NOISE CONSIDERATIONS IN THE DEVELOPMENT OF COALBED METHANE

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Abstract
A significant challenge for Coal Bed Methane producers is dealing with the impacts of high density development needed to effectively recover the natural gas resource. One such concern is the need to meet regulatory requirements for environmental noise as stated in the Energy Resources Conservation Board (ERCB) *Directive 038: Noise Control* (*ERCB Directive 038*) and Colorado Oil and Gas Conservation Commission (COGC) *Aesthetic& Noise Control Regulations, Series 800 (COGCC Noise Regulations)*. Anyone who has ever been involved in the process of complying with regulatory noise standards will agree that it is a complex and challenging task. Some regulated companies struggle through this process often dealing with unfamiliar considerations such as trying to predict facility noise levels before it is even built, or gambling on a best guess as to what is the right, least expensive amount of noise mitigation needed to meet regulatory requirements for environmental and occupational noise. Even the best of intentioned operators fail to hit the mark, sometimes by wide margins and end up with a situation that is potentially worse than when they started. No company wants to go through a process where in the end a lot of time, resources, and public confidence have been lost not to mention now being in a regulatory non-compliant status.

This paper will elucidate valuable lessons & experience learned and case histories for the successful approach to noise solutions accepted by regulatory agencies and industry clients. In addition to discussing the complexities of acoustical engineering practices this presentation will also cover the most significant points of *ERCB Directive 038* and *COGCC Noise Regulations*.

Introduction

The energy needs of North America are continuing to grow nearly exponentially and the desire to have clean energy options makes natural gas an obvious contender. Considering the maturity of conventional gas reservoirs in the Western Canadian Sedimentary Basin (WCSB) and Western United States, the most significant new source of natural gas are unconventional deposits found primarily in coal or shale seams. In the first few years of the new millennium, the base price of natural gas had been very low on the belief that there was an oversupply in the marketplace and incentives were towards renewable energy sources (NEB 2003). Although crude oil prices were rising dramatically, natural gas was not tracking this increase leading to a decline in exploration and replacement of reserves.

Change started to occur slowly largely on the hypothesis that carbon dioxide (CO_2) from the burning of fossil fuels was the sole driver in climate change (IPCC, 2007) despite the steadily growing volume of peer reviewed scientific literature demonstrating that CO2 is an extremely minor forcing at best (2 – 3%). Yet, this anthropogenic caused global warming view dominated in the media coverage and has for a time molded the development of government policy toward the reduction of CO_2 and indeed its reclassification as a pollutant.

Regardless, it is becoming increasingly clear that unless we intend to return to the dark ages, North America's energy must come from some non-renewable source given the limited production capabilities of the so called renewable options such as wind and solar. Deep conventional gas reservoirs can only deliver limited supplies and new pool finds that can satisfy the demand are not likely to be discovered in the continental basin. Hence the move to coal bed methane, a readily available source of clean natural gas that can go a long way to meeting the energy demands of North America. However, for coal bed methane to reach its potential operators must find innovative ways to overcome the growing concerns of nearby communities on the impacts of development such as environmental noise.

Coalbed Methane Background

Coalbed methane (CBM), also know as natural gas in coal (NGC), is natural gas that resides in coal deposits. CBM is largely composed of methane and requires minimal processing to meet sales gas specifications for distribution and use in household or industrial markets. (CAPP, 2006) CBM is generated during the coal formation process and is contained in the coal either by absorption to the coal substrate or as a free gas within the small fractures in the coal bed. Reservoir pressure holds the methane gas in place. (AGS, 2003b)

CBM can originate from wet or dry coal formations. Wet coals possess free liquid phase water within small spaces of the coal bed matrix. Dissolved solids of varying concentrations such as salts may be present within this water. Dry coals have little or no free liquid water, but may contain water in the vapor phase.

CBM is a potential natural gas resource from the sedimentary basins in North America with coal bearing formations such as: the WCSB in Alberta, Saskatchewan, British Columbia; the Powder River basin in parts of Montana, North Dakota, Wyoming; the Uinta basin in Wyoming; the San Juan basin in New Mexico, Colorado. (CSUG, 2008) The Alberta Geological Society estimated there is approximately 500 trillion cubic feet (tcf) of CBM in place in the WCSB. (AGS, 2003b) A recent presentation by Canadian Society for Unconventional Gas (CSUG) compared the CBM potential of the WCSB to other basin in North America. (CSUG, 2008) A summary of this information is shown in Table 1 and is illustrative of differences in CBM reserve levels, daily production, and drilling activity between each of the basins.

Table 1: CBM Potential in North America

Basins	**Potential Resources** (tcf)	**Daily Production** (mmcf/day)	**Production Wells**
WCSB	528	>700	>11,000 drilled
San Juan	85	~2000	>3,600
Powder River	39	~1000	>11,000
Uinta	10	280	>580
Raton	10	~160	>1,100
Piceance	99	4	40-50

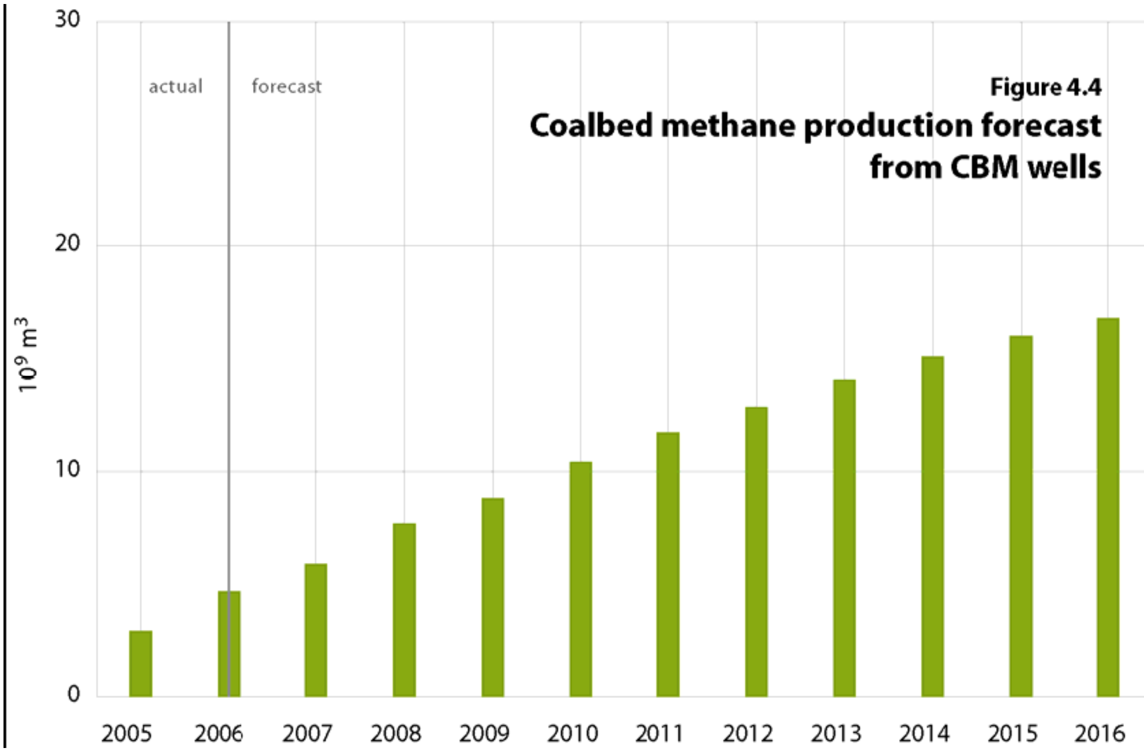
Source: CSUG. Unconventional Gas: Opportunities and Challenges. January 2008 Presentation

In Alberta, most of the CBM development to date has occurred in three coal zones of the WCSB: Ardley, Horseshoe Canyon, Mannville. At the beginning of 2005, there were 3575 CBM wells in Alberta producing less than 0.5% of the provinces total gas production for 2004. (EUB, 2005) Greater than 90% of the CBM produced at this time was from the Horseshoe Canyon coals, estimated to be more than 150 mmcf/day. (CAPP, 2006) Organizations such as the CSUG indicate that CBM is a growing source of natural gas in Canada (CSUG, 2007) where:

- more than 11, 000 CBM well have been drilled since 2001,
- production is projected to reach more than 700 mmcf/day in 2008,
- CBM could potentially be around 10% of future Canadian natural gas production.

In addition, an EUB generated forecast shows CBM production is expected to increase from 4.7 109 m3 in 2006 to 16.8 109 m3 in 2016. This would be an increase from 3 per cent in 2006 to about 13 per cent in 2016 of total Alberta marketable gas production. (EUB, 2007)

Figure 1: Coal Bed Methane Production Forecast



Source: EUB (ST) 2007-98: Alberta's Reserves 2006 and Supply/Demand Outlook 2007-2016.

CBM developments are similar to conventional gas projects with respect to the technologies and methods to drill, complete wells and operate the resulting surface production facilities. (CAPP, 2006) One key difference between CBM projects and conventional gas developments is that CBM production uses very low well producing pressures to optimize gas recovery rates. In Alberta, gas production per CBM well is less than 300 mcf/D. (CAPP, 2006) Therefore, CBM developments require immediate gas compression to transport produced gas in high pressure sales pipelines. CBM also needs multiple wells over large areas with greater spacing densities to economically recover the gas. In addition, the production life of a well is expected to be 20 to 40 years or more. This potentially intensifies the cumulative impacts of CBM, in particular, increased noise levels in the surrounding area.

Coalbed Methane Issues

As society has learned many times over, too much of a good thing usually carries some additional baggage. CBM development is no different in that regard and in some areas local communities have expressed a number of concerns about the potential and sometimes real impacts. There are usually three key areas of concern expressed about the exploitation of CBM, impacts to potable groundwater, size of the development’s footprint, and lastly the sensory effects on neighbours.

While preserving the quality and management of groundwater is a high priority we would like to concentrate on the other two impacts. The footprint can be expressed as the amount of land that is needed for the entire development process including well sites, access roads, pipeline gathering, dehydration, compressor stations, and other handling and disposition points. The more of these surface facilities the more land is removed from typical land use purposes such as agriculture, housing, and other industrial applications, also greater access to public lands, more traffic, security and safety concerns, etc. In addition there are other impacts associated with expanding developmental footprint like the potential for sensory effects including odours, visual aesthetics of industrial operations in a pristine locale, or light pollution, and of course industrial noise that may assault a previously quiet rural landscape.

Given our inevitable need for energy, CBM development remains one of the best available and secure options so industry will need to deal effectively with noise to reduce landowner concerns and streamline the regulatory process. Although occupational noise is certainly a consideration for industrial operators the focus of this paper is on the management of environmental noise, that which will impact on nearby residents.

Noise is generally viewed as one of a number of general biological stressors. It is felt that excessive exposure to noise might be considered a health risk as noise may contribute to the development and aggravation of stress related conditions such as high blood pressure, coronary disease, ulcers, colitis, and migraine headaches. While it is generally believed that there is no health risk from short term exposure to noise because the body has a chance to recover (DeGagne et. al., 2007). A little stress, as many people will attest, may be beneficial. There may be exceptions; for example, it is possible that repeated or constant exposure to noise can contribute to deterioration in health.

Whether or not environmental or industrial noise by itself can lead to health effects is hard to determine since there are so many other stresses to which people are exposed. This research is difficult to conduct and little has been done in this area. The research that has been conducted is growing and suggests a relationship between some long-term noise exposures and stress-related health effects. Physiological responses (bodily reactions) as part of a general stress response are triggered by impulses from the brain activate centers of the autonomic nervous system. Systems that may be affected include the glandular, cardiovascular, gastrointestinal, and musculoskeletal systems.

Although the noise generated by coal bed methane operations like compressors and cooler occurs twenty four hours a day most of the concern is with night time conditions. This stands to reason as during the day people may be away from their homes at work in another location or there are other sources of noise that will mask or be equally as loud as the production equipment needed to extract, treat, and transport coal bed methane. At night the big concern is with sleep disturbance. Probably the most significant contributor to a stress response due to annoyance from industrial noise for nearby residents is the formation of a sleep disorder or sleep disturbance.

Sleep disorder is a disruptive pattern of sleep that may include difficulty falling or staying asleep, falling asleep at inappropriate times, excessive total sleep time, or abnormal behaviors associated with sleep (Bronzaft, 2002). Noise typically affects sleep at roughly 30 decibels, or about the background noise from an air conditioner. The louder or more frequently noise occurs, the worse one's sleep will be.

Sleep disturbance is one of the major causes of annoyance due to noise. If it becomes a chronic problem, sleep disturbance may potentially lead to health disorders. Noise, of course, can make it difficult to fall asleep. Noise levels can create momentary disturbances of natural sleep patterns by causing shifts from deep to lighter stages. Noise may even cause awakening which the person may or may not be able to recall.

At levels of 40 to 50 dBA, some subjects have reported difficulty in falling asleep, frequently taking over an hour. The number of subjects having difficulty increases as the sound level increases. Studies have shown that at levels of 70 dBA or above, behavioral awakening will most likely occur. The temporal pattern of exposure (i.e., short or long duration) has a major effect on awakenings due to noise. Short signals have to be much higher in level to awaken people as a longer, steady noise.

Not all sounds of the same level are equally capable of awakening people (Kryter, 1994). The character of some sounds causes more people to awaken than other sounds at the same level. People living in higher background noise neighborhoods tend to awaken less than people living in quieter background noise neighborhoods.

The awakening effects of noise appear to be related to the time of occurrence of exposure during the night. The probability of awakening to noises of the same level is slightly lower within two hours after retiring than when it occurs later in the night. A person typically goes through a cycle of sleep which becomes progressively deeper, and the stages of this cycle may vary in length of time. These stages are reflected in physiological effects such as heart rate changes, vasoconstriction, respiration changes, electrodermal activity, and motor responses which are all sensitive to noise during sleep.

As seen in Figures 2 and 3. (adapted from a summary and analysis of recent experimental sleep data related to noise exposure) there is a relationship between frequency of response (disruption or awakening) and the sound level of an intrusive noise. In Figure 2, the frequency of sleep disruption (as measured by changes in sleep stage, including behavioral awakening) is plotted as a function of the Sound Exposure Level. Similarly, the frequency of awakening is shown in Figure 3. From these figures it is possible to predict the probability of sleep disturbance at a certain sound exposure level.

Figure 2: Probability of a noise induced sleep stage change.

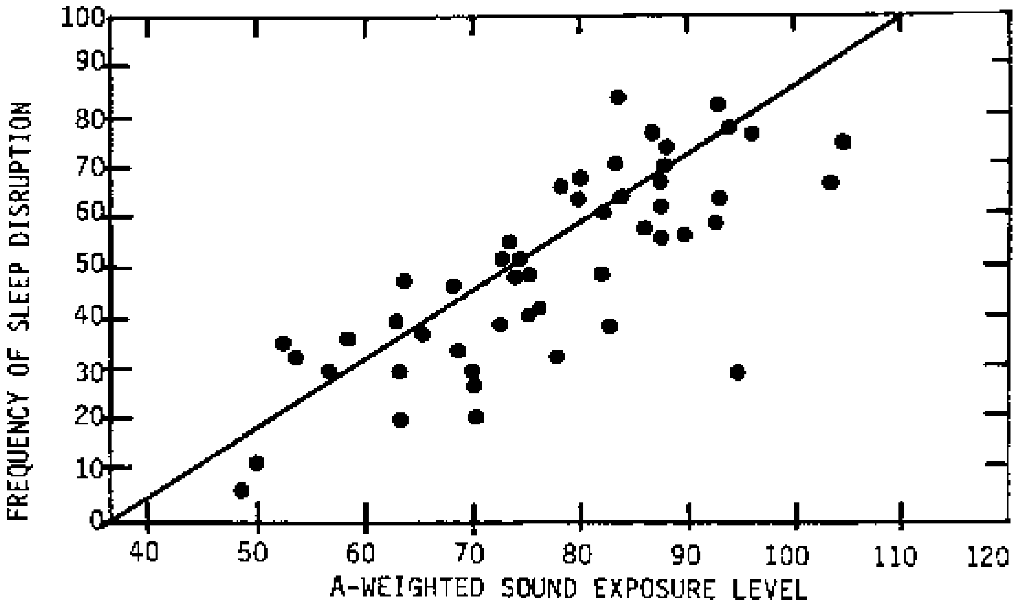
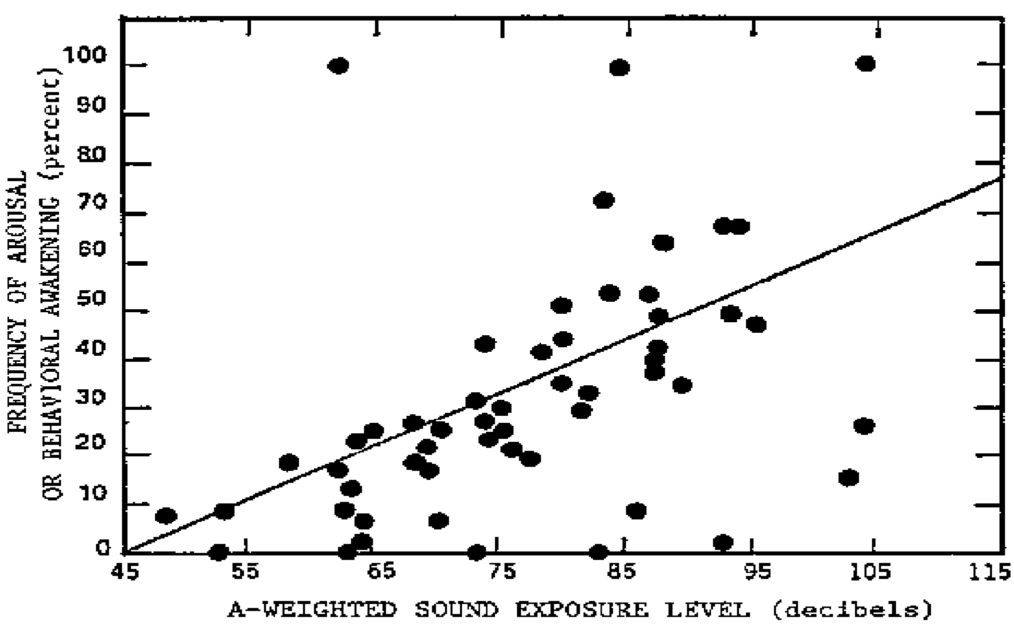


Figure 3: Probability of a noise induced awakening.



Generally, the higher the noise level the greater the probability of a response. Researchers (Passchier-Vermeer, 1993) found that there was a 5 percent probability of subjects being awakened by peak levels of 50 dBA and a 30 percent probability at 70 dBA. If the number of sound peaks increases, the person will take longer to fall asleep even if the average sound level decreases. However, continuous or very frequent noise throughout the night, even as high as 95 dBA, appears to cause little change in the average duration of the sleep stages. This occurs because disturbances to sleep stages are more likely to be caused by sound peaks that vary widely from the background ambient level than by high continuous levels alone. Inherently meaningful sound, such as one's name or sound that acquires meaning by instructions or conditioning, can awaken a sleeper at lower intensities than those required for meaningless or neutral sounds. Also, unfamiliar sounds may awaken people at a lower level than familiar ones.

Several investigators have reported that middle-aged women may be less sensitive to noise during sleep. In general, the older the subject, the more likely he is to respond to noise while sleeping. Young children, on the other hand, appear to be less affected by noise in all stages of sleep.

In some jurisdictions the impacts of environmental noise are well understood and consequently regulatory bodies have crafted legislation that serves to control noise emissions to acceptable levels. These regulatory instruments are instrumental to controlling noise as they provide industry with targets that are consistent providing a level playing field and in some cases opportunity for competitive edge in areas where noise is a significant community issue. Two excellent examples that take slightly different approaches are the *Energy Resources Conservation Board (ERCB) Directive 038: Noise Control (ERCB Directive 038)*, and *Colorado Oil and Gas Conservation Commission (COGCC) Aesthetic & Noise Control Regulations, Series 800 (COGCC Noise Regulations).*

Regulatory Noise Requirements

Energy Resources Conservation Board (ERCB) Noise Requirements. *ERCB Directive 038* outlines the noise control requirements for facilities and operations under the jurisdiction of the ERCB. The Directive applies to most projects involved in the production of oil, natural gas, oil sands, and coal resources in Alberta.

Directive 038 is descended from the original comprehensive environmental noise guidelines published in 1988 and was recently revised in February 2007. The review process was undertaken through the Directive Review Committee, which consisted of members of the public at large, professors from the University of Calgary and Alberta, industry representatives, government representatives, acoustical engineers, consultants, and ERCB staff.

The purpose of *ERCB Directive 038* is to provide noise requirements with clear expectations for compliance, technical standards, and consistent enforcement. The Directive focus is on the quality of life for human receptors near ERCB licensed facilities and to maintain acceptable indoor sound levels. Core principles of the Directive are:

- noise levels are measured at the point of receptor: the closest, most likely impacted
- A-weighted sound scale is used: similar to the frequency response of the human ear
- sound level increases must be kept to a minimum: not more than 5 dBA above ambient noise levels
- cumulative noise (energy related only) is included in compliance measurements

The Directive provides direction regarding the following compliance requirements.

Permissible Sound Levels (PSLs). This is the sound level that an ERCB regulated facility must not exceed at the nearest or most impacted residence. The PSL is an average A-weighted sound level over a nighttime period and is generally calculated by adding 5dBA to the average rural ambient sound (nighttime) in Alberta – 35 dBA. As shown in Table 2, the PSL is adjusted depending on the proximity of the residence to roads and higher population density. New facilities must meet a PSL of 40 dBA Leq (nighttime) at 1.5 kilometers from the facility if there are no closer residences. A daytime (7:00 to 22:00) PSL is calculated by adding 10 dBA to the nighttime (22:00 to 7:00) value.

Table 2. Basic sound levels for nighttime

	Dwelling unit density per quarter section of land		
Proximity to transportation	**1 - 8 dwellings; 22:00 - 07:00 (nighttime) (dBA Leq)**	**9 - 160 dwellings; 22:00 - 07:00 (nighttime) (dBA Leq)**	**>160 dwellings; 22:00 - 07:00 (nighttime) (dBA Leq)**
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

Source: Energy Resources Conservation Board (ERCB) *Directive 038: Noise Control*.

Low Frequency Noise. Low frequency noise (LFN) investigations must be conducted where a concern is identified. If the potential for LFN does exist, measurements must be conducted in both C and A weighted networks concurrently. LFN condition may exist when the dBC minus dBA is 20 dB or greater, and a clear tonal component exists at 250 Hz or lower. If LFN is confirmed then a 5 dBA penalty is added to the overall sound level and the licensees will be required to identify the potential source and outline an action plan to address the issue in a timely way.

Noise Impact Assessments (NIAs). These studies must be done by licensees for all project applications where noise emissions are expected. The purpose is to

- predict what the sound levels will be at the nearest (most impacted) residence before the facility is constructed or in operation
- ensure noise levels meet *ERCB Directive 038* requirements

Noise Complaint Investigations and Compliance. Licensees are expected to resolve noise complaints in a timely manner. A noise complaint form must be used before noise surveys are performed. ERCB will begin an investigation when a valid complaint is registered with the local ERCB Field Center. A facility is in compliance if the results of a comprehensive noise survey conducted at representative conditions are equal or lower than the established PSL.

Noise Measurement and Surveys. Components of a comprehensive noise survey and the specifications for measurement, instrumentation, monitor siting are outlined in the Directive. Key measurement requirements include:

- measurement instrumentation must measure A-weighted (dBA) continuous energy equivalent sound and meet international technical specifications for Type II sound level meters,
- instrument calibration requirements are included for sound meters in accordance with industry standards,
- wind speed and direction requirements are specified to ensure representative monitoring conditions,

- microphone position and orientation requirements are outlined (height, distance from dwelling).

Colorado Oil and Gas Conservation Commission (COGCC) Noise Requirements. COGCC noise requirements are stated in *COGCC Noise Regulations* and are applicable to drilling, completions and operations of oil and gas wells and production facilities in Colorado. The goal of the Regulations is to identify noise sources related to oil and gas operations that impact surrounding landowners, and to implement cost-effective and technically feasible mitigation measures that achieve compliance with the noise level requirements. Key principles of the *COGCC Noise Regulations* are:

- noise levels are measured at a set distance from the noise source,
- A-weighted sound scale is used,
- maximum permissible sound levels vary according to the land zone of the surrounding area.

Noise abatement requirements and permissible noise levels are specified in section 802 of the *COGCC Noise Regulations*. These requirements are highlighted as follows:

Maximum Permissible Noise Levels. These are the maximum noise levels that oil and gas operations and facilities must comply with in designated land use zones, measured at a distance of 350 feet from the noise source. These levels are presented in Table 3.

Table 3: Maximum Permissible Noise Levels

Zone	7:00 am to next 7:00 pm	7:00 pm to next 7:00 am
Residential/Agricultural/Rural	55 db(A)	50 db(A)
Commercial	60 db(A)	55 db(A)
Light industrial	70 db(A)	65 db(A)
Industrial	80 db(A)	75 db(A)

Source: Colorado Oil and Gas Conservation Commission (COGC) *Aesthetic& Noise Control Regulations, Series 800.*

Oil and gas facility operators are required to meet the same noise levels at existing residences within the 350 foot distance. If the oil and gas facility is located on land owned, leased, or otherwise controlled by the operator, the noise levels must be met at 350 feet or at the property line, whichever is greater. If the oil and gas activity is related to well site operations (drilling, completions, workover, etc) or gas facility installation, then the maximum permissible noise level for industrial zones is applied.

Low Frequency Noise. Low frequency noise (LFN) must be measured when an onsite inspection indicate it is a concern. A sound measurement must be recorded at the residence closest to the noise source using the dBC scale. In situations where the reading is greater than 65 dBC, the operator is required to conduct a LFN impact analysis and identify mitigative measures.

Noise Complaint Investigations and Compliance. An onsite inspection and sound measurements will be conducted by the COGCC upon receiving a noise complaint.

Noise Measurement and Surveys. Guidance for noise level measurement is provided in the Noise Regulations. Main items include:

- maximum windspeed is specified and wind screens required for sound microphones,

- microphone position requirements are outlined (height),
- measurements must be taken under conditions that are representative of the complaint circumstances,
- sound levels determined by averaging minute by minute measurements taken over a minimum 15 minute sample duration.

A cursory comparison of the two regulations indicates they are significantly different in the methodolgy to determine permissible sound levels and the location of the sound level measurement. *ERCB Directive 38* is a receptor-based system, where noise is measured at the location of the closest, most impacted resident, and the permissible sound level is generally derived from a base value which includes a 5 dBA allowance to the ambient sound level. The *COGCC Noise Regulations* is a source-based system, where noise is measured at a set distance (350 feet) from the source or at the property line (if the distance is greater than 350 feet and operator owns or leases the facility land), and maximum sound levels are specified for different land use zones

The other differences that should be noted are:

- *ERCB Directive 038* requires NIA's for all project applications where noise emissions are expected, the COGCC Noise Regulation does not.
- *ERCB Directive 038* requires noise measurements determined by A-weighted (dBA) continuous energy equivalent sound, whereas the *COGCC Noise Regulations* requires sound levels determined by averaging minute by minute measurements taken over a minimum 15 minute sample duration.

Notwithstanding the differences above, the two regulations share some common features:

- LFN must be measured if it is determined to be a concern. However, the methodology to classify when LFN is a concern is different between the two regulations.
- Landowner complaints trigger noise level investigations and compliance actions.
- No requirements for construction noise.

Key Decisions and Case Studies

EUB Decision 2006-102: CBM Project with Noise Control Conditions. EnCana Energy (EnCana) applied to the Alberta Energy and Utilities Board (EUB) (now the ERCB) for approval to construct and operate a 1000 kilowatt gas compressor and inlet separator at an existing compressor station to accommodate production from 15 new CBM wells in the Torrington area. A number of landowners and occupants from within the project area objected to the application due concerns ranging from groundwater protection to soil conservation and weed control. A key concern was the potential for excessive noise associated with an additional compressor.

The project area is within Township 32, Ranges 25 and 26, West of the 4th Meridian (W4M) and Township 33, Range 25 W4M. The nearest urban centre is the town of Torrington, about 3.2 kilometres (km) west of the project area. The nearest residence is located approximately 955 metres north-northwest of the facility and another residence is located 965 meters east of the site.

The existing facility equipment consists of an engine driven compressor unit housed in an insulated metal building. A Caterpillar Model 3516SITA engine drives the compressor and an externally located cooling fan is mounted in an Amercool Model 144VCI cooler.

EnCana proposed a new engine driven compressor unit to the facility housed in an insulated metal building. A Catapillar Model 3516SITA engine will drive the compressor and an externally located cooling fan is mounted in an Air-X-Changers Model 144EH cooler. The engine exhaust will be fitted with a Noise Solutions Zeron model exhaust silencer.

EnCana commissioned noise impact assessments and two monitoring surveys to measure the noise levels from the existing compressor and to predict the noise levels of the proposed compressor addition. The noise prediction model showed that the expanded facility would meet *ERCB Directive 038* requirements at both nearby residents, being as low as 30 dBA at the residence 955 metres from the facility.

EnCana had installed some noise attenuation equipment on the existing facility, including a new muffler and building ventilation. Five additional recommended noise control measures would also be implemented in order to reduce noise levels. These measures included:

1) enclosing the existing compressor building ground void, the cooler ground void, and the building skid with a Noise Solutions Inc. (NSI) compressor building skid enclosure;
2) installing an NSI acoustically treated building ventilation system on the building for the proposed compressor;
3) enclosing the proposed compressor building ground void, the cooler ground void, and the building skid with an NSI compressor building skid enclosure;
4) installing an NSI Box “T” silencer on the cooler inlet of the proposed unit; and
5) installing an NSI “L” style silencer on the cooler outlet of the proposed unit in addition to enclosing the exposed plenum walls of the cooler with an acoustically rated wall panel system.

EnCana indicated that these measures would consist of an additional mitigative measure for the existing compressor and four measures that would be allocated to the proposed compressor.

EnCana made a firm commitment that it would ensure that the expanded facility, if approved, would operate within the ERCB’s permissible sound levels (PSLs); in this case, 50 decibels (dBA) during the day and 40 dBA at night. EnCana made a further commitment to meet the predicted sound level of 25 dBA resulting from incorporating the five additional noise control measures.

The Board accepted EnCana’s commitment and conditioned the approval such that EnCana must demonstrate that noise from the expanded compressor be within 25 dBA at the residence 955 metres from the facility.

This case study demonstrates the increased concern by local landowners regarding excessive noise associated with CBM projects due to the need for additional compressor facilities. The outcome of this ERCB hearing illustrates the increasing expectations of landowners for noise control and the critical role of regulations to protect nearby residents from excessive noise emitted from CBM developments. Incorporating appropriate noise control technologies in CBM or other energy related facilities is instrumental to meet the expectations of nearby landowners and reach a common goal for all parties to create a quieter noise landscape.

Case Study: ProspEx Resources Site. In winter 2006, ProspEx Resources Ltd. (ProspEx), a rapidly growing, Calgary based Canadian Junior Oil and Gas company had proposed the development of a new facility to surrounding residents in Harmattan Alberta. The site was to include a Waukesha F3521GSI Engine with a 48" Cooler, a Hampton Engine and Cooler, a 125 HP Unit Cooler, an ALCO Heater and a 10 HP Electric ACE Cooler.

With the closest resident only 289 meters (SW) away from the proposed site, strict noise control regulations had to be met before ProspEx could go through with their development. The Noise Impact Assessment revealed that without the necessary noise control equipment, the noise impact for the resident would reach approximately 47.8 dBA. The *ERCB Directive 038*, allows for only 50 dBA during daytime hours and 40 dBA during nighttime hours.

Clearly, extensive noise attenuation was in order. The close proximity of the resident, as well as the high noise impact posed a problem for all involved, but ProspEx's commitment to meet the regulations and objectives required extensive noise mitigation equipment design.

ProspEx utilized only the highest-quality and superiorly designed equipment available. Among the many adjustments to the new facility, the engine exhaust muffler on the F3521GSI unit was replaced with Zeron® Engine Exhaust Silencer, and a full Cooler Silencer package was installed as well as an Engine Air Intake Silencer, Fan Forced Ventilation, a Purge Fan Hood, and Induced Draft Ventilation. The Heater Exhaust Silencer was customized to fit the ALCO Line Heater and Exhaust Pipe.

Also, Noise Solutions provided the 125 HP Cooler unit with a full Cooler Silencer package and Building Ventilation. The equipment was skillfully designed and installed, ensuring that all noise sources met required noise attenuation levels, including addressing any specific frequencies of concern. In the end the noise levels at the nearest resident(289 meters) was 35 dBA Leq night time, 5 dBA below the 40 dBA Permissible Sound Level (Noise Solutions Inc.).

Case Study: Trident Site. Trident Exploration Corporation (Trident) operates the massive Sandhills Gas Plant and is renowned for its leading-edge environmentally conscious techniques. Trident showed concern not only for its own efficient production, but also for the surroundings of its site.

Knowing that prolonged exposure to noise, like that being emitted from the Sandhills site, could cause resident discontent and even potentially detrimental health effects to nearby residents, Trident set out to address this issue and ensure the contentment of all involved.

As a Western-Canada based company, engaging in the exploration and development of CBM, Trident was focused on maintaining its reputation as an innovator in the area of environmentalism. Trident set out to go above and beyond the *ERCB Directive 038* compliance regulations and set a new standard of noise control in the oil and gas industry.

The Sandhills Plant proved a unique challenge, as its size and contents supplied many noise sources and frequencies to be dealt with. Through Trident's unwavering determination they were able to greatly exceed their objectives. The accomplishments at the Sandhills Gas Plant served not only to provide unparalleled noise attenuation, but also to show the entire Industry what was truly possible in noise control.

The Sandhills Gas Plant contained five separate compressor units each with a CAT3516TALE engine at 1340 horse power and an Air-X-Hemphill 144 ZF Cooler. Adding further noise complications were the Refrigeration and Amine Coolers also located on the site.

In order to fully attenuate all noise sources and frequencies on the location, Trident utilized the highest-performing equipment it could find that was further tailored it to meet its needs. On each of the five compressor units Trident installed Acoustical Compressor Buildings, Induced Draft Acoustical Building Ventilation Inlets and Fan Forced Acoustical Building Ventilation Outlets, ensuring superior cooling performance and noise attenuation. For each of the coolers, Horizontal Inlet and Outlet Silencers proved more than efficient at diminishing the excess cooler noise. For the two additional coolers, Inlet and Outlet Silencers were also used.

This expert combination of equipment and design customizations brought about an outstanding 19 dBA noise reduction going from 72 dBA to 53 dBA at a distance of 50 metres (Noise Solutions Inc.).

Current State of Noise Control Technology

The old adage that "Necessity is the Mother of Invention" could not be more true than in the case of environmental nose control for industrial applications. The necessity of course was spurred on by the increasingly stringent and comprehensive noise control regulations in socially responsible jurisdictions such as Alberta and Colorado. The invention is being provided by a few innovative free thinkers not hemmed in by the sides of a box containing conventional wisdom on noise control.

Today's noise control technology allows companies to meet almost any level of noise control necessary to be in compliance. The following is a short examination of the more common pieces of equipment used in CBM operations today.

Noise Impact Assessments. An NIA is an analytical examination of the sound potential of a facility, its significance relative to the regulatory limits, and what needs to be done to achieve the desired results. An effective NIA will have taken into consideration the steps below:

- work closely with lead engineering firm to provide the strongest results for clients,
- use template with meticulous attention to details providing high level of confidence that any proposed noise control equipment will meet or exceed the targeted noise levels reductions noted in NIA. A theoretical NIA will provide accurate noise levels at the nearest most impacted residences or point of interest as required by the regulatory jurisdiction in place,
- utilizes proper analysis instead of relying on rules of thumb,
- sound power data is derived from manufacturer's data, sound pressure measurements, or theoretical calculations,
- set PSL based on distance, dwelling density & proximity to transportation corridors,
- supply a detailed source order ranking table identifying the loudest sources for treatment.

Engine Exhaust Silencers. A muffler should completely silences engine exhaust noise and be coupled with these additional benefits:

- minimal system backpressure to keep your engines running at peak efficiency,
- internal acoustic treatment to eliminate radiated noise from the muffler shell,
- superior insulation that keeps the muffler cool for operator and visitor safety,
- corrosion allowance 5 times the industry average for superior longevity,
- integrated sacrificial anode for further corrosion protection,
- options of painted finishes,
- superior waste air dispersion to eliminate recirculation and improve cooling
- fireproof, waterproof, mildew resistant, noise reducing insulation,

- custom design capabilities for any size,
- rugged construction design for equipment longevity in the harshest conditions.

Cooler Silencers. Not all cooler fan silencers are created equal. Improperly designed and installed equipment can result in sub-standard noise control and interfere with the facility's overall performance. To ensure the best performance horizontal and vertical cooler fan silencers should offer:

- relocation-friendly design for when you need to move your facility,
- cooler tube bundle access panels for easy cooler maintenance,
- acoustic access doors for interior access while maintaining acoustic control,
- solid interior floors for operator and visitor safety,
- ensure minimal system backpressure and unimpeded cooler performance,
- improved cooler efficiency (air is directed across the entire cooling tube bundle),
- superior waste air dispersion to eliminate recirculation and improve cooling
- fireproof, waterproof, mildew resistant, noise reducing insulation,
- custom design capabilities for any size vertical or horizontal cooler,
- rugged construction design for equipment longevity in the harshest conditions.

Acoustical Buildings. Acoustic building requirements should be considered when your compressor package and associated building are being designed and fabricated. Because a typical compressor building is not built with acoustical requirements in mind, all the other noise control efforts on your site can be easily undone. A minor investment up front will save you costly retro fits in the field. Proper acoustic building design will include the following:

- perforated liner and special acoustic insulation,
- acoustic building ventilation,
- acoustic doors,
- no windows, roof panels or roof vents,
- your building will be quieter inside and out, with fresher cooler air inside.

Building Ventilation. Open doors and windows can undermine all other noise suppression efforts while doing very little to improve the building's interior airflow. Properly engineered and designed ventilation options will achieve the following:

- improved airflow for a building interior much cooler than from simply opening doors,
- elimination of the noise that would otherwise escape through open doors, windows and roof vents,
- back draft dampers allow operators to control the building's airflow,
- powered sites include staged thermostatically controlled ventilation,
- ventilation works in harmony with your gas detection devices,
- fast and simple to install, with no operational downtime.

Landscape Friendly Buildings. As an offset to the encroachment of CBM development and rural residential land uses, companies are designing their industrial sites to blend in with the local land use and erect aesthetically pleasing buildings to local communities. The buildings (see Figure 4) showcase architectural features that resemble the farm yard down the road. This pleasing design combined with effective noise control makes for a good neighbour policy that many coal bed methane operators are striving hard to establish.

Figure 4: Examples of Disguised Industrial Buildings

The above examples can be customized to meet any industrial application. Some clients have even requested to have small well site shelters look like large boulders or haystacks. There is no end to the creative level that can be achieved for a very small premium over the cost of a typical industrial version.

Conclusions and Future Actions

Coal bed methane development presents many challenges that all stakeholders must overcome. Environmental noise is one that can clearly be managed efficiently and in a cost effective manner. Companies that invest in state of the art noise control combined with a stakeholder consultation program that respects the community's needs and concerns will be able to operate harmoniously with regulators and neighbours alike, and may even reach a positions of being viewed as a valuable member of the community as opposed to a reviled invader disrupting the well being of the region. The choice seems simple and as demonstrated in the case studies very real in its outcome.

References

Alberta Energy and Utilities Board (EUB). 2005. “2004 Alberta Coalbed Methane Activity Summary and Well Locations”. EUB Bulletin 2005-15

Alberta Energy and Utilities Board (EUB). 2006. “2006. EUB Hearing Decision Report: EnCana Corporation Applications for Licences for 15 Wells, a Pipeline, and a Compressor Addition in the Wimborne and Twining Fields”. EUB Decision 2006-102.

Alberta Energy and Utilities Board (EUB). “2007. Alberta’s Reserves 2006 and Supply/Demand Outlook 2007-2016”. 2007. Statistical Series (ST) 2007-98”.

Alberta Geological Survey AGS). 2003. “2003a. Production Potential of Coalbed Methane Resources in Alberta”. Earth Sciences Report ESR 2003-04.

American Association of Petroleum Geologists. .2001. Various papers in the Special Publication "AAPG Studies in Geology #47.

Baliunas, Dr. Sallie. The Kyoto Protocol and Global Warming.

Bronzaft, A.L. 2002. Noise and Mental Health. Handbook of Environmental Psychology. Editors: R. Bechtel and A. Churchman. New York: John Wiley & Sons, Inc.

Canadian Association of Petroleum Producers (CAPP). “2006. Best Management Practices: Natural Gas in Coal (NGC)/ Coalbed Methane (CBM)”. CAPP Publication 2005-0040.

Canadian Society for Unconventional Gas (CSUG). 2007. Natural Gas from Coal Development in Alberta. February 2007 Presentation

Canadian Society for Unconventional Gas (CSUG). 2008. Unconventional Gas: Opportunities and Challenges. January 2008 Presentation

Chylek, Petr. 2002. “A Long Term Perspective on Climate Change”. Fraser Forum. April, page 7.

Croll, James. 1875. Climate and Time, Appleton & Co, New York.

Daly, John. The 'Hockey Stick': A New Low in Climate Science.

de Freitas, C.R. 2002. “Are Observed Changes in the Concentration of Carbon Dioxide in the Atmosphere Really Dangerous?”. Bulletin CPG. Vol. 50, #2.

DeGagne, D.C., Lewis, A. 2007. The Problem With Quantifying Health Effects Related To Noise Annoyance Levels. Paper presented at the Alberta Acoustical Society Spring 2007 Conference.

Essex,C. & McKitrick,R. Taken by Storm , Key Porter Books. ISBN 1552632121.

Gagosian, R.B. 2002. Abrupt Climate Change.

Goldenberg, S. B., Landsea, C. W., Mestas-Nunez, A. M., and Gray, W. M. 2001. “The Recent Increase in Atlantic Hurricane Activity: Causes and Implications”. Science. v.223, p.474-479.

Ernst-Georg Beck. 2007. "180 Years of Atmospheric CO2 Gas Analysis by Chemical Methods". Energy & Environment. Volume 18, Number 2.

Hansen and Sato. 2001. “Trends of Measured Climate Forcing Agents”. Proc. Natl. Acad. Sci. USA. Vol. 98, Issue 26, 14778-14783, December 18.

Hansen, Sato, et. al. 2000. “Global warming in the twenty-first century: An alternative scenario”, Proc. Natl. Acad. Sci. USA, Vol. 97, Issue 18, 9875-9880.

Hearing Rehabilitation Quarterly: International Noise Awareness Day, 1999.

Horner, Christopher C. The Politically Incorrect Guide to Global Warming. ISBN 978-1-59698-501-8.

Hoyt, Douglas V. & Schatten, Kenneth H.. 1997. The Role of the Sun in Climate Change. Oxford University Press. New York - Oxford. ISBN 0-19-509414-X.

Imbrie, John & Katherine. 1979. Ice Ages, Solving the Mystery. Harvard Un. Pr.

Intergovernmental Panel on Climate Change (IPCC) 2007. Climate Change 2007. IPCC Fourth Assessment Report.

Khandekar, M.L., Murty, T.S., and Chittibabu, P. 2005. "The Global Warming Debate: A Review of the State of Science". Pure Appl. Geophys. 162, 1557–1586.

Kryter, K. D. 1994. The Handbook of Hearing and the Effects of Noise. San Diego. Academic Press.

Leroux, Marcel & Comby, Jacques. 2006. Global Warming - Myth or Reality?: The Erring Ways of Climatology. Springer - Praxis Books.

Lindzen, Richard S. 2001. "The Press Gets It Wrong". WSJ.Com Opinion Journal. 11 June.

Lindzen, Richard S. 2001. Testimony before the Senate Environment and Public Works Committee. May.

Loehle C. 2007. "A 2000 Year Global Temperature Reconstruction Based on Non-Treering Proxies". Energy & Environment. 18, pp.1049-1058.

McBean, G., Weaver, A.,& Roulet, N. The Science of Climate Change What do We Know?.

McIntyre, S., and McKitrick, R. 2005. "Hockey Sticks, Principal Components and Spurious Significance". Geophys. Res. Lett., 32, L03710, doi:10.1029/2004GL021750.

McKitrick, R. 2002. "Asking the Right Questions About Climate Change and the Kyoto Protocol". Fraser Forum. February.

McKitrick, R. 2003. "Emission Scenarios & Recent Global Warming Projections". Fraser Forum. January.

Michaels, P. J., Knappenberger, P. C., and Davis, R. E. 2005. Sea-Surface Temperatures and Tropical Cyclones: Breaking the Paradigm. 15th Conference on Applied Climatology.

National Energy Board 2003, *Canada's Energy Future: Scenarios for Supply and Demand to 2025*

Passchier-Vermeer, W. 1993. Noise and Health. The Hague: Health Council of the Netherlands.

Pielke, Jr., R.A., C. Landsea, K. Emanuel, M. Mayfield, J. Laver, and R. Pasch. 2005. Hurricanes and Global Warming. American Meteorological Society.

Robinson A. R., Robinson N. E. and Soon W. 2007. "Environmental Effects of IncreasedAtmospheric Carbon Dioxide". Journal of American Physicians and Surgeons. 12, pp79-90.
Sarewitz, D. & Pielke, R. 2000. "Breaking the Global Warming Deadlock". Atlantic Monthly. July.

Segalstad, Tom V. 1995. The Distribution of CO2 between Atmosphere, Hydrosphere, and Lithosphere. University of Oslo.

Spencer, R.W., and J.R. Christy. 2003: Global Temperature Report, 1978-2003.

Soon, W., and Baliunas, S. 2003. "The Varying Sun and Climate Change". Fraser Forum. January.

Singer, S. Fred & Avery, Dennis T. 2007. Unstoppable Global Warming - Every 1500 Years. Rowman & Littlefield. ISBN 13:(978)-0-7425-5117-6/2pbk.

Svensmark, Henrik & Calder, Nigel. 2007. The Chilling Stars - A New Theory of Climate Change. Icon Books. ISBN 1840468157.

The Oregon Petition : signed by 2,660 scientists in related fields, and 12,140 others (as of May 2003).

Trenberth, K. 2005. "Uncertainty in Hurricanes and Global Warming". Science. Vol.308, pp.1753-1754.

Wiskel, Bruno. The Emperors New Climate. Evergreen Environmental Company Ltd. ISBN 0-9737643-0-9.