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Pen Y Ffridd
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Proposed Replacement Poultry Units

PLANT NOISE ASSESSMENT

Acoustics Report M2134/R01
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1. Introduction

This acoustic report documents a plant noise assessment for the ventilation fans on the proposed replacement poultry units at Pen Y Ffridd, Saron; Figures 1 and 2.

The report is divided into the following sections:

- Section 2: Overview of the Development
- Section 3: BS4142:2014+A1:2019
- Section 4: Background Noise survey
- Section 5: Noise Impact Assessment
- Section 6: Conclusion
- Appendix A: Survey Data
- Appendix B: Calculations

2. Overview of the Development

The proposal is for 6 poultry units at Pen Y Ffridd, Saron, which will replace 8 existing poultry sheds; Figures 1 and 2.

The external plant for the proposed replacement poultry units will consist of ridge mounted extract fans, namely:

- Extract fan type: Hydor HRU710/6
- Sound pressure level: 59dB(A) at 3m, 45° lateral
- Total number of fans: 9 fans per shed
- Duct terminations: ridge mounted ducts arranged along the length of the shed, terminating 6.7m above ground

The closest dwellings, labelled A - D in Figure 2, are approximately between 130m - 180m from the proposed poultry units. Dwellings A – C will be fully acoustically shielded from the extract fan duct terminations (i.e., the line of sight is fully block) by local topography. There will however be an unobstructed noise path between the fans on Shed 6 and Dwelling D.

The proposed poultry units are within context of the sheds that they will replace, in both terms of operation and nature of noise emissions.

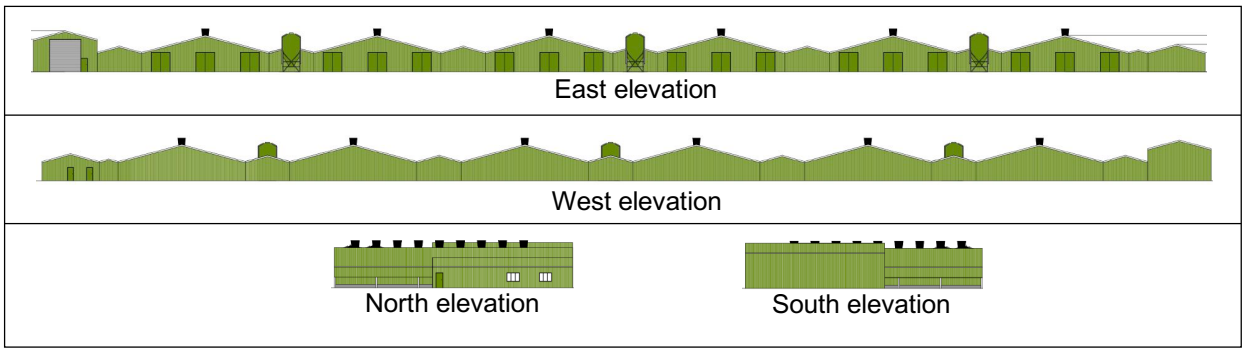


Figure 1. Elevations of the proposed replacement poultry units

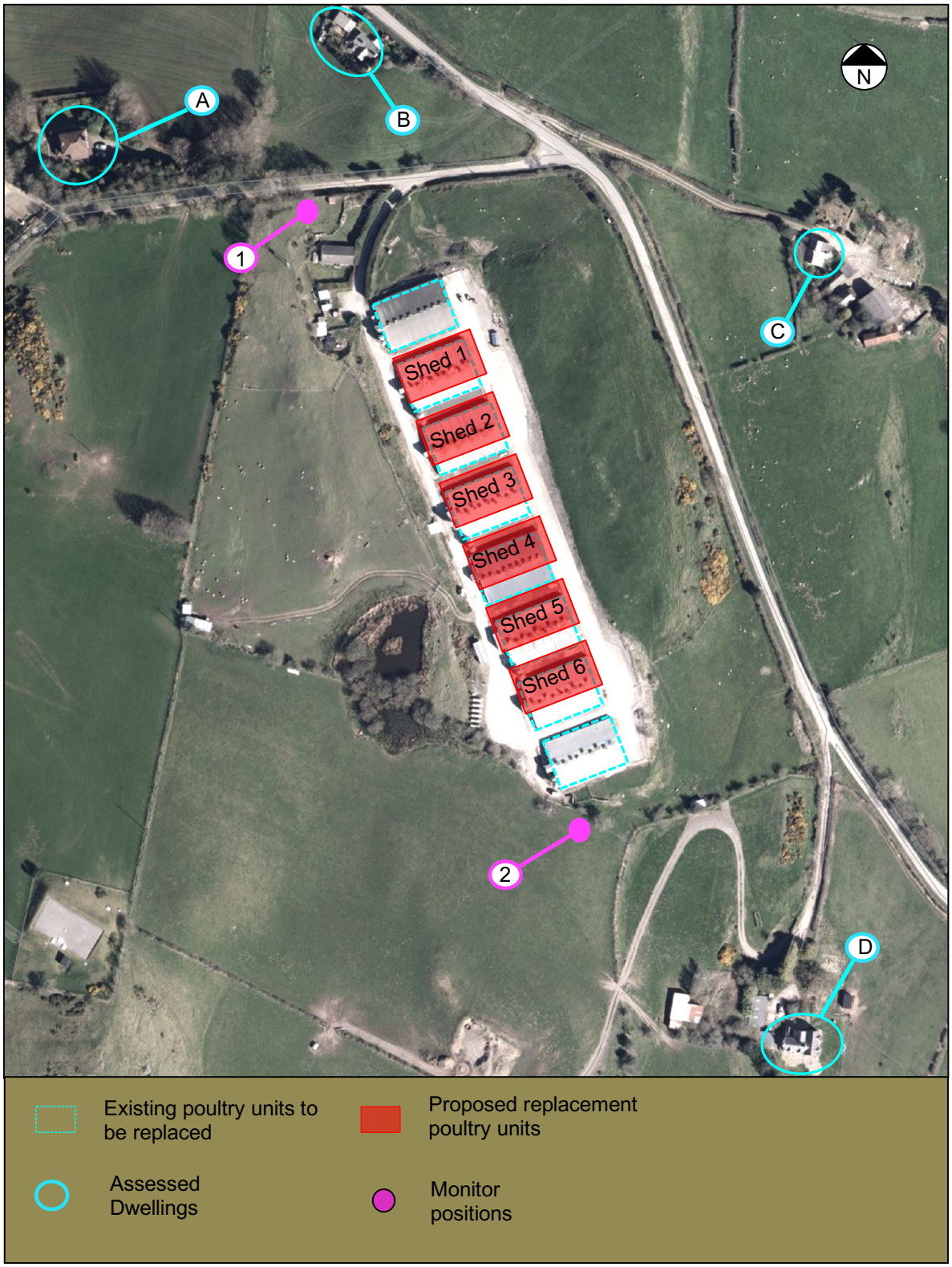


Figure 2. Aerial view (source: www.google.com) showing footprint of proposed replacement poultry units, assessed dwellings and monitor positions

3. BS4142:2014+A1:2019

The plant noise assessment detailed in this report has been conducted in accordance of BS4142:2014+A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound'.

3.1 BS4142

BS4142 provides a methodology to assess the impact of industrial and commercial noise affecting dwellings, whereby the 'typical' background noise level is deducted from the industrial noise Rating Level (industrial noise corrected to account for the 'on-time' and noise character of the noise source; see sections 3.2 and 3.3 below). The following guidance is given based on the established difference:

- A difference of around +10dB or more is likely to be an indication of significant adverse impact, depending on context
- A difference of +5dB is likely to be an indication of an adverse impact, depending on 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 context

Context, as defined in BS4142, includes the consideration of the following factors:

- The absolute level of the noise emissions
- Character and level of the residual sound compared to the character and level of the Specific Level
- Sensitivity of the receptor and any acoustic design measures (e.g., façade sound insulation, use of mechanical ventilation and acoustic screening) incorporated at premises used for residential purposes

Where background noise and Rating Levels are low, BS4142:2014+A1:2019 states that *'absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night'*. Low background noise and rating levels are not defined. However, in BS4142:1997 it states that '*background noise levels below 30dB and rating levels below about 35dB are considered to be very low'*.

3.2 On-time correction

To take account of industrial/commercial noise sources that do not operate continually an 'on-time' correction is applied using:

$$- 10 \log (r/r_{ref})$$

Where:

$r_{ref.}$ = reference time (1hr between 07:00 – 23:00hrs and 15 minutes between 23:00 – 07:00hrs)

r = total 'on-time' during the reference period

Note that the shorter reference time interval between 23:00 – 07:00hrs is designed to penalise industrial/commercial noise events that occur during the night.

3.3 Noise character correction

BS4142 provides four noise character correction categories with associated penalties that must be applied when determining the Rating Level, namely:

- **Tonality:**
  - Not perceptible = 0dB
  - Just perceptible = +2dB
  - Clearly perceptible = +4dB
  - Highly perceptible = +6dB
- **Impulsivity:**
  - Not perceptible = 0dB
  - Just perceptible = +3dB
  - Clearly perceptible = +6dB
  - Highly perceptible = +9dB
- **Intermittency:** +3dB if the intermittency of operation is readily distinctive against the residual noise environment
- **Other:** +3dB applied if the specific sound is neither tonal or impulsive but features noise characteristics that are readily distinctive against the residual noise environment

4. Background Noise Survey

During the survey, the existing poultry units were not operational.

- **Survey dates**: Tuesday 31st August – Wednesday 1st September 2021
- **Weather;** Table A2, Appendix A:
  - Precipitation: Dry
  - Wind Speed: highest recorded wind speed = 2.2m/s, with a median wind speed of 0m/sec
  - Wind direction:
    - 15:00 – 19:00hrs: E
    - 19:00 – 22:00hrs: NE
    - 22:00 – 03:00hrs: E
    - 03:00 – 08:00hrs: NE
    - 08:00 – 15:00hrs: E
  - The weather conditions will not have adversely affected the noise measurements.
- **Noise monitor locations:** With the microphones attached to tripod the noise monitors were located at Positions 1 and 2 as shown in Figure 1
- **Weather station location:** Weather station, mounted on a tripod, located **at** Bryn Golau, Saron (1.5km north west of Pen Y Ffridd); the wind speeds recorded will be equivalent to those at the noise measurement positions
- **Equipment:**
  - Weather Station: Kestrel type 4500
  - Noise monitors: Brüel & Kjær Type 2238 (Positions 1 & 2) and Brüel & Kjær Type 2260 (Position 3)
- **Monitor configuration:**
  - Weather station: Configured to measure the average wind speed and temperature over consecutive 10-minute periods
  - Noise Monitors: configured to measure consecutive 15-minute samples of noise.
- **Calibration:** Noise monitors calibrated before and after the survey using a Brüel & Kjær Type 4231 calibrator with no deviations found

All noise measurements are free-field. Full tabulated results are given in Table A1, Appendix A.

4.1 Survey observations

During the setting up and collection of the noise monitors, it was observed that the general underlying noise environment was very quiet, consisting of road traffic on the nearby roads and birdsong. As the poultry units were not operational, there was no contribution of the noise emissions from the existing extract fans.

4.2 Typical background noise level, L_{A90}, at Dwellings A - D

Figures 3 and 4 show the variation in the measured maximum ($L_{Amax,F}$), ambient (L_{Aeq}) and background (L_{A90}) noise levels obtained at Positions 1 and 2 respectively.

Figure 3. Position 1 noise monitor data (free-field)

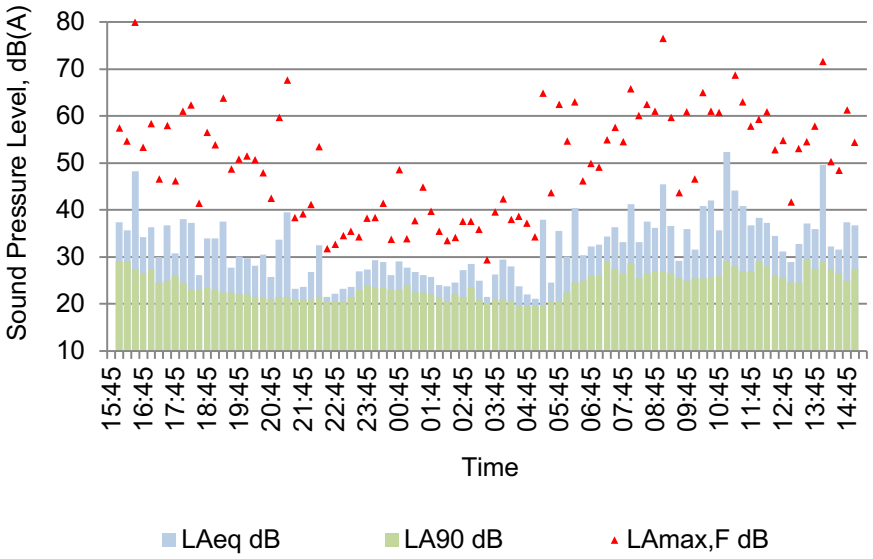
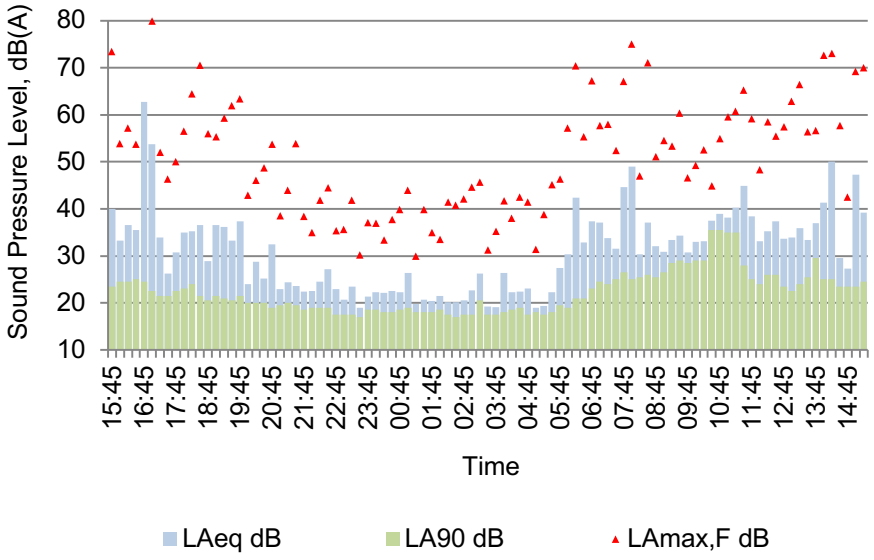


Figure 4. Position 2 noise monitor data (free-field)



As can be seen the background noise levels are generally slightly higher at Position 1. This will be due to its proximity to the adjacent roads.

From the survey data the typical background noise levels at Positions 1 and 2 have been established as:

- Position 1 (represents Dwellings A - C):
  - Day (07:00 – 20:00hrs): L_{A90} 26dB
  - Evening (20:00 – 23:00hrs): L_{A90} 21dB
  - Night (23:00 – 07:00hrs): L_{A90} 20dB
- Position 2 (represents Dwelling D):
  - Day (07:00 – 20:00hrs): L_{A90} 25dB
  - Evening (20:00 – 23:00hrs): L_{A90} 20dB
  - Night (23:00 – 07:00hrs): L_{A90} 18dB

It should be highlighted that in all cases the above representative background noise levels are very low.

5. Noise Impact Assessment

5.1 Calculation of aggregate extract fan and transport noise at Dwellings A - D

The full calculations of the extract fan noise emissions are provided in Tables B1 – B4, Appendix B. The resultant BS4142 Rating and Assessment Level at Dwellings A - D are given in Table 1.

5.2 Source noise data

- Extract fan type: Hydor HRU710/6
- Sound pressure level: 59dB(A) at 3m, 45° lateral
- Total number of fans: 9 per shed
- Duct terminations: ridge mounted ducts arranged along the length of the shed, terminating 6.5m above ground

5.3 Extract fan operation

The temperature within the sheds is determined by a combination of the heat generated by the birds themselves, the external temperature and the ventilation provided by the extract fans.

To provide sufficient ventilation of the bird generated heat, as required to maintain the ideal internal operating temperature of around 20°C, up to 25% of the roof extract fans will be required to operate (either intermittently or on variable speed).

With the influence of the external temperature additional extract fans may be required in order to maintain the ideal operating internal temperature. Here the fans are operated in Stages, triggered with each 1°C rise above the ideal internal temperature. The highest Stage will typically only be triggered when the internal temperature rises above 23°.

The operation of 100% of the roof extract fans are only expected to occur during the day period when the external temperatures have the potential to be higher.

During the evening and night, when the external temperature will fall, there will be a corresponding decrease in the number of roof extract fans needed above those for bird generated heat alone; the expected percentage of ridge extract fans required to maintain the set temperature are 50% and 25% for the evening and night periods respectively.

For the assessment the calculations have therefore reviewed the following scenarios:

- Day (07:00 – 20:00hrs): 100% extract fans operating
- Evening (20:00 – 23:00hrs): 50% extract fans operating
- Night (23:00 – 07:00hrs): 25% extract fans operating

5.4 Derivation of aggregate Specific Level

The individual noise level of each extract fan has been calculated at Dwellings A - D; Figure 1. The following corrections have been applied to the source noise data:

- **Directivity correction:** correction to convert the fan noise data from the manufacturers stated level at 45° lateral to 90° lateral (the propagation angle for the assessed dwellings), determined using the corrections given in Duct Directivity Index Applications (Day H. Hansen C & Bennett B, Acoustics Australia 96 Vol. 37 December (2009) No. 3). For the calculation a frequency spectra has been used
- **Reflections:** 3dB added to account for reflections off the poultry shed roof
- **Distance correction:** 20 x log (d_1/d_0), where d_1 = distance between receptor and noise source and d_0 = reference distance.
- **Shielding attenuation:** Where the line of sight between the noise source and dwelling is fully blocked by a solid barrier (e.g., by the poultry units themselves or local topography) 10dB shielding correction has been applied in accordance with BS5228-1 2009.
- **Ground absorption correction:** ISO 9613-2: Attenuation of sound during propagation

  $$A_{gr} = 4.8 – (2h_m/d)[17 + (300/d)]$$

  Where,

  h_m = mean height of the propagation path above ground

  d = distance from source to receptor

  In accordance with ISO 9613-2 the ground absorption correction is assumed to be zero when the line of sight of the noise source is partially or fully blocked by a solid body (i.e., when a shielding correction is applicable)
- **Atmospheric attenuation:** ISO 9613-2: Attenuation of sound during propagation outdoors, Formula 8:

  $$A_{atm} = \alpha d/100$$

  Where,

  α = is the atmosphere attenuation coefficient for a temperature of 10°C and 70% relative humidity

  d = distance from source to receptor

  In accordance with ISO 9613-2 the attenuation at 500Hz has been used as only the dB(A) value of the extract fans are known
- **On-time correction:** it has been assumed that the extract fans are operating continuously and consequently no 'on-time' correction has been applied

Tables B1 – B3, Appendix B provide the full calculations of the aggregate Specific Levels at the Dwellings A - C.

5.5 Source noise data

- Extract fans:
  - Extract fan type: Hydor HRU710/6
  - Sound pressure level: 59dB(A) at 3m, 45° lateral
  - Total number of fans: Building 1 – 8 fans, Building 2 - 9 fans
  - Duct terminations: ridge mounted ducts arranged along the length of the shed, terminating 6.5m above ground

5.6 Extract fan operation

The temperature within the sheds is determined by a combination of the heat generated by the birds themselves, the external temperature and the ventilation provided by the extract fans.

To provide sufficient ventilation of the bird generated heat, as required to maintain the ideal internal operating temperature of around 20°C, up to 25% of the roof extract fans will be required to operate (either intermittently or on variable speed).

With the influence of the external temperature additional extract fans may be required in order to maintain the ideal operating internal temperature. Here the fans are operated in Stages, triggered with each 1°C rise above the ideal internal temperature. The highest Stage will typically only be triggered when the internal temperature rises above 23°.

The operation of 100% of the roof extract fans are only expected to occur during the day period when the external temperatures have the potential to be higher.

During the evening and night, when the external temperature will fall, there will be a corresponding decrease in the number of roof extract fans needed above those for bird generated heat alone; the expected percentage of ridge extract fans required to maintain the set temperature are 50% and 25% for the evening and night periods respectively.

For the assessment the calculations have therefore reviewed the following scenarios:

- Day (07:00 – 20:00hrs): 100% extract fans operating
- Evening (20:00 – 23:00hrs): 50% extract fans operating
- Night (23:00 – 07:00hrs): 25% extract fans operating

5.7 Derivation of aggregate Specific Level

The individual noise level of each noise source has been calculated at Dwellings A - E; Figure 1. The following corrections have been applied to the source noise data:

- **Directivity correction:** correction to convert the fan noise data from the manufacturers stated level at 45° lateral to 90° lateral (the propagation angle for the assessed dwellings), determined using the corrections given in Duct Directivity Index Applications (Day H. Hansen C & Bennett B, Acoustics Australia 96 Vol. 37 December (2009) No. 3). For the calculation a frequency spectra has been used
- **Reflections:** 3dB added to account for reflections off the poultry shed roof
- **Distance correction:** 20 x log (d_1/d_0), where d_1 = distance between receptor and noise source and d_0 = reference distance.
- **Shielding attenuation:** Where the line of sight between the noise source and dwelling is fully blocked by a solid barrier (e.g., by the poultry units themselves or local topography) 10dB shielding correction has been applied in accordance with BS5228-1 2009.
- **Ground absorption correction:** ISO 9613-2: Attenuation of sound during propagation

  $$A_{gr} = 4.8 – (2h_m/d)[17 + (300/d)]$$

  Where,

  h_m = mean height of the propagation path above ground

  d = distance from source to receptor

  In accordance with ISO 9613-2 the ground absorption correction is assumed to be zero when the line of sight of the noise source is partially or fully blocked by a solid body (i.e., when a shielding correction is applicable)
- **Atmospheric attenuation:** ISO 9613-2: Attenuation of sound during propagation outdoors, Formula 8:

$$A_{atm} = \alpha d/100$$

Where,

α = is the atmosphere attenuation coefficient for a temperature of 10°C and 70% relative humidity

d = distance from source to receptor

In accordance with ISO 9613-2 the attenuation at 500Hz has been used as only the dB(A) value of the extract fans are known

- **On-time correction:** it has been assumed that the extract fans are operating continuously and consequently no 'on-time' correction has been applied

Tables B1 – B3, Appendix B provide the full calculations of the aggregate Specific Levels at the Dwellings A - C.

5.8 Rating Level

To establish the Rating Level the following BS4142 character corrections have been applied to the Specific Level:

- **Tonality:**
  - Correction: 0dB
  - Reason: the proposed extract fans, as in common with other surveyed comparable units, are not expected to be tonal
- **Impulsivity:**
  - Correction: 0dB
  - Reason: The proposed extract fans will not contain an impulsive noise element such as bangs or a very sudden jump in sound output due to quick start-up/change in fan speed.
- **Intermittency:**
  - Correction: 0dB
  - Reason: It is possible on occasion that two or more extract fans will start/stop at the same time. However, the greatest expected increase/decrease in the aggregate fan noise is 3dB, which will only occur if the total number of fans operating doubles/halves. A 3dB increase/decrease is a just perceptible change in noise, which would not incur a BS4142 intermittency penalty (i.e., the change or 'intermittency' would not be 'readily distinctive against the residual noise environment').
- **Other**
  - Correction: 3dB
  - Reason: safety factor to allow for any potential 'other' noise characteristics of the fans.

The resultant aggregate Rating Levels are provided in Table 1

5.9 Assessment Level

We define Assessment Level = RL – min L_{A90} dB, where:

RL = aggregate Rating Level, dB(A); see Appendix B

L_{A90} dB = established typical background noise level, L_{A90}

Table 1 provides the resultant Assessment Levels at Dwellings A - D.

Where the Rating Level is at parity with the typical background noise level (Assessment Level = 0dB) BS4142 states that the Specific Level will have a low impact depending on context; an adverse impact is indicated where the Rating Level is ≥ 5dB and <10dB above the typical background noise level.

Table 1. Typical background and calculated Rating and Assessment Levels at Dwellings A - D									
	Day: 07:00 - 20:00hrs			Evening : 20:00 - 23:00hrs			Night : 23:00 - 07:00hrs		
		100% roof fans operating			50% roof fans operating			25% roof fans operating	
Dwelling	Typical L_{A90} dB	Rating Level, dB	Assessment Level, dB	Typical L_{A90} dB	Rating Level, dB	Assessment Level, dB	Typical L_{A90} dB	Rating Level, dB	Assessment Level, dB
A	26	23	-3	21	20	-1	20	18	-2
B	26	25	-1	21	23	2	20	20	0
C	26	24	-2	21	22	1	20	20	0
D	25	18	-7	20	16	-4	18	14	-4

As can be seen in Table 1, during both the day and night periods, the Assessment Level does not exceed 0dB at Dwellings A – D, which indicates a BS4142 low noise impact.

During the evening the highest Assessment Level is 2dB. As a 2dB change in noise level is imperceptible, this higher Assessment Level would be perceived as 0dB. We therefore conclude that the noise impact during the evening is also low.

Additionally, during the night (23:00 – 07:00hrs) both the typical background noise level and established Rating Levels are very low. We therefore consider, in accordance with BS4142, that the absolute noise levels at Dwellings A - D during the night maybe of more relevance in determining the noise impact than the Assessment Levels in this case.

We consider it is reasonable to assume that the occupiers of the nearest dwellings will be within their houses during the night period. A room with an open window will provide 10 – 15dB sound reduction.

Using the lower 10dB reduction the highest noise ingress would be 7dB(A). This extremely low noise ingress level is both below the lowest measured background noise level and >10dB below BS8233 L_{Aeq} 30dB noise ingress limits for bedrooms (noise limit applicable to road traffic noise and continuous operating plant).

We therefore conclude that during the night the extract fan noise ingress via an open window will result in a **negligible** noise impact.

5.10 Assessment uncertainty

With all calculations there is a +/-3dB level of uncertainty. This small level of uncertainty, which equates to a just perceptible change in noise level, has no meaningful impact on the assessment findings (note that the calculation includes a precautionary +3dB 'other' character penalty).

The representative background noise levels used in the assessment are very low; lower background noise levels are not expected.

The difference between halving or doubling the number of fans operating (e.g., 50% to 100%) is 3dB. With smaller changes in the number of fans operating, for example, 50% to 70%, the change in aggregate noise emissions will be less than 2dB; this represents an imperceptible change in noise.

We therefore consider the used percentage of fans as suitably robust for the purpose of the assessment; it reflects the percentage of fans used in poultry units as advised by both operators and experts and would not result in a perceptible change in noise emissions with a 20 – 25% increase/decrease in the number of fans operating.

6. Conclusion

A noise survey has been conducted to determine representative background noise levels at the nearest dwellings (Dwellings A - D, Figure 2) to the proposed replacement poultry units at Pen Y Ffridd, Saron; Figure 1 and 2.

The extract fan noise emissions as a result of the proposed replacement sheds have been assessed in accordance with BS4142:2014+A1:2019; see Appendix B for the calculations.

The determined noise impact during the day, evening and night periods is low; no mitigation measures are required.

Additionally, during the night the extract fan noise ingress via an open window will be below the existing underlying noise environment and >10dB below BS8233's noise ingress limits for bedrooms. We therefore conclude that during the night the absolute noise levels will result in a negligible noise impact.

On the basis that the operation of the extract fans on the proposed replacement poultry units will not result in an adverse noise impact at the nearest dwellings, we conclude that on noise grounds they are acceptable.

Table A1. Noise monitor data (free-field)													
Start Time	Position 1			Position 2			Start Time	Position 1			Position 2		
	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB		$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB
15:45				73.4	40.0	23.5	03:45	39.7	26.3	21.0	35.2	19.1	17.5
16:00	57.5	37.4	29.0	53.9	33.3	24.5	04:00	42.4	29.4	21.0	41.7	26.4	18.0
16:15	54.7	35.7	29.0	57.2	36.5	24.5	04:15	38.1	28.0	20.5	38.0	22.3	18.5
16:30	80.0	48.3	27.5	53.8	35.5	25.0	04:30	38.7	23.8	19.5	42.5	22.4	19.0
16:45	53.4	34.2	26.5	83.1	62.8	24.5	04:45	37.2	22.0	19.5	41.5	23.1	17.5
17:00	58.4	36.3	27.5	79.9	53.7	22.5	05:00	34.4	21.1	19.5	31.4	19.0	18.0
17:15	46.7	30.0	24.5	52.0	33.9	21.5	05:15	64.9	37.9	19.5	38.8	19.4	17.5
17:30	58.0	36.7	25.0	46.4	26.2	21.5	05:30	43.7	24.6	20.5	45.1	22.2	18.0
17:45	46.3	30.8	26.0	50.1	30.7	22.5	05:45	62.5	35.6	20.5	46.4	27.4	19.5
18:00	61.1	38.1	24.5	56.5	34.9	23.0	06:00	54.7	30.1	22.5	57.2	30.3	19.0
18:15	62.4	37.2	23.0	64.5	35.2	24.0	06:15	63.0	40.4	24.5	70.4	42.4	21.0
18:30	41.5	26.1	23.0	70.6	36.6	21.5	06:30	46.2	30.4	25.0	55.4	32.9	21.0
18:45	56.6	33.9	23.5	56.0	28.9	20.5	06:45	50.0	32.3	26.0	67.2	37.3	23.0
19:00	53.9	34.0	23.0	55.4	36.5	21.5	07:00	49.2	32.6	26.0	57.7	37.1	24.5
19:15	63.8	37.5	22.5	59.3	36.1	21.0	07:15	55.0	34.3	29.0	58.0	33.8	24.0
19:30	48.8	27.8	22.5	61.9	33.3	20.5	07:30	57.7	36.4	27.5	52.4	31.5	25.0
19:45	50.9	30.1	22.0	63.4	37.3	21.5	07:45	54.6	33.1	26.5	67.1	44.6	26.5
20:00	51.6	29.7	22.0	42.9	24.0	20.0	08:00	65.8	41.2	28.5	75.0	49.0	25.0
20:15	50.7	28.2	21.5	46.1	28.8	20.0	08:15	60.1	33.2	25.5	47.0	30.3	25.5
20:30	48.0	30.5	21.5	48.7	25.2	20.0	08:30	62.6	37.5	26.5	71.1	37.1	26.0
20:45	42.5	25.8	21.0	53.7	32.4	19.0	08:45	61.1	36.2	27.0	51.1	32.1	25.5
21:00	59.8	33.7	21.5	38.5	22.9	19.5	09:00	76.5	45.5	27.0	54.6	30.9	26.5
21:15	67.7	39.5	21.5	44.0	24.4	20.0	09:15	59.7	36.6	26.5	53.3	33.4	28.5
21:30	38.5	23.3	21.0	53.9	23.6	19.5	09:30	43.7	29.2	25.5	60.4	34.3	29.0
21:45	39.3	23.6	21.0	38.4	22.4	18.5	09:45	61.0	35.9	25.0	46.6	30.7	28.5
22:00	41.2	26.8	21.0	34.9	22.5	19.0	10:00	46.7	31.6	25.5	49.3	33.0	29.0
22:15	53.6	32.5	21.5	41.9	24.5	19.0	10:15	65.0	40.8	25.5	52.5	33.1	29.0
22:30	31.8	21.5	20.5	44.5	27.2	19.0	10:30	61.1	42.0	25.5	44.9	37.5	35.5
22:45	32.8	22.2	20.5	35.3	22.9	17.5	10:45	60.8	35.7	26.0	54.9	38.9	35.5
23:00	34.6	23.2	20.5	35.6	20.7	17.5	11:00	80.9	52.3	29.0	59.6	38.2	35.0
23:15	35.6	23.6	21.5	41.8	23.4	17.5	11:15	68.8	44.2	28.0	60.8	40.3	35.0
23:30	34.4	27.0	23.0	30.2	18.9	17.0	11:30	63.0	40.8	27.0	65.2	44.9	28.0
23:45	38.3	27.3	24.0	37.1	21.4	18.5	11:45	57.9	36.8	27.0	59.2	38.4	25.0
00:00	38.5	29.3	23.5	36.9	22.2	18.5	12:00	59.4	38.3	29.0	48.3	33.1	24.0
00:15	41.5	28.9	23.5	33.4	22.1	18.0	12:15	60.9	37.3	28.0	58.5	35.2	26.0
00:30	33.8	26.2	23.0	37.8	22.5	18.0	12:30	52.9	34.5	26.0	55.5	37.3	26.0
00:45	48.7	29.1	23.0	39.9	22.3	18.5	12:45	54.9	31.2	25.5	57.5	33.6	23.5
01:00	34.0	27.8	24.0	43.9	26.3	19.0	13:00	41.7	28.9	24.5	62.9	33.9	22.5
01:15	37.8	26.8	22.5	29.9	19.8	18.0	13:15	53.1	32.8	24.5	66.4	35.9	24.0
01:30	44.9	26.2	22.5	39.8	20.7	18.0	13:30	54.6	37.1	29.5	56.4	33.4	25.5
01:45	39.8	25.7	22.0	34.9	20.4	18.0	13:45	57.9	36.0	27.5	56.6	37.0	29.5
02:00	35.6	24.1	21.5	33.5	21.5	18.5	14:00	71.6	49.6	29.0	72.7	41.3	25.0
02:15	33.5	23.8	20.5	41.4	20.1	17.5	14:15	50.3	32.2	27.5	73.1	50.0	25.0
02:30	34.2	24.5	22.0	40.8	20.1	17.0	14:30	48.5	31.6	26.5	57.7	29.5	23.5
02:45	37.7	27.2	21.5	42.1	20.5	17.5	14:45	61.4	37.4	25.0	42.5	27.3	23.5
03:00	37.6	28.5	23.5	44.6	22.7	17.5	15:00	54.5	36.7	27.5	69.2	47.3	23.5
03:15	36.0	24.9	21.0	45.7	26.2	20.5	15:15				70.0	39.2	24.5
03:30	29.4	21.5	20.0	31.3	19.2	17.5							

Table A2. Weather station data											
Start Time	Wind Speed, m/s	Temp, °C	Start Time	Wind Speed, m/s	Temp, °C	Start Time	Wind Speed, m/s	Temp, °C	Start Time	Wind Speed, m/s	Temp, °C
15:40	0.8	13.3	21:30	0.0	12.3	03:20	0.0	10.2	09:10	0.0	11.3
15:50	1.7	13.2	21:40	0.0	12.6	03:30	0.0	10.0	09:20	0.0	11.2
16:00	1.5	13.3	21:50	0.0	12.4	03:40	0.0	9.7	09:30	1.3	11.4
16:10	1.4	13.3	22:00	0.0	12.4	03:50	0.0	9.4	09:40	0.7	11.7
16:20	0.9	13.2	22:10	0.0	12.3	04:00	0.7	9.7	09:50	1.4	11.6
16:30	0.9	13.1	22:20	0.0	12.2	04:10	0.0	9.5	10:00	1.0	11.7
16:40	0.7	13.3	22:30	0.0	12.2	04:20	0.5	9.2	10:10	1.1	11.7
16:50	0.0	13.4	22:40	0.0	12.4	04:30	0.0	9.3	10:20	0.0	12.1
17:00	1.3	13.4	22:50	0.0	12.6	04:40	0.0	9.3	10:30	0.0	12.1
17:10	0.0	13.5	23:00	0.0	13.2	04:50	0.0	9.0	10:40	1.0	12.3
17:20	0.0	13.5	23:10	0.5	13.0	05:00	0.0	8.9	10:50	0.8	12.2
17:30	0.0	13.8	23:20	1.2	12.8	05:10	0.0	7.5	11:00	1.0	12.9
17:40	0.4	14.1	23:30	1.4	12.9	05:20	0.0	8.1	11:10	1.5	13.2
17:50	0.7	13.8	23:40	0.7	12.5	05:30	0.0	7.8	11:20	0.7	13.0
18:00	1.1	13.8	23:50	0.0	12.7	05:40	0.0	9.2	11:30	1.4	13.1
18:10	0.9	13.7	00:00	0.7	12.4	05:50	0.0	9.5	11:40	0.0	13.1
18:20	0.0	13.8	00:10	0.0	12.5	06:00	0.0	9.6	11:50	1.0	13.2
18:30	0.0	13.5	00:20	0.5	12.5	06:10	0.0	9.9	12:00	0.0	13.4
18:40	0.0	13.4	00:30	1.1	12.6	06:20	0.0	9.9	12:10	2.2	12.6
18:50	0.9	13.2	00:40	1.0	12.2	06:30	0.0	9.8	12:20	0.7	12.5
19:00	0.6	13.1	00:50	1.0	12.5	06:40	0.0	10.2	12:30	0.8	12.5
19:10	0.0	13.0	01:00	0.5	12.2	06:50	0.0	10.0	12:40	0.6	12.8
19:20	0.0	12.9	01:10	0.0	12.5	07:00	0.0	10.0	12:50	0.4	13.3
19:30	0.0	13.0	01:20	0.6	12.3	07:10	0.0	9.6	13:00	0.9	13.2
19:40	0.0	12.6	01:30	0.4	12.3	07:20	0.0	9.8	13:10	1.1	12.7
19:50	0.0	12.8	01:40	1.1	12.0	07:30	0.0	10.4	13:20	0.4	13.0
20:00	0.0	12.5	01:50	0.6	12.3	07:40	0.0	10.4	13:30	0.6	13.1
20:10	0.0	12.9	02:00	0.0	11.9	07:50	0.0	10.9	13:40	0.6	13.0
20:20	0.0	12.9	02:10	0.0	11.8	08:00	0.0	10.6	13:50	0.7	13.2
20:30	0.0	12.6	02:20	0.0	11.8	08:10	0.0	10.9	14:00	0.7	13.8
20:40	0.0	12.5	02:30	0.0	12.0	08:20	0.5	11.0	14:10	0.5	13.8
20:50	0.0	12.5	02:40	0.4	11.9	08:30	0.8	11.1	14:20	1.8	13.4
21:00	0.0	12.8	02:50	1.0	11.3	08:40	0.0	11.0	14:30	0.7	14.1
21:10	0.0	12.5	03:00	0.6	10.6	08:50	0.0	11.1	14:40	1.8	14.0
21:20	0.0	12.5	03:10	0.0	10.5	09:00	1.0	11.1	14:50	1.1	14.1

Table B1. Calculation of extract fan Rating Levels at Dwelling A

Extract Fans: Hydor HRU710/6	Octave Band Centre Frequency, Hz 63	125	250	500	1k	2k	4k	dB(A)
[A] Lp at 3m, 45° lateral:	61	57	55	52	54	52	52	59
[B] directivity correction (45° to 90°):	0	1.5	3	4.5	9	11	18	
[C] Reflection off poultry shed roof:	3	3	3	3	3	3	3	
[A] - [B] + [C] L_p at 90° lateral:	64	59	55	51	48	44	37	53.5

Fan		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6
1	Direct distance, m	166.2	188.6	212.1	236.3	261.0	286.2	Distance correction, dB	34.9	36.0	37.0	37.9	38.8	39.6	Shielding attenuation, dB	10	10	10	10	10	10
2		168.0	190.2	213.5	237.5	262.2	287.3		35.0	36.0	37.0	38.0	38.8	39.6		10	10	10	10	10	10
3		169.9	191.8	215.0	238.8	263.4	288.4		35.1	36.1	37.1	38.0	38.9	39.7		10	10	10	10	10	10
4		171.7	193.5	216.5	240.2	264.6	289.5		35.2	36.2	37.2	38.1	38.9	39.7		10	10	10	10	10	10
5		173.7	195.2	218.0	241.6	265.8	290.6		35.3	36.3	37.2	38.1	39.0	39.7		10	10	10	10	10	10
6		175.6	196.9	219.5	243.0	267.1	291.8		35.3	36.3	37.3	38.2	39.0	39.8		10	10	10	10	10	10
7		177.6	198.7	221.1	244.4	268.4	293.0		35.4	36.4	37.3	38.2	39.0	39.8		10	10	10	10	10	10
8		179.6	200.5	222.7	245.8	269.8	294.2		35.5	36.5	37.4	38.3	39.1	39.8		10	10	10	10	10	10
9		181.6	202.3	224.4	247.3	271.1	295.4		35.6	36.6	37.5	38.3	39.1	39.9		10	10	10	10	10	10
1	Ground absorption, dB	0.0	0.0	0.0	0.0	0.0	0.0	Atmospheric attenuation, dB	0.3	0.4	0.4	0.4	0.5	0.5	Sound pressure level at dwelling, dB	8.3	7.2	6.1	5.1	4.2	3.4
2		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.5		8.2	7.1	6.0	5.1	4.2	3.3
3		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.5		8.1	7.0	6.0	5.0	4.1	3.3
4		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.6		8.0	6.9	5.9	5.0	4.1	3.3
5		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.6		7.9	6.9	5.9	4.9	4.0	3.2
6		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.6		7.8	6.8	5.8	4.9	4.0	3.2
7		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.6		7.7	6.7	5.7	4.8	4.0	3.1
8		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.6		7.6	6.6	5.7	4.8	3.9	3.1
9		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.4	0.4	0.5	0.5	0.6		7.5	6.5	5.6	4.7	3.9	3.1

BS4142 character correction		3
Day (07:00 - 20:00hrs): 100% roof & gable end extract fans operating	Specific Level, dB	20
	Rating Level, dB	23
Evening (20:00 - 23:00hrs): 50% roof extract fans operating - Note 1	Specific Level, dB	17
	Rating Level, dB	20
Night (23:00 - 07:00hrs): 25% roof extract fans operating - Note 2	Specific Level, dB	15
	Rating Level, dB	18

Note 1: Assumed only odd numbered roof fans operating
Note 2: Assumed only 2, 5 and 8 numbered roof fans operating on proposed replacement sheds

Table B2. Calculation of extract fan Rating Levels at Dwelling B

Extract Fans: Hydor HRU710/6	Octave Band Centre Frequency, Hz 63	125	250	500	1k	2k	4k	dB(A)
[A] Lp at 3m, 45° lateral:	61	57	55	52	54	52	52	59
[B] directivity correction (45° to 90°):	0	1.5	3	4.5	9	11	18	
[C] Reflection off poultry shed roof:	3	3	3	3	3	3	3	
[A] - [B] + [C] L_p at 90° lateral:	64	59	55	51	48	44	37	53.5

Fan		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6
1	Direct distance, m	133.6	160.3	187.0	213.8	240.7	267.6	Distance correction, dB	33.0	34.6	35.9	37.1	38.1	39.0	Shielding attenuation, dB	10	10	10	10	10	10
2		133.1	159.9	186.7	213.5	240.4	267.3		32.9	34.5	35.9	37.0	38.1	39.0		10	10	10	10	10	10
3		132.7	159.5	186.4	213.2	240.2	267.1		32.9	34.5	35.9	37.0	38.1	39.0		10	10	10	10	10	10
4		132.3	159.2	186.1	213.0	240.0	266.9		32.9	34.5	35.9	37.0	38.1	39.0		10	10	10	10	10	10
5		132.1	159.0	185.9	212.9	239.8	266.8		32.9	34.5	35.8	37.0	38.1	39.0		10	10	10	10	10	10
6		131.8	158.8	185.8	212.7	239.7	266.7		32.9	34.5	35.8	37.0	38.1	39.0		10	10	10	10	10	10
7		131.7	158.7	185.7	212.6	239.6	266.6		32.8	34.5	35.8	37.0	38.0	39.0		10	10	10	10	10	10
8		131.6	158.6	185.6	212.6	239.6	266.6		32.8	34.5	35.8	37.0	38.0	39.0		10	10	10	10	10	10
9		131.6	158.6	185.6	212.6	239.6	266.6		32.8	34.5	35.8	37.0	38.0	39.0		10	10	10	10	10	10
1	Ground absorption, dB	0.0	0.0	0.0	0.0	0.0	0.0	Atmospheric attenuation, dB	0.3	0.3	0.4	0.4	0.5	0.5	Sound pressure level at dwelling, dB	10.3	8.6	7.2	6.0	5.0	4.0
2		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.3	8.7	7.3	6.0	5.0	4.0
3		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.3	8.7	7.3	6.1	5.0	4.0
4		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.4	8.7	7.3	6.1	5.0	4.0
5		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.4	8.7	7.3	6.1	5.0	4.0
6		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.4	8.7	7.3	6.1	5.0	4.0
7		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.4	8.7	7.3	6.1	5.0	4.0
8		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.4	8.7	7.3	6.1	5.0	4.0
9		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.4	0.4	0.5	0.5		10.4	8.7	7.3	6.1	5.0	4.0

BS4142 character correction		3
Day (07:00 - 20:00hrs): 100% roof & gable end extract fans operating	Specific Level, dB	22
	Rating Level, dB	25
Evening (20:00 - 23:00hrs): 50% roof extract fans operating - Note 1	Specific Level, dB	20
	Rating Level, dB	23
Night (23:00 - 07:00hrs): 25% roof extract fans operating - Note 2	Specific Level, dB	17
	Rating Level, dB	20

Note 1: Assumed only odd numbered roof fans operating
Note 2: Assumed only 2, 5 and 8 numbered roof fans operating on proposed replacement sheds

Table B3. Calculation of extract fan Rating Levels at Dwelling C

Extract Fans: Hydor HRU710/6	Octave Band Centre Frequency, Hz 63	125	250	500	1k	2k	4k	dB(A)
[A] Lp at 3m, 45° lateral:	61	57	55	52	54	52	52	59
[B] directivity correction (45° to 90°):	0	1.5	3	4.5	9	11	18	
[C] Reflection off poultry shed roof:	3	3	3	3	3	3	3	
[A] - [B] + [C] L_p at 90° lateral:	64	59	55	51	48	44	37	53.5

Fan		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6
1	Direct distance, m	168.5	168.7	173.1	181.6	193.4	208.1	Distance correction, dB	35.0	35.0	35.2	35.6	36.2	36.8	Shielding attenuation, dB	10	10	10	10	10	10
2		165.5	165.7	170.2	178.8	190.8	205.7		34.8	34.8	35.1	35.5	36.1	36.7		10	10	10	10	10	10
3		162.5	162.7	167.3	176.1	188.3	203.3		34.7	34.7	34.9	35.4	36.0	36.6		10	10	10	10	10	10
4		159.5	159.7	164.4	173.3	185.7	200.9		34.5	34.5	34.8	35.2	35.8	36.5		10	10	10	10	10	10
5		156.5	156.7	161.5	170.6	183.1	198.6		34.3	34.4	34.6	35.1	35.7	36.4		10	10	10	10	10	10
6		153.5	153.7	158.6	167.8	180.6	196.2		34.2	34.2	34.5	35.0	35.6	36.3		10	10	10	10	10	10
7		150.5	150.7	155.7	165.1	178.0	193.9		34.0	34.0	34.3	34.8	35.5	36.2		10	10	10	10	10	10
8		147.5	147.8	152.8	162.4	175.5	191.6		33.8	33.8	34.1	34.7	35.3	36.1		10	10	10	10	10	10
9		144.5	144.8	150.0	159.7	173.0	189.3		33.7	33.7	34.0	34.5	35.2	36.0		10	10	10	10	10	10
1	Ground absorption, dB	0.0	0.0	0.0	0.0	0.0	0.0	Atmospheric attenuation, dB	0.3	0.3	0.3	0.3	0.4	0.4	Sound pressure level at dwelling, dB	8.2	8.2	7.9	7.5	6.9	6.3
2		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.4	0.4		8.4	8.3	8.1	7.7	7.1	6.4
3		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.4	0.4		8.5	8.5	8.3	7.8	7.2	6.5
4		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.4	0.4		8.7	8.7	8.4	7.9	7.3	6.6
5		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.3	0.4		8.9	8.8	8.6	8.1	7.4	6.7
6		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.3	0.4		9.0	9.0	8.7	8.2	7.6	6.8
7		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.3	0.4		9.2	9.2	8.9	8.4	7.7	6.9
8		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.3	0.4		9.4	9.4	9.1	8.5	7.8	7.0
9		0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.3	0.3	0.3	0.3	0.4		9.6	9.6	9.2	8.7	8.0	7.1

BS4142 character correction		3
Day (07:00 - 20:00hrs): 100% roof & gable end extract fans operating	Specific Level, dB	21
	Rating Level, dB	24
Evening (20:00 - 23:00hrs): 50% roof extract fans operating - Note 1	Specific Level, dB	19
	Rating Level, dB	22
Night (23:00 - 07:00hrs): 25% roof extract fans operating - Note 2	Specific Level, dB	17
	Rating Level, dB	20

Note 1: Assumed only odd numbered roof fans operating
Note 2: Assumed only 2, 5 and 8 numbered roof fans operating on proposed replacement sheds

Table B4. Calculation of extract fan Rating Levels at Dwelling D

Extract Fans: Hydor HRU710/6	Octave Band Centre Frequency, Hz 63	125	250	500	1k	2k	4k	dB(A)
[A] Lp at 3m, 45° lateral:	61	57	55	52	54	52	52	59
[B] directivity correction (45° to 90°):	0	1.5	3	4.5	9	11	18	
[C] Reflection off poultry shed roof:	3	3	3	3	3	3	3	
[A] - [B] + [C] L_p at 90° lateral:	64	59	55	51	48	44	37	53.5

Fan		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6		Shed 1	Shed 2	Shed 3	Shed 4	Shed 5	Shed 6
1	Direct distance, m	320.4	293.8	267.3	240.9	214.6	188.5	Distance correction, dB	40.6	39.8	39.0	38.1	37.1	36.0	Shielding attenuation, dB	10	10	10	10	10	0
2		319.9	293.3	266.7	240.2	213.9	187.7		40.6	39.8	39.0	38.1	37.1	35.9		10	10	10	10	10	0
3		319.4	292.8	266.1	239.6	213.2	186.9		40.5	39.8	39.0	38.0	37.0	35.9		10	10	10	10	10	0
4		319.0	292.3	265.6	239.0	212.5	186.2		40.5	39.8	38.9	38.0	37.0	35.9		10	10	10	10	10	0
5		318.6	291.8	265.1	238.5	211.9	185.5		40.5	39.8	38.9	38.0	37.0	35.8		10	10	10	10	10	0
6		318.2	291.4	264.7	238.0	211.4	184.9		40.5	39.7	38.9	38.0	37.0	35.8		10	10	10	10	10	0
7		317.9	291.0	264.2	237.5	210.9	184.3		40.5	39.7	38.9	38.0	36.9	35.8		10	10	10	10	10	0
8		317.6	290.7	263.9	237.1	210.4	183.7		40.5	39.7	38.9	38.0	36.9	35.7		10	10	10	10	10	0
9		317.3	290.4	263.5	236.7	209.9	183.2		40.5	39.7	38.9	37.9	36.9	35.7		10	10	10	10	10	0
1	Ground absorption, dB	0.0	0.0	0.0	0.0	0.0	3.7	Atmospheric attenuation, dB	0.6	0.6	0.5	0.5	0.4	0.4	Sound pressure level at dwelling, dB	2.3	3.1	4.0	4.9	6.0	13.5
2		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.4		2.3	3.1	4.0	5.0	6.0	13.5
3		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.4		2.3	3.2	4.0	5.0	6.1	13.5
4		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.4		2.4	3.2	4.1	5.0	6.1	13.6
5		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.4		2.4	3.2	4.1	5.0	6.1	13.6
6		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.4		2.4	3.2	4.1	5.1	6.1	13.7
7		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.4		2.4	3.2	4.1	5.1	6.2	13.7
8		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.5	0.4	0.3		2.4	3.2	4.1	5.1	6.2	13.7
9		0.0	0.0	0.0	0.0	0.0	3.7		0.6	0.6	0.5	0.4	0.4	0.3		2.4	3.2	4.1	5.1	6.2	13.8

BS4142 character correction		3
Day (07:00 - 20:00hrs): 100% roof & gable end extract fans operating	Specific Level, dB	15
	Rating Level, dB	18
Evening (20:00 - 23:00hrs): 50% roof extract fans operating - Note 1	Specific Level, dB	13
	Rating Level, dB	16
Night (23:00 - 07:00hrs): 25% roof extract fans operating - Note 2	Specific Level, dB	11
	Rating Level, dB	14

Note 1: Assumed only odd numbered roof fans operating
Note 2: Assumed only 2, 5 and 8 numbered roof fans operating on proposed replacement sheds