Appendix 9-B

Calculation of Noise Emissions from the Energy Centre

Noise levels for typical plant that may be installed at the Energy Centres are shown in Table 9-.

Table 9-B1 Noise levels for plant typically used at Energy Centres

Equipment Source	Indoor	Lp dB(A)	Lw dB(A)
Plant Internal to Energy Centre			
Gas turbine air intake	Y	96	107
Gas turbine	Y	85	96
Steam Turbine Generator 1	Y	93	104
Condenser unit	Y	94	105
Boiler Feed Pump	Y	99	110
Air Compressors	Y	98	109
Circulating Water Pumps	Y	77	88
Condensate pumps	Y	80	91
Total Internal Lw			**115**
Plant External to Energy Centre			
Stack (after attenuators)		76	87

Plant to be installed at the Energy Centre has the potential to generate high levels of noise. Noise associated with the stack would typically be mitigated by fitting attenuators, as has been assumed in Table 9-. Most of the remaining plant will be housed within buildings and the building envelope would be designed to provide the required level of attenuation to reduce noise levels to acceptable outdoor levels at the closest receptor. The typical sound reduction index (Rw) that would be afforded by materials used to construct the Energy Centres is shown in Table 9-B2.

Table 9-B2 Sound Reduction Index (Rw) for commonly used Building Materials

Material	Rw
Single skin galvanized steel cladding roof	22
Double skin galvanized steel cladding with mineral fibre infill	38
150mm dense blockwork (1900Kg/m^3)	44
200mm dense concrete (2300Kg/m3)	55
100 mm lightweight blockwork fair faced	41
Cavity brickwork with ties	52

13mm acoustic laminate glazing	39
13/12/13 acoustic laminate glazing	45
Steel acoustic door set with perimeter and threshold seals	40
Roller shutter door	20

For the purposes of this assessment it has been assumed that the entire building envelope is constructed of metal cladding. This presents a possible worst case as a higher Rw can be achieved by selecting materials such as brick and block, or a combination of materials with air spaces between. All personnel doors are assumed to be of steel construction as well. A roller shutter door would typically have a lower Rw and therefore the Rw for the building envelope has therefore been assumed as 32dB.

The reverberant sound pressure level is calculated using the following formula:

$$SPL = SWL + 10LOG_{10}\left[\left\{\frac{Q}{S}\right\} + \left\{\frac{4}{R_c}\right\}\right]$$

Where: -

SPL = Internal Sound pressure

SWL = Internal Sound Power Level

Q = Directivity Factor (Q = 2 has been used)

S = Surface Area

Rc = Room Constant

Plant Sound Pressure Level Calculation

The Internal Sound Pressure Level has been calculated by logarithmic addition of the sound power levels for the various items of plant as follows:

Table 9-B3 Total sound pressure level for plant to be installed at the Energy Centre

Equipment Source	Distance	Total noise level	Lw	
	m	dB(A)		
Gas turbine air intake		96	107	50118723363
Gas turbine	1	85	96	3981071706
Steam Turbine Generator 1	1	93	104	25118864315
Condenser unit	1	94	105	31622776602
Boiler Feed Pump (HRB)	1	99	110	100000000000
Air Compressors (rotary & reciprocating)	1	98	109	79432823472
Circulating Water Pumps	1	77	88	630957344
Condensate pumps		80	91	1258925412

Total			**115**	**292164142214**
Stack (with attenuator)		76	87	501187234

Room Constant (Rc) Calculation

The Room Constant can be calculated from the following formula:

$$R_c = \frac{S \times \alpha_{Average}}{1 - \alpha_{Average}}$$

Where -

Rc = Room constant

S = Surface area of room in m^2

$\alpha_{average}$ = Average absorption coefficient

Table 9-B4 Room Constant (Rc) calculation

Lodge Hill Energy Centre										
ROOM DESCRIPTION		ROOM CONSTANT CALC FOR ENERGY CENTRE								
		SURFACE AREA M^2	**OCTAVE BAND CENTRE FREQUENCY**							
			63	125	250	500	1000	2000	4000	8000
WALLS		500.0	0.02	0.03	0.03	0.03	0.04	0.07	0.07	0.07
ROOF		200.0	0.02	0.03	0.03	0.03	0.04	0.07	0.07	0.07
DOOR		0.0	0.02	0.03	0.03	0.03	0.04	0.07	0.07	0.07
FLOOR		150.0	0.02	0.02	0.03	0.03	0.03	0.04	0.07	0.08
VENTS		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		850.0	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03
NOTES:		*ABSORPTION COEFFICIENT OF VENTS HAS BEEN IGNORED*								
ABSORPTION COEFFICIENT DATA			**OCTAVE BAND CENTRE FREQUENCY**							
	DATA SOURCE		63	120	250	500	1000	2000	4000	8000
WALLS	Engineering Noise Control, Bies and Hanson		10.0	15.0	15.0	15.0	20.0	35.0	35.0	35.0
ROOF	Engineering Noise Control, Bies and Hanson		4.0	6.0	6.0	6.0	8.0	14.0	14.0	14.0

DOOR	RAUVOLET acoustic-line Alumminium Door		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOOR	Engineering Noise Control, Bies and Hanson		3.0	3.0	4.5	4.5	4.5	6.0	10.5	12.0
TOTAL ABSORPTION			17.0	24.0	25.5	25.5	32.5	55.0	59.5	61.0
AVERAGE ABSORPTION			0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
ROOM CONSTANT			17.3	24.7	26.3	26.3	33.8	58.8	64.0	65.7
Total										**68.0**

Reverberant Sound Pressure Level Calculation

Table 9-B5 Reverberant sound pressure level calculation

	Energy Centre	TOTAL Lp 115 dB
	Room Constant	68.4
1	4/Rc	0.06
2	Q {Directivity Factor}	2
3	Q/{4X3.142X.r SQ}	0.0011
4	3 + 1	0.06
5	10 X LOG [4]	-12.7
6	SWL + [5]	102.3

The assumed Rw of 32dB for the building envelope has been used to calculate the external noise level for the Energy Centre. The following formula is used for this calculation:

$Lp_{(outside)} = Lp_{(reverberant)} – Rw – 6$

Therefore:

$Lp_{(outside)} = 102.3 – 32 – 6$

$Lp_{(outside)} = 64.3$ dB

The outside sound pressure level of 64.3 dB(A) and the stack noise of 76 dB have been used to predict the noise impact from the Energy centre at 50m, 100m, 200m and 300m. In accordance with BS4142 a 5dB penalty has been added to account for annoyance from any characteristic whine, whistle or tonal characteristic of the noise from the Energy Centre.

Predicted Noise Impact for Energy Centre

The predicted noise impacts from the Energy Centre are shown below.

Table Error! No text of specified style in document.**-A6 Predicted noise levels for Energy Centre with distance from source**

Equipment	SPL dBA	Penalty BS 4142	Total SPL (dBA)	L_{Aeq} at 50m	L_{Aeq} at 100m	L_{Aeq} at 200m	L_{Aeq} at 300m
Energy Centre							
External SPL	64.3	5	69.3	35.3	29.3	23.3	19.8
Plant External to Energy Centre							
Stack (after attenuators)	76	5	81	47.0	41.0	35.0	31.5
Total				**47.3**	**41.3**	**35.3**	**31.7**