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Environmental Noise Impact Assessment
For

# STP McKay Thermal Project – Phase 2

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## Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Southern Pacific Resource Corp. (STP) to conduct an environmental noise impact assessment (NIA) for the proposed STP McKay Thermal Project – Phase 2 (the Project) in northeast Alberta. The purpose of the work was to generate a computer noise model of the Project under Baseline Case and Application Case conditions and to compare the resultant sound levels to the Alberta Energy Resources Conservation Board (ERCB) permissible sound level guidelines (Directive 038 on Noise Control, 2007) as well as the Alberta Utilities Commission (AUC) Rule 012 on Noise Control.

The results of the noise modeling indicated Baseline Case noise levels associated with Phase 1 (with the average ambient sound level of 35 dBA included) will be below the ERCB Directive 038 PSL of 40 dBA $L_{eq}$Night[1] for all surrounding theoretical 1,500 m receptors. The noise levels without the average ambient sound level were more than 5 dBA below the PSL at all but one location.

The Application Case noise levels associated with Phase 1 and the Project (with the average ambient sound level of 35 dBA included) will be below the ERCB Directive 038 PSL of 40 dBA $L_{eq}$Night for all surrounding theoretical 1,500 m receptors. The noise levels without the average ambient sound level are modeled to be more than 5 dBA below the PSL at most locations.

For both the Baseline Case and Application Case, the dBC – dBA sound levels are projected to be less than 20 dB at most locations. There are some locations, however with values greater than 20 dB, resulting in the possibility of low frequency tonal noise. The dominant low frequency noise sources are the gas turbine exhaust stacks. These tend not to be specifically tonal in nature. They tend to have a more broadband low frequency quality. As such, the possibility of a low frequency tonal component (as specified by ERCB Directive 038 and AUC Rule 012) is low. In addition, there are no residential receptors nearby to express concerns for the low frequency noise. As a result, no additional noise mitigation is required.

[1] The term $L_{eq}$ represents the energy equivalent sound level. This is a measure of the equivalent sound level for a specified period of time accounting for fluctuations.

# Application Case Modeled Sound Levels

| Receptor (1,500m From Project) | ASL-Night (dBA) | Application Case $L_{eq}$Night (dBA) | ASL + Application Case $L_{eq}$Night (dBA) | PSL-Night (dBA) | Compliant | | Application Case $L_{eq}$Night (dBC) | dBC - dBA | Tonal |
|---|---|---|---|---|---|---|---|---|---|
| R_01 | 35.0 | 25.6 | 35.5 | 40.0 | YES | | 48.1 | 22.5 | POSSIBLE |
| R_02 | 35.0 | 24.3 | 35.4 | 40.0 | YES | | 44.0 | 19.7 | NO |
| R_03 | 35.0 | 28.4 | 35.9 | 40.0 | YES | | 47.7 | 19.3 | NO |
| R_04 | 35.0 | 29.3 | 36.0 | 40.0 | YES | | 51.4 | 22.1 | POSSIBLE |
| R_05 | 35.0 | 31.0 | 36.5 | 40.0 | YES | | 52.7 | 21.7 | POSSIBLE |
| R_06 | 35.0 | 35.5 | 38.3 | 40.0 | YES | | 55.7 | 20.2 | POSSIBLE |
| R_07 | 35.0 | 36.4 | 38.8 | 40.0 | YES | | 58.5 | 22.1 | POSSIBLE |
| R_08 | 35.0 | 32.0 | 36.8 | 40.0 | YES | | 50.7 | 18.7 | NO |
| R_09 | 35.0 | 29.1 | 36.0 | 40.0 | YES | | 48.0 | 18.9 | NO |
| R_10 | 35.0 | 29.0 | 36.0 | 40.0 | YES | | 47.8 | 18.8 | NO |
| R_11 | 35.0 | 31.1 | 36.5 | 40.0 | YES | | 50.1 | 19.0 | NO |
| R_12 | 35.0 | 34.5 | 37.8 | 40.0 | YES | | 52.9 | 18.4 | NO |
| R_13 | 35.0 | 32.1 | 36.8 | 40.0 | YES | | 51.4 | 19.3 | NO |
| R_14 | 35.0 | 32.0 | 36.8 | 40.0 | YES | | 51.4 | 19.4 | NO |
| R_15 | 35.0 | 32.5 | 36.9 | 40.0 | YES | | 51.3 | 18.8 | NO |
| R_16 | 35.0 | 29.6 | 36.1 | 40.0 | YES | | 46.7 | 17.1 | NO |
| R_17 | 35.0 | 31.4 | 36.6 | 40.0 | YES | | 50.7 | 19.3 | NO |
| R_18 | 35.0 | 31.3 | 36.5 | 40.0 | YES | | 47.5 | 16.2 | NO |
| R_19 | 35.0 | 29.2 | 36.0 | 40.0 | YES | | 46.0 | 16.8 | NO |
| R_20 | 35.0 | 31.8 | 36.7 | 40.0 | YES | | 49.2 | 17.4 | NO |
| R_21 | 35.0 | 33.6 | 37.4 | 40.0 | YES | | 51.3 | 17.7 | NO |
| R_22 | 35.0 | 37.9 | 39.7 | 40.0 | YES | | 54.9 | 17.0 | NO |
| R_23 | 35.0 | 31.6 | 36.6 | 40.0 | YES | | 49.3 | 17.7 | NO |
| R_24 | 35.0 | 30.6 | 36.3 | 40.0 | YES | | 50.3 | 19.7 | NO |
| R_25 | 35.0 | 26.6 | 35.6 | 40.0 | YES | | 47.7 | 21.1 | POSSIBLE |
| R_26 | 35.0 | 26.9 | 35.6 | 40.0 | YES | | 49.3 | 22.4 | POSSIBLE |

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## 1.0 Introduction

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Southern Pacific Resource Corp. (STP) to conduct an environmental noise impact assessment (NIA) for the proposed STP McKay Thermal Project – Phase 2 (the Project) in northeast Alberta. The purpose of the work was to generate a computer noise model of the Project under Baseline Case and Application Case conditions and to compare the resultant sound levels to the Alberta Energy Resources Conservation Board (ERCB) permissible sound level guidelines (Directive 038 on Noise Control, 2007) as well as the Alberta Utilities Commission (AUC) Rule 012 on Noise Control.

## 2.0 Project Location and Description

The Project is situated in the McKay River area within the Municipal District of Wood Buffalo and is located approximately 40 km north-west of the community of Fort McMurray, as shown in Figure 1. In 2010, STP received approval for the STP McKay Thermal Project – Phase 1 with a production capacity of 1908 $m^3$ (12,000 barrels) of bitumen per day for 30 years (Phase 1). Phase 1 (currently under construction) consists of a central processing facility (CPF) located at NE-07-91-14-W4M and three well pads located within Section 07-91-14-W4M.

The Project is designed for 24,000 bpd Capacity which will bring the total capacity for Phase 1 and Phase 2 to 36,000 bpd. The Project will span Sections 3 – 10, 15 – 18, 20 – 22, 25 – 29, 34 – 36 in 91-14-W4M as well as Sections 1 and 12 of 91-15-W4M and Section 30-91-13-W4M. The Phase 2 CPF will be located in the middle of Section 10-91-14-W4M and the well pads will be located throughout the study area. As indicated in Figure 1, the initial stages of the Project will have the Phase 1 CPF and 3 well pads as well as the Phase 2 CPF and 8 well pads. In time, additional well pads will be brought on-line and existing well pads will be decommissioned. For the purposes of the noise impact assessment, however, all of the proposed well pad locations have been modeled as fully operational at the same time. This provides a more conservative result and covers all possible well pad operational configurations.

There are no major roadways nearby and there are no existing industrial facilities within 5 km of the Project lease boundary. In addition, there are no residents or Trappers' Cabins within at least 5 km of the Project lease area. Topographically, the land in the area has a general downward slope into the MacKay River from the CPF and the well pads (maximum elevation change of approximately 40 m). The land is covered with field grasses, trees and bushes (as observed through aerial photos). As such, the level of vegetative sound absorption is considered moderate.

## 3.0 Measurement & Modeling Methods

### 3.1. Baseline Noise Monitoring

Due to the lack of residential receptors or existing industrial noise sources in the surrounding area, baseline noise monitoring was not conducted. This conforms with the requirements of the ERCB Directive 038 and AUC Rule 012.

### 3.2. Computer Noise Modeling (General)

The computer noise modeling was conducted using the CADNA/A (version 4.1.137) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and stationary sources. Topographical features such as land contours, vegetation, and bodies of water and meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction are considered in the assessment. The modeling methods utilized met or exceeded the requirements of the ERCB Directive 038 and AUC Rule 012.

The calculation method used for noise propagation follows the International Standards Organization (ISO) 9613-2. All receiver locations were assumed as being downwind from the source(s). In particular, as stated in Section 5 of the ISO 9613-2 document:

> "*Downwind propagation conditions for the method specified in this part of IS0 9613 are as specified in 5.4.3.3 of IS0 1996-2:1987, namely*
>
> - *wind direction within an angle of* ± $45^0$ *of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver, and*
> - *wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.*
>
> *The equations for calculating the average downwind sound pressure level LAT(DW) in this part of IS0 9613, including the equations for attenuation given in clause 7, are the average for meteorological conditions within these limits. The term average here means the average over a short time interval, as defined in 3.1.*
>
> *These equations also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights*".

Due to the large size of the study area and the density of vegetation within the study area, vegetative sound absorption was included in the model. A ground absorption coefficient of 0.5 was used along with a temperature of $10^0$C and a relative humidity of 70%. Although there are trees in the area, they were not incorporated into the model. As a result, all sound level propagation calculations are considered a conservative representation of summertime conditions (as specified in ERCB Directive 038 and AUC Rule 012).

As part of the study, two noise modeling scenarios were conducted:

1) Baseline Case: Noise sources, buildings and tanks associated with the Phase 1 CPF and well pads.
2) Application Case: Baseline Case conditions along with noise sources, buildings and tanks associated with Phase 2 CPF and all proposed well pads.

The computer noise modeling results were calculated in two ways. First, sound levels were calculated at the theoretical 1,500 m receiver locations. Second, sound levels were calculated using a 20 m x 20 m receptor grid pattern within the entire study area. This provided color noise contours for easier visualization and evaluation of the results.

### 3.3. Noise Sources

The noise sources for the equipment associated with the Project are provided in Appendix I. The data were obtained from equipment specific noise level information provided by STP and assessments carried out for other projects using similar operating equipment combined with aci in-house information and calculations using methods presented in various texts. All sound power levels (PWLs) used in the modeling are considered conservative.

All noise sources have been modeled as point sources at their appropriate heights[1]. Sound power levels for all noise sources were modeled using octave-band information. Buildings and tanks were included in the modeling calculations because of their ability to provide shielding as well as reflection for noise[2]. Refer to Appendix I for building and tank dimensions.

[1] The heights for many of the sources are generally slightly higher than actual. This makes the model more conservative
[2] Exterior building and tank walls were modeled with an absorption coefficient of 0.21 which is generally highly reflective.

Finally, ERCB Directive 038 and AUC Rule 012 require the assessment to include background ambient noise levels in the model. As specified in ERCB Directive 038 and AUC Rule 012, in most rural areas of Alberta where there is an absence of industrial noise sources the average night-time ambient noise level is approximately 35 dBA. This is known as the average ambient sound level (ASL). This value was used as the ambient condition in the modeling with the various Project related noise sources added.

### 3.4. Modeling Confidence

As mentioned previously, the algorithms used for the noise modeling follow the ISO 9613 standard. The published accuracy for this standard is ±3 dBA between 100 m – 1,000 m. Accuracy levels beyond 1,000 m are not published. Professional experience based on similar noise models and measurements conducted over large distances shows that, as expected, as the distance increases, the associated accuracy in prediction decreases. Experience has shown that environmental factors such as wind, temperature inversions, topography and ground cover all have increasing effects over distances larger than approximately 1,500 m. As such, for all receptors within approximately 1,500 m of the various noise sources, the prediction confidence is considered high, while for all receptors beyond 1,500 m, the prediction confidence is considered moderate.

## 4.0 Permissible Sound Levels

Environmental noise levels from industrial noise sources are commonly described in terms of equivalent sound levels or $L_{eq}$. This is the level of a steady sound having the same acoustic energy, over a given time period, as the fluctuating sound. In addition, this energy averaged level is A–weighted to account for the reduced sensitivity of average human hearing to low frequency sounds. These $L_{eq}$ in dBA, which are the most common environmental noise measure, are often given for day-time (07:00 to 22:00) $L_{eq}$Day and night-time (22:00 to 07:00) $L_{eq}$Night while other criteria use the entire 24-hour period as $L_{eq}$24. Refer to Appendix II for a description of the acoustical terms used and to Appendix III for a list of common noise sources.

The documents which relate to the Permissible Sound Levels (PSLs) for this NIA are the ERCB Directive 038 on Noise Control (2007) and the AUC Rule 012 on Noise Control. Both documents are essentially identical, in particular, as they pertain to the PSLs for this project. Both documents set the PSL at the receiver location based on population density and relative distances to heavily traveled road and rail as shown in Table 1. In all instances, there is a Basic Sound Level (BSL) of 40 dBA for the night-time (night-time hours are 22:00 – 07:00) and 50 dBA for the day-time (day-time hours are 07:00 – 22:00). Note that for this location, none of the adjustments to the BSL apply. Finally, both documents specify that new or modified facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line if there are no closer dwellings. As such, the PSLs at a distance of 1,500 m are an **$L_{eq}$Night of 40 dBA and an $L_{eq}$Day of 50 dBA.** Refer to Appendix IV for a detailed determination of the permissible sound levels.

The PSLs provided are related to noise associated with activities and processes at the Project and are not related to vehicle traffic on nearby highways (or access roads). This includes all traffic related to the construction and operation of the Facility. Noises from traffic sources are not covered by any regulations or guidelines at the municipal, provincial, or federal levels. As such, an assessment of the noises related to vehicle traffic was not conducted. In addition, construction noise is not specifically regulated by ERCB Directive 038 or AUC Rule 012. However, construction noise mitigation recommendations are provided in Section 5.3.1.

**Table 1. Basic Night-Time Sound Levels (as per ERCB Directive 038 and AUC Rule 012)**

| Proximity to Transportation | Dwelling Density per Quarter Section of Land | | |
|---|---|---|---|
| | 1-8 Dwellings | 9-160 Dwellings | >160 Dwellings |
| Category 1 | 40 | 43 | 46 |
| Category 2 | 45 | 48 | 51 |
| Category 3 | 50 | 53 | 56 |

Category 1 Dwelling units more than 500m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

Category 2 Dwelling units more than 30m but less than 500m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

Category 3 Dwelling units less than 30m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

# 5.0 Results and Discussion

## 5.1. Baseline Case Results

The results of the Baseline Case noise modeling are presented in Table 2 and illustrated in Figure 2. The modeled noise levels at the theoretical 1,500 m receptor locations are under the PSLs with the Phase 1 noise combined with the 35 dBA ASL. In addition, the noise levels resulting from the Phase 1 equipment alone (i.e. no ASL) are more than 5 dBA below the PSL at all but one location.

**Table 2. Baseline Case Modeled Sound Levels**

| Receptor (1,500m From Project) | ASL-Night (dBA) | Baseline Case $L_{eq}$Night (dBA) | ASL + Baseline Case $L_{eq}$Night (dBA) | PSL-Night (dBA) | Compliant |
|---|---|---|---|---|---|
| R_01 | 35.0 | 16.1 | 35.1 | 40.0 | YES |
| R_02 | 35.0 | 15.7 | 35.1 | 40.0 | YES |
| R_03 | 35.0 | 16.9 | 35.1 | 40.0 | YES |
| R_04 | 35.0 | 18.0 | 35.1 | 40.0 | YES |
| R_05 | 35.0 | 18.3 | 35.1 | 40.0 | YES |
| R_06 | 35.0 | 17.8 | 35.1 | 40.0 | YES |
| R_07 | 35.0 | 16.9 | 35.1 | 40.0 | YES |
| R_08 | 35.0 | 16.9 | 35.1 | 40.0 | YES |
| R_09 | 35.0 | 17.1 | 35.1 | 40.0 | YES |
| R_10 | 35.0 | 20.3 | 35.1 | 40.0 | YES |
| R_11 | 35.0 | 26.4 | 35.6 | 40.0 | YES |
| R_12 | 35.0 | 29.3 | 36.0 | 40.0 | YES |
| R_13 | 35.0 | 28.8 | 35.9 | 40.0 | YES |
| R_14 | 35.0 | 29.7 | 36.1 | 40.0 | YES |
| R_15 | 35.0 | 31.1 | 36.5 | 40.0 | YES |
| R_16 | 35.0 | 28.2 | 35.8 | 40.0 | YES |
| R_17 | 35.0 | 29.3 | 36.0 | 40.0 | YES |
| R_18 | 35.0 | 30.3 | 36.3 | 40.0 | YES |
| R_19 | 35.0 | 28.3 | 35.8 | 40.0 | YES |
| R_20 | 35.0 | 30.5 | 36.3 | 40.0 | YES |
| R_21 | 35.0 | 32.4 | 36.9 | 40.0 | YES |
| R_22 | 35.0 | 37.7 | 39.6 | 40.0 | YES |
| R_23 | 35.0 | 30.8 | 36.4 | 40.0 | YES |
| R_24 | 35.0 | 25.9 | 35.5 | 40.0 | YES |
| R_25 | 35.0 | 21.8 | 35.2 | 40.0 | YES |
| R_26 | 35.0 | 19.8 | 35.1 | 40.0 | YES |

In addition to the broadband A-weighted (dBA) sound levels, the modeling results at the theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at most locations, as shown in Table 3. As specified in ERCB Directive 038 and AUC Rule 012, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. For those locations with dBC – dBA values above 20, the modeling indicates that the possibility exists for a low frequency tonal component. However, both ERCB Directive 038 and AUC Rule 012 have additional requirements related to the 1/3 octave band sound pressure levels to have an identified low frequency tonal component. Sound level data for the various noise sources is only available in 1/1 octave band resolution. As such, a specific low frequency tonal component cannot be determined. The modeling does indicate that the dominant source of the low frequency noise is the gas turbine exhaust from the CoGen units. Noise from this equipment tends to have a more broadband low frequency content with no specific tones. Note also that the study area is remote and there are no residential receptors nearby. Both ERCB Directive 038 and AUC Rule 012 require a complaint to be filed with a specific low frequency concern before and investigation would be required to even determine the presence of a low frequency tonal component. At this location, this is very unlikely.

**Table 3. Baseline Case Modeled dBA and dBC Sound Levels**

| Receptor (1,500m From Project) | Baseline Case $L_{eq}$Night (dBA) | Baseline Case $L_{eq}$Night (dBC) | dBC - dBA | Tonal |
|---|---|---|---|---|
| R_01 | 16.1 | 36.1 | 20.0 | POSSIBLE |
| R_02 | 15.7 | 35.7 | 20.0 | POSSIBLE |
| R_03 | 16.9 | 36.5 | 19.6 | NO |
| R_04 | 18.0 | 38.5 | 20.5 | POSSIBLE |
| R_05 | 18.3 | 39.2 | 20.9 | POSSIBLE |
| R_06 | 17.8 | 37.2 | 19.4 | NO |
| R_07 | 16.9 | 36.5 | 19.6 | NO |
| R_08 | 16.9 | 36.5 | 19.6 | NO |
| R_09 | 17.1 | 36.7 | 19.6 | NO |
| R_10 | 20.3 | 38.8 | 18.5 | NO |
| R_11 | 26.4 | 44.3 | 17.9 | NO |
| R_12 | 29.3 | 44.2 | 14.9 | NO |
| R_13 | 28.8 | 46.7 | 17.9 | NO |
| R_14 | 29.7 | 47.2 | 17.5 | NO |
| R_15 | 31.1 | 47.2 | 16.1 | NO |
| R_16 | 28.2 | 44.6 | 16.4 | NO |
| R_17 | 29.3 | 44.7 | 15.4 | NO |
| R_18 | 30.3 | 45.8 | 15.5 | NO |
| R_19 | 28.3 | 44.4 | 16.1 | NO |
| R_20 | 30.5 | 45.1 | 14.6 | NO |
| R_21 | 32.4 | 47.3 | 14.9 | NO |
| R_22 | 37.7 | 54.4 | 16.7 | NO |
| R_23 | 30.8 | 48.0 | 17.2 | NO |
| R_24 | 25.9 | 42.8 | 16.9 | NO |
| R_25 | 21.8 | 40.4 | 18.6 | NO |
| R_26 | 19.8 | 39.8 | 20.0 | POSSIBLE |

## 5.2. Application Case Results

The results of the Application Case noise modeling are presented in Table 4 and illustrated in Figure 3. The modeled noise levels at the theoretical 1,500 m receptor locations are under the PSLs with the Phase 1 and Project noise combined with the 35 dBA ASL. In addition, the noise levels resulting from the Phase 1 and Project equipment alone (i.e. no ASL) are more than 5 dBA below the PSL at most of the theoretical receptor locations. The order-ranked noise source contribution from the Phase 1 and Project noise sources at the receptors with the highest noise levels (R07 & R22) are presented in Appendix V.

**Table 4. Application Case Modeled Sound Levels**

| Receptor (1,500m From Project) | ASL-Night (dBA) | Application Case $L_{eq}$Night (dBA) | ASL + Application Case $L_{eq}$Night (dBA) | PSL-Night (dBA) | Compliant |
|---|---|---|---|---|---|
| R_01 | 35.0 | 25.6 | 35.5 | 40.0 | YES |
| R_02 | 35.0 | 24.3 | 35.4 | 40.0 | YES |
| R_03 | 35.0 | 28.4 | 35.9 | 40.0 | YES |
| R_04 | 35.0 | 29.3 | 36.0 | 40.0 | YES |
| R_05 | 35.0 | 31.0 | 36.5 | 40.0 | YES |
| R_06 | 35.0 | 35.5 | 38.3 | 40.0 | YES |
| R_07 | 35.0 | 36.4 | 38.8 | 40.0 | YES |
| R_08 | 35.0 | 32.0 | 36.8 | 40.0 | YES |
| R_09 | 35.0 | 29.1 | 36.0 | 40.0 | YES |
| R_10 | 35.0 | 29.0 | 36.0 | 40.0 | YES |
| R_11 | 35.0 | 31.1 | 36.5 | 40.0 | YES |
| R_12 | 35.0 | 34.5 | 37.8 | 40.0 | YES |
| R_13 | 35.0 | 32.1 | 36.8 | 40.0 | YES |
| R_14 | 35.0 | 32.0 | 36.8 | 40.0 | YES |
| R_15 | 35.0 | 32.5 | 36.9 | 40.0 | YES |
| R_16 | 35.0 | 29.6 | 36.1 | 40.0 | YES |
| R_17 | 35.0 | 31.4 | 36.6 | 40.0 | YES |
| R_18 | 35.0 | 31.3 | 36.5 | 40.0 | YES |
| R_19 | 35.0 | 29.2 | 36.0 | 40.0 | YES |
| R_20 | 35.0 | 31.8 | 36.7 | 40.0 | YES |
| R_21 | 35.0 | 33.6 | 37.4 | 40.0 | YES |
| R_22 | 35.0 | 37.9 | 39.7 | 40.0 | YES |
| R_23 | 35.0 | 31.6 | 36.6 | 40.0 | YES |
| R_24 | 35.0 | 30.6 | 36.3 | 40.0 | YES |
| R_25 | 35.0 | 26.6 | 35.6 | 40.0 | YES |
| R_26 | 35.0 | 26.9 | 35.6 | 40.0 | YES |

In addition to the broadband A-weighted (dBA) sound levels, the modeling results at the theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at most locations, as shown in Table 5. Similar to the Baseline Case, some locations have dBC – dBA sound levels greater than 20 dB. Again, the dominant low frequency noise sources are the gas turbine exhaust stacks. These tend not to be specifically tonal in nature. They tend to have a more broadband low frequency quality. In addition, there are no residential receptors nearby to express concerns for the low frequency noise.

**Table 5. Application Case Modeled dBA and dBC Sound Levels**

| Receptor (1,500m From Project) | Application Case $L_{eq}$Night (dBA) | Application Case $L_{eq}$Night (dBC) | dBC - dBA | Tonal |
|---|---|---|---|---|
| R_01 | 25.6 | 48.1 | 22.5 | POSSIBLE |
| R_02 | 24.3 | 44.0 | 19.7 | NO |
| R_03 | 28.4 | 47.7 | 19.3 | NO |
| R_04 | 29.3 | 51.4 | 22.1 | POSSIBLE |
| R_05 | 31.0 | 52.7 | 21.7 | POSSIBLE |
| R_06 | 35.5 | 55.7 | 20.2 | POSSIBLE |
| R_07 | 36.4 | 58.5 | 22.1 | POSSIBLE |
| R_08 | 32.0 | 50.7 | 18.7 | NO |
| R_09 | 29.1 | 48.0 | 18.9 | NO |
| R_10 | 29.0 | 47.8 | 18.8 | NO |
| R_11 | 31.1 | 50.1 | 19.0 | NO |
| R_12 | 34.5 | 52.9 | 18.4 | NO |
| R_13 | 32.1 | 51.4 | 19.3 | NO |
| R_14 | 32.0 | 51.4 | 19.4 | NO |
| R_15 | 32.5 | 51.3 | 18.8 | NO |
| R_16 | 29.6 | 46.7 | 17.1 | NO |
| R_17 | 31.4 | 50.7 | 19.3 | NO |
| R_18 | 31.3 | 47.5 | 16.2 | NO |
| R_19 | 29.2 | 46.0 | 16.8 | NO |
| R_20 | 31.8 | 49.2 | 17.4 | NO |
| R_21 | 33.6 | 51.3 | 17.7 | NO |
| R_22 | 37.9 | 54.9 | 17.0 | NO |
| R_23 | 31.6 | 49.3 | 17.7 | NO |
| R_24 | 30.6 | 50.3 | 19.7 | NO |
| R_25 | 26.6 | 47.7 | 21.1 | POSSIBLE |
| R_26 | 26.9 | 49.3 | 22.4 | POSSIBLE |

## 5.3. Noise Mitigation Measures

The results of the noise modeling indicated that no specific additional noise mitigation measures are required.

### 5.3.1. Construction Noise

Although there are no specific construction noise level limits detailed by ERCB Directive 038, there are general recommendations for construction noise mitigation. This includes all activities associated with construction of the facility, well-pads (including drilling), borrow-pits, etc. The document states:

> "*While Directive 038 is not applicable to construction noise, licensees should attempt to take the following reasonable mitigating measures to reduce the impact on nearby dwellings of construction noise from new facilities or modifications to existing facilities. Licensees should:*
>
> - *Conduct construction activity between the hours of 07:00 and 22:00 to reduce the potential impact of construction noise;*

- *Advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption to them;*
- *Ensure all internal combustion engines are fitted with appropriate muffler systems; and*
- *Take advantage of acoustical screening from existing on-site buildings to shield dwellings from construction equipment noise.*

*Should a valid complaint be made during construction, the licensee is expected to respond expeditiously and take appropriate action to ensure that the issue has been managed responsibly.*"

## 6.0 Conclusion

The results of the noise modeling indicated Baseline Case noise levels associated with Phase 1 (with the average ambient sound level of 35 dBA included) will be below the ERCB Directive 038 PSL of 40 dBA $L_{eq}$Night for all surrounding theoretical 1,500 m receptors. The noise levels without the ASL were more than 5 dBA below the PSL at all but one location.

The Application Case noise levels associated with Phase 1 and the Project (with the average ambient sound level of 35 dBA included) will be below the ERCB Directive 038 PSL of 40 dBA $L_{eq}$Night for all surrounding theoretical 1,500 m receptors. The noise levels without the ASL are modeled to be more than 5 dBA below the PSL at most locations.

For both the Baseline Case and Application Case, the dBC – dBA sound levels are projected to be less than 20 dB at most locations. There are some locations, however with values greater than 20 dB, resulting in the possibility of low frequency tonal noise. The dominant low frequency noise sources are the gas turbine exhaust stacks. These tend not to be specifically tonal in nature. They tend to have a more broadband low frequency quality. As such, the possibility of a low frequency tonal component (as specified by ERCB Directive 038 and AUC Rule 012) is low. In addition, there are no residential receptors nearby to express concerns for the low frequency noise. As a result, no additional noise mitigation is required.

A short form (ERCB form) noise impact assessment is presented in Appendix VI.

## 7.0 References


- *Environmental Noise Impact Assessment for STP McKay SAGD Project at LSD NW-07-91-14-W4M.* Prepared for Southern Pacific Resource Corp., by aci Acoustical Consultants Inc., April, 2009.
- Alberta Energy Resources Conservation Board (ERCB), *Directive 038 on Noise Control, 2007*, Calgary, Alberta.
- Alberta Utilities Commission (AUC), *Rule 012 on Noise Control, 2010*, Calgary, Alberta.
- International Organization for Standardization (ISO), *Standard 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures, 2003*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere, 1993*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, 1996*, Geneva Switzerland.

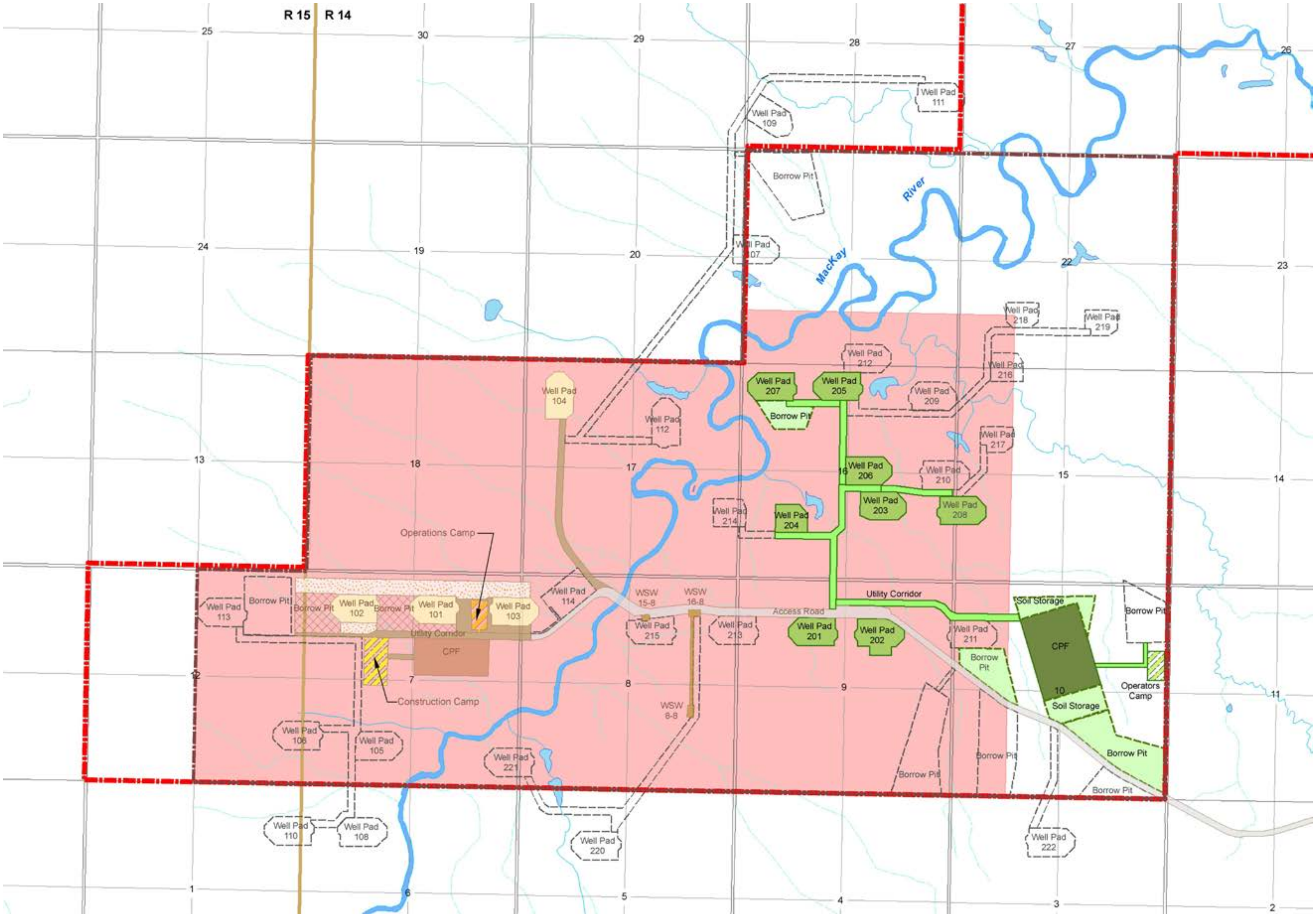



**Figure 1. Study Area**

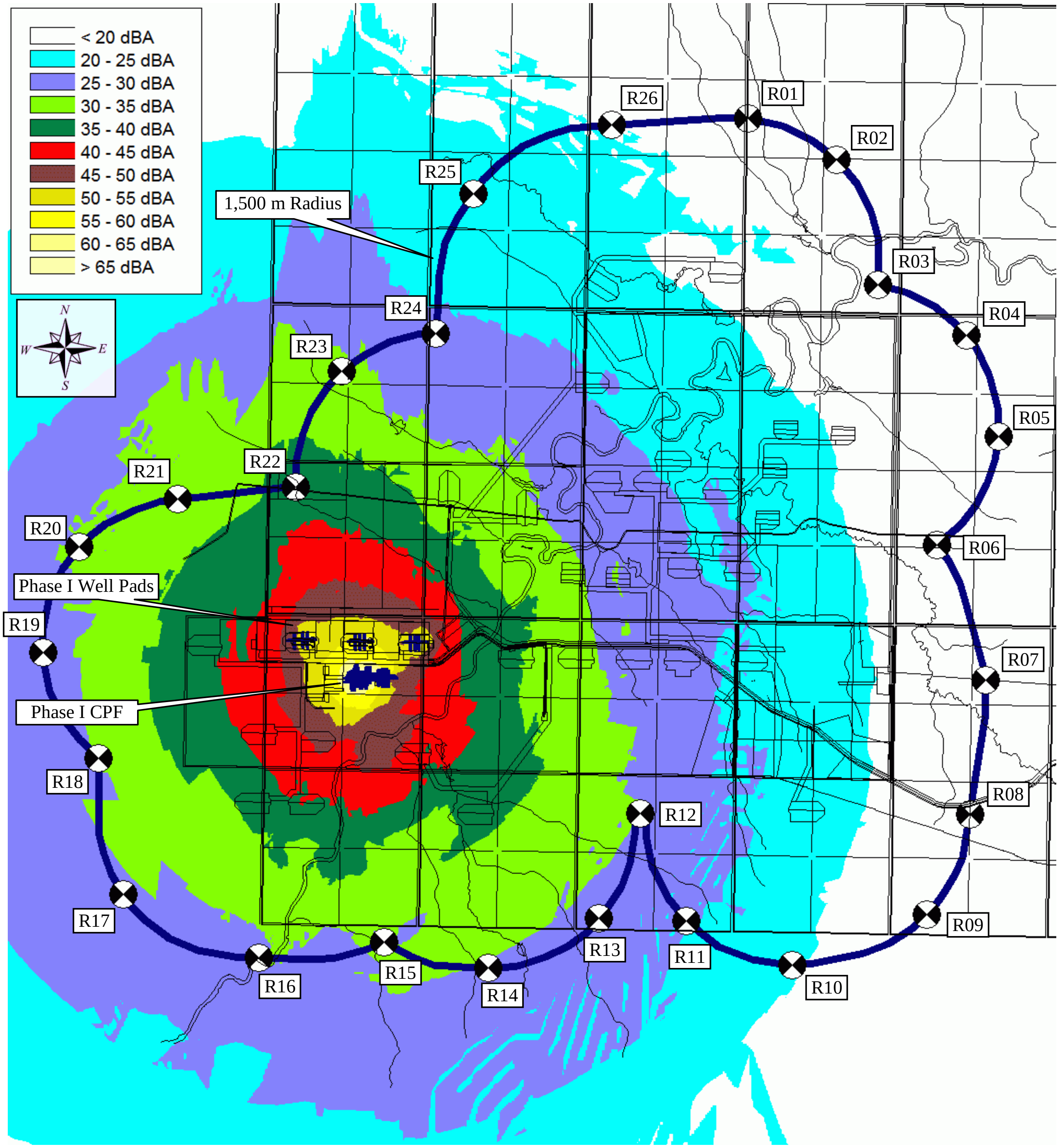



**Figure 2. Baseline Case Modeled Night-time Noise Levels (Without ASL)**

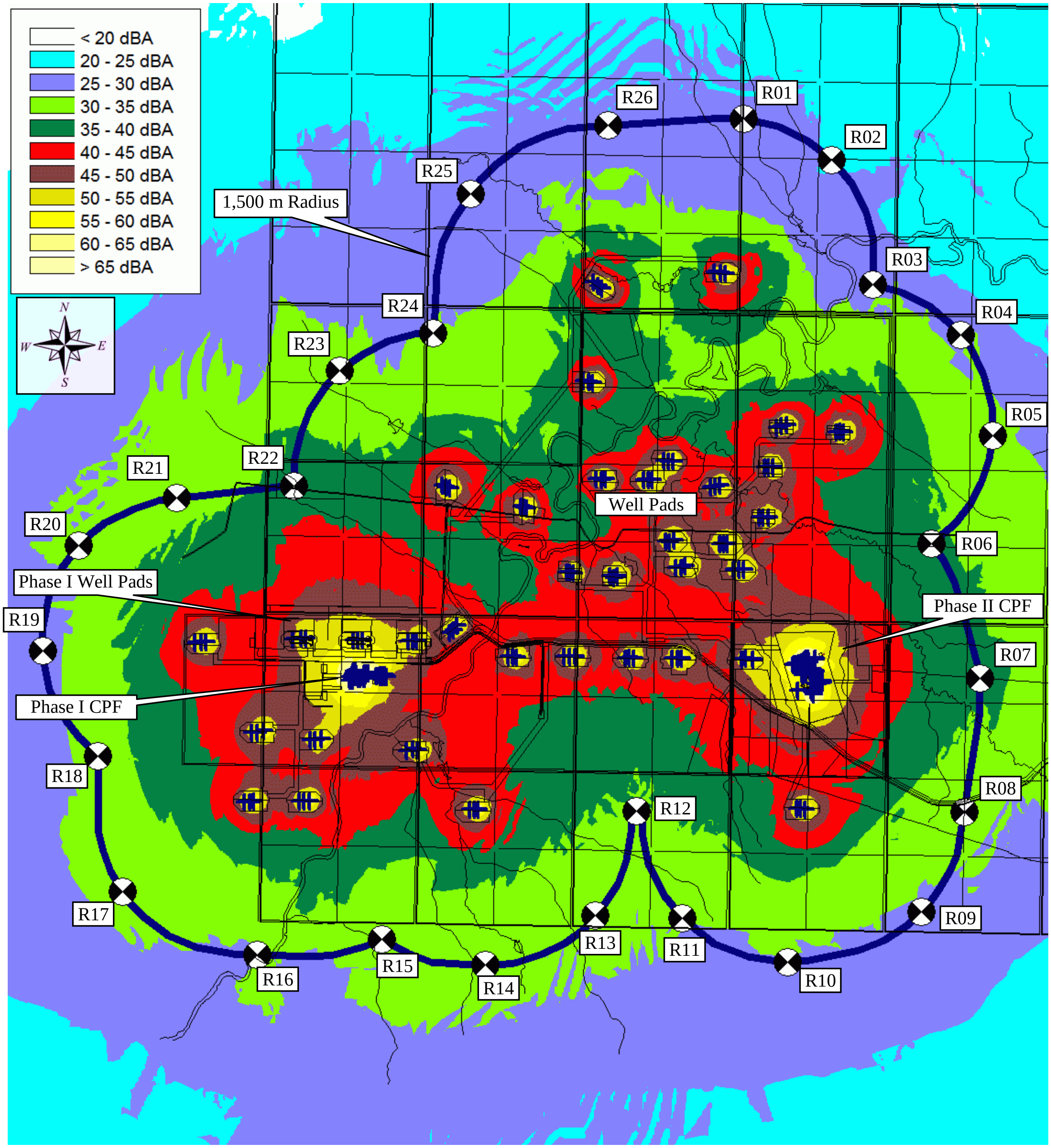



**Figure 3. Application Case Modeled Night-time Noise Levels (Without ASL)**

# Appendix I NOISE MODELING PARAMETERS

## Phase 1 Noise Source Broadband Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated)

| Tag | Description | Location | Height (m) | Model/Type | Rating (kW) | # Units | Equipment Sound Power Level (dBA) | Building Attenuation (dBA) | Overall Sound Power Level (dBA) |
|---|---|---|---|---|---|---|---|---|---|
| K-606/616 | Vapour Compressor | Evaporator Building | 3 | Reciprocating | 1700 | 2 | 124.3 | 25 | **99.3** |
| P-582/592 | Evaporator Recirc Pump | Evaporator Building | 2 | Centrifugal | 375 | 2 | 108.7 | 24 | **84.7** |
| P-520 | Primary Feed Pump | Evaporator Building | 2 | Centrifugal | 30 | 1 | 102.4 | 24 | **78.4** |
| P-521 | Evaporator Feed Pump | Evaporator Building | 2 | Centrifugal | 30 | 1 | 102.4 | 24 | **78.4** |
| P-581/591 | Distillate Pump | Evaporator Building | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| EF-101-109 | Evaporator Building Exhaust Fan | Evaporator Building | 18 | Axial Fan | 2 | 9 | 99.6 | 0 | **99.6** |
| EF-501 - 509 | Treater Building Exhaust Fant | Treater Building | 8 | Axial Fan | 1 | 9 | 96.5 | 0 | **96.5** |
| K-604 | Combustion Air Blower | Steam Generator Building | 7 | Axial Fan | 450 | 1 | 109.5 | 0 | **109.5** |
| H-604 | Steam Boiler Casing | Steam Generator Building | 3 | Heater | 71153 | 1 | 98.8 | 20 | **78.8** |
| H-604 | Steam Boiler Stack | Steam Generator Building | 30.5 | Heater | 71153 | 1 | 98.8 | 0 | **98.8** |
| K-605 | Combustion Air Blower | Steam Generator Building | 7 | Axial Fan | 450 | 1 | 109.5 | 0 | **109.5** |
| H-605 | Steam Boiler Casing | Steam Generator Building | 3 | Heater | 71153 | 1 | 98.8 | 20 | **78.8** |
| H-605 | Steam Boiler Stack | Steam Generator Building | 30.5 | Heater | 71153 | 1 | 98.8 | 0 | **98.8** |
| P-541 A/B/C | HP Boiler Feedwater Pump | BFW Pump Building | 2 | Centrifugal | 275 | 3 | 110.1 | 24 | **86.1** |
| P-537 A/B/C | LP Boiler Feedwater Pump | Water Pump Building | 2 | Centrifugal | 100 | 3 | 108.8 | 24 | **84.8** |
| K-608/609 | Instrument Air Compressor | Water Pump Building | 2 | Reciprocating | 40 | 2 | 108.0 | 25 | **83.0** |
| E-421 A-H | Glycol Aerial Cooler | Cooler Skid | 5 | Axial Fan | 45 | 8 | 110.6 | 0 | **110.6** |
| P-553 A/B/C | Glycol Circulation Pump | Glycol Building | 2 | Centrifugal | 60 | 3 | 108.1 | 24 | **84.1** |
| K-610 | Glycol Heater Blower | Glycol Building | 3 | Axial Fan | 25 | 1 | 101.0 | 0 | **101.0** |
| H-610 | Glycol Heater Casing | Glycol Building | 3 | Heater | 3000 | 1 | 83.2 | 20 | **63.2** |
| H-610 | Glycol Heater Stack | Glycol Building | 9 | Heater | 3000 | 1 | 83.2 | 0 | **83.2** |
| | Utility Heater Blower | Glycol Building | 3 | Axial Fan | 25 | 1 | 101.0 | 0 | **101.0** |
| | Utility Heater Casing | Glycol Building | 3 | Heater | 3000 | 1 | 83.2 | 20 | **63.2** |
| | Utility Heater Stack | Glycol Building | 9 | Heater | 3000 | 1 | 83.2 | 0 | **83.2** |
| K-600/601 | VRU Compressor | Tank Building | 2 | Reciprocating | 100 | 2 | 112.0 | 25 | **87.0** |
| P-503 | Off Spec Oil Recycle Pump | Tank Building | 2 | Centrifugal | 20 | 1 | 101.9 | 24 | **77.9** |
| P-505/507 | Slop Pump | Tank Building | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| P-521 | Wash Water Pump | Tank Building | 2 | Centrifugal | 40 | 1 | 102.8 | 24 | **78.8** |

## Phase 1 Noise Source Broadband Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated) Cont.

| Tag | Description | Location | Height (m) | Model/Type | Rating (kW) | # Units | Equipment Sound Power Level (dBA) | Building Attenuation (dBA) | Overall Sound Power Level (dBA) |
|---|---|---|---|---|---|---|---|---|---|
| P-557 | Recycle Pump | Tank Building | 2 | Centrifugal | 40 | 1 | 102.8 | 24 | **78.8** |
| P-509 A/B | Diluent Pump | Tank Building | 2 | Centrifugal | 50 | 2 | 106.1 | 24 | **82.1** |
| P-524 A/B | ORF Feed Pump | Tank Building | 2 | Centrifugal | 50 | 2 | 106.1 | 24 | **82.1** |
| P-525 A/B | De-Oiled Water Pump | Tank Building | 2 | Centrifugal | 40 | 2 | 105.8 | 24 | **81.8** |
| P-559 A/B | Skim Tank Feed Pump | Tank Building | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| EF-601 - 610 | Tank Building Exhaust Fant | Tank Building | 11 | Axial Fan | 1 | 10 | 97.0 | 0 | **97.0** |
| P-523 A/B | IGF Recycle Pump | IGF Building | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| | Gas Turbine Inlet | CoGen Building | 5 | Gas Turbine | | 1 | 103.2 | 0 | **103.2** |
| | Gas Turbine Exhaust | CoGen Building | 13 | Gas Turbine | | 1 | 111.8 | 0 | **111.8** |
| | Gas Turbine Casing | CoGen Building | 3 | Gas Turbine | | 1 | 82.8 | 22 | **60.8** |
| | HRSG Casing | CoGen Building | 3 | HRSG | | 1 | 82.8 | 22 | **60.8** |
| | Lube Oil Cooler | CoGen Building | 3 | Axial Fan | | 1 | 103.1 | 0 | **103.1** |
| | Gas Turbine Inlet | CoGen Building | 5 | Gas Turbine | | 1 | 103.2 | 0 | **103.2** |
| | Gas Turbine Exhaust | CoGen Building | 13 | Gas Turbine | | 1 | 111.8 | 0 | **111.8** |
| | Gas Turbine Casing | CoGen Building | 3 | Gas Turbine | | 1 | 82.8 | 22 | **60.8** |
| | HRSG Casing | CoGen Building | 3 | HRSG | | 1 | 82.8 | 22 | **60.8** |
| | Lube Oil Cooler | CoGen Building | 3 | Axial Fan | | 1 | 103.1 | 0 | **103.1** |
| KM-611/612 | Instrument Air Compressor | Well-Pad 1 Utility Building | 2 | Reciprocating | 30 | 2 | 106.8 | 13 | **93.8** |
| KM-611/612 | Instrument Air Compressor | Well-Pad 2 Utility Building | 2 | Reciprocating | 30 | 2 | 106.8 | 13 | **93.8** |
| KM-611/612 | Instrument Air Compressor | Well-Pad 3 Utility Building | 2 | Reciprocating | 30 | 2 | 106.8 | 13 | **93.8** |
| P-850 | Emulsion Pump | Well-Pad 1 Vessel Building | 2 | Centrifugal | 75 | 1 | 103.6 | 13 | **90.6** |
| P-850 | Emulsion Pump | Well-Pad 2 Vessel Building | 2 | Centrifugal | 75 | 1 | 103.6 | 13 | **90.6** |
| P-850 | Emulsion Pump | Well-Pad 3 Vessel Building | 2 | Centrifugal | 75 | 1 | 103.6 | 13 | **90.6** |
| | Wellpad Piping | Well-Pad 1 | 2 | piping | N/A | 6 | 103.2 | 0 | **103.2** |
| | Wellpad Piping | Well-Pad 2 | 2 | piping | N/A | 6 | 103.2 | 0 | **103.2** |
| | Wellpad Piping | Well-Pad 3 | 2 | piping | N/A | 6 | 103.2 | 0 | **103.2** |

## Phase 1 Noise Source Octave Band Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated)

| Description | 31.5Hz | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| Vapour Compressor | 114.3 | 110.3 | 115.3 | 114.3 | 112.3 | 115.3 | 120.3 | 117.3 | 110.3 |
| Evaporator Recirc Pump | 97.7 | 98.7 | 99.7 | 101.7 | 101.7 | 104.7 | 101.7 | 97.7 | 91.7 |
| Primary Feed Pump | 91.4 | 92.4 | 93.4 | 95.4 | 95.4 | 98.4 | 95.4 | 91.4 | 85.4 |
| Evaporator Feed Pump | 91.4 | 92.4 | 93.4 | 95.4 | 95.4 | 98.4 | 95.4 | 91.4 | 85.4 |
| Distillate Pump | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| Evaporator Building Exhaust Fan | 100.6 | 103.6 | 103.6 | 100.6 | 97.6 | 93.6 | 90.6 | 87.6 | 79.6 |
| Treater Building Exhaust Fant | 97.5 | 100.5 | 100.5 | 97.5 | 94.5 | 90.5 | 87.5 | 84.5 | 76.5 |
| Combustion Air Blower | 110.5 | 113.5 | 113.5 | 110.5 | 107.5 | 103.5 | 100.5 | 97.5 | 89.5 |
| Steam Boiler Casing | 107.8 | 106.8 | 101.8 | 95.8 | 94.8 | 92.8 | 90.8 | 90.8 | 90.8 |
| Steam Boiler Stack | 107.8 | 106.8 | 101.8 | 95.8 | 94.8 | 92.8 | 90.8 | 90.8 | 90.8 |
| Combustion Air Blower | 110.5 | 113.5 | 113.5 | 110.5 | 107.5 | 103.5 | 100.5 | 97.5 | 89.5 |
| Steam Boiler Casing | 107.8 | 106.8 | 101.8 | 95.8 | 94.8 | 92.8 | 90.8 | 90.8 | 90.8 |
| Steam Boiler Stack | 107.8 | 106.8 | 101.8 | 95.8 | 94.8 | 92.8 | 90.8 | 90.8 | 90.8 |
| HP Boiler Feedwater Pump | 99.1 | 100.1 | 101.1 | 103.1 | 103.1 | 106.1 | 103.1 | 99.1 | 93.1 |
| LP Boiler Feedwater Pump | 97.8 | 98.8 | 99.8 | 101.8 | 101.8 | 104.8 | 101.8 | 97.8 | 91.8 |
| Instrument Air Compressor | 98.0 | 94.0 | 99.0 | 98.0 | 96.0 | 99.0 | 104.0 | 101.0 | 94.0 |
| Glycol Aerial Cooler | 111.6 | 114.6 | 114.6 | 111.6 | 108.6 | 104.6 | 101.6 | 98.6 | 90.6 |
| Glycol Circulation Pump | 97.1 | 98.1 | 99.1 | 101.1 | 101.1 | 104.1 | 101.1 | 97.1 | 91.1 |
| Glycol Heater Blower | 102.0 | 105.0 | 105.0 | 102.0 | 99.0 | 95.0 | 92.0 | 89.0 | 81.0 |
| Glycol Heater Casing | 92.2 | 91.2 | 86.2 | 80.2 | 79.2 | 77.2 | 75.2 | 75.2 | 75.2 |
| Glycol Heater Stack | 92.2 | 91.2 | 86.2 | 80.2 | 79.2 | 77.2 | 75.2 | 75.2 | 75.2 |
| Utility Heater Blower | 102.0 | 105.0 | 105.0 | 102.0 | 99.0 | 95.0 | 92.0 | 89.0 | 81.0 |
| Utility Heater Casing | 92.2 | 91.2 | 86.2 | 80.2 | 79.2 | 77.2 | 75.2 | 75.2 | 75.2 |
| Utility Heater Stack | 92.2 | 91.2 | 86.2 | 80.2 | 79.2 | 77.2 | 75.2 | 75.2 | 75.2 |
| VRU Compressor | 102.0 | 98.0 | 103.0 | 102.0 | 100.0 | 103.0 | 108.0 | 105.0 | 98.0 |
| Off Spec Oil Recycle Pump | 90.9 | 91.9 | 92.9 | 94.9 | 94.9 | 97.9 | 94.9 | 90.9 | 84.9 |
| Slop Pump | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| Wash Water Pump | 91.8 | 92.8 | 93.8 | 95.8 | 95.8 | 98.8 | 95.8 | 91.8 | 85.8 |

## Phase 1 Noise Source Octave Band Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated) Cont.

| Description | 31.5Hz | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| Recycle Pump | 91.8 | 92.8 | 93.8 | 95.8 | 95.8 | 98.8 | 95.8 | 91.8 | 85.8 |
| Diluent Pump | 95.1 | 96.1 | 97.1 | 99.1 | 99.1 | 102.1 | 99.1 | 95.1 | 89.1 |
| ORF Feed Pump | 95.1 | 96.1 | 97.1 | 99.1 | 99.1 | 102.1 | 99.1 | 95.1 | 89.1 |
| De-Oiled Water Pump | 94.8 | 95.8 | 96.8 | 98.8 | 98.8 | 101.8 | 98.8 | 94.8 | 88.8 |
| Skim Tank Feed Pump | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| Tank Building Exhaust Fant | 98.0 | 101.0 | 101.0 | 98.0 | 95.0 | 91.0 | 88.0 | 85.0 | 77.0 |
| IGF Recycle Pump | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| Gas Turbine Inlet | 107.5 | 110.5 | 111.5 | 110.5 | 94.5 | 68.5 | 56.5 | 80.5 | 82.5 |
| Gas Turbine Exhaust | 121.5 | 123.5 | 116.5 | 113.5 | 112.5 | 100.5 | 95.5 | 92.5 | 88.5 |
| Gas Turbine Casing | 106.5 | 99.5 | 100.5 | 101.5 | 102.5 | 98.5 | 98.5 | 94.5 | 87.5 |
| HRSG Casing | 106.5 | 99.5 | 100.5 | 101.5 | 102.5 | 98.5 | 98.5 | 94.5 | 87.5 |
| Lube Oil Cooler | 107.5 | 114.5 | 111.5 | 104.5 | 99.5 | 96.5 | 92.5 | 88.5 | 83.5 |
| Gas Turbine Inlet | 107.5 | 110.5 | 111.5 | 110.5 | 94.5 | 68.5 | 56.5 | 80.5 | 82.5 |
| Gas Turbine Exhaust | 121.5 | 123.5 | 116.5 | 113.5 | 112.5 | 100.5 | 95.5 | 92.5 | 88.5 |
| Gas Turbine Casing | 106.5 | 99.5 | 100.5 | 101.5 | 102.5 | 98.5 | 98.5 | 94.5 | 87.5 |
| HRSG Casing | 106.5 | 99.5 | 100.5 | 101.5 | 102.5 | 98.5 | 98.5 | 94.5 | 87.5 |
| Lube Oil Cooler | 107.5 | 114.5 | 111.5 | 104.5 | 99.5 | 96.5 | 92.5 | 88.5 | 83.5 |
| Instrument Air Compressor | 96.8 | 92.8 | 97.8 | 96.8 | 94.8 | 97.8 | 102.8 | 99.8 | 92.8 |
| Instrument Air Compressor | 96.8 | 92.8 | 97.8 | 96.8 | 94.8 | 97.8 | 102.8 | 99.8 | 92.8 |
| Instrument Air Compressor | 96.8 | 92.8 | 97.8 | 96.8 | 94.8 | 97.8 | 102.8 | 99.8 | 92.8 |
| Emulsion Pump | 92.6 | 93.6 | 94.6 | 96.6 | 96.6 | 99.6 | 96.6 | 92.6 | 86.6 |
| Emulsion Pump | 92.6 | 93.6 | 94.6 | 96.6 | 96.6 | 99.6 | 96.6 | 92.6 | 86.6 |
| Emulsion Pump | 92.6 | 93.6 | 94.6 | 96.6 | 96.6 | 99.6 | 96.6 | 92.6 | 86.6 |
| Wellpad Piping | 108.8 | 111.8 | 101.8 | 99.8 | 98.8 | 97.8 | 95.8 | 94.8 | 89.8 |
| Wellpad Piping | 108.8 | 111.8 | 101.8 | 99.8 | 98.8 | 97.8 | 95.8 | 94.8 | 89.8 |
| Wellpad Piping | 108.8 | 111.8 | 101.8 | 99.8 | 98.8 | 97.8 | 95.8 | 94.8 | 89.8 |

**Phase 2 Noise Source Broadband Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated)**

| Description | Location | Height (m) | Model/Type | Rating (kW) | # Units | Equipment Sound Power Level (dBA) | Building Attenuation (dBA) | Overall Sound Power Level (dBA) |
|---|---|---|---|---|---|---|---|---|
| INSTRUMENT AIR SCREW COMPRESSOR PACKAGE #1 | Air Bldg | 2 | Reciprocating | 168 | 2 | 114.3 | 25 | **89.3** |
| OIL PRODUCTION RECYCLE PUMP | Tank Bldg | 2 | Centrifugal | 30 | 1 | 102.4 | 24 | **78.4** |
| SALES OIL RECYCLE PUMP | Tank Bldg | 2 | Centrifugal | 30 | 1 | 102.4 | 24 | **78.4** |
| OFF SPEC. OIL RECYCLE PUMP | Tank Bldg | 2 | Centrifugal | 30 | 1 | 102.4 | 24 | **78.4** |
| SLOP TRANSFER PUMP | Tank Bldg | 2 | Centrifugal | 22 | 1 | 102.0 | 24 | **78.0** |
| SLOP TRANSFER PUMP | Tank Bldg | 2 | Centrifugal | 22 | 1 | 102.0 | 24 | **78.0** |
| WASH WATER PUMP | Tank Bldg | 2 | Centrifugal | 30 | 1 | 102.4 | 24 | **78.4** |
| SURGE PUMP | Tank Bldg | 2 | Centrifugal | 60 | 2 | 106.3 | 24 | **82.3** |
| EDUCTOR SUPPLY PUMP | Tank Bldg | 2 | Centrifugal | 75 | 2 | 106.6 | 24 | **82.6** |
| OIL REMOVAL FILTER BACKWASH PUMP | Tank Bldg | 2 | Centrifugal | 75 | 2 | 106.6 | 24 | **82.6** |
| OIL REMOVAL FILTER FEED PUMP | Tank Bldg | 2 | Centrifugal | 75 | 2 | 106.6 | 24 | **82.6** |
| DE-OILED WATER PUMP | Tank Bldg | 2 | Centrifugal | 75 | 2 | 106.6 | 24 | **82.6** |
| DILUENT PUMP | Tank Bldg | 2 | Centrifugal | 112 | 2 | 107.2 | 24 | **83.2** |
| VRU COMPRESSOR #1 | Tank Bldg | 2 | Reciprocating | 224 | 1 | 112.5 | 25 | **87.5** |
| VRU COMPRESSOR #2 | Tank Bldg | 2 | Reciprocating | 224 | 1 | 112.5 | 25 | **87.5** |
| DILBIT LOAD PUMP | Tank Bldg | 2 | Centrifugal | 112 | 2 | 107.2 | 24 | **83.2** |
| ORF AGITATOR | Tank Bldg | 2 | Motor | 30 | 1 | 101.6 | 24 | **77.6** |
| ORF AGITATOR | Tank Bldg | 2 | Motor | 30 | 1 | 101.6 | 24 | **77.6** |
| ORF AGITATOR | Tank Bldg | 2 | Motor | 30 | 1 | 101.6 | 24 | **77.6** |
| ORF AGITATOR | Tank Bldg | 2 | Motor | 30 | 1 | 101.6 | 24 | **77.6** |
| CLEAN OIL STORAGE TRANSFER PUMP | Tank Bldg | 2 | Centrifugal | 112 | 1 | 104.1 | 24 | **80.1** |
| CLEAN OIL STORAGE RECYCLE PUMP | Tank Bldg | 2 | Centrifugal | 37 | 1 | 102.7 | 24 | **78.7** |
| EVAPORATOR FEED PUMP | Evap Bldg #1 | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| EVAPORATOR 1 DISTILLATE PUMP | Evap Bldg #1 | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| EVAPORATOR 1 RECIRCULATION PUMP | Evap Bldg #1 | 2 | Centrifugal | 261 | 2 | 108.3 | 24 | **84.3** |
| EVAPORATOR 1 VAPOR COMPRESSOR | Evap Bldg #1 | 5 | Reciprocating | 2300 | 2 | 125.6 | 25 | **100.6** |
| CRYSTALLIZER RECIRC. PUMP | Evap Bldg #1 | 2 | Centrifugal | 187 | 2 | 107.8 | 24 | **83.8** |

## Phase 2 Noise Source Broadband Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated) Cont.

| Description | Location | Height (m) | Model/Type | Rating (kW) | # Units | Equipment Sound Power Level (dBA) | Building Attenuation (dBA) | Overall Sound Power Level (dBA) |
|---|---|---|---|---|---|---|---|---|
| EVAPORATOR FEED PUMP | Evap Bldg #2 | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| EVAPORATOR 2 DISTILLATE PUMP | Evap Bldg #2 | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| EVAPORATOR 2 RECIRCULATION PUMP | Evap Bldg #2 | 2 | Centrifugal | 261 | 2 | 108.3 | 24 | **84.3** |
| EVAPORATOR 2 VAPOR COMPRESSOR | Evap Bldg #2 | 5 | Reciprocating | 2300 | 2 | 125.6 | 25 | **100.6** |
| CRYSTALLIZER RECIRC. PUMP | Evap Bldg #2 | 2 | Centrifugal | 187 | 2 | 107.8 | 24 | **83.8** |
| L.P. BOILER FEEDWATER PUMP | Evap Bldg #1 | 2 | Centrifugal | 224 | 3 | 109.8 | 24 | **85.8** |
| SOFT WATER PUMP | Evap Bldg #1 | 2 | Centrifugal | 30 | 2 | 105.4 | 24 | **81.4** |
| H.P. BOILER FEEDWATER PUMP | HP BFW Bldg | 2 | Centrifugal | 597 | 3 | 111.1 | 24 | **87.1** |
| TURBINE #1 ENCLOSURE VENTILATION FAN | Cogen Bldg | 3 | Axial Fan | 30 | 1 | 101.7 | 0 | **101.7** |
| TURBINE #1 START MOTOR | Cogen Bldg | 2 | Motor | 93 | 2 | 109.5 | 24 | **85.5** |
| SEAL AIR FAN | Cogen Bldg | 3 | Axial Fan | 8 | 1 | 96.0 | 0 | **96.0** |
| COOLING AIR BLOWER | Cogen Bldg | 3 | Axial Fan | 3 | 1 | 91.8 | 0 | **91.8** |
| TURBINE #2 ENCLOSURE VENTILATION FAN | Cogen Bldg | 3 | Axial Fan | 15 | 1 | 98.8 | 0 | **98.8** |
| TURBINE #2 START MOTOR | Cogen Bldg | 2 | Motor | 93 | 2 | 109.5 | 24 | **85.5** |
| SEAL AIR FAN | Cogen Bldg | 3 | Axial Fan | 8 | 1 | 96.0 | 0 | **96.0** |
| COOLING AIR BLOWER | Cogen Bldg | 3 | Axial Fan | 3 | 1 | 91.8 | 0 | **91.8** |
| TURBINE #3 ENCLOSURE VENTILATION FAN | Cogen Bldg | 3 | Axial Fan | 15 | 1 | 98.8 | 0 | **98.8** |
| TURBINE #3 START MOTOR | Cogen Bldg | 2 | Motor | 93 | 2 | 109.5 | 24 | **85.5** |
| SEAL AIR FAN | Cogen Bldg | 3 | Axial Fan | 8 | 1 | 96.0 | 0 | **96.0** |
| COOLING AIR BLOWER | Cogen Bldg | 3 | Axial Fan | 3 | 1 | 91.8 | 0 | **91.8** |
| STEAM BOILER STACK | Steam Gen Bldg | 30 | Heater | 100844 | 1 | 101.1 | 0 | **101.1** |
| BOILER COMBUSTION AIR FAN | Steam Gen Bldg | 5 | Axial Fan | 373 | 1 | 102.7 | 0 | **102.7** |
| STEAM BOILER STACK | Steam Gen Bldg | 30 | Heater | 100844 | 1 | 101.1 | 0 | **101.1** |
| BOILER COMBUSTION AIR FAN | Steam Gen Bldg | 5 | Axial Fan | 373 | 1 | 102.7 | 0 | **102.7** |
| STEAM BOILER STACK | Steam Gen Bldg | 30 | Heater | 100844 | 1 | 101.1 | 0 | **101.1** |
| BOILER COMBUSTION AIR FAN | Steam Gen Bldg | 5 | Axial Fan | 373 | 1 | 102.7 | 0 | **102.7** |
| STEAM BOILER STACK | Steam Gen Bldg | 30 | Heater | 100844 | 1 | 101.1 | 0 | **101.1** |
| BOILER COMBUSTION AIR FAN | Steam Gen Bldg | 5 | Axial Fan | 373 | 1 | 102.7 | 0 | **102.7** |
| STEAM BOILER STACK | Steam Gen Bldg | 30 | Heater | 100844 | 1 | 101.1 | 0 | **101.1** |
| BOILER COMBUSTION AIR FAN | Steam Gen Bldg | 5 | Axial Fan | 373 | 1 | 102.7 | 0 | **102.7** |

## Phase 2 Noise Source Broadband Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated) Cont.

| Description | Location | Height (m) | Model/Type | Rating (kW) | # Units | Equipment Sound Power Level (dBA) | Building Attenuation (dBA) | Overall Sound Power Level (dBA) |
|---|---|---|---|---|---|---|---|---|
| GLYCOL HEATER BLOWER | Glycol Building | 3 | Axial Fan | 25 | 1 | 101.0 | 0 | **101.0** |
| GLYCOL HEATER STACK | Glycol Building | 9 | Heater | 5200 | 1 | 86.7 | 0 | **86.7** |
| UTILITY HEATER BLOWER | Glycol Building | 3 | Axial Fan | 25 | 1 | 101.0 | 0 | **101.0** |
| UTILITY HEATER STACK | Glycol Building | 10 | Heater | 5900 | 1 | 87.6 | 0 | **87.6** |
| HEATING GLYCOL CIRCULATION PUMP | Glycol Bldg | 2 | Centrifugal | 112 | 2 | 107.2 | 24 | **83.2** |
| COOLING GLYCOL CIRCULATION PUMP | Glycol Bldg | 2 | Centrifugal | 298 | 3 | 110.2 | 24 | **86.2** |
| COOLING GLYCOL COOLER FANS | Glycol Coolers | 5 | Axial Fan | 37 | 16 | 110.8 | 0 | **110.8** |
| GAS TURBINE INLET | CoGen Building | 5 | Gas Turbine | | 1 | 94.3 | 0 | **94.3** |
| GAS TURBINE EXHAUST | CoGen Building | 20 | Gas Turbine | | 1 | 102.1 | 0 | **102.1** |
| GAS TURBINE CASING | CoGen Building | 3 | Gas Turbine | | 1 | 88.0 | 22 | **66.0** |
| HRSG CASING | CoGen Building | 3 | HRSG | | 1 | 88.0 | 22 | **66.0** |
| LUBE OIL COOLER | CoGen Building | 3 | Axial Fan | | 1 | 103.1 | 0 | **103.1** |
| GAS TURBINE INLET | CoGen Building | 5 | Gas Turbine | | 1 | 94.3 | 0 | **94.3** |
| GAS TURBINE EXHAUST | CoGen Building | 20 | Gas Turbine | | 1 | 102.1 | 0 | **102.1** |
| GAS TURBINE CASING | CoGen Building | 3 | Gas Turbine | | 1 | 88.0 | 22 | **66.0** |
| HRSG CASING | CoGen Building | 3 | HRSG | | 1 | 88.0 | 22 | **66.0** |
| LUBE OIL COOLER | CoGen Building | 3 | Axial Fan | | 1 | 103.1 | 0 | **103.1** |
| GAS TURBINE INLET | CoGen Building | 5 | Gas Turbine | | 1 | 94.3 | 0 | **94.3** |
| GAS TURBINE EXHAUST | CoGen Building | 20 | Gas Turbine | | 1 | 102.1 | 0 | **102.1** |
| GAS TURBINE CASING | CoGen Building | 3 | Gas Turbine | | 1 | 88.0 | 22 | **66.0** |
| HRSG CASING | CoGen Building | 3 | HRSG | | 1 | 88.0 | 22 | **66.0** |
| LUBE OIL COOLER | CoGen Building | 3 | Axial Fan | | 1 | 103.1 | 0 | **103.1** |
| FIELD STEP UP TRANSFORMER 13.8KV/25KV | Switch Yard | 3 | Transformer | 15 MVA | 1 | 97.0 | 0 | **97.0** |
| FIELD STEP UP TRANSFORMER 13.8KV/25KV COOLING FANS | Switch Yard | 3 | Axial Fan | 1 | 4 | 93.0 | 0 | **93.0** |
| 13.8/4160 VAC STEP DOWN TRANSFORMERS | Switch Yard | 3 | Transformer | 5MVA | 3 | 101.8 | 0 | **101.8** |
| 13.8/480 VAC STEP DOWN TRANSFORMERS | Switch Yard | 3 | Transformer | 3 MVA | 4 | 103.1 | 0 | **103.1** |
| INSTRUMENT AIR | Well-Pad (Typical) | 2 | Reciprocating | 30 | 2 | 106.8 | 13 | **93.8** |
| Emulsion Pump | Well-Pad (Typical) | 2 | Centrifugal | 75 | 1 | 103.6 | 13 | **90.6** |
| Wellpad Piping | Well-Pad (Typical) | 2 | piping | N/A | 6 | 103.2 | 0 | **103.2** |

## Phase 2 Noise Source Octave Band Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated)

| Description | 31.5Hz | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| INSTRUMENT AIR SCREW COMPRESSOR PACKAGE #1 | 104.3 | 100.3 | 105.3 | 104.3 | 102.3 | 105.3 | 110.3 | 107.3 | 100.3 |
| OIL PRODUCTION RECYCLE PUMP | 91.4 | 92.4 | 93.4 | 95.4 | 95.4 | 98.4 | 95.4 | 91.4 | 85.4 |
| SALES OIL RECYCLE PUMP | 91.4 | 92.4 | 93.4 | 95.4 | 95.4 | 98.4 | 95.4 | 91.4 | 85.4 |
| OFF SPEC. OIL RECYCLE PUMP | 91.4 | 92.4 | 93.4 | 95.4 | 95.4 | 98.4 | 95.4 | 91.4 | 85.4 |
| SLOP TRANSFER PUMP | 91.0 | 92.0 | 93.0 | 95.0 | 95.0 | 98.0 | 95.0 | 91.0 | 85.0 |
| SLOP TRANSFER PUMP | 91.0 | 92.0 | 93.0 | 95.0 | 95.0 | 98.0 | 95.0 | 91.0 | 85.0 |
| WASH WATER PUMP | 91.4 | 92.4 | 93.4 | 95.4 | 95.4 | 98.4 | 95.4 | 91.4 | 85.4 |
| SURGE PUMP | 95.3 | 96.3 | 97.3 | 99.3 | 99.3 | 102.3 | 99.3 | 95.3 | 89.3 |
| EDUCTOR SUPPLY PUMP | 95.6 | 96.6 | 97.6 | 99.6 | 99.6 | 102.6 | 99.6 | 95.6 | 89.6 |
| OIL REMOVAL FILTER BACKWASH PUMP | 95.6 | 96.6 | 97.6 | 99.6 | 99.6 | 102.6 | 99.6 | 95.6 | 89.6 |
| OIL REMOVAL FILTER FEED PUMP | 95.6 | 96.6 | 97.6 | 99.6 | 99.6 | 102.6 | 99.6 | 95.6 | 89.6 |
| DE-OILED WATER PUMP | 95.6 | 96.6 | 97.6 | 99.6 | 99.6 | 102.6 | 99.6 | 95.6 | 89.6 |
| DILUENT PUMP | 96.2 | 97.2 | 98.2 | 100.2 | 100.2 | 103.2 | 100.2 | 96.2 | 90.2 |
| VRU COMPRESSOR #1 | 102.5 | 98.5 | 103.5 | 102.5 | 100.5 | 103.5 | 108.5 | 105.5 | 98.5 |
| VRU COMPRESSOR #2 | 102.5 | 98.5 | 103.5 | 102.5 | 100.5 | 103.5 | 108.5 | 105.5 | 98.5 |
| DILBIT LOAD PUMP | 96.2 | 97.2 | 98.2 | 100.2 | 100.2 | 103.2 | 100.2 | 96.2 | 90.2 |
| ORF AGITATOR | 88.6 | 88.6 | 91.6 | 93.6 | 96.6 | 96.6 | 95.6 | 90.6 | 82.6 |
| ORF AGITATOR | 88.6 | 88.6 | 91.6 | 93.6 | 96.6 | 96.6 | 95.6 | 90.6 | 82.6 |
| ORF AGITATOR | 88.6 | 88.6 | 91.6 | 93.6 | 96.6 | 96.6 | 95.6 | 90.6 | 82.6 |
| ORF AGITATOR | 88.6 | 88.6 | 91.6 | 93.6 | 96.6 | 96.6 | 95.6 | 90.6 | 82.6 |
| CLEAN OIL STORAGE TRANSFER PUMP | 93.1 | 94.1 | 95.1 | 97.1 | 97.1 | 100.1 | 97.1 | 93.1 | 87.1 |
| CLEAN OIL STORAGE RECYCLE PUMP | 91.7 | 92.7 | 93.7 | 95.7 | 95.7 | 98.7 | 95.7 | 91.7 | 85.7 |
| EVAPORATOR FEED PUMP | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| EVAPORATOR 1 DISTILLATE PUMP | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| EVAPORATOR 1 RECIRCULATION PUMP | 97.3 | 98.3 | 99.3 | 101.3 | 101.3 | 104.3 | 101.3 | 97.3 | 91.3 |
| EVAPORATOR 1 VAPOR COMPRESSOR | 115.6 | 111.6 | 116.6 | 115.6 | 113.6 | 116.6 | 121.6 | 118.6 | 111.6 |
| CRYSTALLIZER RECIRC. PUMP | 96.8 | 97.8 | 98.8 | 100.8 | 100.8 | 103.8 | 100.8 | 96.8 | 90.8 |

## Phase 2 Noise Source Octave Band Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated) Cont.

| Description | 31.5Hz | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| EVAPORATOR FEED PUMP | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| EVAPORATOR 2 DISTILLATE PUMP | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| EVAPORATOR 2 RECIRCULATION PUMP | 97.3 | 98.3 | 99.3 | 101.3 | 101.3 | 104.3 | 101.3 | 97.3 | 91.3 |
| EVAPORATOR 2 VAPOR COMPRESSOR | 115.6 | 111.6 | 116.6 | 115.6 | 113.6 | 116.6 | 121.6 | 118.6 | 111.6 |
| CRYSTALLIZER RECIRC. PUMP | 96.8 | 97.8 | 98.8 | 100.8 | 100.8 | 103.8 | 100.8 | 96.8 | 90.8 |
| L.P. BOILER FEEDWATER PUMP | 98.8 | 99.8 | 100.8 | 102.8 | 102.8 | 105.8 | 102.8 | 98.8 | 92.8 |
| SOFT WATER PUMP | 94.4 | 95.4 | 96.4 | 98.4 | 98.4 | 101.4 | 98.4 | 94.4 | 88.4 |
| H.P. BOILER FEEDWATER PUMP | 100.1 | 101.1 | 102.1 | 104.1 | 104.1 | 107.1 | 104.1 | 100.1 | 94.1 |
| TURBINE #1 ENCLOSURE VENTILATION FAN | 102.7 | 105.7 | 105.7 | 102.7 | 99.7 | 95.7 | 92.7 | 89.7 | 81.7 |
| TURBINE #1 START MOTOR | 96.5 | 96.5 | 99.5 | 101.5 | 104.5 | 104.5 | 103.5 | 98.5 | 90.5 |
| SEAL AIR FAN | 97.0 | 100.0 | 100.0 | 97.0 | 94.0 | 90.0 | 87.0 | 84.0 | 76.0 |
| COOLING AIR BLOWER | 92.8 | 95.8 | 95.8 | 92.8 | 89.8 | 85.8 | 82.8 | 79.8 | 71.8 |
| TURBINE #2 ENCLOSURE VENTILATION FAN | 99.8 | 102.8 | 102.8 | 99.8 | 96.8 | 92.8 | 89.8 | 86.8 | 78.8 |
| TURBINE #2 START MOTOR | 96.5 | 96.5 | 99.5 | 101.5 | 104.5 | 104.5 | 103.5 | 98.5 | 90.5 |
| SEAL AIR FAN | 97.0 | 100.0 | 100.0 | 97.0 | 94.0 | 90.0 | 87.0 | 84.0 | 76.0 |
| COOLING AIR BLOWER | 92.8 | 95.8 | 95.8 | 92.8 | 89.8 | 85.8 | 82.8 | 79.8 | 71.8 |
| TURBINE #3 ENCLOSURE VENTILATION FAN | 99.8 | 102.8 | 102.8 | 99.8 | 96.8 | 92.8 | 89.8 | 86.8 | 78.8 |
| TURBINE #3 START MOTOR | 96.5 | 96.5 | 99.5 | 101.5 | 104.5 | 104.5 | 103.5 | 98.5 | 90.5 |
| SEAL AIR FAN | 97.0 | 100.0 | 100.0 | 97.0 | 94.0 | 90.0 | 87.0 | 84.0 | 76.0 |
| COOLING AIR BLOWER | 92.8 | 95.8 | 95.8 | 92.8 | 89.8 | 85.8 | 82.8 | 79.8 | 71.8 |
| STEAM BOILER STACK | 110.1 | 109.1 | 104.1 | 98.1 | 97.1 | 95.1 | 93.1 | 93.1 | 93.1 |
| BOILER COMBUSTION AIR FAN | 103.7 | 106.7 | 106.7 | 103.7 | 100.7 | 96.7 | 93.7 | 90.7 | 82.7 |
| STEAM BOILER STACK | 110.1 | 109.1 | 104.1 | 98.1 | 97.1 | 95.1 | 93.1 | 93.1 | 93.1 |
| BOILER COMBUSTION AIR FAN | 103.7 | 106.7 | 106.7 | 103.7 | 100.7 | 96.7 | 93.7 | 90.7 | 82.7 |
| STEAM BOILER STACK | 110.1 | 109.1 | 104.1 | 98.1 | 97.1 | 95.1 | 93.1 | 93.1 | 93.1 |
| BOILER COMBUSTION AIR FAN | 103.7 | 106.7 | 106.7 | 103.7 | 100.7 | 96.7 | 93.7 | 90.7 | 82.7 |
| STEAM BOILER STACK | 110.1 | 109.1 | 104.1 | 98.1 | 97.1 | 95.1 | 93.1 | 93.1 | 93.1 |
| BOILER COMBUSTION AIR FAN | 103.7 | 106.7 | 106.7 | 103.7 | 100.7 | 96.7 | 93.7 | 90.7 | 82.7 |
| STEAM BOILER STACK | 110.1 | 109.1 | 104.1 | 98.1 | 97.1 | 95.1 | 93.1 | 93.1 | 93.1 |
| BOILER COMBUSTION AIR FAN | 103.7 | 106.7 | 106.7 | 103.7 | 100.7 | 96.7 | 93.7 | 90.7 | 82.7 |

## Phase 2 Noise Source Octave Band Sound Power Levels (Re $10^{-12}$ Watts, un-mitigated) Cont.

| Description | 31.5Hz | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| GLYCOL HEATER BLOWER | 102.0 | 105.0 | 105.0 | 102.0 | 99.0 | 95.0 | 92.0 | 89.0 | 81.0 |
| GLYCOL HEATER STACK | 95.7 | 94.7 | 89.7 | 83.7 | 82.7 | 80.7 | 78.7 | 78.7 | 78.7 |
| UTILITY HEATER BLOWER | 102.0 | 105.0 | 105.0 | 102.0 | 99.0 | 95.0 | 92.0 | 89.0 | 81.0 |
| UTILITY HEATER STACK | 96.6 | 95.6 | 90.6 | 84.6 | 83.6 | 81.6 | 79.6 | 79.6 | 79.6 |
| HEATING GLYCOL CIRCULATION PUMP | 96.2 | 97.2 | 98.2 | 100.2 | 100.2 | 103.2 | 100.2 | 96.2 | 90.2 |
| COOLING GLYCOL CIRCULATION PUMP | 99.2 | 100.2 | 101.2 | 103.2 | 103.2 | 106.2 | 103.2 | 99.2 | 93.2 |
| COOLING GLYCOL COOLER FANS | 111.8 | 114.8 | 114.8 | 111.8 | 108.8 | 104.8 | 101.8 | 98.8 | 90.8 |
| GAS TURBINE INLET | 111.5 | 111.5 | 107.5 | 97.5 | 77.5 | 52.5 | 51.5 | 79.5 | 76.5 |
| GAS TURBINE EXHAUST | 124.5 | 121.5 | 112.5 | 104.5 | 97.5 | 88.5 | 83.5 | 82.5 | 81.5 |
| GAS TURBINE CASING | 119.5 | 112.5 | 109.5 | 106.5 | 104.5 | 103.5 | 101.5 | 98.5 | 93.5 |
| HRSG CASING | 119.5 | 112.5 | 109.5 | 106.5 | 104.5 | 103.5 | 101.5 | 98.5 | 93.5 |
| LUBE OIL COOLER | 107.5 | 114.5 | 111.5 | 104.5 | 99.5 | 96.5 | 92.5 | 88.5 | 83.5 |
| GAS TURBINE INLET | 111.5 | 111.5 | 107.5 | 97.5 | 77.5 | 52.5 | 51.5 | 79.5 | 76.5 |
| GAS TURBINE EXHAUST | 124.5 | 121.5 | 112.5 | 104.5 | 97.5 | 88.5 | 83.5 | 82.5 | 81.5 |
| GAS TURBINE CASING | 119.5 | 112.5 | 109.5 | 106.5 | 104.5 | 103.5 | 101.5 | 98.5 | 93.5 |
| HRSG CASING | 119.5 | 112.5 | 109.5 | 106.5 | 104.5 | 103.5 | 101.5 | 98.5 | 93.5 |
| LUBE OIL COOLER | 107.5 | 114.5 | 111.5 | 104.5 | 99.5 | 96.5 | 92.5 | 88.5 | 83.5 |
| GAS TURBINE INLET | 111.5 | 111.5 | 107.5 | 97.5 | 77.5 | 52.5 | 51.5 | 79.5 | 76.5 |
| GAS TURBINE EXHAUST | 124.5 | 121.5 | 112.5 | 104.5 | 97.5 | 88.5 | 83.5 | 82.5 | 81.5 |
| GAS TURBINE CASING | 119.5 | 112.5 | 109.5 | 106.5 | 104.5 | 103.5 | 101.5 | 98.5 | 93.5 |
| HRSG CASING | 119.5 | 112.5 | 109.5 | 106.5 | 104.5 | 103.5 | 101.5 | 98.5 | 93.5 |
| LUBE OIL COOLER | 107.5 | 114.5 | 111.5 | 104.5 | 99.5 | 96.5 | 92.5 | 88.5 | 83.5 |
| FIELD STEP UP TRANSFORMER 13.8KV/25KV | 97.0 | 100.0 | 102.0 | 97.0 | 97.0 | 91.0 | 86.0 | 81.0 | 74.0 |
| FIELD STEP UP TRANSFORMER 13.8KV/25KV COOLING FANS | 94.0 | 97.0 | 97.0 | 94.0 | 91.0 | 87.0 | 84.0 | 81.0 | 73.0 |
| 13.8/4160 VAC STEP DOWN TRANSFORMERS | 101.8 | 104.8 | 106.8 | 101.8 | 101.8 | 95.8 | 90.8 | 85.8 | 78.8 |
| 13.8/480 VAC STEP DOWN TRANSFORMERS | 103.1 | 106.1 | 108.1 | 103.1 | 103.1 | 97.1 | 92.1 | 87.1 | 80.1 |
| INSTRUMENT AIR | 96.8 | 92.8 | 97.8 | 96.8 | 94.8 | 97.8 | 102.8 | 99.8 | 92.8 |
| Emulsion Pump | 92.6 | 93.6 | 94.6 | 96.6 | 96.6 | 99.6 | 96.6 | 92.6 | 86.6 |
| Wellpad Piping | 108.8 | 111.8 | 101.8 | 99.8 | 98.8 | 97.8 | 95.8 | 94.8 | 89.8 |

## Phase 1 Building Dimensions

| Tag | Building Name | Length (m) | Width (m) | Height (m) |
|---|---|---|---|---|
| BU-000 | Office | 30.0 | 27.0 | 6.1 |
| BU-001 | Electrical Building | 15.0 | 7.0 | 4.5 |
| BU-002 | Electrical Building | 15.0 | 7.0 | 4.5 |
| BU-003 | Electrical Building | 30.0 | 7.0 | 4.5 |
| BU-004 | Electrical Building | 30.0 | 7.0 | 4.5 |
| BU-020 | Inlet Building | 36.0 | 19.0 | 6.9 |
| BU-021 | Treater Building | 39.0 | 18.0 | 6.5 |
| BU-022 | Tank Building | 83.0 | 26.0 | 8.9 |
| BU-023 | Glycol Building | 20.0 | 16.0 | 4.3 |
| BU-028 | Source Water Building | 30.0 | 20.0 | 6.5 |
| BU-030 | Evaporator Building | 33.0 | 27.0 | 16.0 |
| BU-031 | Steam Generator Building | 33.0 | 31.0 | 11.0 |
| BU-034 | Fuel Gas Building | 12.0 | 6.0 | 4.5 |
| BU-036 | Flare Knockout Building | 12.0 | 6.0 | 4.5 |
| | Cogen Building | 50.0 | 25.0 | 11.0 |

## Phase 2 Building Dimensions

| Building Name | Length (m) | Width (m) | Height (m) |
|---|---|---|---|
| CoGen Switchgear Building | 25.0 | 7.0 | 3.7 |
| Black Start Generator Building | 15.0 | 7.0 | 3.7 |
| 480VAC MCC Building | 30.0 | 7.0 | 4.2 |
| CoGen Building | 25.5 | 35.5 | 10.0 |
| Steam Generator Building | 134.0 | 46.8 | 13.5 |
| Fuel Gas Building | 12.3 | 6.0 | 5.5 |
| HP BFW Pump Building | 18.0 | 7.0 | 6.0 |
| Steam Generator MCC Building | 30.0 | 7.0 | 4.2 |
| MCC | 30.0 | 7.0 | 4.2 |
| East Evaporator / Water Area Building | 82.0 | 21.0 | 15.0 |
| West Evaporator / Water Area Building | 82.0 | 21.0 | 15.0 |
| East Clean Lab | 7.3 | 3.7 | 2.5 |
| West Clean Lab | 7.3 | 3.7 | 2.5 |
| East Evaporator MCC Building | 30.0 | 7.0 | 4.2 |
| West Evaporator MCC Building | 30.0 | 7.0 | 4.2 |
| East MCC - 1 | 30.0 | 7.0 | 4.2 |
| West MCC - 1 | 30.0 | 7.0 | 4.2 |
| Tank Building | 100.0 | 26.0 | 7.0 |
| Northeast Inlet Building | 34.0 | 6.2 | 6.1 |
| Southeast Inlet Building | 34.0 | 6.2 | 6.1 |
| Northwest Inlet Building | 34.0 | 6.2 | 6.6 |
| Southwest Inlet Building | 34.0 | 6.2 | 6.6 |
| Northeast FWKO Building | 25.3 | 6.5 | 6.0 |
| Southeast FWKO Building | 25.3 | 6.5 | 6.0 |
| Northwest FWKO Building | 25.3 | 6.5 | 6.0 |
| Southwest FWKO Building | 25.3 | 6.5 | 6.0 |
| Pop Drum Building | 8.0 | 4.1 | 5.0 |
| North Treater Building | 25.5 | 5.4 | 6.0 |
| North Treater Building | 25.5 | 5.4 | 6.0 |
| Oil Lab | 7.3 | 3.7 | 2.8 |
| North Produced Water Building | 22.0 | 13.0 | 6.9 |
| South Produced Water Building | 22.0 | 13.0 | 6.9 |
| North Clean Oil Building | 12.0 | 6.5 | 6.5 |
| South Clean Oil Building | 12.0 | 6.5 | 6.5 |
| Instrument Air Building | 10.0 | 6.0 | 3.7 |
| Glycol Building | 20.0 | 16.0 | 4.5 |
| Flare Knockout Building | 12.0 | 3.4 | 5.0 |
| Office / Main Control Room | 30.5 | 27.4 | 4.9 |
| Warehouse | 30.5 | 27.4 | 4.9 |

## Phase 1 Tank Dimensions

| Tank Name | Radius (m) | Height (m) |
|---|---|---|
| Tanks 050 | 7.3 | 9.7 |
| Tanks 051 | 7.3 | 9.7 |
| Tanks 052 | 7.3 | 9.7 |
| Tanks 053 | 3.6 | 9.7 |
| Tanks 054 | 7.3 | 9.7 |
| Tanks 055 | 7.2 | 9.7 |
| Tanks 056 | 6.5 | 9.7 |
| Tanks 057 | 3.6 | 9.7 |
| Tanks 058 | 7.3 | 9.7 |
| Tanks 060 | 7.3 | 9.7 |
| Tanks 061 | 3.6 | 9.7 |
| Tanks 062 | 3.1 | 8.2 |
| Tanks 063 | 2.4 | 4.8 |
| Tanks 064 | 7.3 | 9.7 |

## Phase 2 Tank Dimensions

| Tank Name | Radius (m) | Height (m) |
|---|---|---|
| Raw Water Tank | 7.2 | 9.7 |
| Boiler Feedwater Tank | 10.6 | 9.7 |
| Soft Water Tank | 10.6 | 9.7 |
| Desand Tanks (x2) | 3.6 | 9.7 |
| Skim Tanks (x2) | 7.2 | 9.7 |
| IGF Feed Tanks (x2) | 7.2 | 9.7 |
| Slop Tanks (x2) | 7.2 | 9.7 |
| De-Oiled Water Tank | 10.6 | 9.7 |
| Diluent Tank | 10.6 | 9.7 |
| Sales Oil Tanks (x2) | 10.6 | 9.7 |
| Off Spec. Oil Tank | 10.6 | 9.7 |

## Building Sound Level Attenuation

| | 31.5 Hz | 63 HZ | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | 8000 Hz |
|---|---|---|---|---|---|---|---|---|---|
| Building Attenuation (dB) | 3 | 6 | 9 | 12 | 15 | 20 | 25 | 30 | 30 |

## General Modeling Parameters

| Parameter | Value |
|---|---|
| **Modeling Software** | CADNA/A (Version 4.1.137) |
| **Standard Followed** | ISO 9613-2 |
| **Ground Sound Absorption Coefficient** | 0.5 |
| **Wind Speed** | 1 - 5 m/s (3.6 - 18 km/hr) |
| **Wind Direction** | Downwind from all sources to all receptors |
| **Temperature** | 10 °C |
| **Humidity** | 70% |
| **Topography** | Used Digital Terrain Model Contours Provided by Client |

# Appendix II THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

## Sound Pressure Level

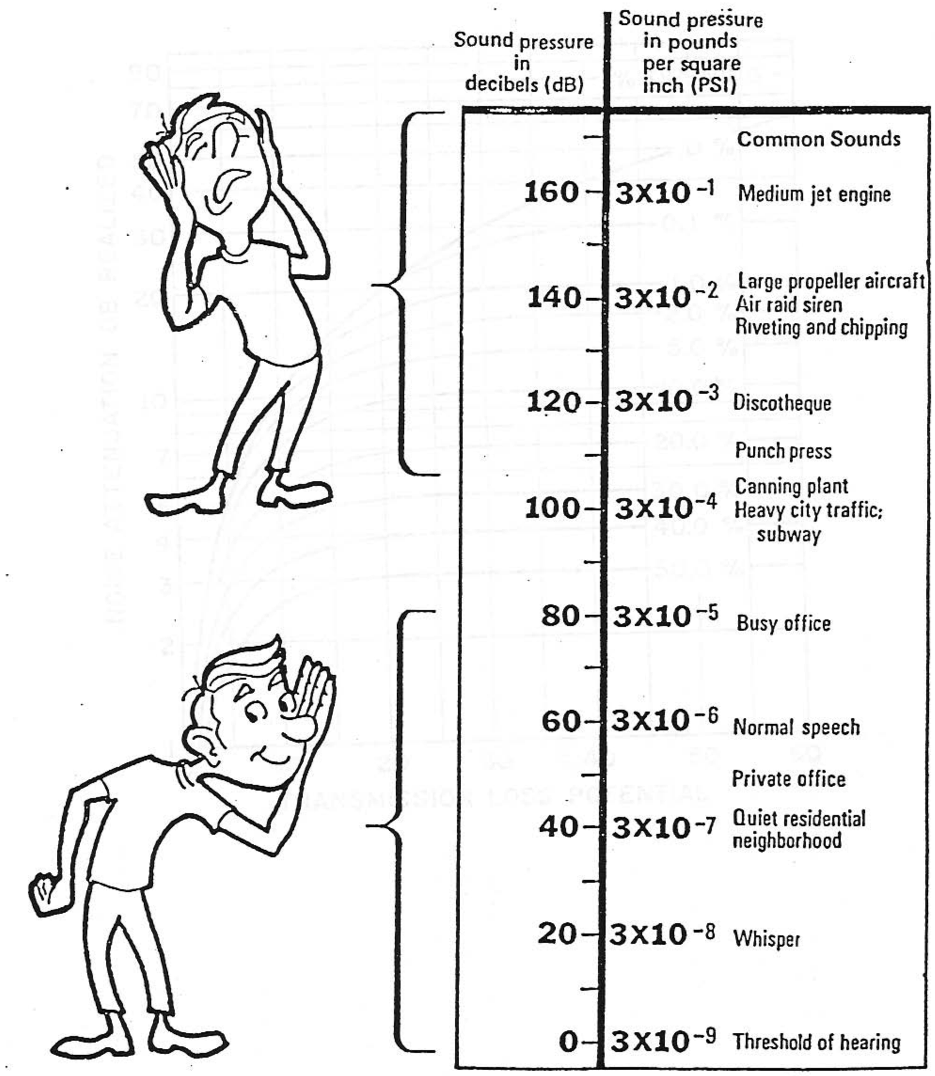
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we measure pressure we typically measure the RMS sound pressure.

$$SPL = 10\log_{10}\left[\frac{P_{RMS}^{2}}{P_{ref}^{2}}\right] = 20\log_{10}\left[\frac{P_{RMS}}{P_{ref}}\right]$$

Where: $SPL$ = Sound Pressure Level in dB
$P_{RMS}$ = Root Mean Square measured pressure (Pa)
$P_{ref}$ = Reference sound pressure level ($P_{ref} = 2\text{x}10^{-5}$ Pa = 20 μPa)

This reference sound pressure level is an internationally agreed upon value. It represents the threshold of human hearing for "typical" people based on numerous testing. It is possible to have a threshold which is lower than 20 μPa which will result in negative dB levels. As such, zero dB does not mean there is no sound!

In general, a difference of 1 – 2 dB is the threshold for humans to notice that there has been a change in sound level. A difference of 3 dB (factor of 2 in acoustical energy) is perceptible and a change of 5 dB is strongly perceptible. A change of 10 dB is typically considered a factor of 2. This is quite remarkable when considering that 10 dB is 10-times the acoustical energy!


Sound pressure in decibels (dB)
Sound pressure in pounds per square inch (PSI)
Common Sounds
160 3X10 -1 Medium jet engine
140 3X10 -2 Large propeller aircraft
Air raid siren
Riveting and chipping
120 3X10 -3 Discotheque
Punch press
Canning plant
100 3X10 -4 Heavy city traffic; subway
80 3X10 -5 Busy office
60 3X10 -6 Normal speech
Private office
40 3X10 -7 Quiet residential neighborhood
20 3X10 -8 Whisper
0 3X10 -9 Threshold of hearing

## Frequency

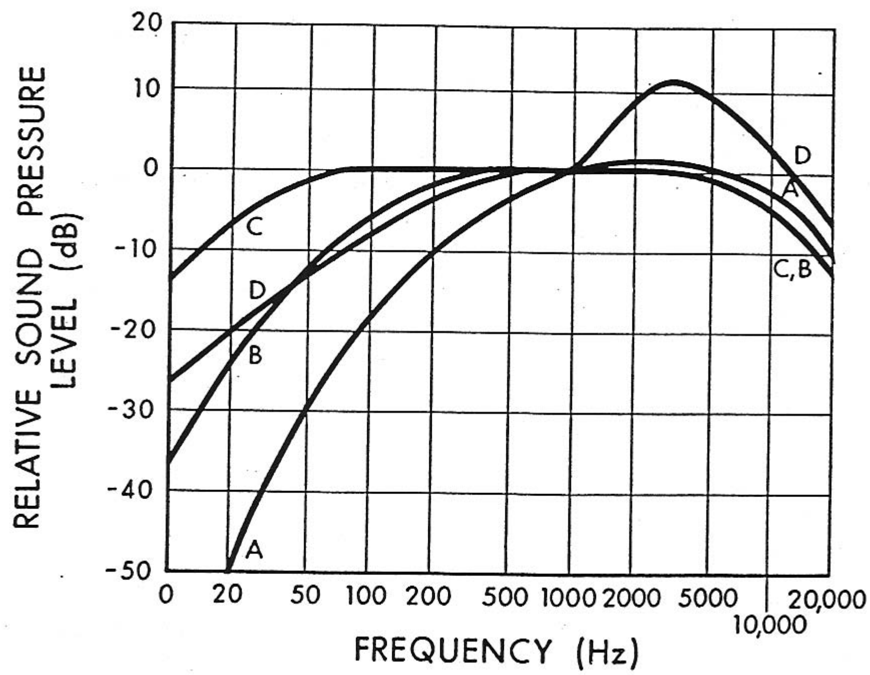
The range of frequencies audible to the human ear ranges from approximately 20 Hz to 20 kHz. Within this range, the human ear does not hear equally at all frequencies. It is not very sensitive to low frequency sounds, is very sensitive to mid frequency sounds and is slightly less sensitive to high frequency sounds. Due to the large frequency range of human hearing, the entire spectrum is often divided into 31 bands, each known as a 1/3 octave band.

The internationally agreed upon center frequencies and upper and lower band limits for the 1/1 (whole octave) and 1/3 octave bands are as follows:

| Lower Band Limit | Whole Octave Center Frequency | Upper Band Limit |
|---|---|---|
| 11 | **16** | 22 |
| 22 | **31.5** | 44 |
| 44 | **63** | 88 |
| 88 | **125** | 177 |
| 177 | **250** | 355 |
| 355 | **500** | 710 |
| 710 | **1000** | 1420 |
| 1420 | **2000** | 2840 |
| 2840 | **4000** | 5680 |
| 5680 | **8000** | 11360 |
| 11360 | **16000** | 22720 |

| Lower Band Limit | 1/3 Octave Center Frequency | Upper Band Limit |
|---|---|---|
| 14.1 | **16** | 17.8 |
| 17.8 | **20** | 22.4 |
| 22.4 | **25** | 28.2 |
| 28.2 | **31.5** | 35.5 |
| 35.5 | **40** | 44.7 |
| 44.7 | **50** | 56.2 |
| 56.2 | **63** | 70.8 |
| 70.8 | **80** | 89.1 |
| 89.1 | **100** | 112 |
| 112 | **125** | 141 |
| 141 | **160** | 178 |
| 178 | **200** | 224 |
| 224 | **250** | 282 |
| 282 | **315** | 355 |
| 355 | **400** | 447 |
| 447 | **500** | 562 |
| 562 | **630** | 708 |
| 708 | **800** | 891 |
| 891 | **1000** | 1122 |
| 1122 | **1250** | 1413 |
| 1413 | **1600** | 1778 |
| 1778 | **2000** | 2239 |
| 2239 | **2500** | 2818 |
| 2818 | **3150** | 3548 |
| 3548 | **4000** | 4467 |
| 4467 | **5000** | 5623 |
| 5623 | **6300** | 7079 |
| 7079 | **8000** | 8913 |
| 8913 | **10000** | 11220 |
| 11220 | **12500** | 14130 |
| 14130 | **16000** | 17780 |
| 17780 | **20000** | 22390 |

Human hearing is most sensitive at approximately 3500 Hz which corresponds to the ¼ wavelength of the ear canal (approximately 2.5 cm). Because of this range of sensitivity to various frequencies, we typically apply various weighting networks to the broadband measured sound to more appropriately account for the way humans hear. By default, the most common weighting network used is the so-called "A-weighting". It can be seen in the figure that the low frequency sounds are reduced significantly with the A-weighting.




## Combination of Sounds

When combining multiple sound sources the general equation is:

$$\Sigma SPL_n = 10\log_{10}\left[\sum_{i=1}^{n} 10^{\frac{SPL_i}{10}}\right]$$

Examples:

- Two sources of 50 dB each add together to result in 53 dB.
- Three sources of 50 dB each add together to result in 55 dB.
- Ten sources of 50 dB each add together to result in 60 dB.
- One source of 50 dB added to another source of 40 dB results in 50.4 dB

It can be seen that, if multiple similar sources exist, removing or reducing only one source will have little effect.

## Sound Level Measurements

Over the years a number of methods for measuring and describing environmental noise have been developed. The most widely used and accepted is the concept of the Energy Equivalent Sound Level ($L_{eq}$) which was developed in the US (1970's) to characterize noise levels near US Air-force bases. This is the level of a steady state sound which, for a given period of time, would contain the same energy as the time varying sound. The concept is that the same amount of annoyance occurs from a sound having a high level for a short period of time as from a sound at a lower level for a longer period of time.
The $L_{eq}$ is defined as:

$$L_{eq} = 10\log_{10}\left[\frac{1}{T}\int_0^T 10^{\frac{dB}{10}}\,dT\right] = 10\log_{10}\left[\frac{1}{T}\int_0^T \frac{P^2}{P_{ref}^2}\,dT\right]$$

We must specify the time period over which to measure the sound. i.e. 1-second, 10-seconds, 15-seconds, 1-minute, 1-day, etc. **An $L_{eq}$ is meaningless if there is no time period associated**.

In general there a few very common $L_{eq}$ sample durations which are used in describing environmental noise measurements. These include:

- $L_{eq}$24 - Measured over a 24-hour period
- $L_{eq}$Night - Measured over the night-time (typically 22:00 – 07:00)
- $L_{eq}$Day - Measured over the day-time (typically 07:00 – 22:00)
- $L_{DN}$ - Same as $L_{eq}$24 with a 10 dB penalty added to the night-time

**Statistical Descriptor**

Another method of conveying long term noise levels utilizes statistical descriptors. These are calculated from a cumulative distribution of the sound levels over the entire measurement duration and then determining the sound level at xx % of the time.

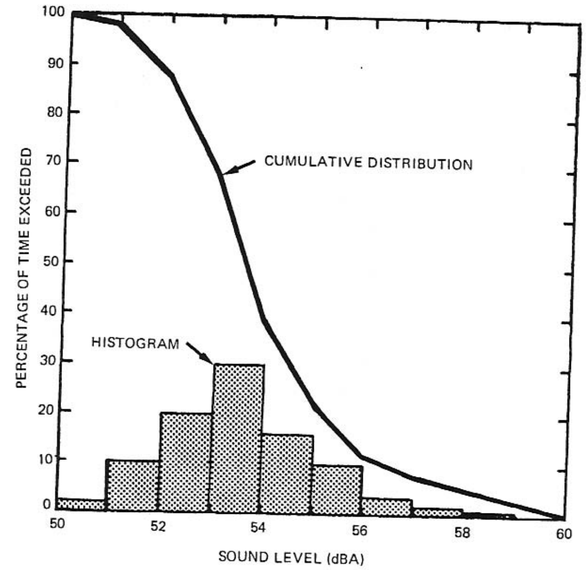



Figure 16.6 Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

*Industrial Noise Control, Lewis Bell, Marcel Dekker, Inc. 1994*

The most common statistical descriptors are:

$L_{min}$ - minimum sound level measured
$L_{01}$ - sound level that was exceeded only 1% of the time
$L_{10}$ - sound level that was exceeded only 10% of the time.
- Good measure of intermittent or intrusive noise
- Good measure of Traffic Noise

$L_{50}$ - sound level that was exceeded 50% of the time (arithmetic average)
- Good to compare to $L_{eq}$ to determine steadiness of noise

$L_{90}$ - sound level that was exceeded 90% of the time
- Good indicator of typical “ambient” noise levels

$L_{99}$ - sound level that was exceeded 99% of the time
$L_{max}$ - maximum sound level measured

These descriptors can be used to provide a more detailed analysis of the varying noise climate:

- If there is a large difference between the $L_{eq}$ and the $L_{50}$ ($L_{eq}$ can never be any lower than the $L_{50}$) then it can be surmised that one or more short duration, high level sound(s) occurred during the time period.
- If the gap between the $L_{10}$ and $L_{90}$ is relatively small (less than 15 – 20 dBA) then it can be surmised that the noise climate was relatively steady.

**Sound Propagation**

In order to understand sound propagation, the nature of the source must first be discussed. In general, there are three types of sources. These are known as ‘point’, ‘line’, and ‘area’. This discussion will concentrate on point and line sources since area sources are much more complex and can usually be approximated by point sources at large distances.

Point Source

As sound radiates from a point source, it dissipates through geometric spreading. The basic relationship between the sound levels at two distances from a point source is:

$$\therefore SPL_1 - SPL_2 = 20\log_{10}\left(\frac{r_2}{r_1}\right)$$

Where: $SPL_1$ = sound pressure level at location 1, $SPL_2$ = sound pressure level at location 2
$r_1$ = distance from source to location 1, $r_2$ = distance from source to location 2

Thus, the reduction in sound pressure level for a point source radiating in a free field is **6 dB per doubling of distance**. This relationship is independent of reflectivity factors provided they are always present. Note that this only considers geometric spreading and does not take into account atmospheric effects. Point sources still have some physical dimension associated with them, and typically do not radiate sound equally in all directions in all frequencies. The directionality of a source is also highly dependent on frequency. As frequency increases, directionality increases.

Examples (note no atmospheric absorption):

- A point source measuring 50 dB at 100m will be 44 dB at 200m.
- A point source measuring 50 dB at 100m will be 40.5 dB at 300m.
- A point source measuring 50 dB at 100m will be 38 dB at 400m.
- A point source measuring 50 dB at 100m will be 30 dB at 1000m.

Line Source

A line source is similar to a point source in that it dissipates through geometric spreading. The difference is that a line source is equivalent to a long line of many point sources. The basic relationship between the sound levels at two distances from a line source is:

$$SPL_1 - SPL_2 = 10\log_{10}\left(\frac{r_2}{r_1}\right)$$

The difference from the point source is that the ‘20’ term in front of the ‘log’ is now only 10. Thus, the reduction in sound pressure level for a line source radiating in a free field is **3 dB per doubling of distance**.

Examples (note no atmospheric absorption):

- A line source measuring 50 dB at 100m will be 47 dB at 200m.
- A line source measuring 50 dB at 100m will be 45 dB at 300m.
- A line source measuring 50 dB at 100m will be 34 dB at 400m.
- A line source measuring 50 dB at 100m will be 40 dB at 1000m.

## Atmospheric Absorption

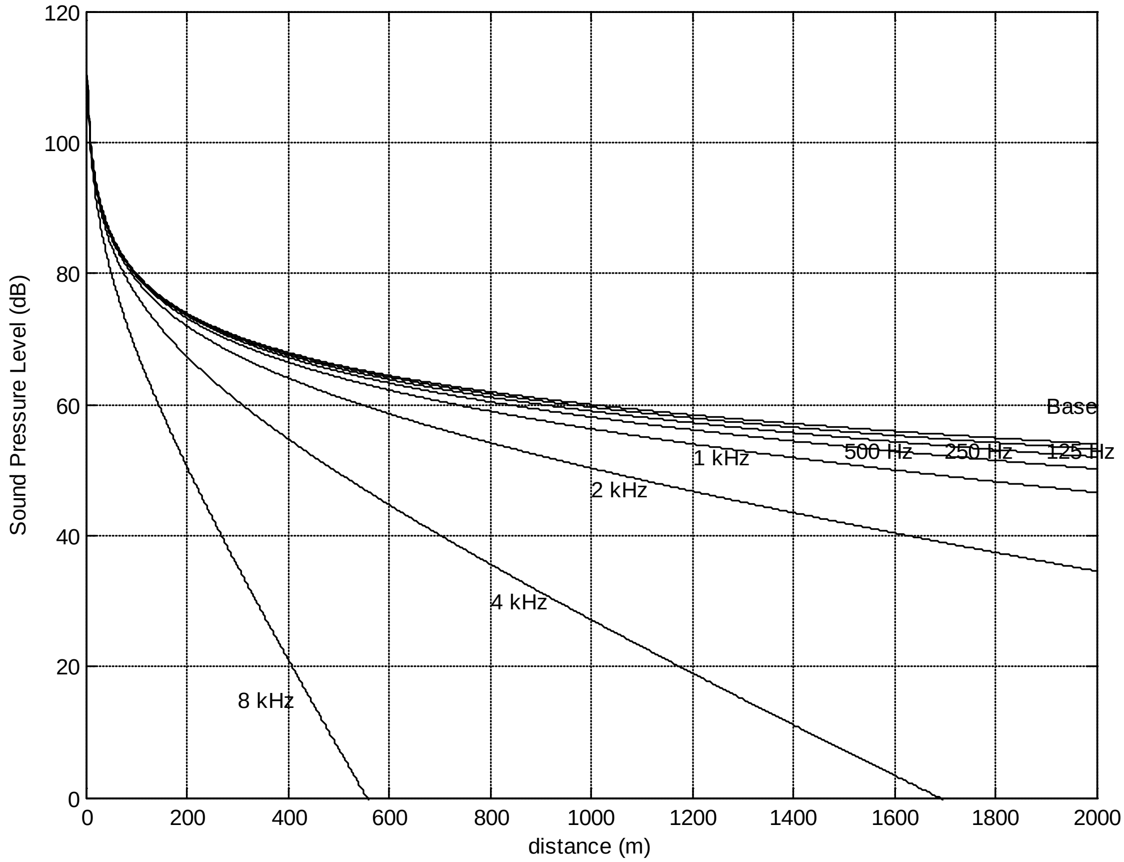
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

1) **Viscous Effects** - Dissipation of acoustic energy due to fluid friction which results in thermodynamically irreversible propagation of sound.
2) **Heat Conduction Effects** - Heat transfer between high and low temperature regions in the wave which result in non-adiabatic propagation of the sound.
3) **Inter Molecular Energy Interchanges** - Molecular energy relaxation effects which result in a time lag between changes in translational kinetic energy and the energy associated with rotation and vibration of the molecules.

The following table illustrates the attenuation coefficient of sound at standard pressure (101.325 kPa) in units of dB/100m.

| Temperature °C | Relative Humidity (%) | Frequency (Hz) 125 | 250 | 500 | 1000 | 2000 | 4000 |
|---|---|---|---|---|---|---|---|
| 30 | 20 | 0.06 | 0.18 | 0.37 | 0.64 | 1.40 | 4.40 |
| | 50 | 0.03 | 0.10 | 0.33 | 0.75 | 1.30 | 2.50 |
| | 90 | 0.02 | 0.06 | 0.24 | 0.70 | 1.50 | 2.60 |
| 20 | 20 | 0.07 | 0.15 | 0.27 | 0.62 | 1.90 | 6.70 |
| | 50 | 0.04 | 0.12 | 0.28 | 0.50 | 1.00 | 2.80 |
| | 90 | 0.02 | 0.08 | 0.26 | 0.56 | 0.99 | 2.10 |
| 10 | 20 | 0.06 | 0.11 | 0.29 | 0.94 | 3.20 | 9.00 |
| | 50 | 0.04 | 0.11 | 0.20 | 0.41 | 1.20 | 4.20 |
| | 90 | 0.03 | 0.10 | 0.21 | 0.38 | 0.81 | 2.50 |
| 0 | 20 | 0.05 | 0.15 | 0.50 | 1.60 | 3.70 | 5.70 |
| | 50 | 0.04 | 0.08 | 0.19 | 0.60 | 2.10 | 6.70 |
| | 90 | 0.03 | 0.08 | 0.15 | 0.36 | 1.10 | 4.10 |

- As frequency increases, absorption increases
- As Relative Humidity increases, absorption decreases
- There is no direct relationship between absorption and temperature
- **The net result of atmospheric absorption is to modify the sound propagation of a point source from 6 dB/doubling-of-distance to approximately 7 – 8 dB/doubling-of-distance (based on anecdotal experience)**




**Atmospheric Absorption at 10°C and 70% RH**

**Meteorological Effects**

There are many meteorological factors which can affect how sound propagates over large distances. These various phenomena must be considered when trying to determine the relative impact of a noise source either after installation or during the design stage.

Wind

- Can greatly alter the noise climate away from a source depending on direction
- Sound levels downwind from a source can be increased due to refraction of sound back down towards the surface. This is due to the generally higher velocities as altitude increases.
- Sound levels upwind from a source can be decreased due to a "bending" of the sound away from the earth's surface.
- Sound level differences of ±10dB are possible depending on severity of wind and distance from source.
- Sound levels crosswind are generally not disturbed by an appreciable amount
- Wind tends to generate its own noise, however, and can provide a high degree of masking relative to a noise source of particular interest.

Temperature

- Temperature effects can be similar to wind effects
- Typically, the temperature is warmer at ground level than it is at higher elevations.
- If there is a very large difference between the ground temperature (very warm) and the air aloft (only a few hundred meters) then the transmitted sound refracts upward due to the changing speed of sound.
- If the air aloft is warmer than the ground temperature (known as an *inversion*) the resulting higher speed of sound aloft tends to refract the transmitted sound back down towards the ground. This essentially works on Snell's law of reflection and refraction.
- Temperature inversions typically happen early in the morning and are most common over large bodies of water or across river valleys.
- Sound level differences of ±10dB are possible depending on gradient of temperature and distance from source.

Rain

- Rain does not affect sound propagation by an appreciable amount unless it is very heavy
- The larger concern is the noise generated by the rain itself. A heavy rain striking the ground can cause a significant amount of highly broadband noise. The amount of noise generated is difficult to predict.
- Rain can also affect the output of various noise sources such as vehicle traffic.

Summary

- In general, these wind and temperature effects are difficult to predict
- Empirical models (based on measured data) have been generated to attempt to account for these effects.
- Environmental noise measurements must be conducted with these effects in mind. Sometimes it is desired to have completely calm conditions, other times a "worst case" of downwind noise levels are desired.

**Topographical Effects**

Similar to the various atmospheric effects outlined in the previous section, the effect of various geographical and vegetative factors must also be considered when examining the propagation of noise over large distances.

Topography

- One of the most important factors in sound propagation.
- Can provide a natural barrier between source and receiver (i.e. if berm or hill in between).
- Can provide a natural amplifier between source and receiver (i.e. large valley in between or hard reflective surface in between).
- Must look at location of topographical features relative to source and receiver to determine importance (i.e. small berm 1km away from source and 1km away from receiver will make negligible impact).

Grass

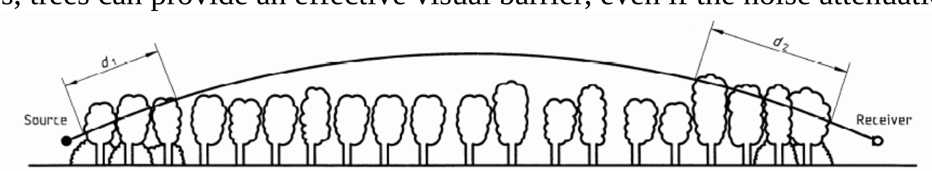
- Can be an effective absorber due to large area covered
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of thumb based on empirical data is:

$$A_g = 18\log_{10}(f) - 31 \qquad (dB/100m)$$

Where: $A_g$ is the absorption amount

Trees

- Provide absorption due to foliage
- Deciduous trees are essentially ineffective in the winter
- Absorption depends heavily on density and height of trees
- No data found on absorption of various kinds of trees
- Large spans of trees are required to obtain even minor amounts of sound reduction
- In many cases, trees can provide an effective visual barrier, even if the noise attenuation is negligible.




NOTE — $d_f = d_1 + d_2$

For calculating $d_1$ and $d_2$, the curved path radius may be assumed to be 5 km.

**Figure A.1 — Attenuation due to propagation through foliage increases linearly with propagation distance $d_f$ through the foliage**

**Table A.1 — Attenuation of an octave band of noise due to propagation a distance $d_f$ through dense foliage**

| **Propagation distance $d_f$** m | **Nominal midband frequency** Hz 63 | 125 | 250 | 500 | 1 000 | 2 000 | 4 000 | 8 000 |
|---|---|---|---|---|---|---|---|---|
| $10 \leq d_f \leq 20$ | Attenuation, dB: 0 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| $20 \leq d_f \leq 200$ | Attenuation, dB/m: 0,02 | 0,03 | 0,04 | 0,05 | 0,06 | 0,08 | 0,09 | 0,12 |

*Tree/Foliage attenuation from ISO 9613-2:1996*

Bodies of Water

- Large bodies of water can provide the opposite effect to grass and trees.
- Reflections caused by small incidence angles (grazing) can result in larger sound levels at great distances (increased reflectivity, Q).
- Typically air temperatures are warmer high aloft since air temperatures near water surface tend to be more constant. Result is a high probability of temperature inversion.
- Sound levels can "carry" much further.

Snow

- Covers the ground for much of the year in northern climates.
- Can act as an absorber or reflector (and varying degrees in between).
- Freshly fallen snow can be quite absorptive.
- Snow which has been sitting for a while and hard packed due to wind can be quite reflective.
- Falling snow can be more absorptive than rain, but does not tend to produce its own noise.
- Snow can cover grass which might have provided some means of absorption.
- Typically sound propagates with less impedance in winter due to hard snow on ground and no foliage on trees/shrubs.

# Appendix III SOUND LEVELS OF FAMILIAR NOISE SOURCES

Used with Permission Obtained from ERCB Directive 038 (January, 2007)

| **Source[1]** | **Sound Level ( dBA)** |
|---|---|
| Bedroom of a country home | 30 |
| Soft whisper at 1.5 m | 30 |
| Quiet office or living room | 40 |
| Moderate rainfall | 50 |
| Inside average urban home | 50 |
| Quiet street | 50 |
| Normal conversation at 1 m | 60 |
| Noisy office | 60 |
| Noisy restaurant | 70 |
| Highway traffic at 15 m | 75 |
| Loud singing at 1 m | 75 |
| Tractor at 15 m | 78-95 |
| Busy traffic intersection | 80 |
| Electric typewriter | 80 |
| Bus or heavy truck at 15 m | 88-94 |
| Jackhammer | 88-98 |
| Loud shout | 90 |
| Freight train at 15 m | 95 |
| Modified motorcycle | 95 |
| Jet taking off at 600 m | 100 |
| Amplified rock music | 110 |
| Jet taking off at 60 m | 120 |
| Air-raid siren | 130 |

[1] Cottrell, Tom, 1980, *Noise in Alberta*, Table 1, p.8, ECA80 - 16/1B4 (Edmonton: Environment Council of Alberta).

# SOUND LEVELS GENERATED BY COMMON APPLIANCES

Used with Permission Obtained from ERCB Directive 038 (January, 2007)

| Source[1] | Sound level at 3 feet (dBA) |
|---|---|
| Freezer | 38-45 |
| Refrigerator | 34-53 |
| Electric heater | 47 |
| Hair clipper | 50 |
| Electric toothbrush | 48-57 |
| Humidifier | 41-54 |
| Clothes dryer | 51-65 |
| Air conditioner | 50-67 |
| Electric shaver | 47-68 |
| Water faucet | 62 |
| Hair dryer | 58-64 |
| Clothes washer | 48-73 |
| Dishwasher | 59-71 |
| Electric can opener | 60-70 |
| Food mixer | 59-75 |
| Electric knife | 65-75 |
| Electric knife sharpener | 72 |
| Sewing machine | 70-74 |
| Vacuum cleaner | 65-80 |
| Food blender | 65-85 |
| Coffee mill | 75-79 |
| Food waste disposer | 69-90 |
| Edger and trimmer | 81 |
| Home shop tools | 64-95 |
| Hedge clippers | 85 |
| Electric lawn mower | 80-90 |

[1] Reif, Z. F., and Vermeulen, P. J., 1979, "Noise from domestic appliances, construction, and industry," Table 1, p.166, in Jones, H. W., ed., *Noise in the Human Environment*, vol. 2, ECA79-SP/1 (Edmonton: Environment Council of Alberta).

# Appendix IV PERMISSIBLE SOUND LEVEL DETERMINATION

## Permissible Sound Levels at Theoretical 1,500 m Receptors

**Basic Sound Level**

| | Dwelling Density (Per Quarter Section of Land) | | | Night-Time | Day-Time |
|---|---|---|---|---|---|
| Proximity to Transportation | 1 - 8 Dwellings | 9 - 160 Dwellings | > 160 Dwellings | | |
| Category 1 | 40 | 43 | 46 | 40 | 40 |
| Category 2 | 45 | 48 | 51 | | |
| Category 3 | 50 | 53 | 56 | | |
| Basic Sound Level (dBA) | | | | 40 | 40 |

**Time of Day Adjustment**

| Time of Day | Adjustment (dBA) | Night-Time | Day-Time |
|---|---|---|---|
| Night-time adjustment for hours 22:00 - 07:00 | 0 | 0 | n/a |
| Day-time adjustment for hours 07:00 - 22:00 | +10 | n/a | +10 |
| Time of day adjustment (dBA) | | 0 | + 10 |

**Class A Adjustments**

| Class | Reason for Adjustment | Adjustment (dBA) | Night-Time | Day-Time |
|---|---|---|---|---|
| A1 | Seasonal Adjustment (Winter) | 0 to +5 | 0 | 0 |
| A2 | Ambient Monitoring Adjustment | -10 to +10 | 0 | 0 |
| Sum of A1 and A2 cannot exceed maximum of 10 dBA Leq | | | | |
| Class A Adjustment (dBA) | | | 0 | 0 |

**Class B Adjustments**

| Class | Duration of Activity | Adjustment (dBA) | Night-Time | Day-Time |
|---|---|---|---|---|
| B1 | ≤ 1 Day | + 15 | 0 | 0 |
| B2 | ≤ 7 Days | + 10 | 0 | 0 |
| B3 | ≤ 60 Days | + 5 | 0 | 0 |
| B4 | > 60 Days | 0 | 0 | 0 |
| Can only apply one of B1, B2, B3, or B4 | | | | |
| Class B Adjustment (dBA) | | | 0 | 0 |

| | Night-Time | Day-Time |
|---|---|---|
| **Total Permissible Sound Level (PSL) [dBA]** | 40 | 50 |

# Appendix V APPLICATION CASE NOISE SOURCE ORDER-RANKING

## Theoretical 1,500 m R07

| Noise Source | Location | dBA | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COOLING GLYCOL COOLER FANS | Phase 2 CPF | 31 | | 41.5 | 44.4 | 36.5 | 32.9 | 29.9 | 25.2 | 12 | -31.4 |
| GAS TURBINE EXHAUST | Phase 2 CPF | 26.4 | | 53.3 | 50.1 | 35.4 | 25.5 | 17.9 | 7.9 | -7.6 | -50.3 |
| GAS TURBINE EXHAUST | Phase 2 CPF | 26.4 | | 53.2 | 50.1 | 35.4 | 25.4 | 17.8 | 7.8 | -7.7 | -50.7 |
| GAS TURBINE EXHAUST | Phase 2 CPF | 26.3 | | 53.2 | 50 | 35.3 | 25.4 | 17.8 | 7.8 | -7.9 | -51 |
| LUBE OIL COOLER | Phase 2 CPF | 21.1 | | 26.5 | 33.4 | 32.4 | 24.2 | 17.7 | 11.6 | -3.3 | -49.1 |
| LUBE OIL COOLER | Phase 2 CPF | 21.1 | | 26.5 | 35.8 | 32.3 | 24.1 | 17.5 | 11.4 | -3.6 | -49.8 |
| 13.8/480 VAC STEP DOWN TRANSFORMERS | Phase 2 CPF | 19.1 | | 22.5 | 25.3 | 26.8 | 20.7 | 19.3 | 10.5 | -4.9 | -50.1 |
| LUBE OIL COOLER | Phase 2 CPF | 18.8 | | 26.6 | 33.4 | 29.9 | 21.8 | 15.4 | 9.4 | -5.4 | -51 |
| TURBINE #1 ENCLOSURE VENTILATION FAN | Phase 2 CPF | 18.4 | | 21.7 | 24.6 | 24.1 | 22.2 | 17.6 | 10.4 | -3.8 | -49.3 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 18.3 | | 24.6 | 27.4 | 26.6 | 22.1 | 17 | 9.4 | -5.4 | -52.5 |
| EVAPORATOR 1 VAPOR COMPRESSOR | Phase 2 CPF | 18.2 | | 42.4 | 32.2 | 26.4 | 20.8 | 14.9 | 12 | 1.8 | -46.7 |
| STEAM BOILER STACK | Phase 2 CPF | 18.1 | | 33.6 | 32.5 | 26.5 | 18.5 | 16.8 | 11.9 | -1.3 | -44.2 |
| STEAM BOILER STACK | Phase 2 CPF | 18 | | 33.5 | 32.3 | 26.4 | 18.3 | 16.7 | 11.7 | -1.6 | -45 |
| STEAM BOILER STACK | Phase 2 CPF | 17.8 | | 33.4 | 32.2 | 26.3 | 18.2 | 16.6 | 11.5 | -2 | -46 |
| 13.8/4160 VAC STEP DOWN TRANSFORMERS | Phase 2 CPF | 17.8 | | 21.2 | 24 | 25.5 | 19.4 | 17.9 | 9.3 | -4 | -49.5 |
| STEAM BOILER STACK | Phase 2 CPF | 17.6 | | 33.3 | 32.1 | 26.1 | 18.1 | 16.4 | 11.3 | -2.3 | -47 |
| STEAM BOILER STACK | Phase 2 CPF | 17.5 | | 30.5 | 32 | 26 | 18 | 16.2 | 11.1 | -2.7 | -47.9 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 17 | | 22.4 | 25.2 | 24.7 | 20.5 | 15.9 | 8.7 | -5.5 | -51.7 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 16.7 | | 22.2 | 25 | 24.5 | 20.3 | 15.6 | 8.3 | -6.3 | -53.6 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 16.4 | | 22 | 24.9 | 24.3 | 20 | 15.3 | 7.9 | -6.9 | -55.2 |
| TURBINE #2 ENCLOSURE VENTILATION FAN | Phase 2 CPF | 15.3 | | 18.7 | 21.5 | 23.3 | 19 | 14.1 | 6.7 | -7.7 | -53.4 |
| Wellpad Piping | Wellpad | 15.1 | | 34.2 | 36.9 | 17.9 | 12.7 | 12 | 9.1 | -10.2 | -79.3 |
| TURBINE #3 ENCLOSURE VENTILATION FAN | Phase 2 CPF | 14.6 | | 18.7 | 23.7 | 22.9 | 18.3 | 13.2 | 5.8 | -8.5 | -54.1 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 14.2 | | 22.4 | 25 | 24 | 18.8 | 11.9 | 2.1 | -14.2 | -62.2 |
| GAS TURBINE INLET | Phase 2 CPF | 14 | | 30.3 | 32.6 | 27.9 | 16.2 | -6.3 | -35.8 | -49.7 | -66.6 |
| GAS TURBINE INLET | Phase 2 CPF | 13.8 | | 30.4 | 30.1 | 28 | 16.5 | -5.8 | -35 | -48.2 | -64.4 |
| GLYCOL HEATER BLOWER | Phase 2 CPF | 13.4 | | 21.1 | 23.8 | 22.8 | 17.6 | 11.5 | 2.5 | -13.4 | -59.8 |
| FIELD STEP UP TRANSFORMER 13.8KV/25KV | Phase 2 CPF | 13.4 | | 16.4 | 19.2 | 20.7 | 14.6 | 13.1 | 6.7 | -8.8 | -54.4 |
| Wellpad Piping | Wellpad | 13.4 | | 33.1 | 35.8 | 16.7 | 11.3 | 10.2 | 6.6 | -15.1 | -100 |
| SEAL AIR FAN | Phase 2 CPF | 13.3 | | 18.6 | 21.4 | 20.9 | 16.7 | 12.2 | 5.1 | -8.8 | -53.7 |
| SEAL AIR FAN | Phase 2 CPF | 13.1 | | 18.5 | 21.3 | 20.8 | 16.6 | 12 | 4.9 | -9.1 | -54.3 |
| UTILITY HEATER BLOWER | Phase 2 CPF | 12.9 | | 21 | 23.6 | 22.7 | 17.5 | 10.7 | 0.7 | -15.9 | -62.6 |
| EVAPORATOR 2 VAPOR COMPRESSOR | Phase 2 CPF | 12.7 | | 31.6 | 21.4 | 22.9 | 16.7 | 9.2 | 4.2 | -6.3 | -56.3 |
| GAS TURBINE INLET | Phase 2 CPF | 12.6 | | 30.5 | 30.3 | 25.8 | 16.4 | -5.6 | -34.2 | -46.5 | -60.8 |
| Wellpad Piping | Wellpad | 12.6 | | 25.8 | 28.6 | 17.9 | 14.5 | 11.4 | 6.5 | -9.2 | -63 |
| Wellpad Piping | Wellpad | 12.1 | | 25.4 | 28.2 | 17.5 | 14 | 10.9 | 5.7 | -10.6 | -66.8 |
| Gas Turbine Exhaust | Phase 1 CPF | 11.2 | | 29.2 | 30.6 | 21.7 | 14.6 | 7.7 | -15.6 | -60.1 | -100 |
| Gas Turbine Exhaust | Phase 1 CPF | 11.2 | | 29.2 | 30.6 | 21.7 | 14.6 | 7.7 | -15.6 | -60 | -100 |
| SEAL AIR FAN | Phase 2 CPF | 10.9 | | 16.1 | 18.9 | 18.4 | 14.3 | 9.9 | 2.8 | -11 | -55.6 |
| Wellpad Piping | Wellpad | 10.3 | | 24.2 | 27 | 16.2 | 12.5 | 9.1 | 3.4 | -15 | -78.9 |
| Wellpad Piping | Wellpad | 10 | | 24 | 26.8 | 16 | 12.2 | 8.7 | 2.9 | -15.8 | -81.1 |
| Combustion Air Blower | Phase 1 CPF | 9.6 | | 20.8 | 23.2 | 21.3 | 14.2 | 5.4 | -9.9 | -52.1 | -100 |
| COOLING AIR BLOWER | Phase 2 CPF | 9 | | 14.3 | 17.1 | 16.6 | 12.5 | 8 | 0.8 | -13 | -57.9 |

Notes:
- 1/3 octave band sound levels are linear (i.e. not A-weighted)
- Data in Tables shows only those noise sources which have a broadband dBA sound level contribution greater than 0.0 dBA

## Theoretical 1,500 m R07 (Continued)

| Noise Source | Location | dBA | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wellpad Piping | Wellpad | 9 | | 23.4 | 26.1 | 15.3 | 11.4 | 7.7 | 1.5 | -18.5 | -88.6 |
| COOLING AIR BLOWER | Phase 2 CPF | 8.9 | | 14.2 | 17.1 | 16.5 | 12.4 | 7.8 | 0.6 | -13.3 | -58.6 |
| Wellpad Piping | Wellpad | 8.5 | | 23.1 | 25.8 | 14.9 | 10.9 | 7.2 | 0.8 | -19.8 | -100 |
| Glycol Aerial Cooler | Phase 1 CPF | 8.4 | | 19.5 | 21.9 | 20 | 13 | 4.3 | -10.6 | -52 | -100 |
| Wellpad Piping | Wellpad | 8.4 | | 23 | 25.7 | 14.8 | 10.8 | 7 | 0.6 | -20.2 | -100 |
| FIELD STEP UP TRANSFORMER 13.8KV/25KV COOLING FANS | Phase 2 CPF | 8.3 | | 13.4 | 16.2 | 15.7 | 11.6 | 7.2 | 0.5 | -13 | -56.3 |
| Wellpad Piping | Wellpad | 7.7 | | 22.5 | 25.2 | 14.3 | 10.2 | 6.3 | -0.4 | -22.3 | -100 |
| Wellpad Piping | Wellpad | 7.3 | | 22.3 | 25 | 14 | 9.9 | 5.8 | -1 | -23.4 | -100 |
| Wellpad Piping | Wellpad | 6.8 | | 22 | 24.7 | 13.6 | 9.4 | 5.3 | -1.8 | -24.9 | -100 |
| GAS TURBINE CASING | Phase 2 CPF | 6.7 | | 35.5 | 22.3 | 18.1 | 9.8 | 2 | -7.5 | -25.9 | -76.5 |
| COOLING AIR BLOWER | Phase 2 CPF | 6.6 | | 11.8 | 14.7 | 14.2 | 10 | 5.6 | -1.4 | -15.2 | -59.7 |
| GAS TURBINE CASING | Phase 2 CPF | 6.5 | | 35.4 | 24.6 | 17.8 | 9.2 | 1.1 | -8.4 | -26.7 | -77.2 |
| GAS TURBINE CASING | Phase 2 CPF | 6.3 | | 35.5 | 22.4 | 15.8 | 10.1 | 2.5 | -6.6 | -24.6 | -75 |
| Wellpad Piping | Wellpad | 6.3 | | 21.7 | 24.4 | 13.3 | 9 | 4.8 | -2.5 | -26.3 | -100 |
| UTILITY HEATER STACK | Phase 2 CPF | 5.6 | | 20.7 | 19.5 | 14 | 6.1 | 4.4 | -0.7 | -13.1 | -53.4 |
| Wellpad Piping | Wellpad | 5.2 | | 21 | 23.6 | 12.5 | 8 | 3.5 | -4.3 | -30 | -100 |
| Wellpad Piping | Wellpad | 5.2 | | 21 | 23.6 | 12.5 | 8 | 3.5 | -4.3 | -30 | -100 |
| HRSG CASING | Phase 2 CPF | 5.1 | | 35.6 | 22.4 | 15.9 | 7.7 | 0.3 | -8.8 | -26.6 | -76.4 |
| HRSG CASING | Phase 2 CPF | 5 | | 35.5 | 22.3 | 15.8 | 7.7 | 0.2 | -9 | -26.8 | -76.8 |
| HRSG CASING | Phase 2 CPF | 5 | | 35.5 | 22.3 | 15.8 | 7.6 | 0 | -9 | -27 | -77.2 |
| Wellpad Piping | Wellpad | 4.9 | | 20.8 | 23.4 | 12.3 | 7.7 | 3.2 | -4.8 | -30.9 | -100 |
| GLYCOL HEATER STACK | Phase 2 CPF | 4.8 | | 19.8 | 18.7 | 13 | 5.3 | 3.5 | -1.4 | -13.9 | -54.4 |
| Wellpad Piping | Wellpad | 4.2 | | 20.3 | 22.9 | 11.7 | 7 | 2.3 | -6.1 | -33.6 | -100 |
| Wellpad Piping | Wellpad | 3.6 | | 20 | 22.6 | 11.3 | 6.6 | 1.7 | -6.9 | -35.4 | -100 |
| Wellpad Piping | Wellpad | 3.5 | | 19.9 | 22.5 | 11.2 | 6.4 | 1.5 | -7.2 | -35.9 | -100 |
| H.P. BOILER FEEDWATER PUMP | Phase 2 CPF | 2.6 | | 16.4 | 11.2 | 8.7 | 6.5 | 0.9 | -4.1 | -22.9 | -73.1 |
| TURBINE #1 START MOTOR | Phase 2 CPF | 2.3 | | 12.6 | 6.4 | 5.9 | 5.1 | 2.5 | -5.6 | -22.6 | -75 |
| Wellpad Piping | Wellpad | 2.2 | | 19.1 | 21.7 | 10.3 | 5.2 | -0.1 | -9.5 | -40.6 | -100 |
| TURBINE #2 START MOTOR | Phase 2 CPF | 2 | | 12.5 | 6.3 | 8.1 | 4.9 | 2.1 | -6.6 | -24.1 | -76.6 |
| Emulsion Pump | Wellpad | 1.9 | | 17 | 14.7 | 4.7 | 1.5 | -0.2 | -1.2 | -24.7 | -100 |
| Wellpad Piping | Wellpad | 1.8 | | 18.9 | 21.4 | 10 | 4.8 | -0.6 | -10.3 | -42.4 | -100 |
| VRU COMPRESSOR #1 | Phase 2 CPF | 1.7 | | 19.2 | 9 | 11 | 5.5 | -1.1 | -6.1 | -16.3 | -63.3 |
| Wellpad Piping | Wellpad | 1.6 | | 18.8 | 21.3 | 9.8 | 4.6 | -0.9 | -10.6 | -43.1 | -100 |
| VRU COMPRESSOR #2 | Phase 2 CPF | 1.5 | | 19.2 | 9.1 | 10.6 | 5.4 | -1.3 | -6.3 | -16.5 | -63.4 |
| Wellpad Piping | Wellpad | 1.5 | | 18.7 | 21.2 | 9.7 | 4.5 | -1 | -10.8 | -43.5 | -100 |
| CRYSTALLIZER RECIRC. PUMP | Phase 2 CPF | 1 | | 13.1 | 7.9 | 7.8 | 4.6 | -0.7 | -5.7 | -24.4 | -74.6 |
| COOLING GLYCOL CIRCULATION PUMP | Phase 2 CPF | 1 | | 15.5 | 10.3 | 7.8 | 4.7 | -0.9 | -5.8 | -24.3 | -73.9 |
| TURBINE #3 START MOTOR | Phase 2 CPF | 0.9 | | 12.5 | 8.5 | 7.6 | 3.9 | 0.7 | -7.7 | -24.8 | -77.2 |
| INSTRUMENT AIR | Wellpad | 0.9 | | 21.1 | 13.8 | 7.8 | 1.6 | -2.1 | -3.1 | -18.7 | -100 |
| INSTRUMENT AIR SCREW COMPRESSOR PACKAGE #1 | Phase 2 CPF | 0.8 | | 19.8 | 9.7 | 11.1 | 4.9 | -2.8 | -8.1 | -19.6 | -71.7 |
| L.P. BOILER FEEDWATER PUMP | Phase 2 CPF | 0.8 | | 15.1 | 9.9 | 7.4 | 4.3 | -0.9 | -5.8 | -24.3 | -74.3 |
| Wellpad Piping | Wellpad | 0.6 | | 18.1 | 20.7 | 9.1 | 3.7 | -2.1 | -12.5 | -47.1 | -100 |
| Emulsion Pump | Wellpad | 0.6 | | 8.5 | 6.3 | 4.6 | 3.1 | -0.9 | -3.9 | -23.9 | -83.5 |
| Wellpad Piping | Wellpad | 0.4 | | 18 | 20.5 | 8.9 | 3.5 | -2.4 | -12.9 | -48 | -100 |

Notes:

- 1/3 octave band sound levels are linear (i.e. not A-weighted)
- Data in Tables shows only those noise sources which have a broadband dBA sound level contribution greater than 0.0 dBA

## Theoretical 1,500 m R22

| Noise Source | Location | dBA | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Combustion Air Blower | Phase 1 CPF | 31.7 | | 41.3 | 44.2 | 37.1 | 34.4 | 30.6 | 25.2 | 10.2 | -40.7 |
| Gas Turbine Exhaust | Phase 1 CPF | 30.8 | | 42.1 | 45.9 | 38.3 | 33.1 | 31.1 | 15.5 | -2.1 | -53.4 |
| Glycol Aerial Cooler | Phase 1 CPF | 28.5 | | 39.8 | 42.6 | 34.6 | 30.8 | 27.4 | 22 | 6.7 | -45 |
| Gas Turbine Exhaust | Phase 1 CPF | 27.6 | | 39.2 | 41.2 | 33.8 | 29.9 | 28.2 | 15.2 | -2.5 | -54.6 |
| Gas Turbine Inlet | Phase 1 CPF | 25.4 | | 35.7 | 41 | 34.1 | 32.2 | 15.8 | -11.7 | -36 | -60.9 |
| Lube Oil Cooler | Phase 1 CPF | 24.5 | | 35.8 | 45.1 | 33.7 | 24.8 | 20.8 | 16.4 | 0.1 | -52.7 |
| Gas Turbine Inlet | Phase 1 CPF | 24.2 | | 35.8 | 38.9 | 33.1 | 31.1 | 14.5 | -13.3 | -37.6 | -61.7 |
| Wellpad Piping | Wellpad | 23.1 | | 39.5 | 42.3 | 23.8 | 19.4 | 19.9 | 19.4 | 8.2 | -29.7 |
| Lube Oil Cooler | Phase 1 CPF | 22.1 | | 35.9 | 42.7 | 31.4 | 22.5 | 18.5 | 14.1 | -2 | -54 |
| Wellpad Piping | Wellpad | 21.8 | | 38.6 | 41.5 | 22.9 | 18.4 | 18.8 | 17.9 | 5.7 | -36 |
| Utility Heater Blower | Phase 1 CPF | 21.1 | | 30.3 | 33.1 | 24.7 | 22.4 | 20.9 | 15.3 | 0 | -51.6 |
| Wellpad Piping | Wellpad | 19.8 | | 37.3 | 40.1 | 21.4 | 16.7 | 16.8 | 15.4 | 1.4 | -47.4 |
| Glycol Heater Blower | Phase 1 CPF | 18.8 | | 30.3 | 33.1 | 24.8 | 19.9 | 17.9 | 13.1 | -2.2 | -53.6 |
| Wellpad Piping | Wellpad | 17 | | 28.7 | 31.6 | 21.1 | 18.1 | 15.6 | 11.8 | 0.1 | -38.6 |
| Evaporator Building Exhaust Fan | Phase 1 CPF | 16.4 | | 18.6 | 21.8 | 22.1 | 19.9 | 15.9 | 8.3 | -7.4 | -59.4 |
| Wellpad Piping | Wellpad | 15.2 | | 27.5 | 30.3 | 19.8 | 16.6 | 14 | 9.7 | -3.5 | -47.8 |
| Steam Boiler Stack | Phase 1 CPF | 14.7 | | 28.7 | 29.4 | 23.4 | 15.3 | 13.5 | 8.1 | -6.1 | -53.2 |
| Steam Boiler Stack | Phase 1 CPF | 14.7 | | 28.7 | 29.3 | 23.4 | 15.2 | 13.4 | 8.1 | -6.2 | -53.4 |
| Vapour Compressor | Phase 1 CPF | 14.1 | | 39.5 | 29.3 | 22.9 | 16.1 | 11.1 | 7.7 | -4.8 | -61.8 |
| Treater Building Exhaust Fant | Phase 1 CPF | 13.5 | | 15.6 | 19.1 | 20.4 | 16.9 | 13 | 5.3 | -10.7 | -63.8 |
| Wellpad Piping | Wellpad | 12.9 | | 25.9 | 28.7 | 18.1 | 14.6 | 11.7 | 6.8 | -8.7 | -61.6 |
| Wellpad Piping | Wellpad | 11.7 | | 25.1 | 27.9 | 17.2 | 13.7 | 10.5 | 5.3 | -11.4 | -69.1 |
| Wellpad Piping | Wellpad | 11 | | 24.7 | 27.4 | 16.7 | 13.1 | 9.8 | 4.3 | -13.2 | -73.9 |
| Wellpad Piping | Wellpad | 10.6 | | 24.4 | 27.2 | 16.4 | 12.7 | 9.4 | 3.8 | -14.3 | -76.8 |
| GAS TURBINE EXHAUST | Phase 2 CPF | 10.5 | | 34.2 | 31.5 | 23.1 | 11.8 | 0.5 | -18.4 | -57.6 | -100 |
| GAS TURBINE EXHAUST | Phase 2 CPF | 10.5 | | 34.2 | 31.5 | 23.1 | 11.8 | 0.5 | -18.3 | -57.5 | -100 |
| GAS TURBINE EXHAUST | Phase 2 CPF | 10.5 | | 34.2 | 31.5 | 23.1 | 11.8 | 0.5 | -18.3 | -57.4 | -100 |
| Tank Building Exhaust Fant | Phase 1 CPF | 10.4 | | 15.4 | 18.3 | 17.7 | 13.6 | 9.2 | 2.9 | -11 | -64.7 |
| COOLING GLYCOL COOLER FANS | Phase 2 CPF | 9.9 | | 20.4 | 22.9 | 21.2 | 14.5 | 6.3 | -7.5 | -45.8 | -100 |
| Wellpad Piping | Wellpad | 9.3 | | 23.6 | 26.3 | 15.4 | 11.6 | 8 | 1.9 | -17.8 | -86.7 |
| Wellpad Piping | Wellpad | 8.8 | | 23.2 | 26 | 15.1 | 11.1 | 7.4 | 1.2 | -19.1 | -100 |
| Wellpad Piping | Wellpad | 8.7 | | 23.2 | 25.9 | 15 | 11.1 | 7.4 | 1.1 | -19.3 | -100 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 8.4 | | 23.8 | 26.3 | 18.3 | 12.2 | 5.4 | -6.5 | -42.7 | -100 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 8.1 | | 23.5 | 26.1 | 17 | 12.2 | 5.5 | -6.3 | -42.4 | -100 |
| Wellpad Piping | Wellpad | 7.9 | | 22.7 | 25.4 | 14.4 | 10.4 | 6.5 | -0.1 | -21.7 | -100 |
| Wellpad Piping | Wellpad | 7.7 | | 22.5 | 25.2 | 14.3 | 10.2 | 6.3 | -0.4 | -22.2 | -100 |
| Wellpad Piping | Wellpad | 7.7 | | 22.5 | 25.2 | 14.3 | 10.2 | 6.3 | -0.5 | -22.3 | -100 |
| Wellpad Piping | Wellpad | 7.6 | | 22.5 | 25.2 | 14.2 | 10.1 | 6.2 | -0.6 | -22.6 | -100 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 7.3 | | 23.4 | 25.9 | 16.9 | 10.9 | 4.4 | -7.2 | -43.6 | -100 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 7.3 | | 23.5 | 26 | 16.9 | 10.9 | 4.4 | -7.1 | -43.3 | -100 |
| GAS TURBINE INLET | Phase 2 CPF | 7.3 | | 31.2 | 30.7 | 19 | 5.8 | -18.1 | -51.1 | -85.9 | -100 |
| GAS TURBINE INLET | Phase 2 CPF | 7.3 | | 31.2 | 30.7 | 19 | 5.8 | -18.1 | -51 | -85.8 | -100 |
| BOILER COMBUSTION AIR FAN | Phase 2 CPF | 7.2 | | 23.4 | 25.9 | 16.8 | 10.8 | 4.3 | -7.3 | -43.9 | -100 |
| Wellpad Piping | Wellpad | 7.1 | | 22.2 | 24.9 | 13.9 | 9.7 | 5.6 | -1.3 | -24 | -100 |
| Wellpad Piping | Wellpad | 6.8 | | 22 | 24.7 | 13.6 | 9.4 | 5.3 | -1.8 | -24.9 | -100 |
| Wellpad Piping | Wellpad | 5.9 | | 21.4 | 24.1 | 13 | 8.6 | 4.3 | -3.2 | -27.7 | -100 |

Notes:

- 1/3 octave band sound levels are linear (i.e. not A-weighted)
- Data in Tables shows only those noise sources which have a broadband dBA sound level contribution greater than 0.0 dBA

## Theoretical 1,500 m R22 (Continued)

| Noise Source | Location | dBA | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emulsion Pump | Wellpad | 5.7 | | 11.8 | 9.6 | 8.2 | 7.2 | 3.8 | 2 | -13.5 | -56.2 |
| TURBINE #1 ENCLOSURE VENTILATION FAN | Phase 2 CPF | 5.6 | | 22.4 | 24.9 | 15.4 | 8.3 | 3.1 | -8.4 | -45.1 | -100 |
| Wellpad Piping | Wellpad | 5.6 | | 21.2 | 23.9 | 12.8 | 8.3 | 4 | -3.7 | -28.7 | -100 |
| Wellpad Piping | Wellpad | 5.4 | | 21.1 | 23.7 | 12.6 | 8.1 | 3.7 | -4.1 | -29.5 | -100 |
| Wellpad Piping | Wellpad | 5.3 | | 27.5 | 29.9 | 10 | 2.6 | -1.1 | -9.8 | -49.4 | -100 |
| INSTRUMENT AIR | Wellpad | 5.2 | | 16.1 | 9 | 11.5 | 7.5 | 2.2 | 0.5 | -6.9 | -47.8 |
| Wellpad Piping | Wellpad | 5.1 | | 20.9 | 23.5 | 12.4 | 7.9 | 3.4 | -4.5 | -30.4 | -100 |
| Wellpad Piping | Wellpad | 5 | | 20.9 | 23.5 | 12.4 | 7.8 | 3.3 | -4.6 | -30.5 | -100 |
| Wellpad Piping | Wellpad | 4.9 | | 20.8 | 23.4 | 12.3 | 7.7 | 3.2 | -4.8 | -30.9 | -100 |
| Combustion Air Blower | Phase 1 CPF | 4.7 | | 21.5 | 20.6 | 15.8 | 7.9 | 1.2 | -6.4 | -21.8 | -72.7 |
| Wellpad Piping | Wellpad | 4.4 | | 20.4 | 23.1 | 11.9 | 7.2 | 2.5 | -5.7 | -32.8 | -100 |
| STEAM BOILER STACK | Phase 2 CPF | 4 | | 24 | 22.5 | 15.8 | 5.6 | 0.4 | -11.3 | -46.7 | -100 |
| STEAM BOILER STACK | Phase 2 CPF | 4 | | 24 | 22.5 | 15.9 | 5.6 | 0.5 | -11.1 | -46.5 | -100 |
| STEAM BOILER STACK | Phase 2 CPF | 3.9 | | 23.9 | 22.4 | 15.8 | 5.5 | 0.3 | -11.4 | -47 | -100 |
| STEAM BOILER STACK | Phase 2 CPF | 3.8 | | 23.9 | 22.3 | 15.7 | 5.4 | 0.2 | -11.6 | -47.5 | -100 |
| STEAM BOILER STACK | Phase 2 CPF | 3.8 | | 23.9 | 22.4 | 15.8 | 5.4 | 0.2 | -11.5 | -47.2 | -100 |
| Gas Turbine Casing | Phase 1 CPF | 3.5 | | 31.9 | 18.7 | 8.3 | 3.4 | 3.9 | -6.4 | -23.6 | -80.9 |
| HRSG Casing | Phase 1 CPF | 3.5 | | 31.9 | 18.7 | 8.3 | 3.4 | 3.9 | -6.4 | -23.6 | -80.9 |
| Wellpad Piping | Wellpad | 3.5 | | 19.9 | 22.5 | 11.3 | 6.5 | 1.5 | -7.1 | -35.7 | -100 |
| Wellpad Piping | Wellpad | 3.5 | | 19.9 | 22.5 | 11.2 | 6.4 | 1.5 | -7.3 | -36 | -100 |
| EVAPORATOR 2 VAPOR COMPRESSOR | Phase 2 CPF | 3.4 | | 32.2 | 21.7 | 14.6 | 6.5 | -3 | -12.7 | -46.6 | -100 |
| Emulsion Pump | Wellpad | 3.4 | | 10.2 | 8.1 | 6.5 | 5.3 | 1.6 | -0.7 | -18.1 | -68 |
| LUBE OIL COOLER | Phase 2 CPF | 3.1 | | -23.3 | -4.1 | 0.4 | -4 | -9 | -19.8 | -58.3 | -100 |
| 13.8/480 VAC STEP DOWN TRANSFORMERS | Phase 2 CPF | 3.1 | | -27.5 | -11.8 | -1.4 | -2.5 | -2.1 | -14.6 | -46.4 | -100 |
| Wellpad Piping | Wellpad | 3.1 | | -19.8 | -4 | -5.2 | -2.6 | -2.2 | -8 | -36.3 | -100 |
| LUBE OIL COOLER | Phase 2 CPF | 2.9 | | -23.3 | -4.2 | 0.3 | -4.3 | -9.3 | -20.2 | -58.7 | -100 |
| UTILITY HEATER BLOWER | Phase 2 CPF | 2.7 | | -28.7 | -13 | -2.1 | -1.3 | -4 | -14.8 | -51.7 | -100 |
| LUBE OIL COOLER | Phase 2 CPF | 2.5 | | -23.4 | -4.4 | -0.1 | -4.8 | -9.4 | -20.4 | -52.6 | -100 |
| INSTRUMENT AIR | Wellpad | 2.4 | | -25.2 | -19.2 | -6.6 | -3.4 | -3.7 | -2.8 | -11.2 | -61.2 |
| Wellpad Piping | Wellpad | 2.4 | | -20.1 | -4.4 | -5.7 | -3.2 | -3 | -9.1 | -38.6 | -100 |
| Steam Boiler Casing | Phase 1 CPF | 2.3 | | -6.1 | -0.1 | -6.4 | -10.7 | -9.3 | -14.4 | -32.1 | -84.8 |
| Steam Boiler Casing | Phase 1 CPF | 2.2 | | -6.2 | -0.1 | -6.4 | -10.8 | -9.4 | -14.4 | -32.2 | -85 |
| Wellpad Piping | Wellpad | 1.9 | | -20.5 | -4.7 | -6.1 | -3.7 | -3.7 | -10.1 | -40.8 | -100 |
| 13.8/4160 VAC STEP DOWN TRANSFORMERS | Phase 2 CPF | 1.8 | | -28.7 | -13 | -2.6 | -3.7 | -3.4 | -15.8 | -54.2 | -100 |
| Evaporator Recirc Pump | Phase 1 CPF | 1.7 | | -16.4 | -8.4 | -9 | -6.1 | -3.6 | -2.9 | -19.5 | -77.6 |
| Wellpad Piping | Wellpad | 1.7 | | -20.6 | -4.8 | -6.2 | -3.8 | -3.9 | -10.4 | -41.3 | -100 |
| Wellpad Piping | Wellpad | 1.7 | | -20.6 | -4.8 | -6.2 | -3.9 | -3.9 | -10.5 | -41.5 | -100 |
| Wellpad Piping | Wellpad | 1.4 | | -20.8 | -5 | -6.4 | -4.1 | -4.3 | -10.9 | -42.4 | -100 |
| VRU Compressor | Phase 1 CPF | 1.3 | | -12.4 | -9.4 | -5.7 | -5.5 | -5.4 | -4.9 | -16.4 | -75.2 |
| Wellpad Piping | Wellpad | 1.2 | | -20.9 | -5.1 | -6.5 | -4.3 | -4.5 | -11.3 | -43.3 | -100 |
| Emulsion Pump | Wellpad | 1.1 | | -30.6 | -19.6 | -11.2 | -5.1 | -3.7 | -3.4 | -21.7 | -79.8 |
| INSTRUMENT AIR | Wellpad | 0.5 | | -26.4 | -20.4 | -8 | -4.9 | -5.5 | -5.2 | -15.4 | -72.2 |
| GLYCOL HEATER BLOWER | Phase 2 CPF | 0.3 | | -28.7 | -13 | -4.6 | -3.8 | -6.3 | -17.1 | -54 | -100 |
| GAS TURBINE INLET | Phase 2 CPF | 0.3 | | -18.9 | -6.2 | -1.8 | -8 | -27.9 | -60.1 | -100 | -100 |
| Emulsion Pump | Phase 1 CPF | 0.1 | | -19.1 | -11 | -11.5 | -8.3 | -5.4 | -3.8 | -19.7 | -65.8 |
| Emulsion Pump | Wellpad | 0.1 | | -31.3 | -20.3 | -11.9 | -5.9 | -4.7 | -4.6 | -24 | -86 |

Notes:

- 1/3 octave band sound levels are linear (i.e. not A-weighted)
- Data in Tables shows only those noise sources which have a broadband dBA sound level contribution greater than 0.0 dBA

# Appendix VI NOISE IMPACT ASSESSMENT

Licensee: **Southern Pacific Resource Corp.**

Facility name: STP McKay Thermal Project – Phase 2

Type: **Steam Assisted Gravity Drain**

Legal location: **TWP 91, RG 13, 14, 15, W4M**

Contact: Vince Parsons Telephone: (403) 984-5335

## 1. Permissible Sound Level (PSL) Determination (*Rule 012,* Section 2)

(Note that the PSL for a pre-1988 facility undergoing modifications may be the sound pressure level (SPL) that currently exists at the residence if no complaint exists and the current SPL exceeds the calculated PSL from Section 2.1.)

Complete the following for the nearest or most impacted residence(s):

| Distance from facility | Direction from facility | BSL (dBA) | Daytime adjustment (dBA) | Class A adjustment (dBA) | Class B adjustment (dBA) | Nighttime PSL (dBA) | Daytime PSL(dBA) |
|---|---|---|---|---|---|---|---|
| 1,500 m | All Directions | 40 | 10 | 0 | 0 | 40 | 50 |

## 2. Sound Source Identification

For the new and existing equipment, identify major sources of noise from the facility, their associated sound power level (PWL) or sound pressure level (SPL), the distance (far or free field) at which it was calculated or measured, and whether the sound data are from vendors, field measurement, theoretical estimates, etc.

| New Equipment | Predicted X PWL (dBA) X SPL (dBA) OR Measured X PWL (dBA) X SPL (dBA) | Data source | Distance calculated or measured (m) |
|---|---|---|---|
| **Listed in Appendix I** | | **Measurements / Calculations** | |
| | | | |
| | | | |

| Existing Equipment/Facility | Predicted X PWL (dBA) X SPL (dBA) OR Measured X PWL (dBA) X SPL (dBA) | Data source | Distance calculated or measured (m) |
|---|---|---|---|
| **Listed in Appendix I** | | **Measurements / Calculations** | |
| | | | |
| | | | |

## 3. Operating Conditions

When using manufacturer's data for expected performance, it may be necessary to modify the data to account for actual operating conditions (for example, indicate conditions such as operating with window/doors open or closed). Describe any considerations and assumptions used in conducting engineering estimates:

**Equipment assumed to be operating at all times at maximum capacity**

### 4. Modelling Parameters

If modelling was conducted, identify the parameters used (see Section 3.5.1):
**Ground absorption 0.5, Temperature 10$^0$C, Relative Humitidy 70%, all receptors downwind, Following ISO 9613**

### 5. Predicted Sound Level/Compliance Determination

Identify the predicted overall (cumulative) sound level at the nearest of most impacted residence. Typically, only the nighttime sound level is necessary, as levels do not often change from daytime to nighttime. However, if there are differences between day and night operations, both levels must be calculated.

Predicted sound level to the nearest or most impacted residence from new facility (including any existing facilities):

Modeled $L_{eq}$-Night = **37.9 dBA,** ASL = **35.0 dBA**, Overall $L_{eq}$-Night = **39.7 dBA,** PSL-Night: **40 dBA**

Is the predicted sound level less than the permissible sound level? **YES** If **YES**, go to number 7

### 6. Compliance Determination/Attenuation Measures

(a) If 5 is **NO**, identify the noise attenuation measures the licensee is committing to:

Predicted sound level to the nearest or most impacted residence from the facility (**with** noise attenuation measures):

N/A

Is the predicted sound level less than the permissible sound level? **YES** If **YES**, go to number 7
(b) If 6 (a) is **NO** or the licensee is not committing to any noise attenuation measures, the facility is not in compliance. If further attenuation measures are not practical, provide the reasons why the measures proposed to reduce the impacts are not practical.
**Note: If 6 (a) is NO, the Noise Impact Assessment must be included with the application filed as non-routine.**

**7. Explain what measures have been taken to address construction noise.**

**Advising nearby residents of significant noise sources and the Project construction schedule**
**Mufflers on all internal combustion engines**
**Taking advantage of acoustical screening where available**
**Limiting vehicle access during night-time**
**Limiting vehicle speeds, at all times, in the Project area**

**8. Analyst's Name : Steven Bilawchuk, M.Sc., P.Eng.**

Company: **ACI Acoustical Consultants Inc.**

Title: **Director**

Telephone: **(780) 414-6373** Date: **November 3, 2011**