Framework Agreement for Professional/Technical Consultancy Services

LCC/2014/0096 Preston New Road and LCC/2014/0101 Roseacre Wood:

Review of Regulation 22 Noise Submission

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1. Introduction

This report documents Jacobs review of the further noise information submitted by the applicant in support of two planning applications:

- LCC/2014/0096 for Temporary Shale Gas Exploration at land to the north of Preston New Road, Little Plumpton, Lancashire
- LCC/2014/0101 for Temporary Shale Gas Exploration at land west, north and east of Roseacre Wood and between Roseacre Road, Roseacre and Inskip road, Wharles.

The further information is set out in a report by Arup titled “Lancashire Shale Gas Exploration Sites, Regulation 22 Information – Noise. Reference AAc/230382-03/R03 Issued 3 March 2015” (hereafter referred to as the ‘report’). This report focuses on noise from drilling and hydraulic fracturing, and sets out: further noise measurements of the proposed drilling rig, revised noise models for drilling and hydraulic fracturing activities, additional mitigation measures and considers the acoustic character of the noise emissions.

The scope of this review has been agreed with Lancashire County Council, and considers whether:

- the input data used is appropriate, and is accompanied by an appropriate level of justification
- the source noise survey for the drilling rig has been appropriately conducted and reported
- the locations selected for measurement and assessment are appropriate
- the noise limits and significance criteria adopted for the assessment are appropriate
- the drilling operation noise predictions are appropriate and reproducible, by means of a noise model
- the appropriate conclusions are drawn from the assessment including an appraisal of any mitigation proposed, together with suggestions for additional mitigation

The review also provides outline recommendations for planning conditions where appropriate.

2. Noise Modelling

2.1 Overview

An overview of the proposed drilling rig, hydraulic fracturing pumps, ancillary equipment and processes is provided. This includes descriptions of proposed equipment, details on the number of each equipment, typical layouts, and for the drilling activities some detail on proposed operational procedures and methods of working. The primary sources of noise emissions are identified for both hydraulic fracturing and drilling.

2.2 Source noise data

Details of the noise measurements undertaken at the operational drilling rig at the Horse Hill site are provided in Appendix C1 of the report. This appendix provides information on:

- the equipment used for the measurements,
- the weather conditions during the survey
- measurement general procedure,
- measurement locations, and,
- a summary of the results.

The information provided is detailed and clear. The survey was undertaken by two experienced Members of the Institute of Acoustics, and included both near-field measurements of specific noise sources, and far-field unattended measurements of the overall drilling rig noise levels. Current calibration certificates for the monitoring equipment are given in Appendix D1.

No detail is provided regarding the conversion of the measured sound pressure levels to sound power levels attributed to noise emitting surfaces in the noise model, however, Arup performed a model validation exercise which indicates that the resulting noise model predicts noise levels that are in good agreement with those measured at nine locations around the Horse Hill site.

2.3 Methodology

2.3.1 Calculation Parameters

The ISO 9613-2 calculation methodology requires the selection of ground effect, air temperature and relative humidity parameters. In addition, there are software specific settings such as maximum search radiuses for noise sources when considering a particular receptor, the number of reflections from surfaces that are considered, and calculation tolerance allowances.

Arup detail the calculation parameters and software settings in tables 1 to 4 of their report. The calculation parameters reflect typical UK conditions, assuming an air temperature of 10°C, a relative humidity of 70% and no meteorological correction (a conservative assumption). Ground floor (daytime) and first floor (night-time) noise levels have been calculated at 1.5m and 4.0m above ground respectively; these values are commonly adopted for noise assessments.

2.3.2 Scenarios and Emission Data

A single operational scenario has been assessed for hydraulic fracturing, and another for drilling. The noise emissions applied to each source in the models are set out in Table 5 (hydraulic fracturing) and Table 8 (drilling).

Arup Table 5: Fracturing pump elements noise spectra – point source sound power levels.

Drilling Equipment	Octave band centre frequency, Hz								dB(A)
	63	125	250	500	1000	2000	4000	8000	
Fan	115	116	113	112	110	104	98	93	114
Pump	88	94	102	105	103	100	94	90	96
Engine	103	112	111	112	111	112	106	100	105

Arup Table 8: Drilling plant calibrated sound power levels per metre, dB

Drilling Equipment	Octave band centre frequency, Hz									dB(A)
	31.5	63	125	250	500	1000	2000	4000	8000	
Generator Sets	90	87	92	80	76	74	68	62	55	80.4
Generator Louvres	86	83	88	66	64	63	56	48	42	73.1
Mud Pumps	84	86	86	89	83	79	76	75	68	85.9
Shale Shaker	95	92	89	83	80	78	76	75	71	84.2
Drilling Rig	87	83	83	92	80	75	69	66	61	85.1
Drill Head	87	86	83	86	84	81	76	69	63	85.7
HPU	82	81	83	86	79	73	72	69	62	81.8
HPU Louvres	81	81	84	87	77	73	72	69	61	81.8

When Jacobs apply the A-weighting network to the spectral values presented in Table 5 for the hydraulic noise sources, we do not calculate the same broadband value as Arup for the pump and engine entries.

Table 2.1 Calculated broadband sound power level for pump

Frequency:	63	125	250	500	1000	2000	4000	8000	dB(A)
Linear Spectrum	88	94	102	105	103	100	94	90	
A-weighting	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.15	
A-weighted Spectrum	61.8	77.9	93.4	101.8	103.0	101.2	95.0	88.9	**107.4**

Table 2.2 Calculated broadband sound power level for engine

Frequency:	63	125	250	500	1000	2000	4000	8000	dB(A)
Linear Spectrum	103	112	111	112	111	112	106	100	
A-weighting	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.15	
A-weighted Spectrum	76.8	95.9	102.4	108.8	111.0	113.2	107.0	98.9	**116.9**

It can be seen that the broadband sound power levels calculated by Jacobs are considerably higher than those reported by Arup in Table 5, and when logarithmically combined, Jacobs calculate the total broadband sound power level of six fan/pump/engine sets to be 126.8 dB(A).

However, this seems to only be an error in Arup's reporting, since predictions of the unmitigated hydraulic fracturing noise conducted using the ISO 9613 broadband methodology with a source sound power level of 126.8 dB(A) yield similar results to those calculated at receptors by Arup.

The sound power levels used by Arup in the drilling noise model are based on near-field sound pressure level measurements made at the Horse Hill drill site in Horley, East Sussex. However, the sound power levels derived from this survey have been adjusted so that the far-field noise levels produced by the model correlate with more distant measurements of the Horse Hill drill site. The resulting 'calibrated' model results show good agreement with the measured values, with differences in the range -1.1 to +2.8. This gives confidence that the base noise model produced realistic results, and in fact predicts marginally higher noise levels at six of the nine measurement locations used for the calibration than were actually measured.

The dimensions of noise sources are not explicitly stated by Arup in the report, however, their Figure 3 provides a 3D projected view of the drilling rig model which clearly identifies each of the noise sources. Comparing this layout to photograph C1-1 which shows the drilling rig at Horse Hill from the perimeter bund, it is clear that the layout in the model is a good representation of the drilling rig.

2.3.3 Acoustic characteristics

Acoustic characteristics such as impulsivity, tonality and low frequency noise are discussed in section 4 of Arup's report.

2.3.3.1 Impulsivity

Impulsive events were identified during the Horse Hill drilling noise survey but are described as "occasional" rather than "regular". Based on this discussion, impulsivity is not portrayed to be a prominent characteristic of the noise, particularly for the fracturing operation.

It is noted that the term "regular" can imply that an event occurs according to a defined pattern, and it is not expected that impulsive events from such activities would ever be regular in this sense. For the purpose of this review it has therefore been taken to mean how frequently an impulsive event might occur.

Arup's Figure C1-4 which shows the time history of the noise levels recorded at NE corner of drill site on perimeter bund would appear to support Arup's view; it can be seen that for protracted periods of time the 1 minute samples show relatively small variation in level. If the drilling noise had a prominent impulsive characteristic, it would result in spikes in the time history which are not present.

However, with any form of construction, drilling or other open site activity, there will always be potential for impulsive noise events arising from activities. The Planning Practice Guidelines for assessing noise impacts from minerals extraction considers this and advises:

> *"Peak or impulsive noise, which may include some reversing bleepers, may also require separate limits that are independent of background noise (e.g. Lmax in specific octave or third-octave frequency bands – and that should not be allowed to occur regularly at night.)*
>
> *Care should be taken, however, to avoid any of these suggested values being implemented as fixed thresholds as specific circumstances may justify some small variation being allowed".*

It is therefore recommended that, should planning permission be granted, consideration be given to a condition limiting the number of L_{Amax} noise events exceeding a certain threshold level at night. The exact requirements of any condition should be carefully considered, as there are practical difficulties in measuring impulsive noise events, particularly at receptors which are near roads or other noise sources which may also generate impulsive noise.

2.3.3.2 Tonality

Arup discuss tonality in section 4.2 of their report. The discussion notes that the Spectrum Acoustics reports on hydraulic fracturing and drilling noise do not indicate that tonality was an issue and also reviews the measurements undertaken in close vicinity of the noise sources at the Horse Hill site. It was considered that subjectively that much of the plant had no tonal quality, but that the measurement results show tonal effects associated with the hydraulic power unit and radiated from the hydraulic pipework. It is stated that this could be readily mitigated if the tonal characteristics were to exist and be discernible at the nearest properties.

Measurements in the near vicinity of the noise sources are unlikely to replicate the frequency spectrum at sensitive properties some distance away, particularly if the noise sources are screened, as different frequency noise is attenuated at different rates. It is possible that the noise model could provide some indication as to whether tonal noise is likely at receptors, but even this should not be relied upon too greatly.

As the applicant claim that the potential source of tonal noise can be easily addressed if it turns out to be an issue, it is recommended that, should planning permission be granted, consideration be given to a condition to ensure tonal noise does not occur, with assessment based on the methodology set out in BS 4142: 2014.

2.3.4 Source Directivity

Source directivity is considered by Arup. The Spectrum Acoustics (SA) measurement reports for drilling and hydraulic fracturing set out approximate directivity corrections for the main items on site during these works. These corrections are in the range -1 to +3 dB for different equipment, with the greatest positive directivity being applicable to the drilling generators.

For the hydraulic fracturing noise model, Arup have applied a positive correction of +5 dB (i.e. increasing noise at receptors) which is substantially greater than the directivity corrections suggested by SA for any direction. These values have been determined so that the noise levels in the model match the far-field measurements conducted by Spectrum Acoustics, and are applied universally to the noise emission from these sources regardless of direction.

Arup have followed a similar procedure for the drilling noise model, although the corrections applied to the noise sources are based on their own measurements at Horse Hill. As discussed in section 2.3.2 above, the resulting noise predictions slightly over-estimate the noise levels at six of the nine measurement locations used to calibrate the model.

2.3.5 Low Frequency Noise

Low frequency noise (LFN) is discussed briefly in 4.3. The report concludes "*In view of the nature of the noise sources and the low levels of noise predicted it is concluded that low frequency noise is very unlikely to give rise to any adverse effect.*"

In assessing whether low frequency noise is causing a disturbance reference is frequently made to the document prepared for Defra "Procedure for the assessment of low frequency noise complaints" by Dr Andy Moorhouse, Dr David Waddington, Dr Mags Adams, published by the University of Salford. Within the objectives section, this document states:

> *"The procedure is intended to assist in the evaluation of existing problems. It is not intended as a means of predicting when disturbance might occur, for example in a planning situation and would not be reliable to use as such. This is because disturbance by LFN depends on a number of factors, such as the character of the sound, whose effects are neither well understood, nor readily predictable. Levels of sound above criteria based on the average threshold of hearing are frequently found to be acceptable and levels falling marginally below can occasionally cause disturbance, so no generic approach to prediction of disturbance appears to be possible"..*

Hence, whilst acknowledging the potential for low frequency noise disturbance may exist it is not considered that this should be a material planning issue.

2.3.6 Error

Sound power levels were reassessed based on Spectrum Acoustics perimeter measurements. This resulted in increased sound power levels of +5.0 dB for fracturing. A similar iterative 'reassessment' process was undertaken for the calibration of the drilling noise model.

It is considered that the orientation of the site equipment selected by Arup, assumed downwind propagation, reassessed sound power levels and consideration of the nearest façade should result in conservative noise predictions.

2.4 Mitigation

Noise mitigation measures are described in Section 3 of the Arup report.

For hydraulic fracturing noise, the solution proposed is a solid noise fence located 2m from the generators, 5m high and topped with a 1m return angled at 45° projecting into the enclosure. Predicted noise levels of 53dB and 52dB were reported for Preston New Road site and Roseacre Wood site respectively at the closest sensitive receptors.

For the drilling noise, the proposed mitigation measures are set out in Tables 9 and 10 of the Arup report. These are summarised as follows.

Table 2.3 Noise reduction measures

Mitigation	Benefit / noise reduction	Justification
7m high sound barrier around the main rig and hydraulic power unit	5dB(A)	Based on PowerClad17 system (900gsm) transmission loss data. The applicant's proposals are a more substantial system, so 5dB is likely to be a cautious estimate
Interventions to the hydraulic power unit (e.g. acoustic louvres); attenuators to generator exhausts, etc.	1dB(A)	Model includes a modest reduction for additional mitigation to various elements. BS5228-1 Table B.4 shows even an open sided shed (at the open side) treated with sound absorbing material will reduce noise emission by 1dB
Sound absorption in enclosures to drilling rig shale shakers (doors closed)	Source level reduced by 5dB	Horse Hill measurements were with shale shaker doors open; these would be closed. The BS5228-1 guidance on enclosures is as below
Sound absorption in enclosures to generators, including louvres	Assumed 4dB	Generators as measured were partially enclosed. Mitigation taken to be lower than the reductions quoted by BS5228-1
Enclosures to drilling rig mud pumps	No reduction included in the model but some effect expected	BS5228-1 Table B.1 5-10dB for engine enclosures BS5228-1 Table B.4 gives ≥6dB for partial enclosures (with sound absorption)
Rubber bushings to reduce pipework vibration	Not quantifiable but some beneficial effect expected	No reduction made in source noise levels. Any reduction would be over and above that assumed

Implementing these measures, Arup indicate that noise levels of 39dB and 37dB can be achieved at the closest receptor to the Preston New Road and Roseacre Wood sites respectively.

Jacobs have replicated these calculations using the ISO 9613-2 broadband method for point sources, and applying the claimed noise reductions of the mitigation measures to the source levels; this methodology is not as accurate as that employed by Arup as it doesn't take the geometry of sources into consideration, or self screening effects. Nonetheless, the result calculated by Jacobs for the mitigated scenario at Staining Wood Cottage is within 1dB of the level predicted by Arup.

It is considered that the noise reduction measures set out in Table 2.3 are reasonable. In particular, the calculation of noise barrier performance is based on an accepted International Standard methodology implemented in noise modelling software which is widely adopted in the UK. Similarly, the sound reductions assumed for the proposed generator and shale shaker enclosures are in accordance with the guidance set out in BS 5228-1. There is no reason to believe that these reductions cannot be achieved in practice, although it is noted that the barrier effect is dependent on geometry and if the drilling rig is arranged differently to the representation in the noise model then the barrier design may need to be altered accordingly.

A framework for a noise management plan is provided by the applicant in section 5. If it is decided to grant planning consent for the application, it is recommended that a noise management plan covering the areas identified in the framework be required by condition. This should include long tern noise monitoring to demonstrate that the noise levels predicted by the applicant are being achieved at noise sensitive receptors.

3. Assessment

3.1 Sensitive Receptors

The use of substantial noise barriers to control drilling and hydraulic fracturing noise raises the issue of the noise sensitive receptors considered by Arups. The locations of Staining Wood Cottages and Plumpton Hall Farm are the closest sensitive receptors to the development, and focusing on these sensitive receptors is therefore not unreasonable. However, screening effects from barriers may be reduced at dwellings on elevated ground in relation to the site, such as the dwellings at Great Plumpton to the north-west of the Preston New Road site.

It is therefore recommended that, if the applicant is granted planning consent, a noise limit condition be stipulated which applies to all dwellings rather than just the receptors selected for the noise assessments.

3.2 Significance Criteria

The report details that a noise level of 39dB at night can be achieved at the nearest noise sensitive receptor (Staining Wood Cottage) during drilling operations with the additional mitigation measures detailed in the report. The report references the WHO guideline of 40 dB $L_{night, outside}$ and quotes *"The LOAEL of night noise, 40 dB$L_{night, outside}$ can be considered a health based value of the night noised guidelines (NNG) necessary to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise."* The predicted noise level of 39dB is below the WHO guideline.

The predicted noise level of 39dB is also considered to be in accordance with Planning Practice Guidance which states that:

> *"For any operations during the period 22.00 – 07.00 noise limits should be set to reduce to a minimum any adverse impacts, without imposing unreasonable burdens on the mineral operator. In any event the noise limit should not exceed 42dB(A) LAeq,1h (free field) at a noise sensitive property".*

4. Conclusions

The applicants noise models for drilling and hydraulic fracturing noise have been revised using more detailed inputs, particularly in relation to the drilling noise based on a measurements of the actual rig proposed for the application sites. The adopted noise prediction methodology is appropriate, and is implemented in widely used noise modelling software.

The majority of the noise model inputs are clearly set out in the report, and simplified noise predictions undertaken by Jacobs using the same input data produce similar results to those calculated by Arup.

The proposed noise mitigation measures are considered to be practicable, and the claimed noise reductions achieved by each of the measures are based on guidance in International and British standards.

With the additional mitigation measures proposed by the applicant, it is considered that efforts have been made to reduce any adverse noise impacts that would arise from the drilling and hydraulic fracturing activities to a minimum. Furthermore, the resulting noise levels from the activities are considered to be in accordance with relevant government guidance.

If it is decided to grant consent to the application, it is recommended that planning conditions be set in relation to:

- Noise limits at noise sensitive receptors.
- Submission of a noise management plan based on the framework provided by the applicant in Section 5 of the report. This should include long term measurements of noise at sensitive receptors to demonstrate that any limit values are being achieved.
- Limiting the number of L_{Amax} noise events exceeding a certain threshold level at night.
- Requiring noise measurements to determine tonal characteristics, based on the methodology set out in BS 4142: 2014, and requiring the applicant to provide further mitigation if tonal characteristics are observed.