Kintore Hydrogen Plant

Environmental Impact Assessment Report
Appendix 10.3: Operational Noise Assessment Methodology and Results

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Kintore Hydrogen
A STATERA COMPANY

Environmental Impact Assessment Report

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Appendix 10.3

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Table of Contents

List of Tables

1 Calculation and Modelling Inputs

1.1 Introduction

1.1.1 This appendix describes the approach and presents the results of modelling the operational noise sources of Kintore Hydrogen Plant. The environmental effects of the noise levels predicted by the modelling are assessed in Volume 2, Chapter 10: Noise and Vibration.

1.2 Data sources

1.2.1 Noise source data for the assessment has been based on manufacturers' data provided to the project team by the equipment manufacturers and/or project engineers.

1.2.2 Source levels have been supplied by the manufacturer for the broadband sound power level of the transformers.

1.2.3 In order to determine the specific sound levels resulting from the operation of the proposed development, a noise model has been built using SoundPLAN v9.0 noise modelling software. The model predicts noise levels under light down-wind conditions based on hemispherical propagation, atmospheric absorption, ground effects, screening and directivity based on the procedure detailed in ISO 9613-2:1996 [1].

1.3 Description of sound sources

1.3.1 The maximum design envelope parameters of the proposed development are detailed in Chapter 10: Noise and Vibration. From these parameters, the following main operational noise sources on the electrolysis plant site have been identified to model:

- H_2 compressors with sound power level (SWL) 119 dBA L_W.
- Cooling tower fans with SWL 89 dBA L_W.
- Cooling tower pumps with SWL 96 dBA L_W.
- Ground flare with SWL 114 dBA L_W.

1.3.2 Due to the high SWL of the H_2 Compressors, and the fact these would potentially operate on a 24/7 basis, these will be installed within a bespoke enclosure providing at least 25 dB attenuation.

1.3.3 The initial SWL of the ground flare, stated above, is based on the flare operating at its maximum capacity, which would only be to safely manage hydrogen release in an abnormal or emergency operating scenario. More routine flare use, to manage smaller hydrogen releases, would be with the flare operating at a reduced capacity, with a sound pressure level of <75 dBA at 1 m, equivalent to a SWL of 99 dBA L_W. This is the level that has been assessed.

1.3.4 Other more minor items of plant include HVAC plant, harmonic filters, rectifier / transformers.

1.3.5 It is likely that the majority of any noise generating plant/equipment at the water abstraction point and potential water treatment works will be below ground; however, to allow for a robust assessment to be completed, a single noise source has been included at each location with a SWL of 88 dBA L_W, which would be representative of an unenclosed pump or similar item of plant that may be above ground.

1.3.6 All plant has been set with an on-time of 100%.

1.3.7 Based on professional experience and review of available data, all sound sources are considered to produce sound with broadband frequency content.

1.3.8 Details on the sound power levels for various plant items used within the noise model are presented in Table 1.1. These are an indicative plant list representing an operating scenario within the design envelope parameters (described in Volume 2, Chapter 2: Project Description). The specific details of the plant items would, at a detailed design stage in due course, be designed to not exceed the overall rating level for operation that is established through this assessment.

Table 1.1: Noise model inputs for individual noise generating plant items.

Source	#	Height AGL (m)	Overall sound power level (dBA L_W)	Linear octave band sound power level (dB L_W)							
				31.5	63	125	25	500	1	2	4	8
External sources												
Ground flare	1	25	99		109.1	99.1	101.1	97.1	92.1	89.1	85.1	83.1
Cooling tower pumps	6	1	96		110.5	109.5	98.5	87.5	80.5	78.5	76.5	73.5
Cooling tower fans	6	6	89		82.6	90.2	91.7	85.7	80.7	80.7	78.2	76.7
N_2 generation & storage	6	0.5	85			70						
HVAC plant	12	1.5	66		59.6	67.2	68.7	62.7	57.7	57.7	55.2	53.7
Harmonic filters	1		70			70						
Distribution transformer	1	1	80		58.8	75.8	82.8	76.8	74.8	69.8	66.8	61.8
Net transformer with fan	1	1	80		56.8	73.8	80.8	74.8	72.8	67.8	64.8	59.8
33/400 kV transformers and switchgear	1	1	78		56.8	73.8	80.8	74.8	72.8	67.8	64.8	59.8
Rectifier / transformers	576	0.5	93		71.8	88.8	95.8	89.8	87.8	82.8	79.8	74.8
Internal sources: electrolysis building												
Electrolysis building	12	7.5	80 dBA L_{pi}		61	61	62	64	64	69	72	78
Cladding SRI	-	-	24 dB R_w		*15*	*16*	*19*	*23*	*26*	*22*	*39*	
Resultant SWL per unit area	-	-	75 dBA $L_{W''}$		106.4	95.4	86.4	78.4	72.4	79.4	66.4	113.4
Internal sources: $_H$2 Compressor enclosure												
H_2 compressor enclosure	6	16	88 dBA L_{pi}		90	94	91	83	83	81	80	74
Cladding SRI	-	-	24 dB R_w		*15*	*16*	*19*	*23*	*26*	*22*	*39*	
Resultant SWL per unit area	-	-	71 dBA $L_{W''}$		97.9	100.9	94.9	82.9	79.9	81.9	63.9	96.9
Water abstraction and discharge point												
Pump (or similar)	1	1	88		102	101	90	79	72	70	68	65
Blending point for export into National Gas existing National Transmission System												
Pump (or similar)	1	1	88		102	101	90	79	72	70	68	65

2 Results

2.1 Specific sound levels

2.1.1 The predicted specific sound levels at the identified most affected NSRs due to the operation of the Kintore Hydrogen Plant are provided in Table 2.1. Note that receptors representative of groups of properties are named for one property.

Table 2.1: Predicted specific sound levels at receptors

NVSR	Floor	Specific Sound level dB $L_{Aeq,Tr}$
Glenview	GF	36
	FF	38
Green Acre	GF	34
	FF	36
'Leylodge House'	GF	39
	FF	39
Leylodge School House	GF	36
	FF	37
North Leylodge	GF	36
	FF	37
Tillybin	GF	31
	FF	33
Womblehill	GF	22
	FF	25
Dalwearie / Deystone Clydesdales [a]	GF	33
	FF	32

(a) highest level presented, which is for Deystone Clydesdales. 20 dB $L_{Aeq,Tr}$ at Dalwearie

2.1.2 Figures showing the operational noise contours from the sound model are provided in Chapter 10: Noise and Vibration.

2.2 Assessment

2.2.1 An initial estimate of impact undertaken in accordance with BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (British Standards Institution [2], is shown in Table 2.2 and Table 2.3 for the daytime and night-time periods. Predicted specific sound levels for the day are taken at ground floor level with night-time level taken at first floor level.

2.2.2 Note that the two nearest existing residential properties at Dewsford are not included in this assessment as NSVRs, due to the committed mitigation concerning vacancy of these properties prior to operation, which is explained in Chapter 10.

2.2.3 The subjective method for determining rating penalties has been used to determine appropriate corrections for each receptor and assessment period. It is considered that the specific sound from the combined sources of the electrolysis plant will not be characterised as intermittent or impulsive, so no penalties have been applied for intermittency or impulsivity. As it is considered that the only source of tonal noise from the proposed development is from the transformers and the contribution from this source to the overall specific sound is negligible (23 dBA), it is most unlikely that noise levels at the nearby NVSRs would be perceived or characterised as tonal. As such, no penalties have been applied for tonality.

Table 2.2: BS 4142 assessment of impact (daytime)

NVSR	Background (dB $L_{A90,T}$)	Specific (dB $L_{Aeq,T}$)	Correction (dB)	Rating (dB $L_{Ar,Tr}$)	Difference (dB)
Glenview	33	36	0	36	+3
Green Acre	34	34	0	34	0
Leylodge House	35	39	0	39	+4
Leylodge School House	35	36	0	36	+1
North Leylodge	33	36	0	36	+3
Tillybin	34	31	0	31	-3
Womblehill	40	22	0	22	-18
Dalwearie / Deystone Clydesdales	35	29	0	33	-6

Table 2.3: BS 4142 assessment of impact (night-time)

NVSR	Background (dB $L_{A90,T}$)	Specific (dB $L_{Aeq,T}$)	Correction (dB)	Rating (dB $L_{Ar,Tr}$)	Difference (dB)
Glenview	29	38	0	38	+9
Green Acre	26	36	0	36	+10
Leylodge House	28	39	0	39	+11
Leylodge School House	28	37	0	37	+9
North Leylodge	29	37	0	37	+8
Tillybin	26	33	0	33	+7
Womblehill	31	25	0	25	-6
Dalwearie / Deystone Clydesdales	31	29	0	32	-2

2.2.4 The results of the initial estimate of impact in Table 2.2 and Table 2.3 are described in the following paragraphs.

2.2.5 During the daytime, the Rating Level is up to +4 dB above the background sound level at the most affected NVSR, the group of properties at receptor location 'Leylodge House', and +3 dB, at the next-most affected NVSRs, Glenview and North Leylodge. This is 1 and 2 dB, respectively, below the threshold level at which a moderate impact may result. At the other receptors, predicted rating levels are between 2 above and 18 dB below background sound levels.

2.2.6 At the most affected NVSR, the resultant daytime ambient sound level would be less than 55 dB $L_{Aeq,T}$ (baseline residual sound level of 42 dB plus Rating Level of 39 dB is 44 dB $L_{Aeq,T}$); as such, the resulting magnitude of impact would be negligible at this NVSR. Similarly, at the other NVSRs the resultant daytime ambient sound level would also be less than 55 dB $L_{Aeq,T}$ and the baseline plus Rating Level is lower; as such, the resulting magnitude of impact would range from no change to negligible at these NVSRs.

2.2.7 The results of the initial estimate of impact during the daytime are therefore indicative of negligible impacts at all receptors, depending on the context.

2.2.8 During the night-time, the Rating Level is up to 11 dB above the background sound level at the most affected receptor, the group of properties at receptor location 'Leylodge House'. This is, initially, indicative of a moderate to major impact at this receptor, depending on the context. At the other receptors, predicted Rating Levels are between 6 dB below to 10 dB above background sound levels. This is indicative of negligible to moderate impacts at all other receptors, depending on the context, with the exception of Womblehill which experiences no change.

2.2.9 However, at all NVSRs, the resultant night-time ambient sound level would be less than 42 dB $L_{Aeq,T}$; as such, the resulting magnitude of impact would be minor to moderate, depending on the context. At the most affected NVSR, Leylodge House, the specific sound level is 39 dB $L_{Aeq,Tr}$ and the baseline residual sound level is 31 dB $L_{Aeq,T}$; consequently, the resultant ambient sound levels would be 40 dB $L_{Aeq,T}$.

2.2.10 To accord with the guidance contained within BS 4142:2014+A1:2019 and provide a thorough assessment, consideration of the context of the scenario has been undertaken. Consideration of the context is provided in terms of the assessment of the absolute noise levels and the change in ambient sound due to the specific sound as addressed further on in this section.

Absolute noise level assessment

2.2.11 Rating Levels of 25 to 39 dB $L_{Ar,Tr}$ are considered to be very low to low (note that the 1997 revision of BS 4142 considered a Rating Level below 35 dB $L_{Ar,Tr}$ to be 'very low'). On this basis it is considered that, regardless of the background sound level, the risk for adverse noise impact is low. In this regard BS 4142 states:

"Where background sound levels and rating levels are low, 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."

2.2.12 With regard to absolute sound levels, the level for the onset of sleep disturbance during the night-time contained in the WHO published 'Night Noise Guidelines for Europe' [3] is 45 dB L_{Aeq} (at the façade), equivalent to a free-field level of 42 dB L_{Aeq}. As stated above, the maximum resultant ambient sound level would be 40 dB $L_{Aeq,T}$, i.e. 2 dB below the level for the onset of sleep disturbance during the night-time period.

2.2.13 In addition to low external sound levels, below the level for the onset of sleep disturbance during the night-time period, resultant internal sound levels, with windows partially open, would not exceed the NR20 octave band criteria, as summarised In Table 2.4 below. This provides a summary of the octave band external predicted specific sound levels at the most affected NVSR (Leylodge House), the attenuation provided by a partially open window, the NR20 criteria and the resultant difference.

Table 2.4: Internal sound levels

	Octave Band Specific Sound Levels (dB $L_{eq,T}$)						
	63	125	250	500	1,000	2,000	4,000
External level	56	48	41	34	30	25	9
Attenuation of open window[1]	*19*	*13*	*11*	*15*	*10*	*15*	*14*
Internal level	37	35	30	19	20	10	-5
NR20	55	44	35	29	20	17	14
Difference	-18	-9	-5	-10	0	-7	-19

Notes:
1.Based on data from Table 5-5 'Derived $D_{n,e}$ result for "200,000 mm^2" open windows' of NANR116: 'Open/Closed Window Research' Sound Insulation Through Ventilated Domestic Windows. [4]

2.2.14 On the basis of the above, although the NVSR Leylodge House experiences the highest Rating Level difference (+11 dB), the impact of the sound is found to be lower than initially predicted after consideration of the context of the sound, and the initial estimate of a moderate to major impact can be reduced to a moderate impact.

2.2.15 Table 2.5 below provides a summary of the final consideration of magnitude of impact at each NVSR for the daytime and night-time periods. Daytime impacts range from a magnitude of no change to negligible, resulting in negligible or minor adverse effects at medium sensitivity NVSRs. Night-time impacts range from a magnitude of no change to moderate, resulting in negligible to moderate adverse effects at medium sensitivity NVSRs.

Table 2.5: BS 4142:2014+A1:2019 assessment of impact

NVSR	Daytime	Night-time
Glenview	Negligible	Minor
Green Acre	Negligible	Moderate
Leylodge House	Negligible	Moderate
Leylodge School House	Negligible	Minor
North Leylodge	Negligible	Negligible
Tillybin	No change	Minor
Womblehill	No change	No change
Dalwearie / Deystone Clydesdales	No change	Negligible

References

[1] International Standard (ISO) 9613-2:1996 ‘Acoustics: Attenuation of sound during propagation outdoors. Part 2: General method of calculation.

[2] British Standards Institute. British Standard 4142:2014+A1:2019 ‘Methods for rating and assessing industrial and commercial sound’

[3] European Centre for Environment and Health. Night Noise Guidelines for Europe. World Health Organisation. 2009.

[4] The building performance centre school of the built environment Napier university. NANR116116: ‘open/closed window research’ sound insulation through ventilated domestic windows. 2007