Update of noise model for proposed new re-liquefaction plant

Re-liquefaction Plant Noise Assessment

Dragon LNG Limited

Assignment Number: L300017-S05
Document Number: L-300017-S05-TECH-001

Xodus Group Ltd
Kenneth Dibben House
Enterprise Road, Southampton Science Park
Chilworth, Southampton
SO16 7NS
UK

T +44 (0)207 246 2990
E info@xodusgroup.com
www.xodusgroup.com

Integrated Services
Asset Support

Re-liquefaction Plant Noise Assessment

L300017-S05

Client: Dragon LNG Limited
Document Type: Technical Note
Document Number: L-300017-S05-TECH-001

			Phill Moxley pp	Simon Stephenson	Simon Stephenson	
R01	12/12/14	Issued for Client Review	LCP	SJS	SJS	
Rev	**Date**	**Description**	**Issued by**	**Checked by**	**Approved by**	**Client Approval**

Table of Contents

1 INTRODUCTION

Dragon LNG plans to install new re-liquefaction plant at its LNG site in Milford Haven, Pembrokeshire. The intention is that the new plant will operate instead of the existing CoGen plant, although there is a possibility that both plants could operate concurrently for a short period of time. Dragon LNG has requested Xodus Group to conduct a study of the impact that this change of equipment will have on noise levels at sensitive receivers in the community surrounding the site.

The technical note describes the methodology and results of the impact assessment due to introduction of the re-liquefaction plant to the existing environment and the eventual operation of the re-liquefaction plant alone.

In this report all sound pressure levels are quoted in dB re 20 μPa and sound power levels in dB re 1 pW.

2 METHODOLOGY

2.1 Approach

The objective of this study is to determine the effect of the introduction of new re-liquefaction plant at the residential receiver locations near the Dragon LNG site at Milford Haven. In order to do this, the existing acoustic model of the Dragon LNG site, including detailed modelling of the existing CoGen equipment, was utilised and the re-liquefaction plant added to the model.

2.2 Re-liquefaction Plant Sound Power Levels

The re-liquefaction project is at a preliminary design stage and therefore detailed specifications of equipment are not yet available. Dragon LNG has provided an equipment list and provisional layout drawing showing some equipment specification and the proposed location of the equipment.

Sound power level data used in the acoustic model was, where possible, derived from on-site measurements of similar equipment on other LNG and oil and gas sites. The sound power level of the compander enclosure, including the compander motor, was calculated based on the manufacturer's sound pressure level limit of 75 dBA at 1 m from the enclosure and the enclosure dimensions stated in the equipment list. Similarly, the sound power levels for the fin fan coolers and pumps were based on an assumed sound pressure at 1 m of 75 and 80 dBA respectively.

The equipment included in the acoustic model and the associated sound power levels are shown in Appendix A.

2.3 Noise Modelling

A computer-based noise model (using CadnaA software) has been developed to predict community noise levels. The detailed terrain model for the development area was based on digital mapping data from Ordnance Survey.

The source term levels (i.e. the calculated sound power levels of equipment) were entered into CadnaA to calculate the expected sound pressure levels in and around the site and in particular at the community receptors. CadnaA uses the propagation method described in CONCAWE Report No. 4/81, "The propagation of noise from petroleum and petrochemical complexes to neighbouring communities".

The Concawe report provides a method of calculating sound propagation outdoors in order to predict the level of environmental noise at locations from various sound sources. The document specifies an engineering method of calculating the attenuation of sound as a result of geometric divergence, direct absorption by the atmosphere, ground effects, refraction through wind gradients, reflection from surfaces and screening from obstacles etc.

Geometrical divergence relates to the way in which sound energy dissipates with distance. In general, sound decays at 6 dB per doubling of distance from a 'point' source, although this factor is modified close to the source by the source dimensions and near-field effects.

The ground interaction effect is a phase cancellation phenomenon caused by destructive interference of direct rays and those reflected by the ground. This effect is significant for a range of mid-frequencies over acoustically soft ground (e.g. grassland, ploughed fields etc.) but is less significant, and less frequency dependant over acoustically hard ground (e.g. concrete, water etc.). The actual ground profile between source and receiver may also modify this phenomenon.

Sound absorption by atmosphere involves a "real" loss mechanism in that a direct transfer of energy occurs between the acoustic wave and the constituents of the atmosphere. There are a number of different attenuation mechanisms involved concerning thermal and viscous losses and transfer of energy to nitrogen and oxygen molecules. This is a frequency dependant phenomenon, with the greatest effect occurring at high frequencies.

The model was set up assuming light winds (from source to receiver) resulting in Meteorological Category 6 for propagation from the site to the receiver locations. This is a worst case scenario and noise levels will be less than this under upwind and cross wind conditions, but it allows for comparison with measurement data obtained under conditions favourable for the propagation of sound from the site towards the receptors.

A 3D view of the noise model is shown in Figure 2.1.

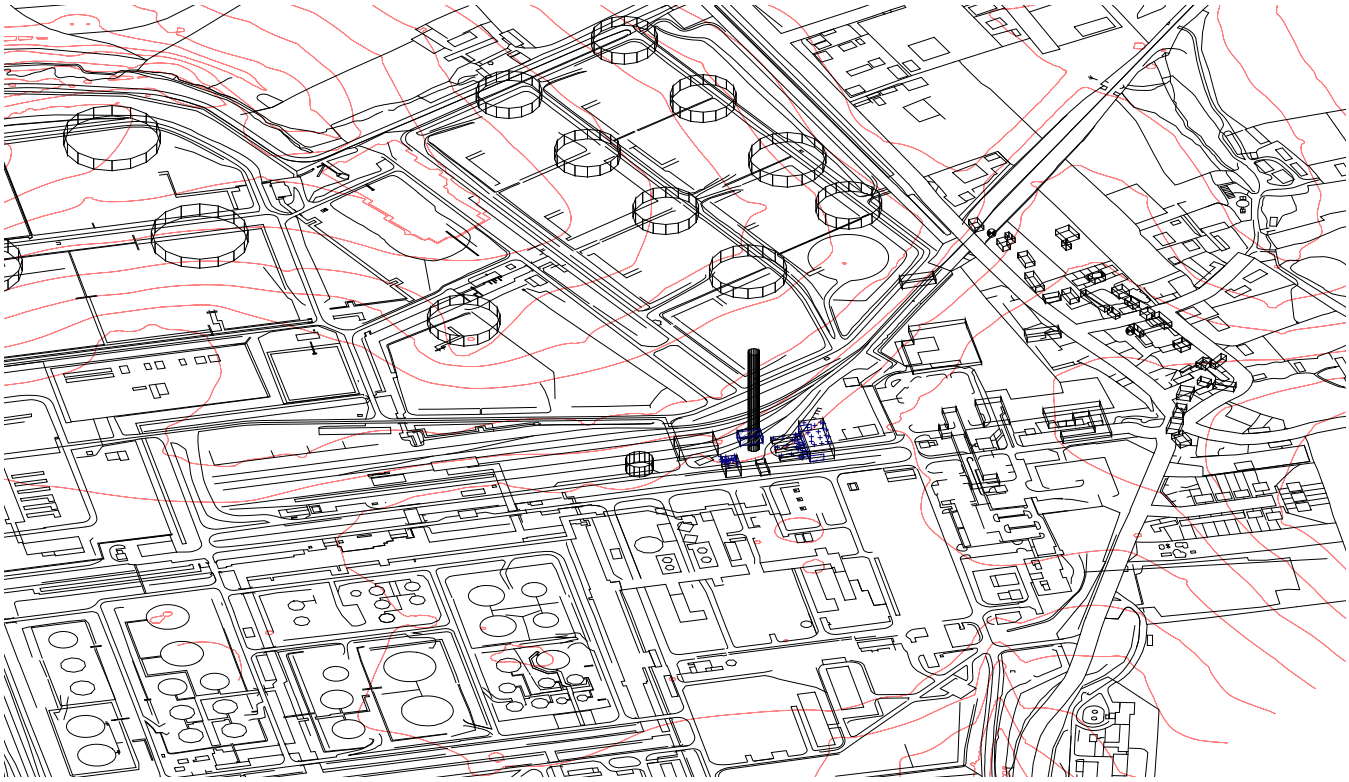


Figure 2.1 3D View of Noise Model

Sound pressure levels were predicted at five noise-sensitive receiver locations, as shown in Appendix B and listed below. These locations each represent a property within 2 km of the proposed location for the re-liquefaction plant.

The receiver locations included in the acoustic model were:

- Venn Farm
- Copybush
- No.2 Main Road
- No.20 Main Road
- Harbour View

For each receiver location, the model considered light downwind conditions from the re-liquefaction plant to that specific receiver location.

2.4 Assessment

The results of the model were compared with one another and with background noise levels which have previously been measured through attended and unattended surveys.

A BS4142 assessment was undertaken to give an indication of the effect of introducing the new plant in both of these scenarios. For the purposes of the assessment, it is assumed that both the CoGen and the re-liquefaction plant operate continuously 24 hours a day.

3 BASELINE NOISE

In order to assess the impact of the re-liquefaction plant, it is necessary to understand the existing noise environment into which the plant is installed. It is anticipated that the re-liquefaction plant will initially operate along with the CoGen plant, before CoGen is shut down. As such, two baseline noise scenarios have been considered in this study, with and without CoGen in operation.

Background noise levels have been obtained from attended and unattended noise surveys which have been carried out at the Dragon LNG site, further details of which can be found in Xodus reports L-300017-S03-TECH-003 and L-300017-S04-TECH-001. The background and ambient noise data taken from the Dragon LNG permanent noise monitor has been analysed to extract the sound pressure levels under light downwind conditions to the Main Road properties. Data measured at the other properties was obtained under light south-easterly wind conditions. A summary of the background levels that were used for the assessment is presented below:

Receiver Location		Background noise level dB L_{A90}		Ambient noise level dB L_{Aeq}	
		With CoGen	Without CoGen	With CoGen	Without CoGen
1	Venn Farm	36	*36***	38	*38***
2	Copybush	41	*40***	43	*43***
3	2 Main Road*	48	40	52	42
4	20 Main Road*	48	40	52	42
5	Harbour View	32	*32***	36	*36***
**Data from the Dragon LNG permanent noise monitor has been used to represent typical background and ambient noise levels at the rear of the properties on Main Road (i.e. facing the Dragon LNG site).*					
***Measurements of background and ambient noise during a CoGen shutdown are not available at these locations – data measured when the CoGen is operating has therefore been used as a proxy.*					

Table 3.1 Baseline noise levels with and without CoGen operating

4 ASSESSMENT

4.1 BS4142 Assessment

A BS4142 assessment of the future noise levels compares the rating level with the existing background level. The rating level is the specific sound level in terms of $L_{Aeq, T}$ plus a correction for certain acoustic features, such as tonality. It has been assumed that noise from the re-liquefaction plant will be designed such that it will not have any such features, thus the rating level is equal to the specific sound level. The BS 4142 assessment is shown in Table 4.1

Receiver Location		Background noise level dB L_{A90}		Specific noise level dB L_{Aeq}	Level Difference, dB	
		With CoGen	Without CoGen	Re-liquefaction plant	With CoGen	Without CoGen
1	Venn Farm	36	*36**	32	-4	-4
2	Copybush	41	*40**	40	-1	0
3	2 Main Road	48	40	36	-12	-4
4	20 Main Road	48	40	38	-10	-2
5	Harbour View	32	*32**	17	-15	-15
**Measurements of background data during a shutdown at LNG are not available at these locations – data measured when the CoGen is operating has therefore been used as a proxy.*						

Table 4.1 BS 4142 assessment for proposed new re-liquefaction plant

According to BS 4142, a level difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context, whereas a difference of around +5 dB is likely to be an indication of an adverse impact. 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

When the CoGen plant is operating, the level difference ranges between -1 to -15 dB. With the CoGen not operating, the rating level ranges between 0 to -15 dB. This indicates that the re-liquefaction plant will not have an adverse impact on environmental noise whether the CoGen is operating or not.

4.2 Absolute Noise Level Assessment

BS 4142 notes that it is not just the level difference that affects the impact of industrial noise, but also the absolute level of noise.

BS 8233 has been used for many years for general guidance on acceptable noise levels in and around buildings. The standard defines ‘good’ and ‘reasonable’ interior ambient noise limits for dwellings from intrusive external noise. According to the standard, an internal noise level in bedrooms of 30 dB L_{Aeq} is classified as ‘good’ and 35 dB L_{Aeq} is classified as ‘reasonable’. These internal noise criteria equate to external noise levels of 40 - 45 dB LAeq for good sleeping conditions (assuming 10 – 15 dBA attenuation through an open window). It should be noted that these levels are similar to those contained in World Health Organisation guidelines. The standard also suggests a desired garden and amenity area noise level of 50 dB L_{Aeq} or below and an upper limit of 55 dB L_{Aeq} for both day and night time periods.

The ambient noise level assessment is shown in Table 4.2. It is estimated that noise levels at Venn Farm and Copybush will increase slightly (by 1 to 2 dB). Given that a 3 dB change in noise is generally taken to be as the minimum noticeable change in noise level, it is unlikely that this slight increase in ambient noise will be perceptible. The noise level at properties on Main Road is expected to reduce by 10 dB when the CoGen is decommissioned, which is subjectively a halving in loudness. There will be no change in noise level for properties on Main Road when the CoGen is operating. Noise from the re-liquefaction plant will not affect the ambient noise levels at Harbour View.

Receiver Location		Baseline ambient noise level dB L_{Aeq}		Specific noise level dB L_{Aeq}	New ambient noise level, dB L_{Aeq}	
		With CoGen	Without CoGen	Re-liquefaction plant	With CoGen	Without CoGen
1	Venn Farm	38	*38**	32	39	39
2	Copybush	43	*43**	40	45	45
3	2 Main Road	52	42	36	52	43
4	20 Main Road	52	42	38	52	43
5	Harbour View	36	*36**	17	36	36
**Measurements of ambient noise data during a shutdown at LNG are not available at these locations – data measured when the CoGen is operating has therefore been used as a proxy.*						

Table 4.2 Ambient noise assessment for proposed new re-liquefaction plant

4.3 Uncertainties

As detailed information about the equipment is not yet available, the acoustic model of the re-liquefaction plant uses sound power levels measured on similar equipment and calculations based on assumptions (e.g. meeting an area noise level limit), rather than manufacturers data or measurements specific to the plant to be installed. Furthermore, the assessment assumes no source tonality or other acoustic features, which could potentially increase the rating level of the re-liquefaction plant sufficiently to exceed background.

5 RECOMMENDATIONS

In order to ensure that the potential impact from the new re-liquefaction plant is minimised, it is recommended that standard good practice noise control measures are implemented in the design from the outset. These are detailed below in general terms, although more specific recommendations will be provided once the design progresses.

5.1 Pipe Lagging

Depending on the type of compressor used, centrifugal and screw compressors can produce highly tonal noise which is then re-radiated via the pipework and support structures. It is therefore recommended that provision is made in the design for acoustic lagging of all suction and discharge compressor pipework. Initially, provision should be made (for weight and space) for Class B insulation according to ISO 15665, although it may be necessary to upgrade or downgrade this requirement at a later date, once manufacturer's data is received. Some manufacturers produce a combined acoustic and thermal insulation product which might be considered most suitable in this application.

5.2 Fin Fans

Fin fan cooler banks can often be a source of low frequency environmental noise. The sound power level of such units can vary considerably depending on the type of fan used. It is recommended that inherently low noise design fans are used for both the main cooler bank and lube oil cooler.

5.3 Recommended Noise Limits

Recommended sound power level limits for the plant are provided in Table 5.1, along with the equivalent sound pressure level at 1m. These are preliminary sound power level limits, which will prevent noise emissions from the development exceeding the community noise levels which have been predicted in the acoustic model. As the deign progresses, the sound power limits may become more refined.

Item	Sound Power Level Limit, dBA re 1 pW	Equivalent Sound Pressure at 1m, dBA re 1 20 µPa
LNG Pump	85	76
Compander Enclosure (external)	98	75
Fin Fan Coolers	99	75
Lube Oil Pump	83	76
Lube Oil Cooler	87	79

Table 5.1 Recommended sound power level limits for new re-liquefaction plant

6 CONCLUSIONS

An assessment of the noise impact of installing a new re-liquefaction facility at the Dragon LNG site has been undertaken. The re-liquefaction equipment has been added to the existing Dragon LNG model in order to assess the predicted noise levels against background levels.

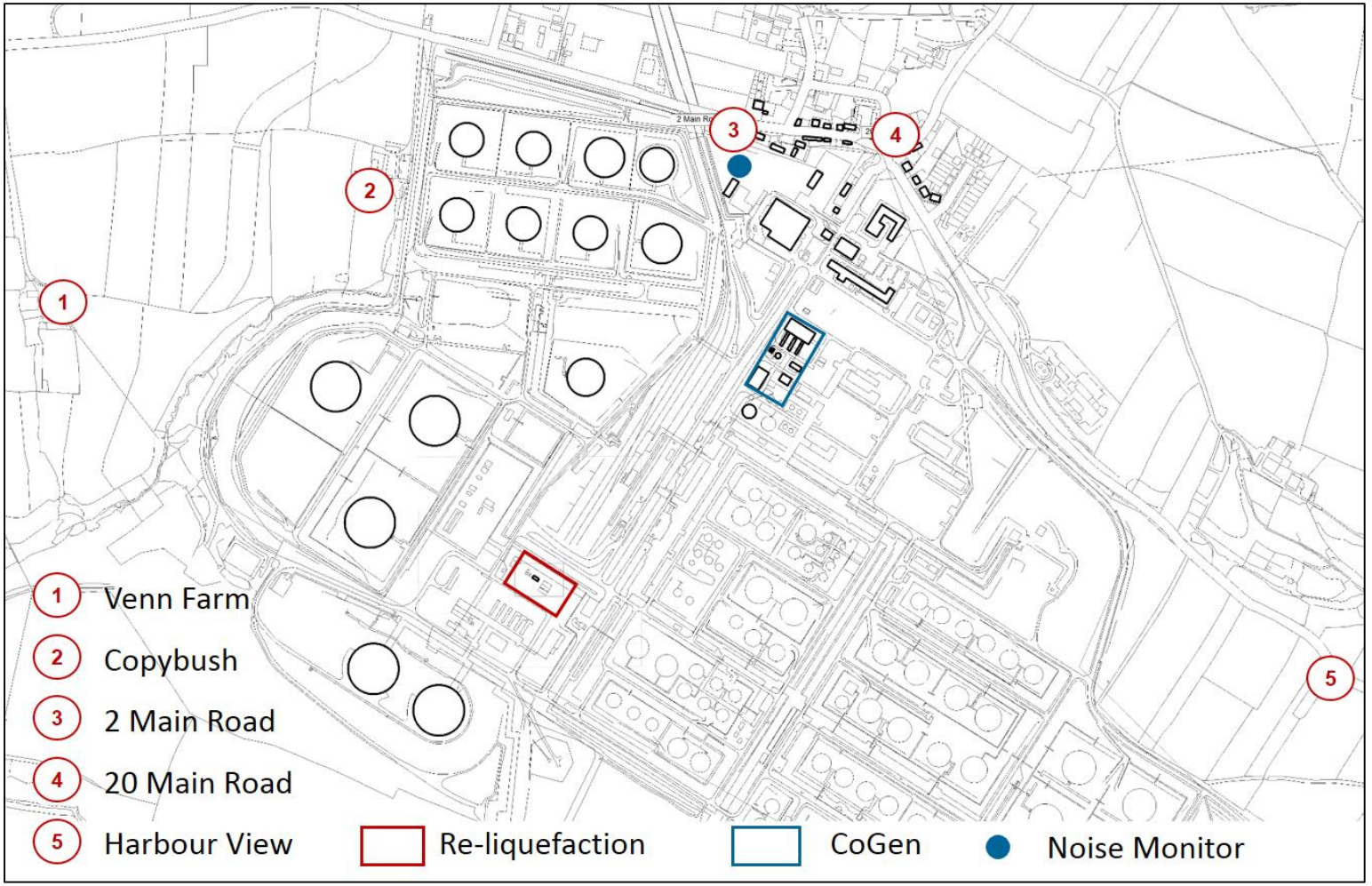
- Noise levels at each of the five residential receiver locations are expected to be lower when the re-liquefaction plant replaces CoGen.
- When CoGen and re-liquefaction are in operation simultaneously, there is not expected to be an adverse impact compared to CoGen operating alone.

APPENDIX A SOUND POWER LEVELS

Item	Overall L_w dBA	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
LNG Pump	**85**	74	75	76	78	78	81	78	74	68
Compander Enclosure	**98**	65	71	85	86	85	92	94	88	81
Fin Fan Coolers	**99**	-	89	95	99	97	94	90	83	76
Lube Oil Pump	**83**	81	83	78	77	76	77	77	75	68
Lube Oil Cooler	**87**	99	94	92	89	84	79	77	72	62
1st Stage Suction Pipework (per m)	**91**	41	47	53	59	65	79	86	87	77
1st Stage Discharge Pipework (per m)	**92**	39	45	51	57	63	77	86	88	84
2nd Stage Suction Pipework (per m)	**89**	36	42	48	54	60	74	84	85	76
2nd Stage Discharge Pipework (per m)	**90**	34	40	46	52	58	72	85	86	77

Table A1 **Linear octave band and overall A-weighted sound power levels of prosed new re-liquefaction plant as assumed in the model**

APPENDIX B SITE MAP


1
2
3
4
5
1 Venn Farm
2 Copybush
3 2 Main Road
4 20 Main Road
5 Harbour View
Re-liquefaction
CoGen
Noise Monitor