	9	WSW
20-Feb-17	01:00	38.0	51.6	40.8	36.7	33.1	0	10	WSW
20-Feb-17	02:00	38.5	50.1	41.3	37.3	33.9	0	10	WSW
20-Feb-17	03:00	38.8	51.7	42.1	36.9	31.9	0	11	WSW
20-Feb-17	04:00	40.4	52.2	43.1	39.6	35.3	0	9	WNW
20-Feb-17	05:00	44.4	58.4	46.5	43.6	40.8	0	9	W
20-Feb-17	06:00	50.1	65.0	52.6	48.9	46.3	0	9	WSW
20-Feb-17	07:00	53.1	75.6	54.4	51.2	49.3	0	9	W
20-Feb-17	08:00	50.6	68.6	52.6	49.8	47.6	0	10	WSW
20-Feb-17	09:00	49.0	68.9	51.0	47.9	45.8	0	11	WSW
20-Feb-17	10:00	48.9	65.5	50.9	47.6	45.5	0	11	WSW

Overall LAeq values

Night	23:00 to 07:00	43.6

TABLE 2: Air intake fan silencers

	A-weighted octave band noise level								Total
	63	125	250	500	1k	2k	4k	8k	dB(A)
Noise level at worst case bungalow, no silencers	32.1	37.0	38.9	45.2	49.6	47.6	40.0	29.0	53.2
Silencer performance IAC type 7LFS at -5m/s face velocity	14	24	42	49	49	35	24	17	
Resulting noise level	18.1	13.0	-3.1	-3.8	0.6	12.6	16.0	12.0	22.1

TABLE 3: Air extract fan silencers

	A-weighted octave band noise level								Total
	63	125	250	500	1k	2k	4k	8k	dB(A)
Noise level at worst case bungalow, no silencers	32.1	36.4	41.1	49.6	51.3	48.0	40.4	29.3	55.1
Silencer performance IAC type 7LFS at +5m/s face velocity	12	23	37	44	45	33	25	17	
Resulting noise level	20.1	13.4	4.1	5.6	6.3	15.0	15.4	12.3	23.4

TABLE 4 : Generator noise levels

	A-weighted octave band noise level								Total
	63	125	250	500	1k	2k	4k	8k	dB(A)
Air intake									
Sound pressure level inside generator room	61	84	90	93	92	91	88	87	99
Silencer performance IAC type 5S at -5 m/s face velocity	10	19	26	44	47	45	38	22	
Sound pressure level external to silencer	51	65	64	49	45	46	50	65	70
Adjustment for silencer area approx 10 sq.m	10	10	10	10	10	10	10	10	
Resulting sound power level	61	75	74	59	55	56	60	75	80
Air outlet									
Sound pressure level inside generator room	61	84	90	93	92	91	88	87	99
Silencer performance IAC type 6S at +5 m/s face velocity	8	18	27	45	48	47	43	30	
Sound pressure level external to silencer	53	66	63	48	44	44	45	57	68
Adjustment for silencer area approx 10 sq.m	10	10	10	10	10	10	10	10	
Resulting sound power level	63	76	73	58	54	54	55	67	78

APPENDIX 1: Instrumentation

Instrumentation for the noise measurements comprised:

Norsonic type 140 sound level meter, serial no. 1403645
Calibration by Campbell Associates on 10/6/2016, certificate no. U21839

Norsonic type 1225 microphone, serial no. 103278
Calibration by Campbell Associates on 10/6/2016, certificate no. 21838

Norsonic type 1251 acoustic calibrator, serial no. 31230
Calibration by Campbell Associates on 10/6/2016, certificate no. U21837

Weather conditions were recorded using a Davis Instruments Vantage Pro2 system.

APPENDIX 2: Uncertainty

BS 4142 requires the level of uncertainty in the noise data and associated calculations to be considered and, where it could affect the conclusions of the assessment, all reasonably practicable steps must be taken to reduce it.

All measurement results have an associated element of doubt about their true value. In general terms, this is known as measurement uncertainty, and is attributed in part to unknown factors influencing the measurement, or an inability to determine the influence of a known quantity with a better accuracy. In the case of environmental noise measurements, it is usually factors influencing the source and propagation path rather than instrumentation shortfalls that influence measurement uncertainty. A knowledge of the source and magnitude of these factors will assist with interpretation of the results, indicating differences which may not be significant and identifying areas where greater attention to detail can improve assessments.

It is necessary to quantify the uncertainties associated with environmental noise measurements in an appropriate and uniform manner. To achieve this, two quantities may be specified: the “confidence interval”, which is the margin within which the true value being measured can be said to lie, and the “level of confidence”, which is a number expressing the degree of confidence in the result.

To obtain these quantities, it is necessary to carry out a procedure that considers each separate contribution to the uncertainty chain, evaluates its contribution, and then combines them according to set statistical procedures. The usual procedure adopted is to set up an “uncertainty budget” in which the various sources of uncertainty, the pertinent magnitudes, the statistical processes and the final combined results are listed.

To manage the process, it is convenient to divide the measurement situation into three sections covering source, transmission path, and receiver. For each section some possible sources of uncertainty are listed below. The magnitude of each uncertainty may be calculated from repeated measurement, or from manufacturers' data, or from calibration certificates, or estimated from experience, all depending on the information available.

For the noise source, possible causes of uncertainty are:

- spectral content of the noise emission (e.g. presence of standing waves, interference patterns, or beats)
- nature of the noise source, its pattern of propagation i.e. point/line/area, and the effect of this at the measurement position
- variability in the running condition of a machine e.g. loaded / unloaded or cyclical operation
- state of repair
- variability of the source due to changes in weather and ground surface
- variability of the source due to changing location or orientation of moving sources

- number of sources in operation, their positions relative to the measuring positions, and any interactions between the sources

- location and state of any enclosures / barriers near the source

For the transmission path, possible causes of uncertainty are:

- the effect of the weather on noise propagation over medium or long distances, especially wind speed / direction, precipitation, temperature and humidity

- nature of the intervening ground surface e.g. wet / dry

- effect of temporary barriers e.g. parked vehicles, dense seasonal foliage

For the receiver, possible causes of uncertainty are:

- microphone position (height, proximity to building facades or other reflecting surfaces, orientation)

- instrumentation (class 1 noise level meters should be used, appropriately calibrated, with a windshield fitted)

- effect of extraneous noise sources not relevant to the assessment

Many of these possible causes of uncertainty can be made small by following good measurement practice. In the case of weather for example, which has the potential to introduce a high level of variability, it is good practice to measure in conditions relevant to the purpose of the survey. For source noise measurements this will normally be stable downwind conditions, i.e. highest noise level at the reception position. To meet these requirements, the wind direction should remain within approximately ± 45°of the direction from the source (wind blowing from source to measurement position) and it should be at a low to moderate speed of no more than 5 m/s (11 mph).

In the main body of this report a section is devoted to the issue of uncertainty and an uncertainty budget is evaluated. Not all of the possible causes of uncertainty are explicitly stated in this evaluation, however the most significant ones are, and those that are not included will either be insignificant in the circumstances of the assessment or will have been reduced to negligible amounts by standard good measurement practice.

APPENDIX 3: Fan noise data

FANselect

fan data	2/28/2017 version AMCA V 1.01 May, 2015 / | 543 | (user mbedder)

1

type	ZN080-ZIL.GL.V7P3
article no.	161471 | Portfolio STD-WW

technical data

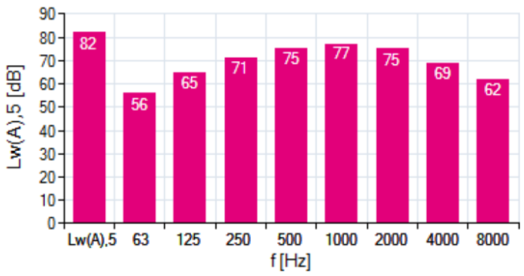
motor		ECblue
mains supply	-	3~ 460V 60Hz
ambient temperature, max. limit (t_r)	°C	55
efficiency η_{statA}	%	58,0
efficiency **N_{actual}** | N_{target}	%	**61,6** | 40
ErP-conformity		2015 | EC controller integrated
grille | influence		no | no

fan data

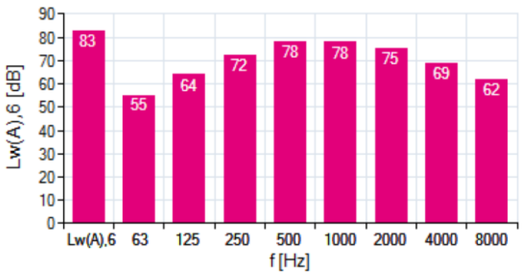
SFP-class | SFP-value (P_{SFP})	- | Ws/m³	**1** | 479
airflow volume (q_V)	m³/s	5.00
pressure, **stat. (p_{sF})** | tot. (p_F)	Pa	**250** | 312
electrical power input (P_{sys})	W	2393
system eff., **stat. ($\eta_{sF,sys}$)** | tot. ($\eta_{F,sys}$)	%	**52.2** | 65.1
fan speed **(n)** | max. (n_{max})	1/min	**1050** | 1100
fan speed, set value (%n_{max})	%	95
frequency **(f_{BP})** | (f_{max})	Hz	**60** | 60
voltage (U_{DP})	V	460
current (I_{DP})	A	3.19
acoustics, suction side **($L_{w(A),5}$)** | ($L_{w,5}$)	dB	**82** | 87
acoustics, pressure side **($L_{w(A),6}$)** | ($L_{w,6}$)	dB	**83** | 88
product weight (m_{pr})	kg	40.8

PF:PF_00; Ano:161471; STol:+-10 %

acoustics ($L_{w(A),5}$)



acoustics ($L_{w(A),6}$)



1 ZN080-ZIL.GL.V7P3

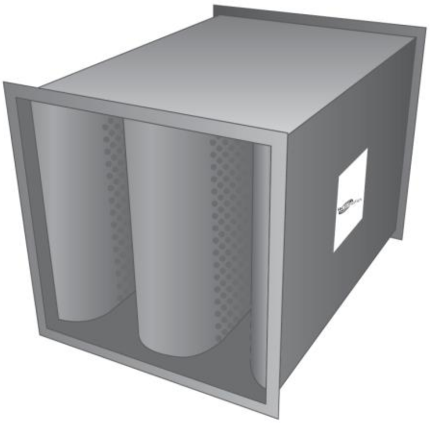
f [Hz]	sum	63	125	250	500	1000	2000	4000	8000
$L_{w(A),5}$	82	56	65	71	75	77	75	69	62
$L_{w,5}$	87	82	81	79	79	77	74	68	63

f [Hz]	sum	63	125	250	500	1000	2000	4000	8000
$L_{w(A),6}$	83	55	64	72	78	78	75	69	62
$L_{w,6}$	88	81	79	80	82	78	74	68	63

Appendix 4: IAC Silencer data sheets

Quiet-Duct® Silencer Type: LFS

Superior Low Frequency Silencers with Forward and Reverse Flow Ratings



Standard modular widths are multiples of 300mm, other widths are also available.

LFS silencers are advantageous where low frequency DIL requirements are high in HVAC systems. In some systems high frequency attenuation may be provided by the system components or may not be needed.

Supplied as Standard

- Aerodynamic inlet and discharge to splitter elements to reduce pressure drop and conserve energy
- Perforated galvanised steel facings to all splitter elements to protect acoustic media from damage and erosion

Designating Silencers (Example)

Model: 5LFS-600-600

Length	Type	Width	Height
1500mm	LFS	600mm	600mm

Weight

Average weight 85kg/m³

Self-Noise Power Levels dB re: 10^{-12} Watts (for a $0.37m^2$ face area silencer)

IAC LFS Model	Octave Band	1	2	3	4	5	6	7	8
	Hz	63	125	250	500	1K	2K	4K	8K
	Silencer Face Velocity, m/s								
LFS All Lengths	-10	58	54	58	61	62	63	65	63
	-7.5	51	49	53	56	56	59	60	53
	-5	45	42	45	43	45	49	44	37
	+5	46	42	45	43	45	49	44	37
	+7.5	56	54	57	56	52	56	57	51
	+10	68	64	65	66	61	61	64	61

Face Area Adjustment Factors (add or subtract from Lw values above)

Quiet-Duct® Face Area, m²*	0.05	0.09	0.19	0.37	0.74	1.5	3.0	6.0	12.0
Lw Adjustment Factor, dB	-9	-6	-3	0	+3	+6	+9	+12	+15

* For intermediate face areas, interpolate to the nearest whole number

Aerodynamic Performance

IAC Model	Length (mm)	Static Pressure Drop N/m²							
LFS	900	10	12	17	22	27	35	42	50
	1500	10	15	20	25	32	40	47	55
	2100	10	15	20	25	33	40	50	57
	3000	10	15	22	27	35	45	52	65
Silencer Face Velocity, m/s		1.27	1.52	1.78	2.03	2.29	2.54	2.79	3.05

Dynamic Insertion Loss (DIL) Ratings: Forward (+) / Reverse (-) Flow

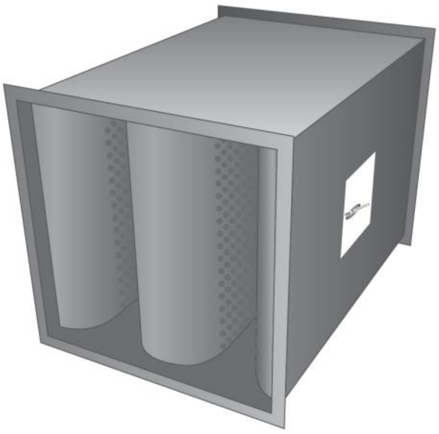
IAC LFS Model (length in mm)	Octave Band	1	2	3	4	5	6	7	8
	Hz	63	125	250	500	1K	2K	4K	8K
	Silencer Face Velocity, m/s	Dynamic Insertion Loss, dB							
3LFS (900)	-10	8	14	25	29	27	20	16	12
	-5	7	13	23	28	26	20	16	14
	0	8	13	23	28	27	21	17	14
	+5	9	12	22	28	27	21	18	14
	+10	7	11	21	25	25	21	17	14
4LFS (1200)	-10	11	19	31	36	35	24	18	13
	-5	10	17	29	35	34	24	19	15
	0	11	17	28	34	34	25	20	15
	+5	11	16	27	32	34	24	20	15
	+10	9	14	25	29	31	25	19	15
5LFS (1500)	-10	13	23	36	42	42	28	19	14
	-5	13	21	35	41	41	28	21	15
	0	13	20	33	39	41	28	22	16
	+5	12	19	31	36	40	27	22	16
	+10	10	17	28	33	37	29	20	16
6LFS (1800)	-10	14	24	38	46	47	32	21	15
	-5	14	23	39	45	45	32	23	16
	0	13	22	37	43	44	31	24	16
	+5	12	21	34	40	43	30	24	17
	+10	10	20	33	39	41	32	22	17
7LFS (2100)	-10	14	25	40	50	51	35	22	16
	-5	14	24	42	49	49	35	24	17
	0	13	24	40	47	47	34	25	17
	+5	12	23	37	44	45	33	25	17
	+10	10	22	37	44	45	34	24	17
8LFS (2400)	-10	16	27	42	51	52	38	23	16
	-5	15	27	45	50	50	38	26	18
	0	15	26	43	49	49	38	27	18
	+5	14	25	40	47	48	38	28	19
	+10	12	23	40	47	48	39	28	19
9LFS (2700)	-10	17	28	44	51	52	40	24	17
	-5	17	29	47	51	52	42	27	18
	0	16	28	46	50	51	42	30	20
	+5	15	26	44	49	50	42	32	21
	+10	14	24	43	50	50	43	32	22
10LFS (3000)	-10	19	30	46	52	53	43	25	17
	-5	18	32	50	52	53	45	29	19
	0	18	30	49	52	53	46	32	21
	+5	17	28	47	52	53	47	35	23
	+10	16	25	46	53	53	48	36	24

Note

- The tabulated airflow in m/s is based upon tests conducted in the IAC Acoustics R&D Laboratory, in accordance with applicable sections of internationally recognised airflow test codes. These codes require specific lengths of straight duct both upstream and downstream of the test specimen. Non-compliance with these codes can add from ½ to several velocity heads depending on specific conditions. The downstream measurements are made far enough downstream to include static regain. Therefore, if silencers are installed immediately before or after elbows, transitions or at the intake or discharge of a system, sufficient allowance to compensate for these factors must be included when calculating the operating static pressure loss through the silencer. See pages 10 & 11 for further details.
- Silencer Face Area is the cross-sectional area at the silencer entrance or exit
- Face velocity (FV) in m/s is the airflow in m^3/s divided by the silencer face area in m^2
- Pressure drop (PD) for any face velocity can be calculated from the equation: $PD = (\text{Actual FV} / \text{Catalogue FV})^2 \times (\text{Catalogue PD})$

Quiet-Duct® Silencer Type: S

With Forward and Reverse Flow Ratings



Standard modular widths are multiples of 300mm, other widths are also available.

Supplied as Standard

- Aerodynamic inlet and discharge to splitter elements to reduce pressure drop and conserve energy
- Perforated galvanised steel facings to all splitter elements to protect acoustic media from damage and erosion

Designating Silencers: Example

Model: 5S-600-600

Length	Type	Width	Height
1500mm	S	600mm	600mm

Weight

Average weight 100kg/m^3

Self-Noise Power Levels dB re: 10^{-12} Watts (for a 0.37m^2 face area silencer)

IAC S Model	Octave Band	1	2	3	4	5	6	7	8
	Hz	63	125	250	500	1K	2K	4K	8K
	Silencer Face Velocity, m/s								
S All Lengths	-10	68	62	61	66	61	64	67	66
	-5	54	51	50	51	54	56	52	40
	-2.5	40	40	39	36	47	48	37	20
	+2.5	36	29	35	30	31	35	22	20
	+5	55	49	49	47	46	49	42	32
	+10	74	69	63	64	61	63	62	56

Face Area Adjustment Factors (add or subtract from Lw values above)

Quiet-Duct® Face Area, m^2*	0.05	0.09	0.19	0.37	0.74	1.5	3.0	6.0	12.0
Lw Adjustment Factor, dB	-9	-6	-3	0	+3	+6	+9	+12	+15

* For intermediate face areas, interpolate to the nearest whole number

Aerodynamic Performance

IAC Model	Length (mm)	Static Pressure Drop N/m^2							
S	900	2	7	15	22	32	45	57	72
	1500	5	10	17	25	37	50	65	82
	2100	5	10	17	27	40	52	70	87
	3000	5	10	20	30	45	60	80	100
Silencer Face Velocity, m/s		1.02	1.52	2.03	2.54	3.05	3.56	4.06	4.57

Dynamic Insertion Loss (DIL) Ratings: Forward (+) / Reverse (-) Flow

IAC S Model (length in mm)	Octave Band	1	2	3	4	5	6	7	8
	Hz	63	125	250	500	1K	2K	4K	8K
	Silencer Face Velocity, m/s	Dynamic Insertion Loss, dB							
3S (900)	-10	6	12	20	33	39	35	23	14
	-5	5	11	17	33	38	35	25	14
	0	5	10	16	32	38	35	26	16
	+5	5	9	15	30	37	35	27	17
	+10	5	8	14	27	36	35	27	17
4S (1200)	-10	8	16	24	35	44	39	30	18
	-5	8	15	22	39	43	40	32	18
	0	7	14	21	38	43	41	33	20
	+5	6	13	19	36	42	41	34	21
	+10	6	12	18	34	41	41	34	21
5S (1500)	-10	10	20	27	45	48	43	36	22
	-5	10	19	26	44	47	45	38	22
	0	9	17	25	43	47	46	39	24
	+5	7	17	23	42	46	46	40	25
	+10	6	16	22	40	46	46	40	25
6S (1800)	-10	11	22	32	47	49	44	39	25
	-5	11	21	31	46	48	46	41	25
	0	10	19	29	45	48	47	42	28
	+5	8	18	27	45	48	47	43	30
	+10	7	16	27	43	48	47	43	30
7S (2100)	-10	12	23	37	48	50	45	41	27
	-5	12	22	35	47	49	47	44	28
	0	11	20	33	47	49	47	45	31
	+5	9	18	31	47	49	47	45	34
	+10	8	16	31	46	49	48	45	35
8S (2400)	-10	13	24	39	49	50	47	42	30
	-5	13	24	37	48	50	48	46	31
	0	12	22	36	48	48	48	46	34
	+5	10	19	34	48	50	48	46	37
	+10	9	17	34	47	50	49	46	39
9S (2700)	-10	13	25	41	49	51	48	44	34
	-5	13	26	40	48	50	49	47	34
	0	12	23	39	48	51	49	48	38
	+5	11	21	38	48	51	49	48	41
	+10	10	18	37	49	51	49	48	42
10S (3000)	-10	14	26	43	50	51	50	45	37
	-5	14	28	42	49	51	50	49	37
	0	13	25	42	49	52	50	49	41
	+5	12	22	41	49	52	50	49	44
	+10	11	19	40	50	52	50	49	46

Note

- The tabulated airflow in m/s is based upon tests conducted in the IAC Acoustics R&D Laboratory, in accordance with applicable sections of internationally recognised airflow test codes. These codes require specific lengths of straight duct both upstream and downsteam of the test specimen. Non-compliance with these codes can add from ½ to several velocity heads depending on specific conditions. The downstream measurements are made far enough downstream to include static regain. Therefore, if silencers are installed immediately before or after elbows, transitions or at the intake or discharge of a system, sufficient allowance to compensate for these factors must be included when calculating the operating static pressure loss through the silencer. See pages 10 & 11 for further details.
- Silencer Face Area is the cross-sectional area at the silencer entrance or exit
- Face velocity (FV) in m/s is the airflow in m^3/s divided by the silencer face area in m^2
- Pressure drop (PD) for any face velocity can be calculated from the equation: PD = (Actual FV / Catalogue FV)^2 x (Catalogue PD)