Noise Constraints and Coal Seam Gas Industry

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ABSTRACT

Environmental noise is a significant constraint upon the new burgeoning coal seam gas (CSG) industry in Australia. Upstream CSG leases cover a large area of Queensland and NSW on the eastern seaboard of Australia. The project scales are enormous and unprecedented, representing many billions of dollars in development costs and many thousands of gas wells and numerous major compression facilities, gathering and transmission pipelines, power generating plants, water treatment plants and other temporary and permanent infrastructure across a vast area.The proposed CSG developments pose significant challenges for regulators, proponents and acoustic engineers with respect to noise regulation, assessment, planning, temporary and permanent noise mitigation, suitable engineering solutions, ongoing maintenance and monitoring. The CSG industry also provides significant opportunities for acoustic engineers and researchers to develop professional expertise and acoustical knowledge.

INTRODUCTION

Environmental noise has emerged as a key constraint for the burgeoning new upstream coal seam (CSG) gas industry in Australia. The upstream portion of the industry is the aspect of the industry where the gas is recovered from the ground, separated from water and then compressed for transmission by pipelines for domestic consumption, or for transmission via pipelines to the coastal downstream LNG facilities. The downstream LNG facilities process the gas for export by ship to overseas countries in Asia and elsewhere.

The upstream industry covers vast tracts of land in predominantly rural areas which are sparsely populated and have very low background noise levels.

The development of the CSG industry provides a conflict between existing and future acoustic amenity, and existing and future economic benefits.

The government regulator and the community expect industry best practice to be applied to this new industry. For the acoustic engineer in a new industry, the challenge is to determine and develop what "best practice" actually represents for the CSG industry.

UPSTREAM CSG INDUSTRY

The upstream CSG industry is the gas recovery part of the industry and from an acoustical perspective comprises both fixed and variable components. Fixed components include: gas wells, field and central compression plants, water treatment plants, pump stations and power stations (permanent and temporary). Variable components include: construction (including fixed plant sites, well sites, laydown areas, ponds and pipelines), well development and maintenance (drilling, completion, work-over and hydraulic fracturing (fraccing)), flaring, pipe maintenance (pigging and venting), work camps and road transport.

ACOUSTIC CONSIDERATIONS

Background noise levels

Background noise levels measured at over twenty locations (Australia Pacific LNG 2010) across the Queensland Surat Basin gas fields demonstrated that the noise of insects generally dominates the background noise levels in all areas of the gas fields that are more than 1km distant from major roads for much of the year. The background noise levels when assessed as the Rating Background Levels (RBLs), in accordance with the methods of the *Planning for Noise Control Guideline* (Queensland Ecoaccess 2004), were typically indicated to be less than 20 dBA and often lower than 17 dBA (the electrical noise floor of the noise loggers).

Best practice baseline noise monitoring across the gas fields is conducted using one-third octave noise loggers. Best practice requires that the contribution of insects, birds and other extraneous noise sources can be identified, and where significant for each daily time period, may be filtered from the noise data to determine the RBL at the locality for each daily time period (Caley M & Savery J 2007).

Best practice background noise levels are based upon rating background noise levels rather than average background noise levels.

Best practice also requires that field weather stations are used to confirm the meteorological conditions that occurred in the area near the noise logger during the monitoring period.

Best practice presentation of noise data involves statistical time-history levels and the corresponding logarithmic frequency sonograms overlaid with meteorological conditions of wind speed, direction and precipitation.

Criteria

The approved noise planning guideline in Queensland for industrial and mining noise is the *Planning for Noise Control Guideline (EPNCG)* (Queensland Ecoaccess 2004) which has similarities to the NSW *Industrial Noise Policy* (NSW Office of Environment & Heritage 1999).

Under the EPNCG when the existing RBL is less than 25 dBA then a deemed RBL of 25 dBA is applied to an assessment. For the rural environment of the gas fields, the methodology of the EPNCG that attempts to prevent background creep results in a planning noise level of $L_{Aeq\ adj\ 1\ hour}$ 28 dBA at night, where "adj" refers to tonal or impulsive adjustments. For continuous fixed noise sources the night planning noise level is the limiting noise constraint.

This limit presents considerable problems for the community, the regulator and the industry since noise that is compliant with the noise limit may still be clearly audible and at levels that are perceived by a receptor to be unreasonable at large distances from the source(s).

The EPNCG also includes sleep disturbance criteria that recognises that short duration noise levels repeated 10-15 times per night period have the potential to cause sleep disturbance for receptors. The EPNCG sleep disturbance methodology is based upon the Max L_p parameter (Berglund B et al 1999).

At large distances from the plants, the noise may be audible with low frequency components. Low frequency noise limits may also be applied. Typical limits may be 60 dBC outside a dwelling and L_{Ceq}-L_{Aeq} < 20 dB (Hessler G 2004).

In such low noise ambient environments, the regulator has the problem of deciding whether noise limits should be applied to construction activities (daytime only) and also to well development (i.e. drilling) activities (twenty-four hours, seven days per week).

Construction is normally controlled in Queensland by limiting the daily construction hours from 6.30 am to 6.30 pm on Monday to Saturday and expecting that reasonable noise levels will result from the implementation of a suitable and approved CEMP.

It could be considered that well development is similar to construction but this notion is a fallacy since for 'block development' in such a quiet ambient environment, individual property owners may be exposed to well development noise for longer periods than may be expected for a typical construction activity (i.e. wells are typically drilled on.a nominal 750m grid).

The regulator in Queensland has responded to these issues with three forms of noise criteria where the criteria levels are related to the duration of the noise making activity. It is yet to be seen whether the proposed criteria are workable and can be considered "best practice" as far as acoustic regulation is concerned. Table 1 shows an example of the three forms of criteria (DERM 2011):

Table 1 Noise Limits

Time period	Parameter	Short term	Medium term	Long-term
7 am to 6 pm	$L_{Aeq\ adj\ T}$	45	43	40
	Max L_p	55	51	45
6 pm to 10 pm	$L_{Aeq\ adj\ T}$	40	38	35
	Max L_p	50	46	40
10 pm to 6 am	$L_{Aeq\ adj\ T}$	28	28	28
	Max L_p	38	36	33
6 am to 7 am	$L_{Aeq\ adj\ T}$	40	38	35
	Max L_p	50	46	40
Drilling 10 pm to 6 am	$L_{Aeq\ adj\ T}$	30 dBA measured indoors at any sensitive receptor		

Notes: T means 15 minutes

Short means < 8 hours and does not re-occur for 7 days

Medium means < 5 days and does not re-occur for 4 weeks

Long means > 5 days, even if respite periods included

Zone of impact

The noise of CSG fixed or variable plant often have characteristic tonal or low frequency characteristics and have been the source of noise complaints at times from community members at distances of more than 5 kms from the source.

The zone of impact is very dependent upon the existing meteorological conditions that occur during the night and early morning period and the degree of prior consultation that has occurred with the landholders.

Noise modelling

Best practice planning for the upstream CSG industry involves extensive noise modelling of noise sources.

Noise modelling is an invaluable planning tool because the noise limits are very low and achievement of compliance by engineering noise control design is very difficult for such large plants with multiple machines in a quiet environment.

The ISO (ISO 9613- 2:*1996)* and CONCAWE (CONCAWE 1981) Models are commonly used for noise modelling for planning or design purposes for all facets of the upstream CSG industry, as implemented in SoundPLAN software.

Noise models for fixed plant are developed during the EIS process using the best available source information. As the design development process occurs the noise models are updated and refined using the latest actual machine information, sound power levels and site layouts. Although it is common practice for the planners and engineers to view each individual facility as a single stand-alone project, the real skill of the acoustic consultant is seen when modelling the cumulative impact of multiple noise sources that are located in close proximity to each other and of achieving a suitable noise control balance for all contributing plants at each receptor location. In such instances to achieve compliance with the noise criteria for the cumulative impact from all sources, the noise control design can be extensive, complex and costly.

Best practice noise modelling involves confirmation of source sound power levels and validation of the noise modelling predictions by measurements at selected locations.

Noise modelling may also be conducted for the construction of pipelines and for construction of other infrastructure, ponds, laydown areas and well development, to assist the planning of the consultation to be conducted by Land Acess Personnel of the gas companies. The modelling also provides an early indication of the potential noise impact which may arise from the activity enabling suitable mitigation strategies to be developed.

In many cases the noise modelling is concerned with noise propagation over larger distances than are normally encountered in acoustic work, i.e. greater than 5 kms.

Best practice noise modelling requires validation by monitoring. Validation monitoring is not simple however and requires careful planning of instrumentation and monitoring locations. Complicating factors include the variability of meteorological conditions at distances from the source, the potential contributions of extraneous noise sources, such as insects, frogs and birds, and other fixed and variable mechanical sources that may also be operating concurrently with the source(s) of interest.

Noise control

Few, if any of the existing gasfield facilities, were designed to mitigate noise levels to comply with the new noise criteria. This means that there may potentially be a considerable requirement for noise control design and implementation of solutions for existing gasfield facilities.

Each proponent has its own view of what best practice operations mean for the gasfield compressor stations, and there are some differences between the various projects.

For fixed plant compressor stations, receiprocating compressors have generally been replaced with large electric motors, however in the short term no electricity is available and so temporary gas turbine power generation will be required (which will also require noise mitigation) until suitable power stations are constructed. The gas engine/motor is likely to be enclosed in a demountable, ventilated, enclosure with aerodynamic fan coolers for the process cooling.

Additional infrastructure, such as water treatment facilties, have generally been designed to achieve the noise criteria.

Best practice noise control for the fixed plants will therefore be known when the cumulative noise levels from the new compressor stations, power plants, water treatment plants and well-heads are shown to comply with the noise criteria.

It is likely that constructed field and processing plants, and water treatment plants may be non-complying after construction due to the strict noise criteria. If this occurs then it will inevitably mean further noise control costs for the proponents, potentially adverse community reactions to the CSG industry, and political pressures.

In many instances it is expected that determination of non-compliances will be difficult due the very low noise criteria and the cumulative effect of plant noise from multiple nearby sources and this will likely result in long delays in achieving further noise mitigation to comply with the criteria.

Best practice in regards to drilling rig noise emission levels is not yet known. Drill rigs are generally designed and constructed overseas and are not designed to comply with the very strict noise criteria being imposed in Queensland. The best practice drilling rigs are still being developed by the industry and the performance of such rigs will not be known for some time yet.

Noise monitoring

Best practice monitoring to confirm compliance of constructed noise sources (eg. compressor stations, water treatment plants), or to validate noise modelling of all sources (eg compressor stations, water treatment plants, well head plants, venting, flaring, drill rigs) requires a combination of close and more distant measurements using one-third octave measurement or logging instrumentation. Careful planning will be required because in many instances there will be multiple noise sources being measured at any location and at any point in time.

Best practice sound power measurements will be required close in to the sources to confirm component sound power levels. The field method for sound power measurement (ISO 3746:2010) will be difficult to implement because of the closeness of multiple sources. Sound intensity measurements are likely to be required to separate out the various source contributions.

For large machines conducting sound intensity measurements accurately will require careful procedures and instrumentation systems.

EDUCATION AND RESEARCH

The scale and expected duration of the upstream CSG industry provides many exciting opportunities for employment of acoustic engineers currently and in the future in Queensland and NSW.

The CSG industry will provide considerable opportunities for acoustics engineers to improve their knowledge and competency in environmental acoustics, noise modelling, applications of instrumentation and software, and particularly sound power level determination from field measurements and engineering noise control.

There are also great opportunities for tertiary engineering institutions to undertake significant research into the relationships between noise propagation over distances greater than 5 kms and meteorological effects.

Research to develop “quiet” drilling and fraccing rigs is also required.

Potential benefits for research into social acoustic factors related to noise annoyance in low background noise environments, low frequency noise and architectural noise mitigation strategies.

There is also need for work to update applicable standards and guidelines to represent actual “best practice” for the industry as “best practice” outcomes are developed and become a reality.

CONCLUSIONS

The scale and expected duration of the upstream CSG industry provides many exciting opportunities and challenges for acoustic engineers in Australia. The first challenge is to develop “best practice” in how acoustic engineers undertake assessments, planning, modelling, noise control design, validation and ongoing monitoring.

The second challenge is to assist the CSG industry to determine what “best practice” means for engineering developments, plant and equipment used in the industry and planning processes used by the industry.

The third challenge is to build and develop the acoustic industry by undertaking the training, research and development studies that will underwrite the health of the acoustic profession in environmental noise for many years to come.

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