Forza Operating, LLC

Drilling Activities for South Hammock Project @ League City, TX

Environmental Sound Survey & Sound Impact Assessment

February 22, 2012

Project 764300

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EXECUTIVE SUMMARY

ATCO Noise Management (ATCO) was retained by Forza Operating, LLC (Forza) to help Forza ensure that it is able to comply with the relevant ordinances of the City of League City, Texas (the City) and to ensure that Forza’s operation remains in compliance with same, during the initial construction/drilling phase of the contemplated operations, as well as the long-term production of minerals from the League City site.

The relevant standard is found in the City’s Oil & Gas Well Drilling Sound Code, Sec. 42.138, limiting day and nighttime sound levels at the nearby Noise Sensitive Areas (NSAs) to the greater of Seventy (70) dBA or five (5) dBA greater than the ambient sound level during the day, and three (3) dBA greater than ambient at night.

Results of acoustical model reveal that unmitigated sound levels emanating from the proposed operation will likely be below the maximum allowed under the relevant ordinance. This report also includes ATCO’s sound mitigation recommendations such as placing the equipment, tanks, and portable buildings in a strategic manner and utilizing the rig equipment as sound barriers in order to further reduce the sound propagation from the site.

ATCO conducted the following operations: (a) one week-long environmental sound level survey; (b) near-field and far-field sound level measurements of the significant sound sources of a drill rig operationally identical to the rig that will be used at the League City site; and (c) generated sound propagation models for the specific site utilizing data from the site plan and the specific equipment list to show (1) sound levels from an unmitigated drill rig at the League City site, and (2) sound levels from a rig mitigated as described in Section 3 of this report.
1. INTRODUCTION

ATCO was retained by Forza to provide advice and assistance to ensure that Forza's drilling and potential production operations at the South Hammock drill site comply with relevant ordinances of the City of League City, Texas.

This report includes the following:

1. Results of an environmental sound survey conducted at the site from May 17 to May 24, 2011;
2. Sound propagation modeling results showing an estimate of the unmitigated sound contribution from the contemplated operations at the nearby NSAs;
3. Sound propagation modeling results showing an estimate of the sound contribution from the contemplated operations utilizing recommended mitigation measures.

1.1 Site Description

The drill site is located approximately 1,400 feet East of 720 Texas Avenue, North of Austin Street, and West and North of Robinson’s Gulley, in the City of League City, Texas. The area is rural in nature. Terrain is flat with some trees and brush located around the perimeter and in the Northern portion of the site. City drainage-ways lie to the South and East of the site. Figure 1, on Page 5, shows an aerial image of the site, identifying the property boundaries, four (4) nearby NSA’s, a nearby self-storage business, and location utilized for the ambient sound survey.
The well at the site will be drilled by a 1500 HP drill rig and a brief description of the rig equipment is as follows:

- 3 - 3512 CAT Engines with generators;
- 2 - fb1600 Mud Pumps w/ 2 752 traction motors on each pump;
- 2 - 50' l x 10' w x 9' h Mud Tanks;
- 26' Box on box sub;
- 1 - Draw works w/ 2 traction motors;
- 1 - 7040 Electric Brake;
- 1 - 142' Mast;
- 2 - 5000 lb Air Hoist;
- 1 - Accumulator w/ 1- Electric motor and 2 - air pumps;
- 1 - Double Ram;
- 1 - Single Ram;
- 1 – Annular;
- 1 - Choke Manifold;
- 1 – SCR House;
- 2 - Crew Houses;
- 2 – Shakers;
- 1 - Fuel tanks;
- 1 - Top House;
- 1 - Parts House;
- 1 - Change House;
- 1 - Top Drive House;
- 1 - Top Drive w/ traction motor;

Figure 2, on Page 7, shows the proposed equipment layout for the drill site.
Figure 2: Aerial picture showing the proposed equipment layout
1.2 Sound Criteria

Section 42.138 of the League City Oil & Gas Well Drilling Code governs “permitted sound levels” to the proposed drill site. In summary, it states that sound contribution from the drilling operations shall not exceed seventy (70) dBA during daytime and nighttime hours. The sound code also states that the operator may conduct a pre-drilling ambient sound survey to determine the background sound levels and if the background sound level is greater than 70 dBA then the sound contribution from the drilling activity shall not exceed the existing ambient by more than five (5) dBA during daytime and three (3) dBA during nighttime hours.
2. ENVIRONMENTAL SOUND SURVEY

ATCO conducted an environmental sound at the site from May 17, 2011, to May 24, 2011. The survey was the first part of the two-phase study requested by the City, the purpose of which is to control the sound levels associated with a potential permanent production facility that would be constructed and operated by Forza to facilitate the production, storage and transport of product from the site.

2.1 Measurement Location

Ambient Measurement Location: N 29° 30’ 25.03” W 95° 4’ 11.97”, shown on the image on Page 5, above

2.2 Measurement Methodology

Measurements were performed in accordance with ANSI standard S12.9-1993. “Quantities and Procedures for Description and Measurement of Environmental Sound, Parts 1 and 3”.

Sound level measurements were taken with a Brüel & Kjær 2250 Type 1 sound level meter set on both the A-weighted and Linear scales. The collected data included the energy equivalent level (L_{eq}) as well as statistical levels (L_{90}) logged in 1-minute intervals. As opposed to the L_{eq} levels, the L_{90} sound levels provide a “clean” description of the ambient sound level by excluding the intermittent sounds using statistical analysis.

The meter was calibrated at the beginning and end of the measurement session. The microphone of the sound level meter was set at 5 feet above the ground with a windscreen to reduce the effects of wind-induced sound while monitoring the long-term sound levels. Measured sound level data was recorded and stored on the equipment for later analysis at ATCO’s office.

2.3 Meteorological Conditions

Meteorological conditions at the site were also monitored using a nearby meteorological station (MD6282) located in League City, Texas. There was no precipitation during the survey period. Meteorological conditions were mostly within acceptable limits for outdoor sound measurement throughout the survey period except for some short intervals when the wind speed exceeded 11 mph. Appendix A shows the temperature, relative humidity and the wind velocity & direction for the entire survey duration.
2.4 Measurement Results

Figure 3, on Page 11, shows the graph of $L_{eq}$ and $L_{90}$ sound levels measured during the entire survey period. The $L_{eq}$ sound levels averaged 56 dBA during daytime and 50 dBA during nighttime. The $L_{90}$ sound levels averaged 46 dBA during daytime and 38 dBA during nighttime. The large difference between the $L_{eq}$ and $L_{90}$ daytime sound levels was due to the presence of high number of intermittent sound sources mainly traffic sound from FM 270. Both $L_{eq}$ and $L_{90}$ measurements show regular spikes between 65-70 dBA mainly due to the traffic sound.
Figure 3: $L_{eq}$ & $L_{90}$ Sound Levels (May 17-24, 2011)
3. SOUND PROPAGATION MODELING

Sound propagation modeling was conducted using the Cadna/A computer software program from DataKustik GmbH. The propagation calculations were carried out using ISO 9613, Part 1 standard: Calculation of the absorption of sound by the atmosphere, (1993); and Part 2: General method of calculation (1996).

Each sound radiating element is modeled based on its geometry and sound emission pattern. Concentrated sources such as exhaust outlets are modeled as point sources, which radiate sound spherically. Large surfaces such as diesel engine/generator casing were modeled as plane area sources. Water tanks, shale tanks, suction tank, fuel tanks and the surrounding storage facilities were modeled as obstacles to incorporate their barrier effect. Figure 4, on Page 13, shows a three dimensional view of the sound propagation model. The propagation calculation parameters are shown in Table 1.

The atmospheric condition affects the way sound is propagated from the source to the receivers. When the wind is blowing gently from the source to the receptor (Slight Downwind condition), the sound will be elevated above average over all wind directions. This condition was modeled to represent a conservative estimate of the sound levels at the potential receptor.

The number of reflections for the model was set to three. This means that three reflections from buildings and obstacles were allowed for individual acoustic rays during propagation calculations.

Table 1: Modeling Input Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Modeling Input and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrain</td>
<td>Generally flat; no topographic contours were included in the acoustic model.</td>
</tr>
<tr>
<td>Temperature</td>
<td>77°F</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>75%</td>
</tr>
<tr>
<td>Weather Condition</td>
<td>1) Slight downwind*</td>
</tr>
<tr>
<td>Ground Attenuation</td>
<td>0.6, rural area</td>
</tr>
<tr>
<td>Number of Sound Reflections</td>
<td>3</td>
</tr>
<tr>
<td>Receptor Height</td>
<td>5 feet above ground level</td>
</tr>
</tbody>
</table>

* Propagation calculations under the ISO 9613 standard incorporate the adverse effects of certain atmospheric and meteorological conditions on sound propagation, such as gentle breeze of 1 to 5 m/s (ISO 1996-2: 1987 and ISO 9613-2:1996, measured between 3 m and 11 m above ground) from source to receiver.
3.1 Equipment Sound Power Level

ATCO personnel conducted near-field and far-field sound level measurements of the significant sound sources at an operational drill rig that will be used for the drilling operations at the proposed well site. The sound power levels for sound sources at the rig were calculated from on-site sound level measurements using commonly accepted engineering methods and are presented in full octave-bands between 31.5 Hz - 8000 Hz in Table 2, on Page 14, order ranked from highest to lowest overall dBA sound power level.
### Table 2: Equipment Sound Power Levels (dB re 1x10⁻¹² W)

<table>
<thead>
<tr>
<th>Sound Source</th>
<th>Octave-Band Center Frequency, Hz</th>
<th>Number of Sources at the rig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31.5</td>
<td>63</td>
</tr>
<tr>
<td>CAT 3512 Engine Casing</td>
<td>104</td>
<td>115</td>
</tr>
<tr>
<td>Power Generator</td>
<td>101</td>
<td>106</td>
</tr>
<tr>
<td>Fuel Pump</td>
<td>103</td>
<td>110</td>
</tr>
<tr>
<td>Engine Radiator</td>
<td>102</td>
<td>117</td>
</tr>
<tr>
<td>Mud Pump</td>
<td>107</td>
<td>114</td>
</tr>
<tr>
<td>Drawworks Motor</td>
<td>92</td>
<td>99</td>
</tr>
<tr>
<td>Engine Exhaust</td>
<td>103</td>
<td>111</td>
</tr>
<tr>
<td>Top Drive</td>
<td>86</td>
<td>93</td>
</tr>
</tbody>
</table>

#### 3.2 Modeling Assumptions

The following assumptions were used to develop the site sound propagation model:

1. Sound sources with infrequent operations such as pneumatic/hydraulic tools used on the rig floor and the impulsive sound from metal to metal banging of the drill pipe were excluded from the sound level calculations.

2. The site sound propagation model includes the proposed equipment orientation. The sound propagation from the site can vary significantly, and beneficially, if the equipment layout is altered during the final installation.

3. The equipment sound power levels used in the model were based on the assumption of standard, steady state drilling operation.

4. The receptor sound levels were calculated under a light downwind condition in summer nighttime.

#### 3.3 Sound Propagation Model Results

This section describes the results of the sound propagation model. Four (4) nearby residential receptors have been selected as the noise sensitive areas (NSAs) for assessing the sound propagation from the drill site. Table 3, on Page 15, shows the description of the receptor locations and the allowable sound contribution at all of the selected locations for
evaluating the sound propagation from the site. Figure 5, on Page 16 shows the selected receptor locations on an aerial view of the site.

Table 3: Description of Receptor Locations and Allowable sound contribution

<table>
<thead>
<tr>
<th>Receptors</th>
<th>Distance &amp; Location from well head</th>
<th>Allowable Sound Contribution as per League City Sound Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daytime (dBA)</td>
</tr>
<tr>
<td>R1</td>
<td>340’ North</td>
<td>70</td>
</tr>
<tr>
<td>R2</td>
<td>590’ Southeast</td>
<td>70</td>
</tr>
<tr>
<td>R3</td>
<td>660’ Southwest</td>
<td>70</td>
</tr>
<tr>
<td>R4</td>
<td>755’ West</td>
<td>70</td>
</tr>
</tbody>
</table>

3.3.1 Base model – Untreated Scenario

This section describes the results of sound propagation from the drill rig equipment without applying any sound mitigation. Results of the untreated scenario show that if the equipment is installed at the site according to the proposed layout, sound contribution level at R1-R4 is expected to range between 61-67 dBA.

Sound levels at all four (4) NSAs are in compliance with the League City sound code. In this scenario, sound from the CAT 3512 diesel engines will dominate the acoustic environment of the surrounding area and will be clearly audible at all the receptor locations at all times during the drilling operations. Figure 6, on Page 17, shows the sound propagation contour for this scenario.

3.3.2 Sound Mitigation Design – Water Storage Tanks as Sound Barriers

Although the unmitigated sound generated by the proposed operation will be in compliance with the City’s Ordinance, it might be appropriate to attempt to exercise certain sound mitigation procedures related to strategic placement of equipment, vehicles, tanks, and temporary buildings and good overall oilfield practice.

It is recommended to place the water storage tanks around the diesel engines/generators such that most of the sound is deflected towards the East of the drill site and away from the nearby NSAs. Figure 7, on Page 18, shows the sound propagation contour for this scenario. Figure 8, on Page 19, shows the three dimensional view of the sound mitigation design. It should be noted that under this scenario sound contribution at R2-R4 is reduced by 4-8 dBA except R1 where the sound level increases by about 1 dBA.
Figure 5: Aerial view of the site showing selected receptors
Figure 6: A-weighted Sound Propagation Contour – Untreated Scenario
Figure 7: A-weighted Sound Propagation Contour – Sound Mitigation Design
Figure 8: Recommended Sound Mitigation Design

Water Storage Tanks placed around Diesel Engines/generators
4. CONCLUSION

ATCO’s environmental sound study revealed that background ambient sound levels were mostly influenced by the traffic sound on FM 270. Comparison of ambient sound levels with the City’s Sound code revealed that measured ambient sound levels were below 70 dBA, and therefore the drilling sound shall not exceed 70 dBA at any time during the drilling operations.

ATCO’s field measurements and sound propagation modeling show that the unmitigated sound generated by the proposed operation will be in compliance with the City’s Ordinance. However, this report still presents a sound mitigation design, utilizing strategic placement of water storage tanks as sound barriers and deflecting the sound away from the nearby NSAs.

Finally, ATCO is able, should the need arise, to generate further recommendations should the sound level be found to be greater than predicted, or should the modeling scenarios prove to be less effective than expected.
5. DISCLAIMER

Our review is based on the NSA locations as determined during the site visit and on the present site conditions and parameters listed in this report only. We cannot and do not warrant any different parameters and conditions that may exist but which were not represented in this study.

Third Party:

The Noise Impact Assessment (NIA), which is reported in the preceding pages, has been prepared in response to a specific request for service from the Client to whom it is addressed. The information contained in this NIA is not intended for the use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed. We deny any liability whatsoever to other parties who may obtain access to the information contained in this NIA for any damages or injury suffered by such third parties arising from the use of this NIA by them without the express prior written permission from ATCO and its Client who has commissioned this NIA.

ATCO NOISE MANAGEMENT

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APPENDIX A: METEOROLOGICAL CONDITIONS

MD6282 Weather Graph for 5/17/2011

- Temperature
- Dew Point

Barometric Pressure

Wind Speed
- km/h

Wind Gust

Wind Dir (deg)

Rainfall Rate
- cm/hr
MD6282 Weather Graph for 5/19/2011

- Temperature
- Dew Point
- Barometric Pressure
- Wind Speed
- Wind Gust
- Wind Dir (deg)
- Rainfall Rate
MD6282 Weather Graph for 5/24/2011

- Temperature
- Dew Point
- Barometric Pressure
- Wind Speed
- Wind Gust
- Wind Dir (deg)
- Rainfall Rate

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APPENDIX: SOUND LEVEL TERMINOLOGY

**Frequency** - the number of cycles per unit interval of time. *Units Hz (Hertz).*

**Bel (B)** - a unit of measure for LEVEL or LEVEL DIFFERENCE (A.G. Bell 1847-1922). If a quantity is increased by a factor $10^n$, its level goes up by $n$ bels.

**Decibel (dB)** - the standard unit of measure, in acoustics, for level or level difference. The decibel scale is based on the ratio $10^{1/10}$; multiplying a power-like quantity (such as sound power or mean square) by this factor increases its level by 1 decibel. If a power-like quantity is increased by a factor $10^{n/10}$, its level goes up by $n$ decibels. *Unit symbol for dB.*

**Sound Pressure (Pa)** - the difference between the instantaneous pressure at a fixed point in a sound field, and the pressure at the same point with the sound absent. *Units Pa (Pascal).*

**Sound Pressure Level (SPL, $L_p$)** - or sound pressure-squared level, at a given point the quantity $L_p$ defined by $L_p = 10 \log_{10}(P_{rms}/P_{ref})^2 = 20 \log_{10}(P_{rms}/P_{ref})$. Here $P_{rms}$ is the ROOT MEAN SQUARE sound pressure, and $P_{ref}$ is the reference rms sound pressure. *Units dB re $(20 \text{ Pa})^2$.*

**A-weighted Sound Pressure Level (SPL, $L_{pA}$, $L_A$)** - the LEVEL of sound pressure signal to which A-WEIGHTING has been applied. *Units dB re $(20 \text{ Pa})^2$.*

**Sound Power** – the rate of acoustic energy flow across a specified surface, or emitted by a specified sound source. *Units W (Watt).*

**Sound Power Level (PWL, $L_w$)** - the level of SOUND POWER expressed in decibels relative to a stated reference value. The quantity $L_w$ is defined by $L_w = 10 \log_{10}(W/W_{ref})$. Here $W_{ref}$ is the reference sound power. *Units dB re $1W$.*

**A-weighting** - a frequency-weighting procedure, in which the power or energy spectrum of a signal is progressively attenuated towards the high and low ends of the human audible range. Frequency components around 1 kHz - 5 kHz are hardly affected, but the attenuation is large at low frequencies (i.e., 70 dB at 10 Hz).
Percentile Sound Levels, $L_N$ - since the noise levels in a community vary with time in a more or less random manner, the descriptors of these time varying noise levels may be defined in statistical terms. The statistical descriptors are referred to as the percentile sound levels, $L_N$; with $L_N$ defined as the level exceeded N% of the time. The descriptors often used are:

$L_0$, **Highest Level** - this is the highest noise level, also known as $L_{\text{max}}$.

$L_1$, **Level of Highly Intrusive Sounds** – the level exceeded 1% of the time, is a measure of the highly intrusive sounds.

$L_{10}$, **Level of Intrusive Sounds** - The level exceeded 10% of the time, and is used to indicate the average level of the intrusive sounds.

$L_{50}$, **Median Level** - The level exceeded 50% of the time or the median level. A useful measure of the average noise conditions on a site.

$L_{90}$, **Background Level** – The level exceeded 90% of the time. It provides a good indication of the steady background noise level on a site.

$L_{\text{eq}}$, **Equivalent Continuous Sound Level** - the prime descriptor used in assessing most types of sounds heard in a community. The $L_{\text{eq}}$ is an average of sounds measured over time. It is strongly influenced by occasional loud, intrusive noises. Because it is able to account for such noises, for example, the $L_{\text{eq}}$ is the best descriptor for the intermittent sound levels from construction activities.

$L_{\text{DN}}$, **The Day-Night Sound Level**, derived by applying a 10 dB “penalty” to noise levels that occur at night, between 10 p.m. and 7 a.m., thus accounting for increased sensitivity to noise during nighttime hours.

**Ambient sound level** - means background sound level. It is the sound level that is present in the acoustic environment of a defined area. Aircraft flyover and rail noise may be excluded in some jurisdictions.