Project done on Behalf of the

Zitholele Consulting

Professional Opinion on the Potential for Environmental Noise Impacts as a Result of the Continuous Disposal of Ash at Kendal Power Station

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Prepared by:

N von Reiche

Airshed Planning Professionals (Pty) Ltd

P O Box 5260
Halfway House
1685

Tel : +27 (0)11 805 1940
Fax : +27 (0)11 805 7010
e-mail : mail@airshed.co.za

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1 Introduction

Kendal Power Station is a coal-fired power generation facility on which construction started in mid-1982 and the last unit came online in 1993. The power station is located in the Nkangala District of Mpumalanga, approximately 10 km south-west of the town of Ogies. Kendal Power Station disposes of boiler- and fly-ash in a dry (8 to 15% moisture content conditioning) format, which is transported by means of conveyors. The ash will be distributed onto the ash disposal facility by means of a stacker at a rate of approximately 4.6 million tons per year for all six generating units. The 10-year ash disposal facility will, at full extent, cover approximately of 310 ha, including associated infrastructure.

Airshed Planning Professionals (Pty) Ltd was appointed by Zitholele Consulting to provide a specialist opinion on the potential for environmental noise impacts as a result of the continuous disposal of ash on the extended footprint.

The study included:

- The measurement of environmental of noise levels to determine prevailing baseline conditions;
- The measurement of noise levels near existing ash stacking activities to determine source sound power levels.
- A discussion on the potential noise impact zone and the potential for noise impacts at noise sensitive receptors in close proximity to the extended ash disposal facility footprint.

2 Noise Defined

As background to the noise study, the reader should take note of some definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

Noise is reported in decibels (dB). "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.

2.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing of a young, healthy person ranges between 20 Hz and 20 000 Hz (20 kHz).

In terms of sound pressure level, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8 to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

2.2 Frequency Weighting

As human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies. "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

2.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added.

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

2.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power;
- The distance between the source and the receiver;
- The extent of atmospheric absorption (attenuation);
- Wind speed and direction;
- Temperature and temperature gradient;
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption;
- Reflections;
- Humidity; and
- Precipitation

To arrive at a representative result from either measurement or calculation, these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

2.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- **L_{Aleq} (T)** – The A-weighted impulse corrected equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **$L_{Req,d}$** – The equivalent continuous day-time (07:00 – 22:00) sound pressure level that includes specified adjustments for tonal character, impulsiveness and time of day.
- **$L_{Req,n}$** – The equivalent continuous night-time (22:00 – 07:00) sound pressure level that includes specified adjustments for tonal character, impulsiveness and time of day.
- **$L_{R,dn}$** – is the equivalent continuous day/night rating level that includes specified adjustments for tonal character, impulsiveness and time of day.

3 Environmental Noise Regulation

Prior to assessing baseline noise levels and potential noise impacts, reference needs to be made to guidelines and standards regulating noise within communities.

The National Environmental Management Air Quality Act (NEMAQA) (Act No. 39 of 2004) makes provision for the control of noise. The Act states that:

1. The minister may prescribe essential national standards –
    a. For the control of noise, either in general or by specified machinery or activities or in specified places or areas; or
    b. For determining –
        i. A definition of noise; and
        ii. The maximum levels of noise.
2. When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

Sample noise regulations were circulated to provinces in 1997, which could be adopted unchanged or adapted to provincial requirements. To date this has happened in only three provinces, i.e. the Free State, Gauteng and Western Cape. These sample noise regulations are in the process of being reviewed and will be published under the NEMAQA.

It is anticipated that, in terms of the setting of standards, the new regulations will make direct and extensive reference to SANS10103, thus giving it legal status instead of only being a guideline document. It successfully addresses the manner in which environmental noise measurements and assessments are to be conducted and assessed in South Africa.

The values given in Table 1 are typical rating levels that should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be considered to be annoying to the community (SANS 10103, 2008). The levels given in Table 1 may be used as a guide for zoning purposes.

The areas surrounding Kendal Power Station are considered a mix of rural and suburban districts.

Table 1: Typical rating levels for outdoor noise in districts

Type of district	Equivalent Continuous rating Level ($L_{Req,T}$) for Outdoor Noise (SANS 10103, 2008)		
	Day/night $L_{R,dn}$ (dBA)	Day-time $L_{Req,d}$ (dBA)	Night-time $L_{Req,n}$ (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following; business premises; and main roads	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

SANS10103 (2008) also provides a useful guideline for estimating community response to an increase in the general ambient noise level caused by intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- ≤ 0 dB: There will be no community reaction.
- 0 dB <Δ≤ 10 dB: There will be 'little' reaction with 'sporadic complaints'. **For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact**.
- dB <Δ≤ 15 dB: There will be a 'medium' reaction with 'widespread complaints'. Δ = 10 dB is subjectively perceived as a doubling in the loudness of the noise.
- 10 dB <Δ≤ 20 dB: There will be a 'strong' reaction with 'threats of community action'.
- 15 dB <Δ: There will be a 'very strong' reaction with 'vigorous community action'.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

4 Measured Baseline Environmental Noise Levels

Noise measurements were conducted at three representative baseline locations (Figure 1). Pictures of these locations and surround areas are presented in Figure 2. Measurements were conducted in accordance with SANS 10103, *'The measurement and rating of noise and speech communication'* (SANS 10103, 2008). Existing sources of noise and the physical environment, including weather conditions, were noted during measurements. A summary of measurement results is provided in Table 2.

To facilitate comparison with SANS Guidelines in Table 1, measured L_{Aleq} levels were used to determine equivalent continuous day-time ($L_{Req,d}$), night-time ($L_{Req,n}$) and day-night ($L_{R,dn}$) sound pressure levels that includes specified adjustments for tonal character and time of day (Table 3). Measurements at locations 1 and 2 showed the presence of tones at 3 150 to 5 000 Hz respectively and a tonal character penalty of 5 dB was added accordingly.

Noise levels at location 1 and 2 were comparable and correspond to typical noise levels prevalent in rural and urban districts. Noise levels typically found in urban districts prevailed at location 3. This is as a result of fast travelling heavy vehicles on the R555.

Table 2: Summary of baseline noise level measurement results

Time of Day	Location	Start Time	Elapsed Time	L_{Aleq} (dBA)	Notes
Day-time	1	15-Apr-13 12:39	00:15:00	47.3	Sunny, warm conditions with moderate wind. Noise generated by wind rustling maize crops. Trucks, light vehicles and air traffic
	2	15-Apr-13 12:13	00:15:00	38.5	Sunny, warm conditions with slight to moderate wind. Birds, insects, farm animals and occasional air traffic contributed to measured noise levels.
	3	15-Apr-13 11:36	00:15:00	55.7	Sunny, warm conditions with moderate wind. Measurements mostly affected by heavy and light vehicle traffic on the R555 and passing dirt roads. Insects and birds also audible.
Night-time	1	14-Apr-13 21:28	00:15:00	34.3	Cold with slight breeze. Audible sources included: occasional traffic, frogs, insects and birds, constant industrial rumbling, barking dogs.
	2	14-Apr-13 21:57	00:15:00	37.7	Cold with slight breeze. Audible sources included: frogs, insects and birds, constant industrial rumbling, cattle lowing.
	3	14-Apr-13 22:35	00:15:00	65.8	Cold, wind still conditions. Audible sources included: frogs and insects, distant reverse sirens, traffic on R555.

Table 3: Equivalent continuous ratings

Location	$L_{Req,d}$ (dBA)	$L_{Req,n}$ (dBA)	$L_{R,dn}$ (dBA)
1	47.3	39.3(a)	48.1
2	38.5	42.7(a)	48.3
3	55.7	65.8	71.1

Notes:

a) Includes a 5 dBA tonal character penalty.

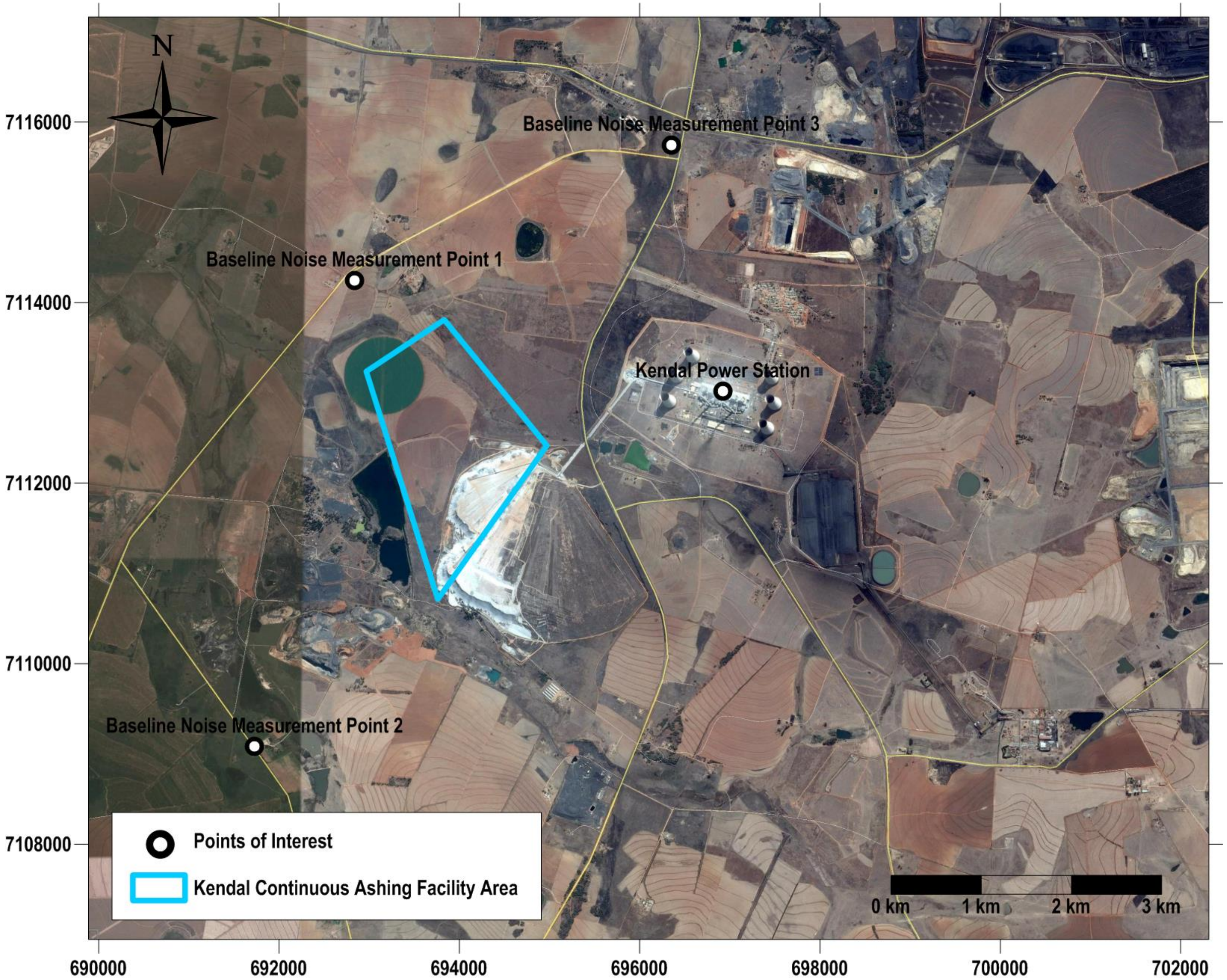

Figure 1: Kendal Power Station continuous ash disposal facility and representative baseline noise measurement locations

Location 1

950 m north-west of extended ash facility footprint

Location 2

2.8 km south-west of extended ash facility footprint

Location 3

3.1 km north-east of extended ash facility footprint

Figure 2: Pictures of baseline noise measurement locations

5 Source Noise Level Measurements

The most significant sources of noise associated with continuous ashing include conveyor transfer and ash stacking. A noise samples was taken at a distance of 10 m from stacking operations on the existing Kendal Power Station ash disposal facility. The stacker/conveyor system's sound power levels (noise 'emissions') were subsequently calculated and are presented in Table 4.

Table 4: Ash stacking/conveying sound power levels as calculated from source measurements

Source	Sound Power Levels, L_{Wi} (dB), at Octave Band Centre Frequencies							A-weighted Sound Power Level, L_{WA} (dBA)
	63 Hz	125 Hz	250 Hz	500 Hz	1 000 Hz	2 000 Hz	4 000 Hz	
Conveying and Stacking of Ash	108.1	103.4	102.3	103.1	99.9	97.3	89.6	**104.9**

6 Zone of Influence

To estimate a potential noise impact zone the propagation of noise from the stacking/conveyor system was calculated by assuming spherical geometric divergence, that is, the reduction of noise over distance from the source. As a conservative measure, the attenuation effects of meteorological and ground conditions were not taken into account in this high level screening study. The expected increase in ambient noise level over the average measured baseline as a function of distance from the source is shown in Figure 3.

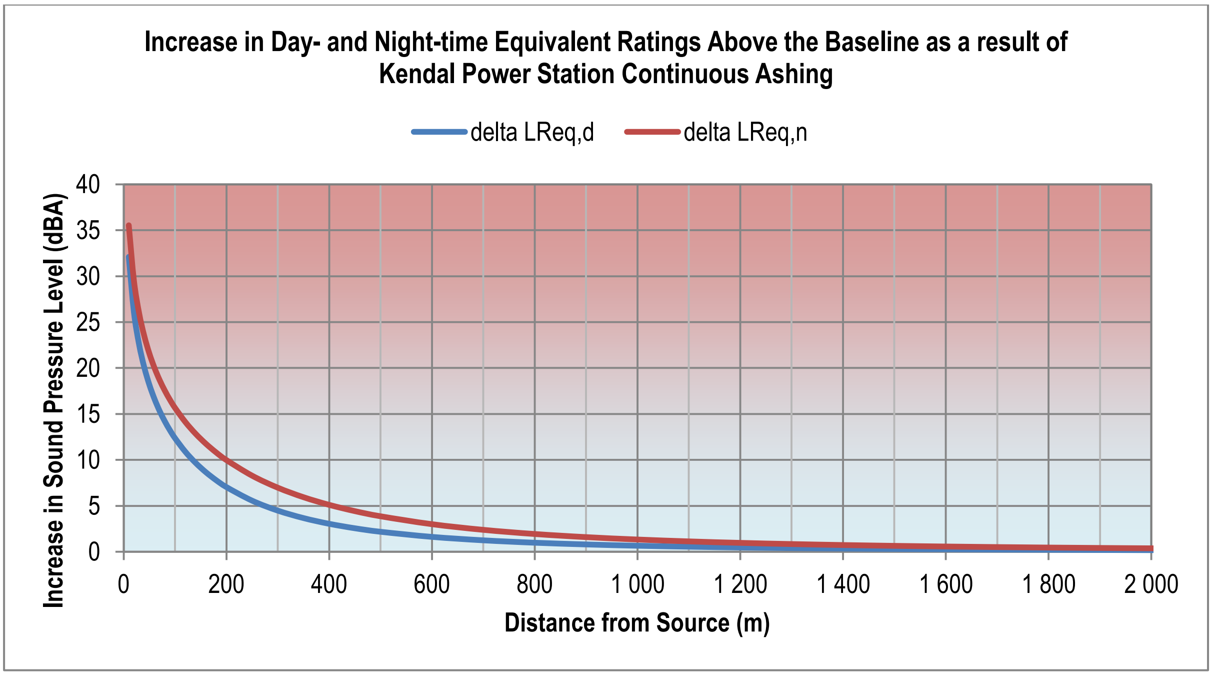

Figure 3: Estimated increase in day-and night-time equivalent ratings above the baseline

7 General Management and Mitigation Measures

7.1 *Mitigation*

The management and mitigations measures referred to in this Section should be considered to minimise potential noise impacts as a result of the Project.

7.1.1 Good Engineering Practice

For general construction, operational and decommissioning activities the following good engineering practice should be applied:

- All diesel powered equipment must be regularly maintained and kept at a high level of maintenance. This must particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment must serve as trigger for withdrawing it for maintenance.
- Rotating elements of conveyors and ash stackers should undergo regular inspection and maintenance to avoid unnecessary noise generation by faulty bearing/roller elements.
- To minimise noise generation, vendors can be required to guarantee optimised equipment design noise levels.
- During the planning and design stages of the project, possibly related noise aspects should always be kept in mind. The enclosure of major sources of noise, such as generator systems, must be included in the design process, since they represent basic good engineering practice.
- Vibrating structures are known to be noisy and good design philosophies should be followed for equipment of this nature. The mentioned equipment must be installed on vibration isolating mountings.
- Develop a mechanism to monitor noise levels, record and respond to complaints and mitigate impacts.

7.1.2 Operational Hours

It is recommended that, as far is as practicable, noise generating activities such as maintenance and construction, be limited to day-time hours (considered to be between 07:00 and 22:00) since noise impacts are most significant during the night.

7.2 *Noise Monitoring*

It is recommended that, should the project get environmental approval, ambient noise measurements be conducted during the construction, operational and decommissioning phases to assess and confirm the impact area.

In addition to the measurement of sound pressure levels, the 3rd octave band frequency spectra should also be recorded. Frequency spectrum data can provide useful insight into the nature of recorded sound pressure levels and assist with distinguishing between potential sources of noise that contribute to noise levels at a certain location.

8 Conclusion

Following the baseline study and high level impact screening, the following can be concluded:

- Baseline noise levels are in line with noise levels reported in rural and suburban districts, that is:
    - 45 to 55 during the day; and
    - 35 to 45 during the night.
- In increase of 3 dBA is used as the noise impact indicator since it represents the level at which, for a person with average hearing acuity, a change is not detectable.
- During the day, a 3 dBA increase can be expected up to 400 m from the stacker/conveyor.
- During the night, a 3 dBA increase can be expected up to 600 m from the stacker/conveyor.
- Since the nearest residential receptors are located approximately 700 m north-west and 1.5 km south-east of the extend ash disposal facility footprint, **noise impacts are expected to be of low consequence**.

9 References

Brüel & Kjær Sound & Vibration Measurement A/S. (2000). *www.bksv.com.* Retrieved October 14, 2011, from Brüel & Kjær: http://www.bksv.com

SANS 10103. (2008). *The Measurement and Rating of Environmental Noise with Respect to Annoyance and to Speech Communication.* Pretoria: Standards South Africa.