

BWV UK Ltd
Margam Waste to Energy – Planning Condition 13

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1.0 INTRODUCTION

Hawksmoor Engineering Ltd has been requested by BWV UK Ltd to undertake a noise assessment of the Margam Waste to Energy development in Margam, South Wales in order to prepare and issue a report detailing the assessment of noise propagation to residential property as required by Planning Conditions 12 and 13 of the project planning consent.

This report details the methodology of assessment of noise contributions from the site, together with the measurements and assessment to establish compliance with the planning condition noise limits.

2.0 CONDITION 12 & 13 REQUIREMENTS.

2.1 Scheme Planning Conditions

The scheme has been granted planning consent via appeal under reference APP/Y6930/A/10/2135473. The consent included a number of conditions, including two related to noise. These are re-stated below:

Condition 12, which states:

“Operational noise from the site shall not be greater than the following levels at the specified locations:

- Longlands House; 48 dbA Leq 1 hour during the day and Leq 5 minutes at night.*
 - Abbots Close; 48 dbA Leq 1 hour during the day and Leq 5 minutes at night.*
 - 10 Acre Wood: 48 dbA Leq 1 hour during the day and Leq 5 minutes at night.*
- All measurements shall be taken in accordance with BS4142 (1997).”*

Condition 13, which states:

“Within 3 months of commencement of operation of the plant a noise assessment, using the original monitoring locations as identified in the Environmental Statement, shall be submitted to and approved in writing by the local planning authority. The assessment shall include measures, including appropriate timescales, to address any noise issues identified. These shall be implemented as approved within the timescales agreed.”

The planning conditions therefore reflects the requirement to achieve absolute noise contributions to the nearest residential locations. We would note that BS4142: 1997 has been replaced to BS4142:2014. For reasons outlined within this report, the change of standard is not relevant to the assessment undertaken.

2.2 Assessment Methodology

Prior to undertaking the site measurement work, a desk top review was undertaken of prior acoustic reports and survey information related to the scheme. The following were reviewed:

- EIS chapter 12 Noise.

This report was submitted as part of the original planning application and included details of noise measurements undertaken at surrounding residential properties.

- Mach Acoustic design stage acoustic report (Margam Green energy Acoustic report, revision 7 dated 9/6/2016)

This report detailed predictions of plant noise and reported extended duration background noise measurements and is understood to have been reviewed by the Planners and EHO during the design and construction stage of the project.

- Noise and Vibration consultants Ltd – Noise assessment to comply with Pre-operational Measures for Environmental Permit (PO5).

This provided predictions of plant noise contributions and is understood to have been submitted to Natural Resources Wales as part of the environmental permitting process.

Based on review of the above documents it was clear that background noise levels were consistently above the plant noise contribution limit detailed within the planning consent conditions at residential properties. This was the case during the day at all locations. At night it was only by exception that background and ambient noise levels reduced to levels at or around the plant noise limit.

It was therefore concluded that direct measurement at residential properties was unlikely to provide clear demonstrable evidence of plant noise contributions, particularly during the daytime period and that the appropriate approach would be to use a combination of measurement evidence to enable a conclusion to be drawn on the plant noise contributions. The approach used has been used by the author of this report for many years when assessing power plant noise contributions, most recently at a number of other Waste to Energy schemes. This approach encompass three methods of assessment.

A. Direct measurement at Residential properties

- Measurement at the three off-site residential locations identified in the planning condition. These measurements to include statistical and overall measurements in 5 minute periods and to be obtained during the night time period (when background noise levels are low).

B. Intermediate Locations where the plant noise contributions dominate measured levels

- Measurements at locations where the plant can be clearly measured above background noise levels, but still acoustically a point source (i.e. more than 1.5 times main plant dimensions) at accessible locations. This was only expected to be possible to the East and North of the site. From these measurements plant noise contributions to residential properties could be readily calculated.

C. On plant measurement and re-modelling

- Measurements on plant of the various noise sources, both internal and external which would then be input to an OCMA / CONCAWE noise model and hence predicted noise levels calculated at the receptor locations using this "As Built" noise data.

It merits noting that each of these assessment methods uses a separate noise measurement data set providing a degree of independence of the conclusions from each assessment method.

The plant operates on a continuous basis at effectively constant load and hence plant noise contributions are essentially constant. In addition to the plant, noise contributions arise from the arrival / unloading / departure of the fuel delivery lorries. We have considered fuel delivery vehicle noise contributions separately to assessment of plant noise.

3.0 PROJECT DESCRIPTION

3.1 Description of the Development

The development comprises a single site for the storage and combustion of waste wood with steam raised within a boiler used to power a single steam turbine. The principle elements of the scheme comprise:

- Fuel Storage Building

This comprises clad lower level concrete walls with upper levels and roof being composite cladding. The building houses two gantry cranes to move waste wood from receiving bunkers to bulk storage areas and hence to a feed hopper. Fuel is delivered by articulated lorries. These offload into the receiving bunkers using moving floors within the lorry trailer. A loading shovel is intermittently used to clear any wood over –spill within the offloading area.

- Conveyer

An enclosed fuel conveyer transfers the wood fuel from the fuel storage building to the main boiler house.

- Boiler House and FGT Building

The boiler house contains a single combustion furnace. The hot exhaust gasses travel through a number of heat exchanger elements within the boiler which turns feed water into high temperature high pressure steam. The exhaust gasses from the boiler then enter a Flue Gas Treatment (FGT) process.

- Steam Turbine Building

The steam turbine building houses the steam turbine train at first floor level (Steam turbine / gear box / electrical generator). The exhaust steam is ducted to an external Air Cooled Condenser (ACC). The steam turbine lube oil coolers (component coolers) are remotely located on the boiler house roof with the turbine train lube oil packages located on the ground floor below the turbine.

- ACC

The exhaust steam is ducted to the ACC, which condenses the steam back to a liquid (water) state by cooling the steam flow. Heat is rejected from the fluid using large heat exchanger surfaces which radiate heat by natural convection, with fan assistance when required.

3.2 Plant Operation

The plant is designed to predominantly operate at or close to baseload. In this condition plant operates in a constant condition with no material short term variation. The main source of variability to the noise level results from changes in ambient temperature and wind speed causing the fans on the ACC and component coolers to change speed – however these fans are inverter driven and hence changes are effected slowly and by small degrees. At constant load the main plant items within the building, such as Steam Turbine train / air supply fans / pumps operate with little change to duty speed.

In practice this results in the L_{Aeq} (overall energy average) noise contributions to off-site locations being very close to the L_{A90} and L_{A10} (statistical noise contributions).

4.0 BACKGROUND AND AMBIENT NOISE LEVELS

As noted in Section 2.1 of this report, background and ambient noise levels have been measured on a number of occasions. Table 1 below summaries these measurements, but we would note the Mach Acoustics extended measurements clearly show a high degree of variability on a day to day basis.

Location	Day		Night	
Survey	L _{Aeq}	L _{A90}	L _{Aeq}	L _{A90}
Abbots Close				
EIA	61	-	48	-
Mach	55	47	47	44
NNC	-	54	-	43
Sweet Briar (10 Acres wood)				
EIA	55	-	49	-
Mach	58	47	48	45
NNC	-	56	-	49
Longlands House				
EIA	59	-	50	-
Mach	58	53	54	52
NNC	-	54	-	51

Table 1: Background Noise Levels from Prior Studies

In all the surveys the dominant noise source was reported as road traffic noise most notably from the M4. During the night-time periods noise contributions were also noted from the existing waste to energy plant / BOC gas liquefaction plant and the Port Talbot steelworks.

These prior surveys clearly indicate the pre-existing ambient and background noise levels have frequently been measured at levels greater than the 48 dB L_{Aeq} planning condition noise contribution limit for the plant.

As would be expected, the night-time noise levels are lower than daytime. As a direct consequence, and given that the plant noise contributions to residential locations are the same during the day and night, it was concluded that undertaken the measurements at residential properties should be undertaken at night time, hence maximising the possibility of direct measurement evidence of compliance with the planning condition noise limit.

5.0 MEASUREMENT AT OFF-SITE RECEPTOR LOCATIONS

5.1 Plant Operating Conditions

The plant was operating at c.40Mw (baseload) in a steady mode. Weather conditions were calm (wind speed 1 to 2) with a temperature of 8 degrees with no precipitation and 5/8th cloud cover. There was no temperature inversion demonstrated by stack discharge plumbs from the various discharge stacks within the area. Weather conditions were therefore very good for environmental noise measurement.

5.2 Measurement at Residential Locations

We have undertaken measurements at the identified residential locations. Appendix 1 of this report details these measurements. A summary is provided in Table 2 below.

Location	Overall (dB L _{Aeq})	Statistical Noise Level (dB(A))		
		L _{A10}	L _{A50}	L _{A90}
Abbots Close	48	50	48	47
Sweet Briar (10 Acre wood)	43	44	43	42
Longlands House	49	50	47	46

Table 2: Measured Noise Levels at Residential Locations

We would comment on the measurements and observations at each location.

Abbots Close

The waste to energy plant was not audibly discernible at any time. Noise contributions from the steelworks were subjectively judged to be the dominant source. Limited contributions were also apparent from the local main road system. There were no local vehicle movements during the duration of the survey measurements.

Sweet Briar (10 Acre Wood)

The waste to energy plant was not audibly discernible at any time. The noise climate was judged to be dominated by industrial noise, primarily from the Port Talbot steel works, with limited contributions from traffic on the M4 and local main roads. There were no local vehicle movements during the survey duration.

Longlands House

The noise climate was dominated by noise from the BOC gas liquefaction plant – subjectively the heat exchanges on the BOC plant appeared dominant. The noise from the BOC site was also noted as tonal in nature. There were intermittent noise events from the steelworks. This location is close to the pre-existing Bio-mass power plant. Subjectively the new Bio-mass power plant was not audible. There were no local vehicle movements during the duration of the survey measurements.

5.2 Comment on the Overall Noise Levels Measured

It can be seen from the measurements that the overall levels recorded at both Longlands House and 10 Acre Wood recorded during this most recent noise survey are significantly lower than prior surveys.

It was very noticeable that noise from the M4 was not particularly discernible at any location, but such noise was noted in the NVC and Mach Acoustics reports as a material noise contributor to all locations. To understand this aspect better, we undertook a brief traffic count (two number 5 minute periods) and recorded an hourly equivalent of some 320 vehicles per hour (allowing for both directions of flow). This compares to published Department of Transport data for this section of the M4, which (for 2017) provides a flowrate estimate of 84,000 movements per day, which is an average of 3,500 per hour. No breakdown of day to night time flowrates are available. Clearly the night time flow rate would be expected to be significantly lower than the daytime, but regardless the traffic flow was considered very low. The author would also note that driving back east after the survey work he was not overtaken or was required to move from the inside lane until East of Cardiff (a distance of some 30 miles), which is considered unusual.

5.3 Conclusions from the off-site Measurement

5.3.1 Abbots Close

The overall noise level was established at 48 dB L_{Aeq} included both the Waste to Energy plant under consideration as well as the other noise sources contributing within the area. This clearly demonstrates compliance with the noise limit applicable to the plant, of a noise contribution not exceeding 48 dB L_{Aeq} .

Given the lack of audibility of the plant compared to other industrial sources we would estimate the noise contribution was no more than c.43 dB(A) allowing for the other noise sources within the area.

5.3.2 Sweet Briar (10 Acre Wood)

The overall noise level at 43 dB L_{Aeq} included both the Waste to Energy plant under consideration as well as the other noise sources within the area. This clearly demonstrates compliance with the night time noise limit applicable to the plant of a noise contribution not exceeding 48 dB L_{Aeq} .

Given the lack of audibility of the plant compared to other industrial sources we would estimate the noise contribution was no more than c.38 dB(A).

5.3.3 Longlands House

The overall noise level at 49 dB L_{Aeq} included both the Waste to Energy plant under consideration as well as the other noise sources within the area. As noted above the dominant noise source was the BOC liquefaction plant. As noted in Section 3.2 of this report, the waste to energy plant noise contributions were essentially constant and hence the contribution to the L_{A90} measured noise can be expected to be the same as the contribution to the L_{Aeq} measured level. As the L_{A90} measured noise level was 47 dB, we can conclude the plant was very likely to not be contributing more than 47 dB(A) at this location.

Subjectively the BOC plant was the dominant source. It would our opinion that the waste to energy plant contributed no more than 42 dB L_{Aeq} .

5.3.4 Tonality and Intermittency Corrections

BS4142:2014 sets out corrections to measured noise levels were the sources under consideration have either or both tonal or intermittency characteristics. We can confirm that no such corrections are considered warranted for any of the measurement locations.

6.0 INTERMEDIATE MEASUREMENT LOCATIONS

6.1 Modelling Details

It was noted in the acoustic proving test measurement strategy that clear direct evidence of noise contributions from the plant may not be possible to establish simply by direct measurement at the residential locations and thus an evidence base would likely be required from further measurements and modelling. Clearly the direct measurements have provided good evidence of compliance, which can be further supported by intermediate location measurements.

Appendix 2 of this report includes the measurements taken at two locations where the plant noise was considered dominant over the other sources and the resulting calculation of contributions to residential locations from this data set.

6.2 Modelling Results

Table 3 below summarises the results included in Appendix 2.

Location	Calculated Noise Contribution (L_{Aeq})
Abbots Close	36
Sweet Briar (10 Acre wood)	33
Longlands House	42

Table 3: Noise contributions calculated from Intermediate location measurements

6.3 Conclusions from Modelling

The results clearly demonstrate compliance with the planning condition noise limit.

It may be noted that this assessment method uses a different measurement data set to the direct measurements obtained at the residential property.

7.0 ON PLANT MEASUREMENT

7.1 Assessment Methodology

The third method of assessment is to compare “as built” noise measurements with the design stage predictions and then undertake a re-modelling exercise. We have used an OCMA / CONCAWE noise model in undertaking this exercise. Appendix 3 of this report provides details of the review.

7.2 Assessment Results

Table 4 summaries the calculated contributions from the various primary noise sources.

Source (nominal sound power dB(A))	Calculated sound pressure level contribution (dB(A))		
	Abbotts Close	Sweet Briar (10 Acre wood)	Longlands House
ACC (105)	33	30	39
Condensate pumps (102)	23	27	36
Component coolers (82)	15	13	19
Boiler House cladding (90)	26	21	27
Boiler house ventilation – north(88)	19	17	22
Boiler house ventilation – south (93)	18	9	21
ST building (95)	22	23	29
Condensate pumps	20	29	35
Export transformer (75)	4	0	9
Stack outlet (98)	32	28	34
Fuel conveyer (91)	21	18	15
Fuel Storage building (87)	21	15	19
Building ventilation & HVAC (95)	26	23	27
Total (dB(A))	37	35	43

Table 4: Noise Model Predictions

This assessment approach also demonstrates compliance with the planning noise limit.

8.0 Summary of Noise Contributions to Offsite Locations – Plant Normal Operations

Table 5 below summarises the three methods of assessment we have used in determining plant contributions to each location.

Location	Nominal Target [1]	Direct Measurement evidence at location (dB LA90) [3]	Predicted noise contribution	
			Intermediate Location (dB LAeq)	Noise model with "as built" data (dB LAeq)
Abbots Close	48	<43	36	37
Sweet Briar (10 Acre wood)	48	<38	33	35
Longlands House	48	<42	42	43

Table 5: Summary of the measured and predicted contributions from the plant

The direct measured noise levels at the Abbots Close and Sweet Briar residential location clearly demonstrated the noise contributions from the plant are at or below the planning consent condition noise limit. The noise modelling methods (which use two different measured data sets) clearly demonstrate the conclusions drawn from the direct measurements of compliance is supported by these further evidential tests.

The measurements at Longlands house included noise contributions from the plant, but also from the other industrial sites within the area, most notably the BOC liquefaction plant. It has been concluded from the direct measurements that the noise contributions from the waste to energy plant are below the planning noise limit. This conclusion is further supported by the two modelling methods which demonstrate compliance.

9.0 Fuel Delivery Noise

As stated in the assessment methodology in Section 2.2 of this report, we have evaluated noise from fuel delivery events as a separate exercise. It is understood that fuel deliveries normally occur during the daytime only. For completeness and to provide for future operating flexibility we have considered the potential noise impact of night time deliveries also.

The delivery vehicles comprise closed sided articulated 40 ton lorries. Each is equipped with a moving floor for offloading the pre-chipped wood fuel. To offload the vehicle, the relevant fuel store loading bay door is opened, the rear doors of the trailer opened and the vehicle is manoeuvred so the rear of the trailer over hangs the fuel store offloading bunker. The vehicle drive engine is then set to high speed to power the hydraulic system driving the moving floor system. The offload takes some 10 minutes.

From an acoustic point of view the main noise contributions occur during the off load. The distances travelled and duration of the vehicle driving onto and off the site (via the weight bridge to record delivery size) is not material to the overall noise contribution of the operation.

The measured noise level was 78 dB L_{Aeq} , measured at 15M. This results in a nominal sound power level of 109 dB(A). Table 6 below provides the details of calculated noise contributions to each receptor location for a single lorry delivery and off-load. We would note that the noise contribution per delivery is the same during the night time and day time, however the planning condition noise limit is different – during the daytime it is evaluated over a 1 hour period but at night it is over a 5 minute period. We have therefore expressed the contributions against each reference period.

Location	Noise contribution per vehicle (dB $L_{Aeq, t}$)	
	Daytime (t=1 hr)	Night time (t=5min)
Abbots Close	19	27
Sweet Briar (10 Acre wood)	28	36
Longlands House	31	39

Table 6: Per Fuel Delivery Vehicle Contributions (normalised to planning consent reference time).

In order to determine the number of delivery lorry movements that would be accommodated within the planning consent noise limit, it is necessary to ascribe a plant noise contribution. Based on Table 5 in Section 8 above we have taken a conservative view on this plant noise contribution. Table 7 provides the conclusion.

Location	Plant noise contribution (dB $L_{Aeq, t}$)	Daytime		Night time	
		Per vehicle noise contribution (dB $L_{Aeq, 5min}$)	Limiting number of vehicles (per hour)	Per vehicle noise contribution (dB $L_{Aeq, 5min}$)	Limiting number of vehicles (any one time)
Abbots Close	38	19	>100	27	>100
Sweet Briar (10 Acre wood)	38	28	>100	36	12
Longlands House	43	31	20	39	3

Table 7: Maximum Number of Fuel Delivery Lorries

We would note that during the night time, the noise limit is evaluated over a 5minute period – hence it is the number of lorries unloading at any one time which is relevant, whereas during the daytime the evaluation period is 1 hour, hence it is the total number of lorries unload over a 1 hour period which is relevant. We would also note the assessment of number of vehicles has not taken

account of acoustic screening effects of multiple lorry offloading at the same time. In practice this means a higher number of offloads can be accommodated than indicated in Table 7.

It is understood the typical delivery schedule is for 6 vehicles per hour. The above assessment demonstrates the combination of plant noise contributions plus fuel delivery vehicles readily meets the overall site noise limit, with a margin for higher number of vehicles. We would note there are 4 delivery bays and hence, based on a 10 minute offload duration per vehicle it is possible for up to 24 deliveries to be made over an hour during the daytime and up to 3 at any one time during the night time. In practice the combination of acoustic screening provided by such a high density of HGV's within a small area and the physical and practical difficulties of achieving such a high off-load throughput makes such a situation both unlikely to occur and unlikely to result in exceedance of the planning noise limit.

11.0 Conclusions

The requirements of planning condition 12 applicable to the project have been assessed and reported as required by condition 13. The methodology outlined to demonstrate the plant noise contributions included obtaining three separate data sets to both directly measure and predict plant noise contributions to residential property. The measurements directly at the properties provided good direct evidence of plant noise compliance with the planning consent criteria which has been further confirmed by the two modelling approaches, each based on separate measurement data sets. Direct observation has concluded BS4142:2014 corrections for character (intermittence and tonality) do not need to be applied to the measured and assessed plant noise contributions.

The survey measurements were assisted by background and ambient noise levels lower than previously recorded at the residential locations. This was attributed to exceptionally low levels of vehicle movements on the M4.

Fuel delivery vehicle noise has been considered separately to plant noise. Based on a conservative assessment of plant noise contributions there is no material acoustic limitation to the number of offloads that can take place.

The evidence base substantiates compliance with condition 12 of the planning consent for the scheme.

APPENDIX 1 2019 NOISE MEASUREMENT SURVEY

1. Survey Details

Date: 14th / 15th February 2019

Personnel: Peter Brailey, Hawksmoor Engineering Ltd

Equipment: Rion NA28 Integrating sound Level Meter, serial number 00960044
Rion NC74 calibrator, serial number 00620354

Calibration: The sound level meters and calibrator have UKAS traceable calibration certificates. The sound level meter was check calibrated prior to and after measurements. No drift in calibration was noted.

Weather conditions: wind speed force 1 to 2, 5/8th cloud cover, no precipitation.

2. Measurement results

2.1 Abbots Close

Start time	End time	L _{Aeq}	L _{Amax}	L _{Amin}	L _{A10}	L _{A50}	L _{A90}
00:40	00:45	48.3	60.1	45.4	49.8	47.7	46.6
00:45	00:50	48.3	53	45.7	49.8	48	46.7
00:50	00:55	48.1	55.4	45.5	49.7	47.5	46.6
00:55	01:00	49.4	57.4	45.5	51.5	48.4	47
01:00	01:05	48.3	54.5	45.7	49.6	48	47
01:05	01:10	48.6	56.1	46.2	50	48.2	47.2

2.2 Sweet Briar (10 Acre wood)

time start	time end	L _{Aeq}	L _{Amax}	L _{Amin}	L _{A10}	L _{A50}	L _{A90}
23:27:05	23:32:05	44.6	64.3	41.4	45.4	44.1	42.9
23:32:05	23:37:05	43.2	51.6	40.4	44.6	42.9	41.7
23:37:05	23:42:05	43.1	47.3	40.0	44.3	43.1	41.4
23:42:05	23:47:05	43.4	49.3	40.4	44.8	43.3	41.8
23:47:05	23:52:05	43.2	46.8	41.0	44.2	43.2	42.2
23:52:05	23:57:05	43.3	52.7	40.8	44.4	43.0	42.2

2.3 Longlands House

time start	time end	L _{Aeq}	L _{Amax}	L _{Amin}	L _{A10}	L _{A50}	L _{A90}
00:01	00:06	50.2	63.9	45.8	52.6	49.0	47.2
00:06	00:11	48.9	58.3	44.4	50.6	48.6	46.5
00:11	00:16	52.2	73.1	44.6	51.1	48.8	46.1
00:16	00:21	52.0	72.1	45.0	52.3	48.4	47.0
00:21	00:26	49.3	72.9	44.4	50.1	47.9	46.2
00:26	00:31	47.5	60.5	42.7	49.3	47.0	45.1

APPENDIX 2: MEASUREMENTS AT INTERMEDIATE LOCATIONS

1.0 Survey Particulars

Date: 14th February 2019

Personnel: Peter Brailey, Hawksmoor Engineering Ltd

Equipment: Rion NA28 Integrating Sound Level Meter, serial number 00960044
Rion NC74 calibrator, serial number 34762402

Calibration: The sound level meters and calibrator have UKAS traceable calibration certificates. The sound level meter was checked calibrated prior to and after measurements. No drift in calibration was noted.

Measurement Procedure

The meter was located at two locations where it was subjectively

Plant Operating Conditions

The plant was operating at a stable 40MWe generator load (approx. 90% of rated duty).

2.0 Measurement Results

2.1 Edge of construction car park

time start	time end	L _{Aeq}	L _{Amax}	L _{Amin}	L _{A10}	L _{A50}	L _{A90}
21:53:59	21:58:59	50.2	56.6	46.6	51.7	49.9	48.6
21:58:59	22:03:59	49.8	57.5	46.2	51.2	49.5	48.0
22:03:59	22:08:59	49.4	58.5	46.4	50.7	49.1	48.0
22:08:59	22:13:59	49.3	55.1	46.2	50.8	49.1	47.4
22:13:59	22:18:59	49.7	55.9	46.8	51.1	49.3	48.0
22:18:59	22:23:59	50.1	56.6	46.4	51.5	49.9	48.1
22:23:59	22:28:59	50.2	57.5	47.1	51.3	50.0	48.6
22:28:59	22:33:59	48.7	58.5	44.1	50.3	48.3	46.6
22:33:59	22:38:59	49.2	54.8	46.4	50.4	49.0	47.8

2.2 East of site

time start	time end	L _{Aeq}	L _{Amax}	L _{Amin}	L _{A10}	L _{A50}	L _{A90}
19:58:47	20:03:47	57.2	63.1	53.8	58.3	57.0	55.7
20:03:47	20:08:47	57.7	63.2	55.2	58.8	57.6	56.6
20:08:47	20:13:47	58.0	64.2	54.9	59.4	57.7	56.4
20:13:47	20:18:47	58.2	64.0	55.1	59.4	57.9	56.7
21:18:47	21:23:47	58.2	72.7	53.8	59.9	57.5	55.7
21:23:47	21:28:47	57.8	65.3	54.0	59.3	57.3	56.0
21:28:47	21:33:47	56.6	62.7	53.5	57.8	56.3	55.2
21:33:47	21:38:47	56.3	60.9	52.8	57.6	56.0	54.8

3.0 Calculation of Contributions to Residential Locations

The measurements were at sufficient distance for the waste to energy plant acoustically appear as a point source, subject to selection of suitable distances and attenuations.

A. Apparent Sound Power Level

The apparent sound power level has been calculated using the following formula:

$$L_w = L_p + 20 \log R + 8$$

Where:

L_w = apparent sound power
 L_p = measured sound pressure level
 R = distance to acoustic centre of the site.

For the Car park measurements we have used a sound pressure contribution of 50 dB(A)

For the Eastern Location measurement we have used a sound pressure contribution of 57 dB(A)

We have assessed the acoustic centre to be approximately the south east corner of the main boiler house, this acknowledges the ACC is a dominant noise source. The distances are hence 180m to the car park and 145m to the eastern location.

The apparent sound power level is thus:

Car Park: 103 dB L_{WA}

Eastern location: 108 dB L_{WA}

B. Propagation to Residential Locations

In essence the same calculation can be undertaken to propagate the apparent sound power level, however ground effects and atmospheric absorption provide additional attenuation over such distances. We have used our experience of prior detailed modelling of comparable waste to energy schemes in estimating these attenuations, with the basis being the OCMA propagation model (which we have used for over 30 years in predicting power and process plant noise).

	Distance to acoustic centre (M)	Base sound power	Base sound pressure level (dB(A))	Allowance for ground effects and atmospheric attenuation (dB)	Net predicted Noise contribution (dB)
Abbots Close	480	103	41	5	36
Sweet Briar (10 Acre wood)	750	106	40	7	33
Longlands House	450	108	47	5	42

APPENDIX 3: External Plant Source Noise Level Assessment

The following sections review the measured site data against the design stage reported noise data (As per Mach Acoustic report). The Mach Acoustic data derived from BWV provided plant noise data and Mach Acoustic's modelling of the plant.

1.0 ACC

1.1 As Measured Assessment

Direct quantification of the noise output of an ACC is not realistically possible at site. Noise is primarily generated by the fans and to a lesser extent the steam distribution ductwork. Access to the underside of the fan deck (which is some 8 meters above grade) is not readily possible. The airflow velocities are also of a level where wind shear on the microphone becomes a material consideration close to the fans. The fan discharge airflow exits via inverted V configuration heat exchanges and access to the atmospheric side is not realistically possible. We would note the heat exchange surfaces provides significant attenuation to the fan discharge noise.

As a result of the above, we have found the only realistic approach is to accept the manufactures noise data (and we have not found any reason to disbelieve such data on any scheme of some 30 years' experience) and to undertake measurements on grade below the fan deck and estimate an apparent sound power level based on this sound pressure level.

	Overall dB(A)	Octave Band Centre Frequency (Hz)							
		31.5	63	125	250	500	1K	2K	4K
Measured sound pressure level at grade below ACC	75	81	76	76	74	66	64	62	60
Estimated Sound Power Level from grade measurement	105	(100)	(100)	(100)	98	98	96	94	90
Design stage assessment	105	83	89	94	97	98	98	95	-

1.2 Comment on significance of difference

The lower frequency octave bands are more difficult to establish from site measurements, hence they are included in brackets above as estimated values. The overall sound power level is however very comparable as are the mid frequency octave bands, which are the most significant for resultant noise levels at the residential property. We would note that lower frequency octave bands are very likely to be dominated by noise contributions from the vibrating ash conveyors within the building and not from ACC noise.

2.0 Fuel conveyor

2.1 As measured assessment

The fuel conveyor is a large noise source, but with the majority of the noise generated by the drive mechanism located at grade level adjacent to the fuel store building. We have used both the measurements obtained at this site and in-house detailed measurement evidence from other comparable sites, were the fuel conveyor (of a very similar type and size) was accessible, to determine the overall sound power level.

	Overall dB(A)	Octave Band Centre Frequency (Hz)							
		31.5	63	125	250	500	1K	2K	4K
Measured at 3M from drive	70.6	73.2	64.8	63.8	62	62.2	62.4	63.5	(66)
Measured at 10m from drive	62.6	69.6	63	58.7	53.7	55.1	56.5	56.6	56.6
Estimated Sound Power Level	91	100	94	90	85	86	86	86	86
Design stage Assessment	91	-	85	85	85	85	85	85	85

2.2 Comment on significance of difference

The overall sound power level estimated from the site measurements is very comparable to the design stage assessment basis.

3.0 Building Breakout

At the design stage, the building breakout via the cladding was calculated based on predicted internal noise levels and assessed cladding performance. The noise contribution via the ventilation openings was assessed based on the internal noise levels and the attenuations provided by the acoustic louvre banks mounted to the rear of the weather louvres.

Direct measurement of the noise levels external to the cladding is not possible – the ambient noise levels are significantly higher than the expected noise contribution via the cladding. However the physical size of the buildings result in a material contribution of sound power to the overall site total. Inspection of the cladding and ventilation louvres has confirmed (so far as we are able to determine) that these elements have been constructed as per the reported acoustic design.

We have modelled the noise breakout of the building based on the measured internal noise levels and the reported performance of the building fabric (with normal allowance for laboratory to site building element degrades).

The key matter to note is the internal noise levels are significantly lower than assumed at the design stage. The table below provides a summary.

Building area	Design stage internal noise level (dB L _{Aeq})	Measured noise level (dB L _{Aeq})
Boiler house		
Ground to 4 th floor	93 to 96	81
5 th to 8 th	"	76
9 th to roof	"	72
Steam turbine	90	93
FGT	93 to 96	80
Fuel store	80	65[1]
Transformer room / electrical building	80	65 [2]

[1]: Predicted from the loading bay door measured noise levels

[2]: Predicted based on experience of other comparable sites – access not possible to these areas on this site.

4.3 Comment on significance of difference

Clearly the internal noise levels are significantly lower than predicted, with only the ST building being marginally higher.

5.0 Secondary Sources

The above detailed noise sources comprise the dominant items on the site. There are a number of secondary noise sources, which we would comment on.

Stack outlet – This cannot be directly measured. We have reviewed the stack ID fan and attenuation provision and have concluded the design stage assessment data forms a reasonable basis for this modelling exercise.

Component coolers – The fin fan cooler noise results from the unit fans. The operation of the fans depends on both required thermal duty (ST load) and ambient temperature. At the time of measurement ambient temperatures were low – noise measurements indicated lower noise levels than the design stage data. We have used the design stage data in the modelling, as this represents worst case.

Export Transformer – It was not possible to obtain near field noise measurements of the main step-up 132Kv transformer. It was not audible or measureable local to the security fencing around the unit. In our experience it is very common for the design stage noise data to be a significant over estimate of the accrual noise levels for transformers. We would note that no tonal noise component was noticeable even local to the transformer. We have estimated the sound power level at 75 L_{WA}

Unit Transformers – it was not possible to gain entry to the unit transformer rooms. Externally the transformers were not measurable or noticeable. These sources are not material and have not been modelled.

Building Services External Plant – The Mach Acoustic report identified a number of external building services plant items. The overall sound power level of these items depends on the duty point of the ventilation and cooling systems and the ambient temperature. Measurements were made of a number of items which demonstrated lower noise levels than assumed at the design stage – this is considered to be a reflection of the duty points at the time rather than the plant being necessarily quieter. The design stage noise data has been used as part of the modelling.

Condensate pumps – These centrifugal pumps are located externally to the east of the ST hall and comprise duty and standby electric motor driven pump sets. Noise levels were 84 dB(A) @ 1M from the pump casing.

6.0 Predicted Residential Property Noise Levels

The table below details the predicted noise levels from each primary noise source. Propagation calculations have been undertaken to the OCMA / CONCAWE modelling techniques which we have used extensively for process plant environmental noise calculations for over 30 years. The model takes account of distance and screening effects as well as atmospheric attenuation and ground effects where the noise source is close to grade. A combination of octave band modelling and overall dB(A) modelling has been used depending on the significance of the noise source to the overall resultant noise levels at residential property.

Source (nominal sound power dB(A))	Calculated sound pressure level contribution (dB(A))		
	Abbots Close	Sweet Briar (10 Acre wood)	Longlands House
ACC (105)	33	30	39
Condensate pumps (102)	23	27	36
Component coolers (82)	15	13	19
Boiler House cladding (90)	26	21	27
Boiler house ventilation –	19	17	22

north(88)			
Boiler house ventilation – south (93)	18	9	21
ST building (95)	22	23	29
Condensate pumps	20	29	35
Export transformer (75)	4	-5	9
Stack outlet (98)	32	28	34
Fuel conveyer (91)	21	18	15
Fuel Storage building (87)	21	15	19
Admin block HVAC (95)	26	23	27
Total	37	35	43