ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR-1') AND ASSOCIATED INFRASTRUCTURE

Noise Impact Assessment

October 2008
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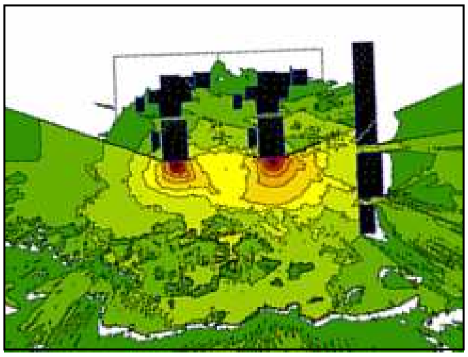
October 2010



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Architectural Acoustics Noise & Vibration Control Environmental Noise Traffic Noise Acoustical Material Research Underwater Sound Nonlinear Acoustics

30 July 2010

DECLARATION OF INDEPENDENCE

I, A.W.D. Jongens as duly authorised representative of Jongens Keet Associates, hereby confirm my independence (as well as that of Jongens Keet Associates) as a specialist and declare that neither I nor Jongens Keet Associates have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Arcus GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear 1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

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EXECUTIVE SUMMARY

A specialist study was conducted into the potential impact of noise emanating from the proposed establishment of a Nuclear Power Station (Nuclear-1), with a maximum electrical generation capacity of 4 000 MW, at three different locations. The three locations are on the Koeberg (Duynefontein) site immediately north of the existing Koeberg Nuclear Power Station (KNPS), Western Cape; at Bantamsklip approximately 5 km east of Pearly Beach, Western Cape; and Thyspunt, east of Oyster Bay, Eastern Cape.

No quantitative noise emission data of machinery and equipment to be installed on site was available. This data, provided by the manufacturers of the respective machines/equipment, is usually only available at the tender and detail design stage once the manufacturers and specific machinery/equipment have been selected.

The maximum 4 000 MW electrical power capacity of Nuclear-1 would be 2,2 times greater than the 1 800 MW of the existing KNPS. It is clarified in this report that if there were to be an associated 2,2 times increase in sound power emitted (in watts) this would not be audible to humans. Such differences are considered insignificant in national and international standards relating to the assessment of environmental noise. It was thus considered justified to use the results of detailed sound measurements conducted at the KNPS to calculate the approximate noise levels on land surrounding the proposed Nuclear-1 at the three alternative sites. This provided the best available data for predicting the potential impact of noise from the proposed Nuclear-1 nuclear power station.

The results of the study indicated that there would be no noise impact on land surrounding any of the three properties during construction and operation of the proposed nuclear power station. No noise mitigation procedures would therefore be required. Noise during the operational phase would thus not have a bearing on the selection of any of the three alternative sites.

It was considered probable that a 50 MW Open Cycle Gas Turbine peaking power plant proposed for the Thyspunt site would result in a noise impact on residences situated within 1 000 m of the plant. It is recommended that this be confirmed by a noise prediction study once quantitative noise emission data of the actual plant to be installed becomes available. Any required noise mitigation procedures would flow from the results of that study.

No noise impact associated with the construction of new roads to the alternative sites was anticipated, excepting the western access road to the Thyspunt site that would pass within 230 m of the Umzamowethu township. In the latter instance the following recommendations are made:

- Construction processes and machinery/vehicles with the lowest noise emission levels available are utilised;
- A well planned and co-ordinated “fast track” procedure is implemented to complete the total construction process in the shortest possible time; and
- Construction work near residences only takes place during normal daytime working hours.

The impact of noise associated with transportation of materials & equipment to site would have a low impact on the nearest residences located along the R27 leading to the Duynefontein site. The noise impact on the nearest residences along the R43 to the Bantamsklip site would be medium. The noise impact on a small number of residences in the nearest informal settlements along the R330 at sea Vista near the Thyspunt site would be medium. In all instances no noise mitigation would be required in terms of the Noise Control Regulations (NCR).

The transportation of heavy machinery on extra-heavy-duty vehicles traveling very slowly on roads within 1000 m of residences is likely to result in a noise impact of medium intensity but of very short duration. Little can be done to reduce the levels of noise emitted by extra-heavy-duty vehicles. In order to minimize the noise impact on affected communities it is recommended that they be informed prior to any such transportation taking place.

DECLARATION OF INDEPENDENCE

I, A.W.D. Jongens as duly authorised representative of Jongens Keet Associates, hereby confirm my independence (as well as that of Jongens Keet Associates) as a specialist and declare that neither I nor Jongens Keet Associates have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Arcus GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear 1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

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GLOSSARY

This glossay contains terms used in the measurement and assessment of sound, or noise. The terms defined in SANS 10103 appear hereunder. Their meanings are in certain instances loosely described to facilitate understanding. These are followed by definitions contained in the National and Western Cape Provincial Noise Control Regulations.

Ambient noise
the totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far. It includes the noise from the noise source(s) under investigation.

A-weighted intensity level, L_{IA} (often referred to as sound level or noise level)
the intensity level, in decibels, relative to a reference sound intensity, and incorporating an electrical filter network (A-weighted) in the measuring instrument corresponding to the human ear's different sensitivity to sound at different frequencies.

Equivalent continuous A-weighted sound level, $L_{Aeq,T}$
A formal definition is contained in SANS 10103. The term "equivalent continuous" may be understood to mean the "average" A-weighted sound level measured continuously, or calculated, over a period of time, T.

Equivalent continuous rating level, $L_{Req,T}$
the equivalent continuous A-weighted sound level, $L_{Aeq,T}$, measured or calculated during a specified time interval T, to which is added adjustments for tonal character, impulsiveness of the sound and the time of day. An adjustment of 5 dB is added for any tonal character, if present, plus a further 5 dB if the noise is also of an impulsive nature. Where neither is present, the $L_{Req,T}$ is equal to the $L_{Aeq,T}$.

Reference intensity, I_{ref} or I_0
is the threshold of audibility or minimum perceptible intensity of sound = 10^{-12} watt/m^2 at 1000 Hz

Reference time interval
The time interval to which an equivalent continuous A-weighted sound level, $L_{Aeq,T}$, or rating level of noise, $L_{Req,T}$, is referred. Unless otherwise indicated, the reference time interval is interpreted as follows:

- Day-time: 06:00 to 22:00hrs T=16 hours when $L_{Req,T}$ is denoted $L_{Req,d}$
- Night-time: 22:00 to 06:00hrs T=8 hours when $L_{Req,T}$ is denoted $L_{Req,n}$

Residual noise
the ambient noise that remains at a given position in a given situation when one or more specific noises (usually those under investigation) are suppressed.

The following terms are defined in the NCR.

Ambient sound level means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation.

Disturbing noise means a noise level that exceeds the ambient sound level measured continuously at the same measuring point by 7 dB or more.

Controlled area means a piece of land designated by a local authority where, in the case of -

(a) road traffic noise directly adjacent to a road –

(i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or

(ii) the outdoor equivalent continuous “A” weighted sound pressure level at a height of at least 1,2 m, but not more than 1,4 m, above the ground for a period extending from 06:00 to 24:00 as calculated in accordance with SABS 0210 and projected for a period of 15 years following the date on which the local authority makes such designation, exceeds 65 dBA

(c) industrial noise directly adjacent to an industry –

(i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or

(ii) the calculated equivalent continuous “A” weighted sound pressure level at a height of at least 1,2 m, but not more than 1,4 m, above the ground for a period of 24 hours exceeds 61 dBA

Certain terminologies used in the Noise Control Regulations and in the SANS 10103 have similar sounding, but not equal, meanings. Thus,

Noise Control Regulations:		SANS 10103:
Ambient sound level	is similar to	Rating level of residual noise
Noise level	is similar to	Rating level of ambient noise

1 INTRODUCTION

1.1 Background

Jongens Keet Associates was commissioned to undertake a specialist study into the potential impact of noise from the proposed establishment of Nuclear-1, a nuclear power station (NPS) with a maximum electrical power capacity of 4 000 MW at three different locations. The three locations are:

- Duynefontein, immediately north of the existing Koeberg Nuclear Power Station, Western Cape;
- Bantamsklip, approximately 7 km east of Pearly Beach, Western Cape; and
- Thyspunt, 4 km east of Oyster Bay, Eastern Cape.

This report describes the noise impact investigation into the establishment of the facility at each of the proposed sites. In particular, the study addresses the following question:

“What impact will noise pollution from the activities of the proposed Nuclear Power Plant during its full life cycle have on the surrounding environment?”

1.2 Legislative Framework and Regulatory Guidelines

The present study into the anticipated impact of noise from the NPS is made complex by the fact that two disparate procedures are to be implemented in the assessment and in the control of noise. These are:

- The procedures contained in South African National Standard (SANS) 10328, *Methods for environmental noise impact assessment* as prescribed under the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA).
- Stipulations contained in the national Noise Control Regulations (NCR), GN R154 in Government Gazette No. 13717 dated 10 January 1992 or provincial NCR in provinces where these have been promulgated. In the Western Cape provincial NCR, promulgated in Provincial Gazette No. 5309 of 20 November 1998, apply.

The procedures, described in greater detail in 1.2.1 through 1.2.4, may be summarised as follows:

SANS 10328 contains procedures to be followed to quantify the predicted impact that noise emanating from a proposed development will have on potentially affected land based on objective, scientific principles. The predicted impact is assessed in accordance with SANS 10103, *The measurement and rating of environmental noise with respect to* *annoyance and to speech communication*, by determining whether the rating level of the predicted noise will exceed the typical rating level of noise during daytime and night time pertaining to the particular district and relating this excess to the estimated response by a community of the respective district to the noise.

SANS 10328 stipulates that a Noise Impact Assessment (NIA) must include legal requirements, if any, and that other relevant and suitable literature may be consulted. The legal requirements are contained in the NCR and are thus required to be included in the present NIA. SANS 10103 is in line with World Health Organisation (WHO) Guidelines for Community Noise (WHO 2002) and a relevant summary is therefore included.

The NCR stipulate that noise emanating from a new industry may not cause noise levels on adjacent land to exceed 61 dBA and noise emanating from a new or changed road may not cause noise levels on adjacent land to exceed 65 dBA.

It is considered important to note that these are statutory limits, yet no distinction is made of the land use and zoning of the adjacent land such as business, or noise sensitive land such as residential, educational, hospitals or places of worship. Both levels significantly exceed those recommended in SANS 10103 and by WHO for noise sensitive land. Thus a noise level may be legally permissible in terms of the NCR yet may be assessed as producing a high noise impact in terms of SANS 10103.

The NCR further stipulates that no person may produce or cause a disturbing noise. In essence this permits the noise emanating from a particular source to increase the prevailing noise level in an area by 6 dB. Again, no distinction is made regarding the zoning and use of the affected land and the impact of the prevailing and future noise level.

For a brief description of the response of humans to noise in general and that emitted by machines relating to this study, the reader is referred to Appendix A. ***Appendix B contains A-weighted sound pressure levels of some typical noise sources.***

1.2.1 South African National Standards

In accordance with SANS 10328, the predicted impact that noise emanating from a proposed development would have on surrounding land is assessed by determining whether the rating level, $L_{Req,T}$, of the predicted ambient noise would exceed the typical rating level of noise on that land as indicated in Table 2 of SANS 10103 (2008). This excess is then related to the probable response of a community to the noise as indicated in Table 5 of SANS 10103. Tables 2 and 5 of SANS 10103 are reproduced hereunder.

SANS 10103 (2008), Table 2 — Typical rating levels for noise in districts

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req,T}$) for noise,** dBA					
	Outdoors			**Indoors, with open windows**		
	Day-night $L_{R,dn}$ [a]	**Day-time** $L_{Req,d}$ [b]	**Night-time** $L_{Req,n}$ [b]	**Day-night** $L_{R,dn}$ [a]	**Day-time** $L_{Req,d}$ [b]	**Night-time** $L_{Req,n}$ [b]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

NOTE 1 If the measurement or calculation time interval is considerably shorter than the reference time intervals, significant deviations from the values given in the table may result.

NOTE 2 If the spectrum of the sound contains significant low frequency components, or when an unbalanced spectrum towards the low frequencies is suspected, special precautions should be taken, and specialist attention is required. In this case the indoor sound levels may significantly differ from the values given in columns 5 to 7. (See also annex B.)

NOTE 3 In districts where outdoor $L_{R,dn}$ exceeds 55 dBA, residential buildings (e.g. dormitories, hotel accommodation and residences) should prerably be treated acoustically to obtain indoor $L_{Aeq,T}$ values in line with those given in Table 1.

NOTE 4 For industrial districts, the $L_{R,dn}$ concept does not necessarily hold. For industries legitimately operating in an industrial district during the entire 24 h day/night cycle, $L_{Req,d} = L_{Req,n}$ = 70 dBA can be considered as typical and normal.

NOTE 5 The values given in columns 2 and 5 are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day.

NOTE 6 The noise from individual noise sources produced, or caused to be produced, by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries, should not exceed a maximum A-weighted sound pressure level of 50 dBA at a distance of 15 m from each individual source.

a The values given in columns 2 and 5 are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day.

b The values given in columns 3, 4, 6 and 7 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise.

It can be observed from the above table that the minimum increment of $L_{Req,T}$ between different districts is 5 dB. With reference to Appendix A, this is related to the human's subjective response to changes in noise level and the minimum change in $L_{Req,T}$ that would be considered to be significant.

In estimating the response of a community (such as residents) in a particular residential district to a particular noise under investigation Table 5 of SANS 10103 incorporates the diversity of response of individuals of a particular community to the same noise level. The estimated response to an excess of $L_{Req,T}$ of noise under investigation over the typical $L_{Req,T}$ is thus not in discrete 5 dB changes, but in overlapping ranges of excess.

SANS 10103 (2008), Table 5 — Categories of community/group response

1	2	3
Excess ($\Delta L_{Req,T}$)[a] dBA	**Estimated community/group response**	
	Category	**Description**
0 – 10	Little	Sporadic complaints
5 – 15	Medium	Widespread complaints
10 – 20	Strong	Threats of community/group action
>15	Very strong	Vigorous community/group action

NOTE Overlapping ranges for the excess values are given because a spread in the community reaction may be anticipated

a $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:

1) $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation).

2) $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level for the ambient noise given in table 1.

3) $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the acceptable rating level for the applicable district as determined from table 2.

4) $\Delta L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in an area because of a proposed development under investigation.

1.2.2 Impact qualifiers

The **intensity** of a predicted noise impact was determined in relation to the categories of community response contained in Table 5 of SANS 10103 and is qualified as follows:

Negligible	Predicted $L_{Req,T}$ does not exceed the typical $L_{Req,T}$
Low	Predicted $L_{Req,T}$ exceeds the typical $L_{Req,T}$ by between 0 & 5 dB
Medium	Predicted $L_{Req,T}$ exceeds the typical $L_{Req,T}$ by between 5 & 10 dB
High	Predicted $L_{Req,T}$ exceeds the typical $L_{Req,T}$ by more than 10 dB

1.2.3 World Health Organisation

The WHO contains the following summary of thresholds for noise nuisance in terms of outdoor daytime L_{Aeq} in residential districts (WHO 2002):

- At 55-60 dBA noise creates annoyance;
- At 60-65 dBA annoyance increases considerably; and
- Above 65 dBA constrained behaviour patterns, symptomatic of serious damage caused by noise, arise.

The WHO recommends a maximum outdoor daytime L_{Aeq} of 55 dBA in residential areas and schools "*in order to prevent significant interference with normal activities of local communities*". It further recommends a maximum night-time L_{Aeq} of 45 dBA outside dwellings (WHO 2002). No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

These recommended maximum levels correspond to the typical daytime rating levels for ambient noise in an urban residential district referred to in Table 2 of SANS 10103.

1.2.4 Noise Control Regulations

The Western Cape Provincial NCR applies to the Duynefontain and Bantamsklip sites. Thyspunt is located in the Eastern Cape, which has not promulgated provincial NCRs. In the latter case the National NCR is applicable. With regard to the present study the relevant Clauses of the provincial and national NCR are the same.

In terms of Regulation 2 (d) of the Noise Control Regulations:

"*A local authority may, before changes are made to existing facilities or existing use of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests be conducted to the satisfaction of the local authority by the owner, developer, tenant or occupant of the facilities, land or buildings and that reports or certificates relating to the noise impact be submitted to the local authority, to the satisfaction of the local authority, by the owner, developer, tenant or occupant."*

In terms of Regulation 3 (c) of the Noise Control Regulations:

"No person shall make changes to existing facilities or existing use of land or buildings or erect new buildings, if these will house or cause activities that will, after such changes or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority."

In terms of Regulation 3(d) of the Noise Control Regulations:

"*No person shall build a road or change an existing road, or alter the speed limit on a road, if this will cause an increase in noise in or near residential areas, or offices, churches, hospitals or educational buildings, unless the need for noise control measures has been properly determined by the local authority in consultation with the road authority concerned to ensure that the land in the vicinity of that road will not be designated as a controlled area.*"

In terms of Regulation 4 of the Noise Control Regulations:

"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, animal, machine, device or apparatus or any combination thereof."

1.2.5 Revised Regulations

Various shortcomings experienced in implementing the NCR of the Province of the Western Cape, including the disparities referred to at the beginning of this Chapter, has resulted in the Western Cape provincial NCR being extensively revised by the Department of Environmental Affairs and Development Planning of the Province of the Western Cape in order to bring the provincial NCR in line with SANS 10103 and WHO recommendations.

The draft regulations have been published in Provincial Gazette No. 6412 of 25 January 2007.

The contents of the above draft NCR have subsequently been incorporated in the Department of Environmental Affairs and Tourism Draft Model Air Quality Management By-Law for adoption and adaptation by Municipalities, GN 964 in Government Gazette No. 32394 of 15 July 2009.

Both of the draft documents redefine disturbing noise as follows:

Disturbing noise means a specific noise level that exceeds either the outdoor equivalent continuous day/night rating level (L_{Rdn}), the outdoor equivalent continuous day rating level (L_{Rd}) and/or the outdoor equivalent continuous night rating level (L_{Rn}) for the particular neighbourhood indicated as the outdoor ambient noise in various districts in SANS 10103.

The existing NCR remain in force until promulgated in revised form.

This report attempts to distinguish between the assessment of noise impact in accordance with SANS and noise level limits and mitigation measures required to comply with the existing NCR. ***For example, an impact may be High in terms of SANS procedures yet not legally require mitigation in terms of the NCR.*** It is the task of the decision makers to determine whether to apply the legal limit of the existing NCR or the SANS 10103 noise level criteria.

1.3 Impact of Noise on Fauna

Procedures to determine and assess the impact of noise on fauna are not included in SANS 10328 and SANS 10103, nor does the impact on fauna form part of the Noise Control Regulations or any International Standard relating to noise that the author is aware of. No objective assessment of the impact that noise might have on fauna at any of the sites can therefore be provided in this study.

The author's subjective impression is that animals and birds will initially, due to survival instinct, vacate an area where an unusual noise suddenly occurs. This is likely to accompany the commencement of construction activities at any of the respective sites. However, upon "learning" that there is no danger to personal survival the animals and birds will eventually return to the area. Birds are abundant in relatively noisy cities as well as close to airport runways where very high levels of noise occur. Driving within the Koeberg site, buck were seen grazing in close proximity to the road, unperturbed by the passing vehicles or any audible noise emanating from the nuclear plant. Only when approached on foot would the animal(s) move to retain a "safe" distance. This is a response to visual stimulus or smell, not noise.

1.4 Study Approach

The study was conducted in accordance with procedures contained in South African National Standard (SANS) 10328, *Methods for environmental noise impact assessments* in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998). A summary of the procedure is outlined hereunder.

1. Determine the land use zoning and identify all potential noise sensitive land that could be impacted upon by activities relating to operation of the proposed NPS at each of the three alternative sites.
2. Determine the typical rating level for noise at identified noise sensitive sites.
3. Identify all noise sources, relating to the activities of the proposed NPS during the construction and operational phases, that could potentially result in a noise impact at the identified noise sensitive sites.
4. Determine the sound emission and nature of the sound emission from each of the identified noise sources.
5. Calculate the expected rating level of noise on the identified noise sensitive land.
6. Calculate the noise impact on the identified noise sensitive land.
7. Assess the noise impact at identified noise sensitive sites in terms of SANS 10103, *The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication*; the Noise Control Regulations; and the World Health Organisation (WHO).
8. Investigate alternative noise mitigation procedures, where appropriate.
9. Prepare and submit an environmental noise impact report containing the procedures and findings of the investigation.

2 DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 Duynefontein Site

Figure 1 displays the proposed plant layout of the Duynefontein site north of the existing Koeberg Nuclear Power Station on an aerial photograph of the area. The closest occupied noise sensitive land is the residential suburb of Duynefontein, with the nearest residences approximately 1 800 m south of the existing NPS and approximately 2 900 m south of the proposed Nuclear-1 infrastructure area. Measured ambient sound levels are contained in 3.1.4. The closest distance of the infrastructure area to the R27 National Road would be 2 000 m.

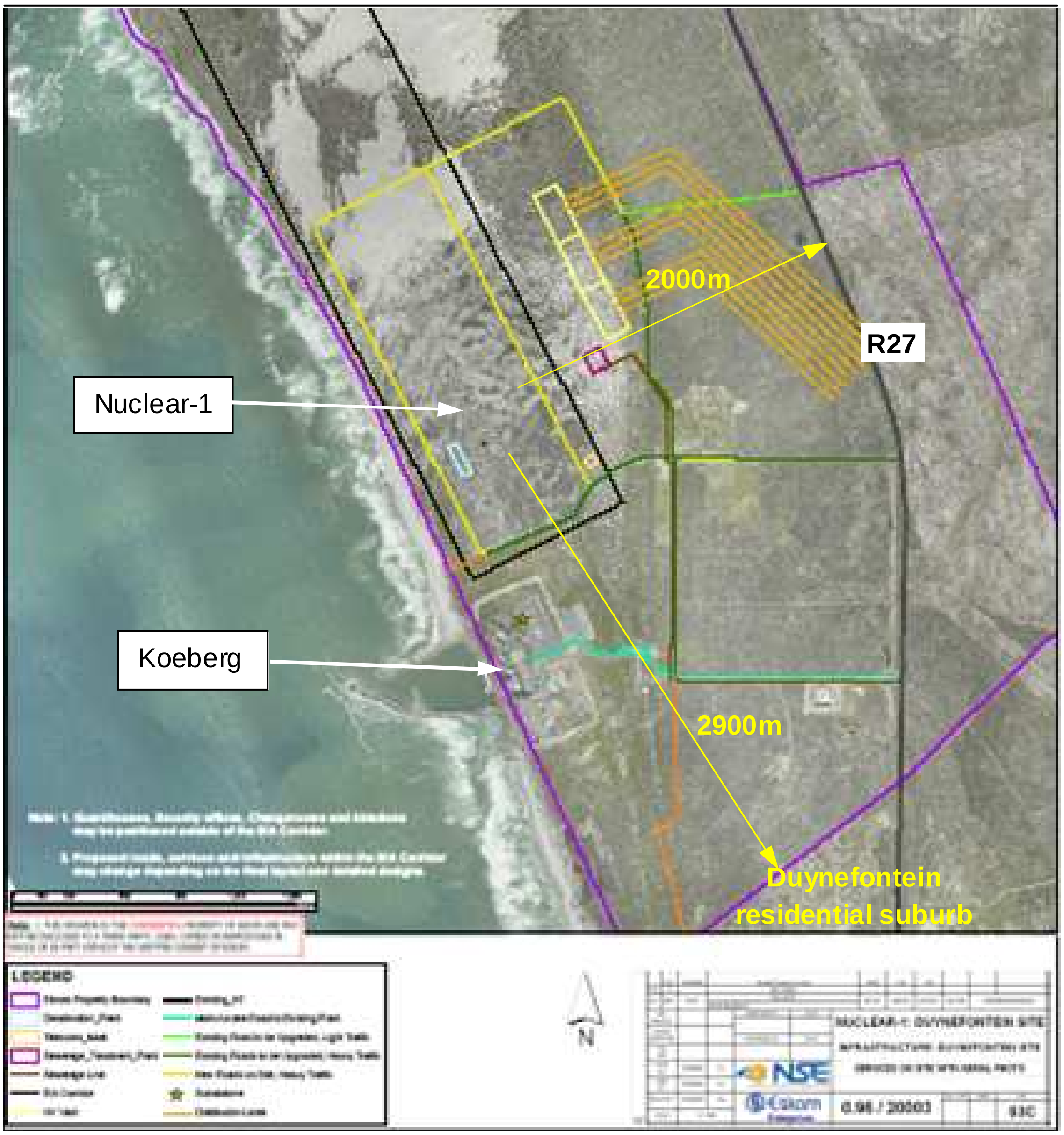

FIGURE 1 Proposed Duynefontein site north of the existing Koeberg nuclear power station

2.2 Bantamsklip Site

Figure 2 displays the proposed Nuclear-1 plant layout on an aerial photograph of the Bantamsklip location. The shortest distance to the property boundary is 1 125 m. The distance to the nearest noise sensitive land appears to be a farm with the farm boundary 3.2 km northeast of the Nuclear-1 infrastructure site where the typical $L_{Req,d}$ would be 45 dBA. The nearest residential suburb of Pearly Beach is located some 7,3 km northwest of the infrastructure site.

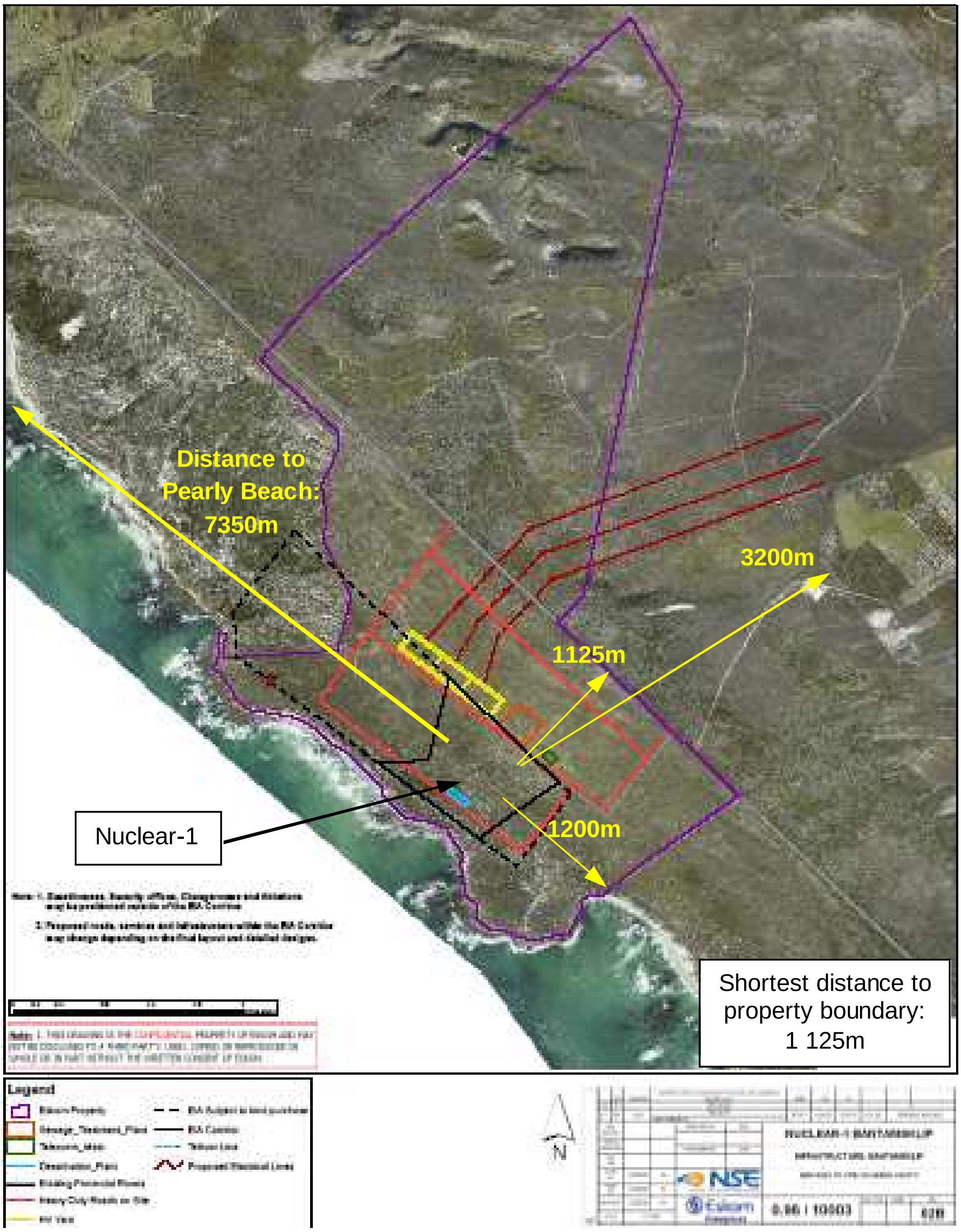

FIGURE 2 Proposed Nuclear-1 site at Bantamsklip

2.3 Thyspunt site

Figure 3 displays the proposed Nuclear-1 plant layout on an aerial photograph of the Thyspunt site. The Nuclear-1 infrastructure site would be 4.2 km east of residential land at Oyster Bay. Most of the residences are located on the slopes of a dune overlooking the coast and are exposed to levels of surf noise in excess of 50 dBA. An $L_{Aeq,T}$ of 43 dBA was measured behind the dune on the road leading to the Umzamowethu township (see also Figure 11). The only audible noise was that of the distant surf. ***A green rectangle shows the proposed location of the High Voltage (HV) yard, where two OCGT peaking power plants with a combined electrical capacity of 50 MW will be installed.*** Outlined in green circles are farm residences nearest to the site boundary where the typical $L_{Req,d}$ would be 45 dBA. One residence (small circle) is situated just outside of the HV yard boundary.

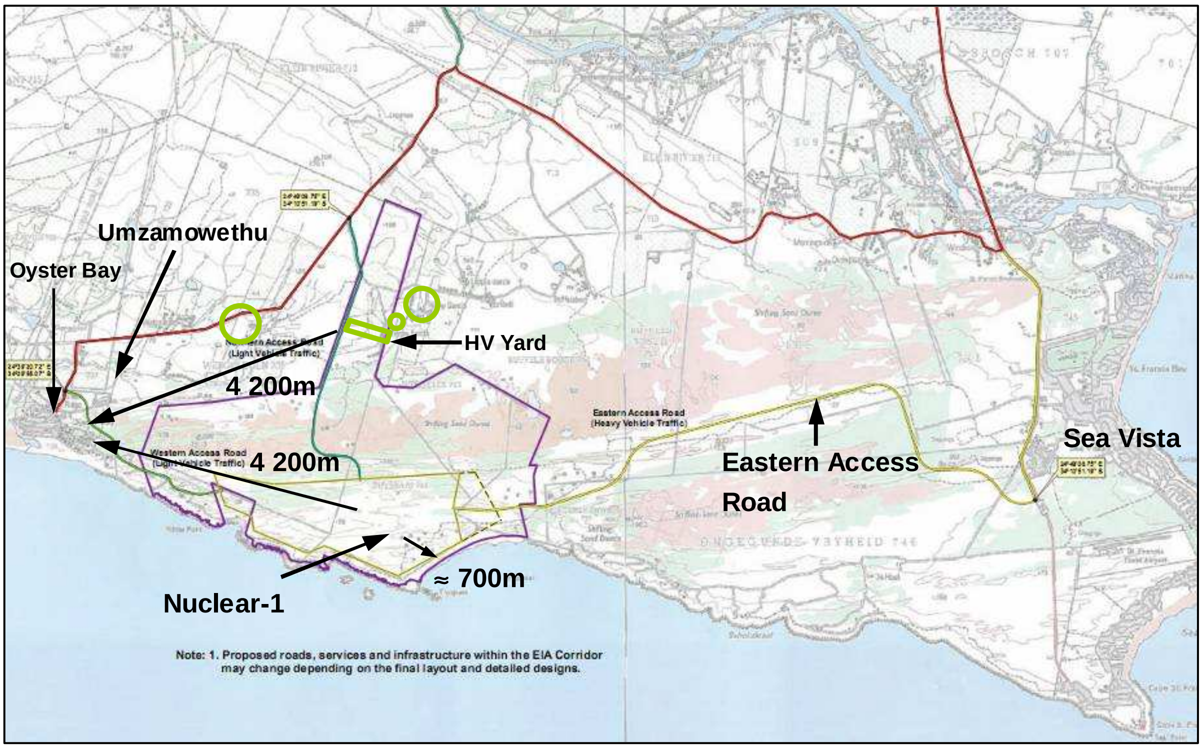

FIGURE 3 Proposed Nuclear-1 site at Thyspunt

3 IMPACT IDENTIFICATION AND ASSESSMENT

3.1 Sources of Noise

Described in simplest terms a nuclear power station consists of a source of heat provided by nuclear reaction to generate steam that causes the rotation of a steam turbine. The shaft of the steam turbine is coupled to an electrical generator that generates electrical power. Noise that might have an environmental impact is produced by the turbines, electrical generators and associated machinery/equipment. No audible noise emanates from the nuclear reactor. This is confirmed in Section 3.1.2.

The proposed NPS and infrastructure will comprise two or three nuclear reactors, turbines and electrical power generators with associated infrastructure including buildings housing administration, training centre, emergency services. The maximum, combined electrical generation capacity would be 4 000 MW.

Figure 4 displays a typical layout of the infrastructure. This information was compiled by Eskom for the EIA. Table 1 contains the dimensions of the larger buildings in the vicinity of the major noise sources that could influence the propagation of sound from these noise sources. This information was used for the noise propagation calculations in Section 4 of this study.

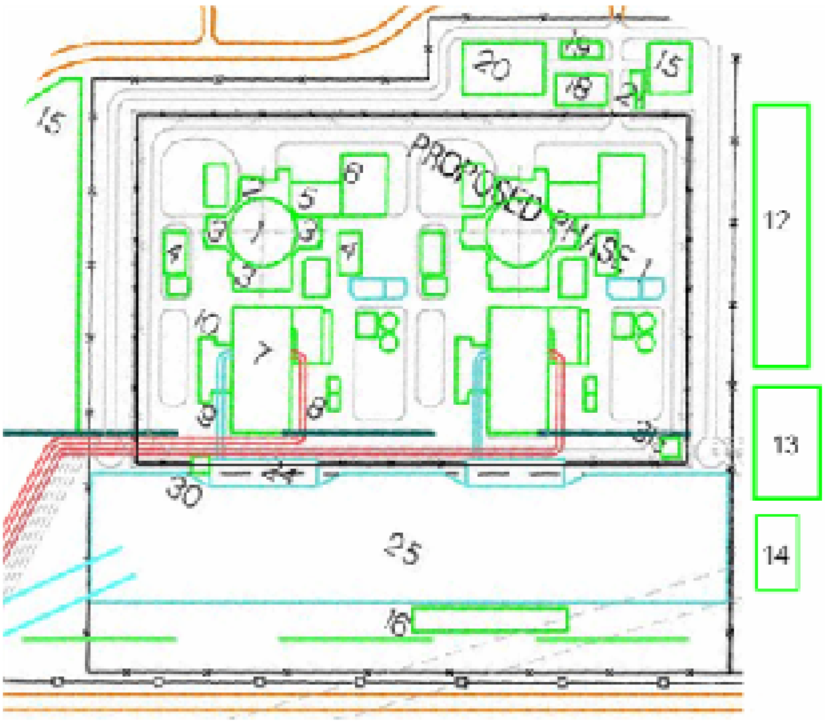

FIGURE 4 Typical layout of the nuclear plant infrastructure

TABLE 1 Dimensions, in metres, of the larger buildings of the nuclear plant infrastructure

Item	Building	Height	Breadth	Length
1	Reactor Building	71	44	44
2	Fuel Building	30	35	75
3	Safeguard Building	30	60	40
4	Diesel Building & storage	15	20	20
5	Nuclear Auxiliary Building	30	35	75
6	Waste Building	15	25	55
7	Turbine Hall	55	51	95
10	Transformer Area	45	10	70
12	Administration Building	10	66	308
13	Training Centre	10	75	135
14	Emergency Control	5	50	90

The layout of the infrastructure of the nuclear power plant will have a significant influence on the propagation of sound emanating from the primary noise sources of the plant to the surrounding land areas. The dimensions of many of the buildings will be large, rendering them as effective sound barriers on the one hand as well as effective sound reflectors, depending on their location with respect to the primary sources of noise.

3.1.1 Assumptions and Limitations

At the time of compiling this report, details of the actual machinery to be installed and therefore the associated noise emission data were not available. Quantitative information with which to identify the major sources of noise and subsequently to predict the environmental noise from the proposed nuclear plant was thus not available.

The proposed nuclear power station will comprise the same technology as that at Koeberg, namely, Koeberg and the proposed NPS are both pressurised water reactors. It was considered that a high degree of confidence could be placed on the extrapolations from Koeberg to the new nuclear power station. Based on this assumption the noise emissions from the existing Koeberg nuclear power station at Duynefontein were measured and the results of these measurements were related to the proposed Nuclear-1 NPS.

Due to the inability to generate a digital terrain model and subsequent $L_{Aeq,T}$ contours for Thyspunt the contours generated for Duynefontein, with a similar topography, were used for Thyspunt.

It is to be noted that in this report all equivalent continuous rating levels, $L_{Req,T}$, of noise, whether measured or calculated, exclude adjustments for tonal character or impulsiveness of the noise. In accordance with SANS 10103 noise measurements are assessed in terms of $L_{Req,T}$ that includes these adjustments. However, these adjustments are not included in the standard procedures for calculating sound propagation (SANS 10357) and procedures for calculating and predicting road traffic noise (SANS 10210).

This study compares measured noise levels with calculated future levels. These comparisons require consistent units to be used for meaningful assessments. Thus, the $L_{Req,T}$ exclude impulse and tone adjustments.

3.1.2 Sound measurements at Koeberg Nuclear Power Station

The existing Koeberg nuclear power station comprises two nuclear reactors, each coupled to a turbine and electrical generator designed and manufactured by Alsthom Atlantique. The electrical generators rotate at 1 500 rpm (25 revolutions per second) with a combined electrical generation capacity of 1 800 MW (ESKOM). The walls and roof of the building housing the two turbine/generator sets consist of sheet metal that present limited airborne sound insulation to noise emitted within the building radiating to the exterior. Banks of transformer oil cooling fans are located in the open on the eastern side of the building. Noise emitted by these fans therefore radiate noise directly into the surrounding environment.

Sound measurements were conducted on Tuesday 6 November 2007 within and exterior to the generator building of the Koeberg NPS. The weather was clear with no wind. Both of the reactors were operating at full capacity. Mr John Daniels of Eskom was in attendance.

The equivalent continuous A-weighted sound pressure level, L_{Aeq}, simultaneously with the octave band and 1/3rd octave band equivalent sound pressure levels were measured within the generator room and exterior to the building using a Larson Davis Type 824 precision integrating sound level meter with the microphone positioned 1.4 m above the ground and at least 1.5 m from any large sound-reflecting surface. The microphone was fitted with a windshield. Prior to and after the measurements the calibration of the meter was checked using a Brüel & Kjaer type 4230 Calibrator.

Sound measurements were conducted at the following locations as shown in Figure 5:

1. Spatial average measurements within the generator building around the northern turbine and generator (Unit 1);
2. Spatial average measurements within the generator building around the southern turbine and generator (Unit 2);
3. Approximately 80 m east of the building at the top of the outside stairs leading to the general office building;
4. Western road edge skirting the nuclear reactors midway between the reactors;
5. Road north of the nuclear reactors, approximately 50 m from the generator building; and

6. Vehicle gates of Access Control Point 2 (A.C.P.2) to the nuclear enclosure.

FIGURE 5 Aerial photograph of Koeberg Nuclear Power Station indicating sound measurement locations. Reference: Google Earth

3.1.3 Results of the sound measurements

The measured $L_{Aeq,T}$, to the nearest decibel, are recorded in Table 2. The A-weighted equivalent continuous 1/3rd frequency octave band sound pressure levels (sound spectra) are contained in Appendix C.

TABLE 2 Measured $L_{Aeq,T}$ in dBA at Koeberg Nuclear Power Station

Sound measurement location	$L_{Aeq,T}$, dBA
1 Northern generator, spatial average	93
2 Southern generator, spatial average	88
3 Steps at top of embankment	71
4 Road edge west of nuclear reactor	55
5 North of northern nuclear reactor	62
6 Gates of Access Control Point 2	54

For a brief description of the response of humans to noise in general and to that emitted by machines relating to this study, please refer to Appendix A.

The $L_{Aeq,T}$ of 93 dBA around the northern turbine generator set (Unit 1) was observed to be 5 dB higher than the 88 dBA measured around the southern generator (Unit 2). 5 dB represents a threefold difference in acoustical power radiation. Inspection of the noise spectra in Figures C1 and C2 indicated that this was primarily due to noise levels in the 500 Hz to 6 300 Hz spectral bands.

These apparently anomalous results prompted discussions with Koeberg site engineers. It was confirmed that both turbines and electrical generators were identical and both running at maximum capacity. It was learnt that, although both turbines were fitted with six identical steam governor valves, the northern Unit 1 needed to run with more throttle of the valves. Throttled flow of steam causes greater turbulence at the valve outlet with associated increased noise at high frequencies being radiated through the valve casings. This explained the increased noise levels at high frequencies and the higher $L_{Aeq,T}$ value around Unit 1. The difference was thus not due to a difference in output capacity of either turbine/generator but due to operating conditions of associated equipment.

Measurement location 3 was 49 m from the nearest bank of oil cooler fans, 80 m from the generator building and at approximately the same elevation as half the height of the generator building. This position was also in clear line-of-sight of the entire eastern building façade, including the two banks of oil coolers. The noise emitted by the fans of the oil coolers was audibly the main contributor to the sound spectra and $L_{Aeq,T}$ measured east of the building at locations 3 and 6, respectively. Refer to Figures C3 and C6.

Location 5 was shielded from noise emanating from the oil cooler fans by the generator building. The sound spectrum levels and $L_{Aeq,T}$ measured at location 5 (refer Figure C5) was thus primarily due to the turbine, generator and governor valve noise emanating from within the generator building. Location 5 was closer to the generator building than location 3, yet the $L_{Aeq,T}$ measured at the latter was a significant 9 dB higher than at location 5. Thus the acoustic power radiated into the environment by the fans significantly exceeded any noise propagating through the walls from within the turbine/generator building, or phrased differently, the combined sound power level emanating from the generator building containing the turbine/generator sets and associated equipment was insignificant compared to that emanating from the oil cooler fans.

Study of the sound spectra in Figures C1 through C3 and Figure C6 show the presence of 25 Hz, 100 Hz and 200 Hz pure tones. Were these pure tones to emanate from the generators, one would expect these to be clearly evident in the spectrum in Figure C5 measured at location 5, the closest measurement exterior to the generator building. The virtual absence of these pure tones appeared to indicate that they emanated from the oil cooler fans and possibly the adjacent transformers (thus not from within the generator building).

At location 4 no noise emanating from the nuclear reactors was audible. Besides noise emanating from beyond the eastern side of the nuclear reactors, surf noise from the coast west of location 4 was just audible.

It was evident from the results of the sound measurements that the oil cooler fans were the main sources of noise of the entire plant. Figure 1 shows a service road in line of sight and 375 m from the southern oil coolers. During a subsequent visit no noise emanating from the cooler fans could be heard above surf noise anywhere along this road.

The octave band sound level spectrum measured at location 3, together with the known distance to the oil cooler fans, was used to calculate the octave band sound power level spectrum of noise emitted by the fans using the procedures contained in SANS 10357 *The calculation of sound propagation by the Concawe method* for neutral meteorological conditions.

For control purposes the $L_{Aeq,T}$ at the gates to A.C.P.2, a distance of 253 m from the oil coolers, was calculated from the octave band sound power level spectrum to be 56.3 dBA. This was 1.9 dB higher than the measured value of 54.4 dBA at the same location. This was attributed to the fact that at location 6 the southern oil cooler fans were wholly screened by an embankment, which also partially screened the northern oil cooler fans. This provided confidence that the calculated octave band sound power level spectrum could be used in the calculation of the noise contours around the proposed NPS.

3.1.4 Sound measurements at nearest residences

The closest occupied noise sensitive land is the residential suburb of Duynefontein, with the nearest residences approximately 1 800 m south of the existing NPS (Refer to Figure 1). During the summer months between November and March the prevailing strong southeasterly wind blows almost unabated in this west coast region. After several attempts ambient sound level measurements were able to be conducted at Duynefontein on the morning of 23 January 2008, when there was a brief period of windless weather. Sound measurements were conducted at the corner of Otto du Plessis Drive and Narcissus Avenue and at the corner of Napoleon Avenue and Horn Crescent. The locations, approximately 1 800 m from the Koeberg NPS, were in direct line-of-sight of the plant and approximately 500 m and 1 200 m, respectively, from the coast. The purpose of the measurements was to determine whether noise from Koeberg could be heard and measured during the lowest prevailing sound levels. It was possible to achieve this during a measurement time period, T, of two minutes in between sporadic passing of vehicles within the vicinity.

During the measurements surf noise was the only audible sound. There was no noise from birds, from road traffic or any other source in the neighborhood. Although listening intently, no noise from the Koeberg plant was audible. The results of the sound measurements are recorded in Table 3. The difference in levels was due to the different distances to the coast and different degrees of noise screening provided by residential buildings between the respective measurement locations and the coast.

TABLE 3 Results of ambient sound measurements conducted in Duynefontein

Location	$L_{Aeq,T}$ dBA
Corner of Otto du Plessis Drive and Narcissus Avenue	56
Corner of Napoleon Avenue and Horn Crescent	49

Due to the absence of any man-made noise it was considered that similar ambient levels would have been recorded during night-time.

3.1.5 Observations and discussion

Sound power emission data of the turbines, generators and associated machinery and equipment to be installed at the proposed NPS was not available. However, from the results of the sound measurements conducted at Koeberg NPS, it transpired that the oil cooler fans were by far the main source of noise emanating from the plant.

There was no knowledge of the type, size and number of the oil cooler units that would be installed at the proposed Nuclear-1. Pertinent factors would be what oil cooling process would be used (water or air cooled); whether a 4 000 MW electrical generation capacity would require 2,2 times (or more, or less than) the oil cooling capacity compared to the existing 1 800 MW capacity of the existing Koeberg Plant; whether there would be a difference in the spectrum of noise emitted; and possibly other factors. There was thus no clear, quantitative basis upon which to adjust the sound power spectrum levels emitted by the Koeberg oil cooler fans so as to provide a more accurate estimate of the sound power emission levels of machinery to be installed at the proposed Nuclear-1.

With reference to Section 3.1.3 and Appendix A, it was considered that use of the sound power emission data of the oil cooler fans at the existing Koeberg Nuclear Power Station would provide the best available data for predicting the potential impact of noise from Nuclear-1. Should it transpire, upon receipt of quantitative data of the actual machinery to be installed at Nuclear-1, that there would be a significant difference in sound power spectrum levels of noise emitted by the major noise source(s), then a more accurate adjustment to the results flowing from this study could be made.

3.2 Noise propagation calculations

The calculation of the predicted rating level, $L_{Req,T}$, of noise at various distances from the noise sources comprised the stages summarised hereunder.

- A 3-dimensional digital terrain model (DTM) was generated from 1 m elevation resolution data of the land within the respective property boundaries obtained from Eskom. The data did not extend beyond the boundaries of the sites.
- The larger buildings of the nuclear plant infrastructure, described in Section 3.1, were included in the DTM. These are depicted in black in Figures 6, 7 and 10.

- The major noise sources, namely the oil cooler fans, were located outdoors close to one end of the turbine hall of each of the two nuclear plants. Choice of this location was partly due to the author's uncertainty at commencement of the calculations of their precise location and partly to illustrate the noise screening effect of larger buildings on the propagation of noise away from the noise sources compared to propagation over unobstructed ground.
- The attenuation of noise with distance from each source was calculated in accordance with SANS 10357, *The calculation of sound propagation by the Concawe method*, for propagation over non-absorbing ground and with meteorological conditions chosen that are most favourable for the propagation of noise from noise source to receiver. These conditions include each receiver location being downwind from the noise sources thereby representing a worst case scenario.
- From the results, noise contours at 5 dB intervals were generated and overlaid on enlarged portions of the aerial photographs of each site displayed in Figures 1 through 3. Each figure contains a colour scale, with each colour representing a 5 dB change in level within that colour between adjacent colours. The $L_{Req,T}$ values range between just higher than 90 dBA (purple) in the immediate vicinity of the noise source (oil cooler fans) to a lowest value of 30 dBA at the furthest extent of the dark green colour. With reference to 1.2.1, 30 dBA is lower than the 35 dBA typical night-time, outdoor rating level for noise in a rural district. Where there is no colour coding, the calculated $L_{Req,T}$ is lower than 30 dBA and no noise from the source would be audible.
- For continuous operation of both nuclear plants, the $L_{Req,T}$ at any instant would thus represent both the daytime and night-time rating levels, $L_{Req,d}$ and $L_{Req,n}$, respectively.

The resulting noise contours displayed in Figures 6, 7 and 10 represent worst case rating levels of noise at any receiver located 360 degrees in the horizontal plane around the noise sources. This includes the effects of light winds blowing in a direction from noise source to receiver, whatever actual prevailing conditions might exist at any of the respective locations. The diagrams do not represent a typical winter or summer condition.

In order to limit computation time the noise calculation area was truncated beyond a few hundred metres out to sea. A study of the noise contours in Figures 6 and 7 indicate that for sound propagating over unobstructed land towards the coast, the noise level would have reduced to 40 dBA at the coastline approximately 500 m from the noise sources. Results of previous sound measurements conducted on beaches at 100 m from the water line recorded $L_{Aeq,T}$ ranging from 60 dBA for typical wave breaking to 80 dBA for heavy wave breaking. The level of noise from the oil cooler fans out at sea would thus be insignificant compared to surf noise.

3.3 Duynefontein

The results of the predicted $L_{Aeq,T}$ contours at Duynefontein are displayed in Figure 6.

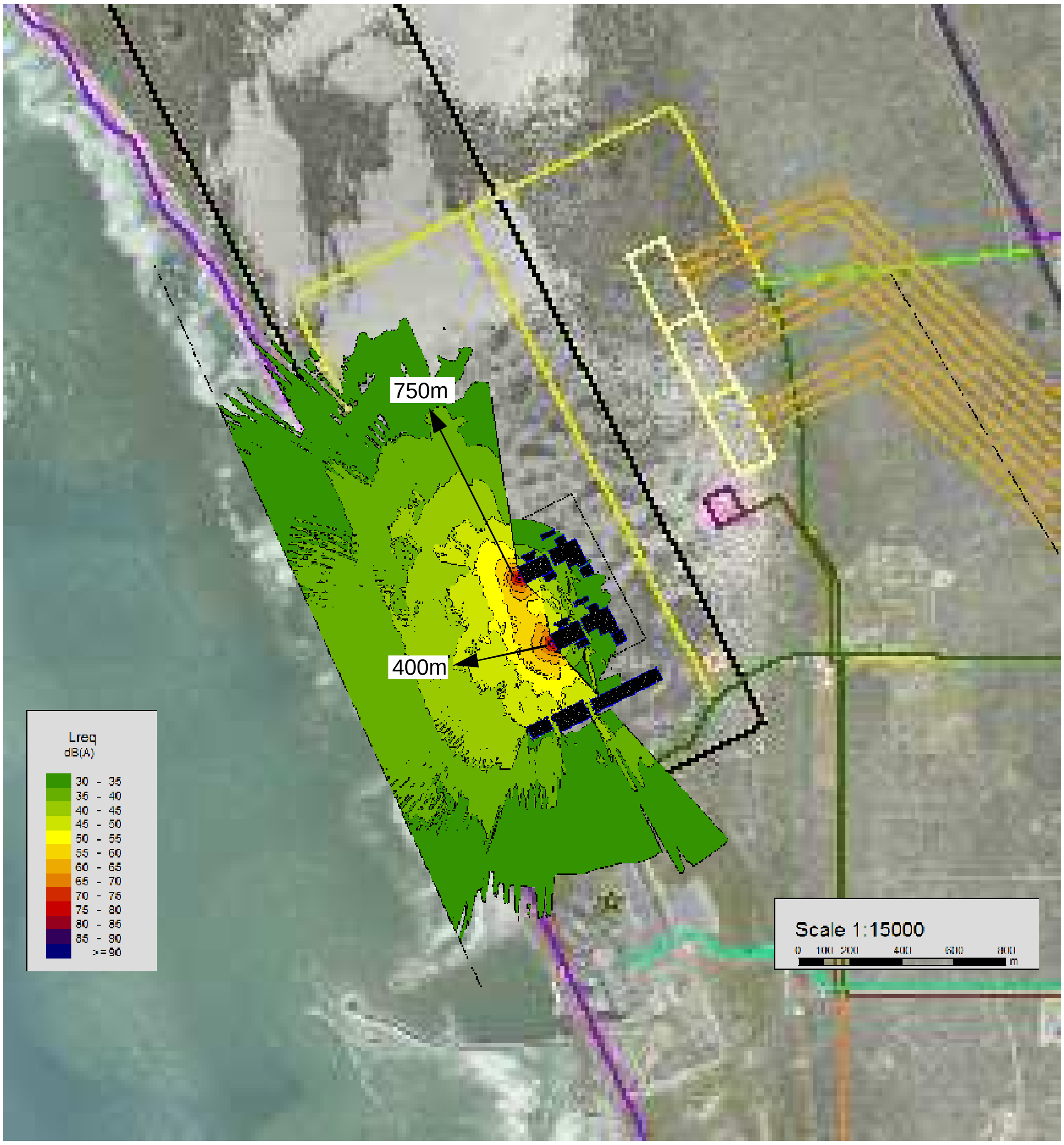

FIGURE 6 Predicted $L_{Aeq,T}$ contours at Duynefontein

3.3.1 Assessment

With reference to Table 2 of SANS 10103 reproduced in Section 1.2.1, the most stringent outdoor rating level is 45 dBA during daytime and 35 dBA during night-time in a rural residential district.

Over unobstructed land the 45 dBA $L_{Aeq,T}$ contour is located approximately 400 m from each noise source (oil cooler fans) whereas the 35 dBA $L_{Aeq,T}$ noise contours occurs at approximately 750 m from a noise source. At both ranges noise from the source would be inaudible above the surf noise. Refer to Section 3.1.3.

The sound screening influence of the large building structures is evident resulting in the $L_{Aeq,T}$ due to the noise sources reducing to below 30 dBA within the infrastructure boundary outlined in orange immediately east of the buildings.

Were the oil cooler fans to be located in the transformer area (item 10 in Figure 4) northwest of each generator building, there would be little screening by buildings of noise emanating particularly from the north-western fans. However, in the latter locations noise from the fans would reduce to 35 dBA at approximately the same distance, namely 750 m from the fans. This distance is well within the 2 000 m distant boundary of the Duynefontein site with the R27. With reference to Section 3.1.3, even at a distance of 400 m from the source and thus 900 m from the coast, the $L_{Aeq,T}$ would be lower than that emanating from the surf.

3.3.2 Cumulative impact

With regard to the potential cumulative effect of noise emanating from Nuclear-1 and from Koeberg, the separation distance between the two infrastructure sites would be such that the combined noise may, at most, increase the noise level midway along a line joining the noise sources between the two sites from 30 dBA to 35 dBA. Noise from the Koeberg plant would not influence the levels of noise northwest of Nuclear-1, nor would that from Nuclear-1 influence the levels of noise southeast of the Koeberg plant. There would be no difference in noise levels at perpendicular distances, namely, in northeast and southwest directions.

A previous noise impact study (Jongens Keet Associates 2007) had been conducted into the proposed establishment of a Pebble Bed Modular Reactor Demonstration Power Plant (PBMR DPP) to be located south of and immediately adjacent to the existing Koeberg Nuclear Power Plant. ***Although the PBMR project has been discontinued, the study predicted that there would no noise impact on the nearest residential suburb of Duynefontein during combined operation of the existing Koeberg plant and the PBMR DPP***.

3.3.3 No development option

The results indicate that there would be no impact of noise during daytime or night-time on land beyond the Duynefontein property boundary during the combined operation of Nuclear-1, the existing Koeberg nuclear power plant and the proposed PBMR DPP. Thus, whether or not Nuclear-1 was to be located at the Duynefontein site, would not have any effect on the impact of noise beyond the Duynefontein property boundary.

3.3.4 Noise impact summary

The noise impact beyond the Duynefontein property boundary during operation of Nuclear-1 is summarized in Table 4.

TABLE 4 Summary of noise impact beyond Duynefontein property boundary

Operation of Nuclear-1	
Criteria	***Rating***
Intensity	***Low***
Extent	***Medium***
Duration	***High***
Impact on irreplaceable resources	***Low***
Consequence	***Low***
Probability	***Low***
Significance	***Low***

3.4 Bantamsklip

The results of the predicted $L_{Aeq,T}$ contours at the Bantamsklip site are displayed in Figure 7.

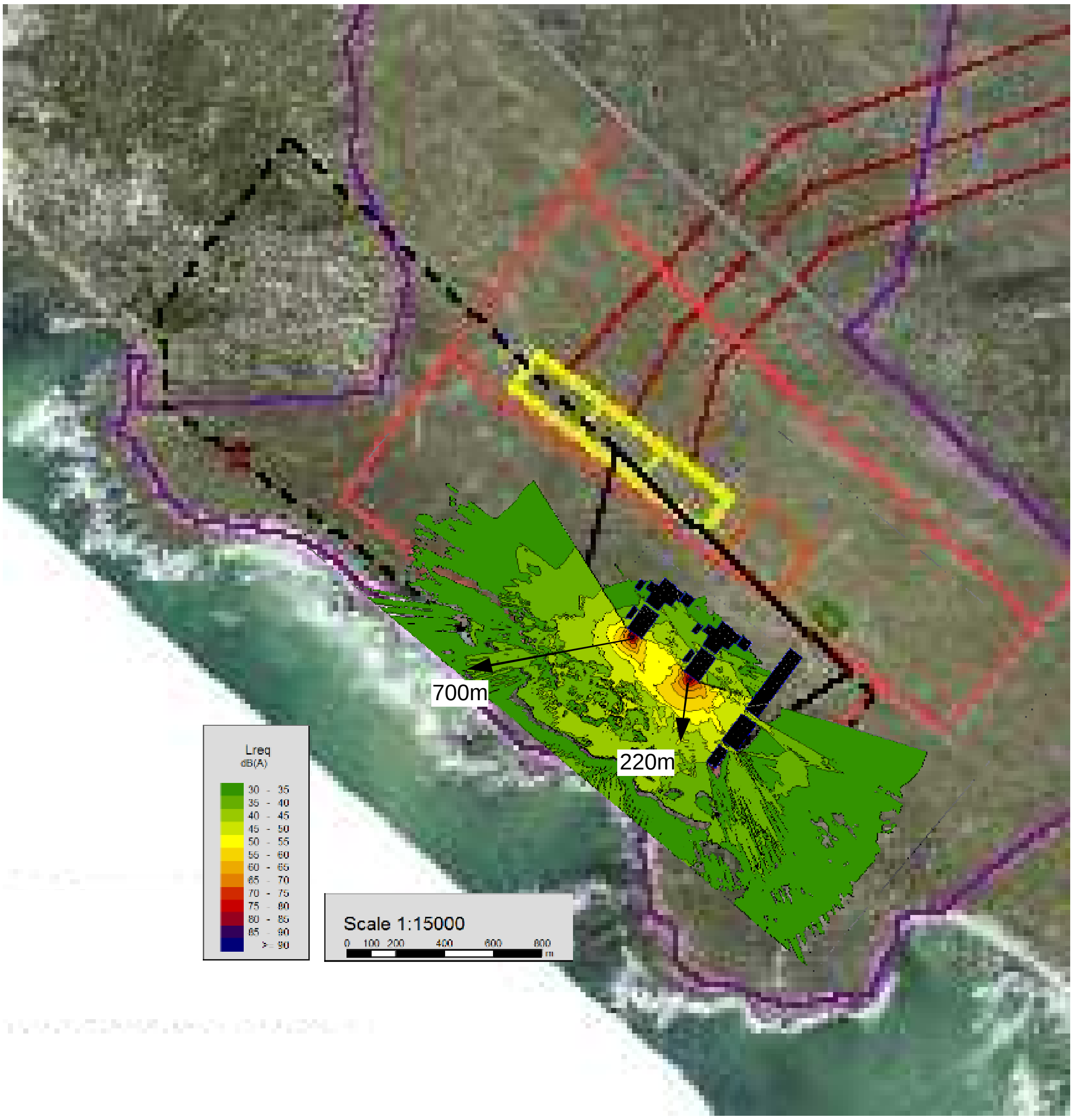

FIGURE 7 Predicted $L_{Aeq,T}$ contours at the Bantamsklip alternative site

3.4.1 Assessment

With reference to Table 2 of SANS 10103 reproduced in Section 1.2.1, the most stringent outdoor rating level is 45 dBA during daytime and 35 dBA during night-time in a rural residential district.

The 45 dBA $L_{Aeq,T}$ contour is located approximately 220 m from each noise source (oil cooler fans). This distance is shorter than at Duynefontein due to greater noise screening provided by the rugged coastline. The 35 dBA $L_{Aeq,T}$ noise contours occur at approximately 700 m from a noise source. At both ranges noise from the source would be inaudible above the surf noise. Refer to Section 3.1.3.

Were the oil cooler fans to be located in the transformer area (item 10 in Figure 4) northwest of each generator building, there would be little screening by buildings of noise emanating from the fans. The flatter inland terrain would provide a similar unobstructed propagation path as the Duynefontein site and noise from the fans would reduce to 45 dBA at approximately the same distance as at Duynefontein, namely 400 m from the fans. It would further reduce to 35 dBA at an approximate distance of 750 m from a noise source. Both distances are well within the shortest distance to the property boundary of 1 125 m.

3.4.2 Cumulative impact and no development option

The results indicate that there would be no impact of noise during daytime or night-time on land beyond the Bantamsklip property boundary during operation of Nuclear-1. Thus, whether or not Nuclear-1 was to be located at the Bantamsklip site, would not have any effect on the impact of noise beyond the Bantamsklip property boundary.

3.4.3 Noise impact summary

The noise impact beyond the Bantamsklip property boundary during operation of Nuclear-1 is summarized in Table 5.

TABLE 5 Summary of noise impact beyond Bantamsklip property boundary

Operation of Nuclear-1	
Criteria	***Rating***
Intensity	***Low***
Extent	***Medium***
Duration	***High***
Impact on irreplaceable resources	***Low***
Consequence	***Low***
Probability	***Low***
Significance	***Low***

3.5 Thyspunt

3.5.1 Noise emanating from Nuclear-1 site

Problems were experienced with the digital terrain data received for the Thyspunt site. Despite numerous attempts a DTM and subsequent $L_{Aeq,T}$ contours of noise emanating from Nuclear-1 could not be generated.

It was observed from a study of elevation contours that the terrain in the vicinity of the proposed Duynefontein site was similar to that at Thyspunt in so far as this would influence the propagation of noise inland, away from the coastline. This is demonstrated in Figures 8 and 9, displaying Google Earth aerial images of the terrain in the vicinity of the Duynefontein site and in the vicinity of the Thyspunt site, respectively. The almost flat topography of the land areas extending at least 750 m around both sites would have negligible influence on the propagation of noise away from the noise sources.

It was considered that the noise contours calculated for the Duynefontein site represented a reasonable estimate of what could be expected for the Thyspunt site. The noise contours determined for Duynefontein were thus superimposed onto the Thyspunt site.

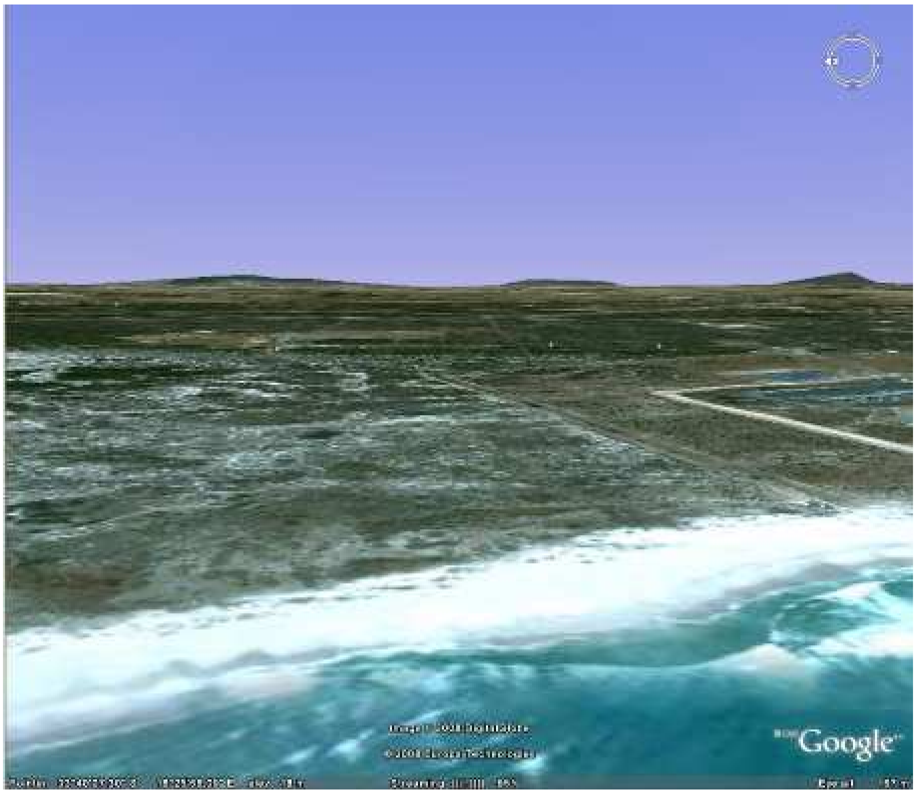

FIGURE 8 Oblique aerial image showing the terrain in the vicinity of the Duynefontein site with part of the Koeberg Nuclear Power Plant infrastructure shown at the right

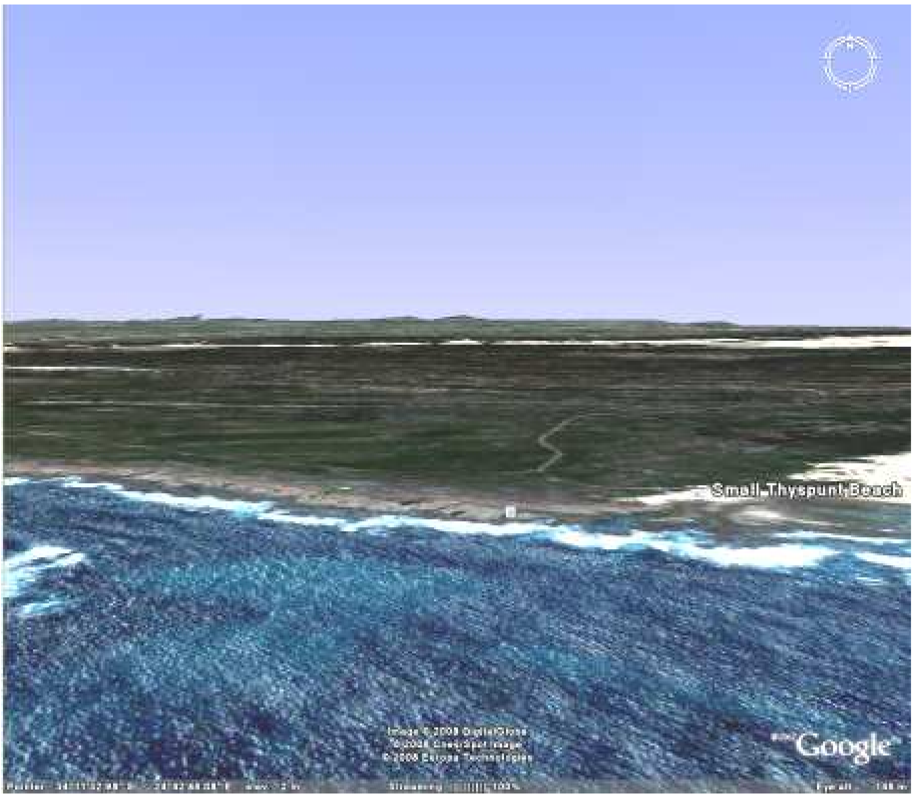

FIGURE 9 Slant aerial image showing the terrain in the vicinity of the Thyspunt site

The results of the predicted $L_{Aeq,T}$ contours at the Thyspunt alternative site are displayed in Figure 10.

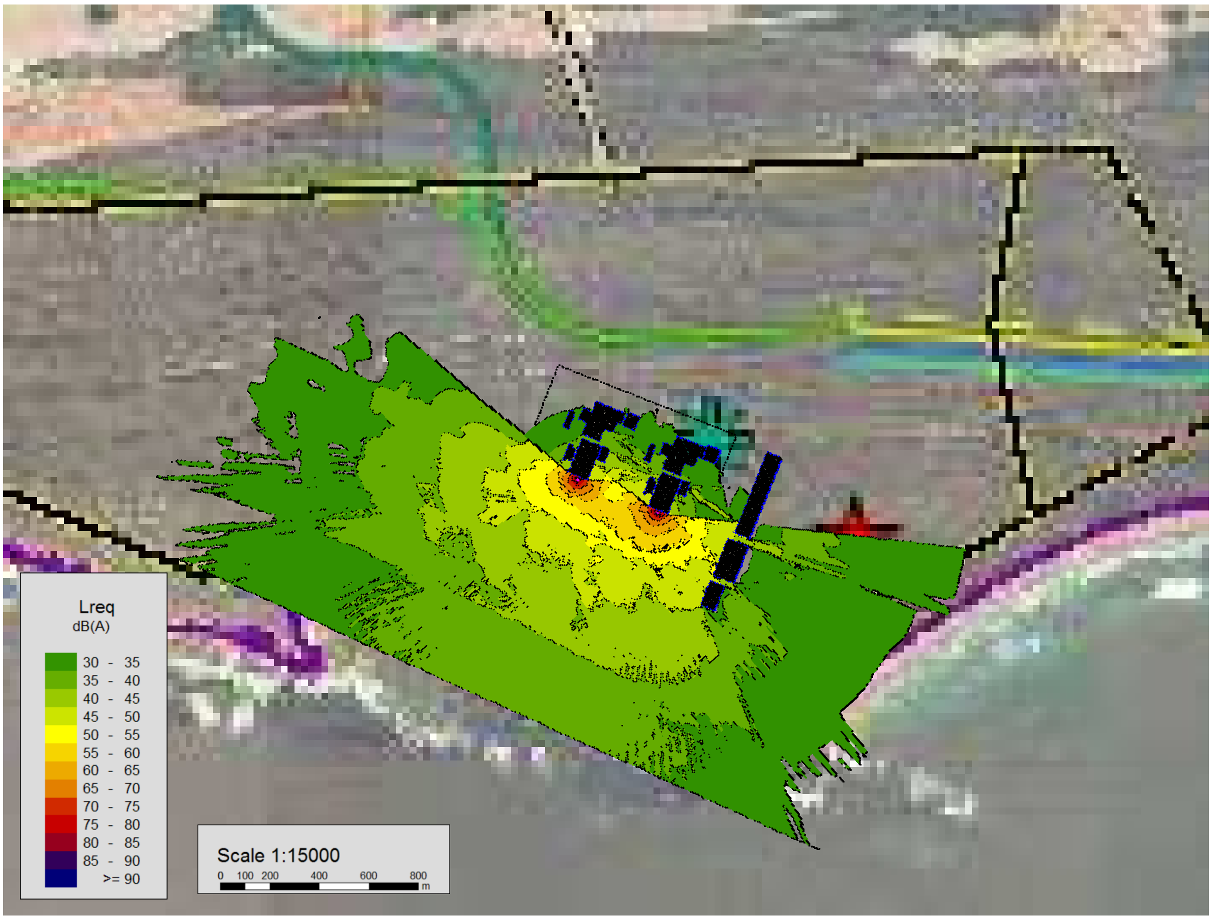

FIGURE 10 Predicted $L_{Aeq,T}$ contours for Nuclear 1 at the Thyspunt site

3.5.2 Assessment of noise from Nuclear-1

With reference to Table 2 of SANS 10103 reproduced in Section 1.2.1, the most stringent outdoor rating level is 45 dBA during daytime and 35 dBA during night-time in a rural residential district.

The 45 dBA $L_{Aeq,T}$ contour would occur approximately 400 m from each noise source (oil cooler fans) with the 35 dBA $L_{Aeq,T}$ noise contours occurring at approximately 750 m from the noise source. The nearest eastern property boundary along Thyspunt Beach would be 700 m from the infrastructure site. With reference to Sections 3.1.2 and 3.1.4, the noise emanating from Nuclear-1 would not be audible above surf noise at this distance. The nearest residential land would be Oyster Bay situated 4.2 km from the site. No noise from Nuclear-1 would be audible at that distance.

3.5.3 Assessment of noise from OCGT peaking power plant

The proposed location of the HV yard in which OCGT peaking power plant is proposed to be located, as well as the location of the nearest residences, is indicated in Figure 3 of Section 2.3.

The combined electrical capacity of the proposed two OCGT plant is 50 MW. No quantitative noise emission data of the plant was available. The maximum number of hours that the plant would operate during any 24-hour period was also not known. A first order estimate of the impact of noise from the proposed 50 MW OCGT plant was made by studying the results of a previous noise impact study (Jongens Keet Associates 2005) into noise emanating from four 150 MW OCGT units to be located at Atlantis; subsequently known as Ankerlig.

Considering a worst-case scenario of all four 150 MW OCGT units operating continuously for 24 hours it was predicted that the $L_{Aeq,T}$ would reduce to 45 dBA and 35 dBA at distances of 2 000 m and 5 000 m, respectively. For shorter operating periods the respective distances would be less. The distances of 2 000 m and 5 000 m would apply in terms of a World Bank assessment that only considers the L_{Aeq} for each hour.

The combined capacity at Thyspunt would be 1/12th that at Atlantis. With reference to the contents of Appendix A it is cautioned that this ratio of electrical power generation can not simply be equated to a similar ratio of sound power emission from different machines/equipment and different manufacturers. However, in the absence of alternative pertinent data, a 1/12 ratio of sound power emitted, assuming an identical sound power spectrum, represents an 11 dB reduction in sound power level emitted. The associated $L_{Aeq,T}$ would reduce to 45 dBA and 35 dBA at distances of approximately 500 m and 1 200 m, respectively.

It is estimated that the $L_{Aeq,T}$ at the nearest farm residence, situated immediately east of the proposed HV yard, would be in excess of 55 dBA for 24-hour operation of the OCGT plant. The associated intensity of noise impact would be high.

The $L_{Aeq,T}$ at the residences of two farms situated approximately 1 000 m west and northeast of the OCGT units would be approximately 35 dBA for 24-hour operation of the OCGT plant. The associated intensity of noise impact would be low at both farm residences.

Noise from the OCGT plant would be inaudible at the nearest residential land of Oyster Bay situated approximately 4 200 m from the OCGT plant. There would thus be no impact of noise from the OCGT plan at Oyster Bay.

It is reiterated that the $L_{Aeq,T}$ values, the distances and the assessments of noise impact relating to operation of the proposed OCGT plant contained in this sub-section are to be considered approximate with a low level of confidence, notwithstanding the assumed worst-case scenario of 24-hour operation of the plant.

3.5.4 Cumulative impact and no development option

The results indicate that there would be no impact of noise during daytime or night-time on land beyond the Thyspunt property boundary during operation of Nuclear-1. Thus, whether or not Nuclear-1 was to be located at the Thyspunt site, would not have any effect on the impact of noise beyond the Thyspunt property boundary.

Operation of the proposed OCGT peaking power plant would probably have a cumulative noise impact of high intensity on occupants of a farm situated immediately to the east of the proposed HV yard. In the absence of the OCGT plant there would be no cumulative impact at this farm.

The cumulative intensity of noise impact on occupants of farm residences situated 1 000 m or more from the proposed OCGT plant would range between negligible and low.

3.5.5 Noise impact summary

TABLE 6 Summary of noise impact beyond Thyspunt property boundary

Operation of Nuclear 1	
Criteria	**Rating**
Cumulative impact	Low
Nature	Negative
Intensity	Low
Extent	Low
Duration	Long-term
Impact on irreplaceable resources	Low
Consequence	Low
Probability	Low
Significance	Low
Confidence level	High

TABLE 7 Summary of noise impact of operation of OCGT peaking power plant

Operation of OCGT peaking power plant			
	Adjacent farm	**Farms at 1000m**	**Residences beyond 1000 m**
Criteria	**Rating**		
Cumulative impact	High	Low	Low
Nature	Negative	Negative	Neutral
Extent	Medium	Medium	Medium
Intensity	High	Low	Low
Duration	High	High	High
Impact on irreplaceable resources	Low	Low	Low
Consequence	Medium	Medium	Medium
Probability	High	Medium	Low

Significance	Medium	Medium	Medium
Confidence level	Low	Low	Medium

3.6 Construction and decommissioning phases

The issues relating to the construction phase and decommissioning phases are similar for all three alternative sites.

3.6.1 Road construction

At all of the alternative sites new roads would need to be constructed or upgraded within the site boundaries. Access to the Bantamsklip and Thyspunt sites would require new road construction to the site and possible upgrading of existing roads.

The level of noise emitted by machinery is related to the mechanical power required by the machine to perform the required function. Thus, greater power is required, for example, by a bulldozer to move earth than a paver to lay a new bituminous road surface. Thus, in principle, higher noise emissions may be expected from a bulldozer during new road construction than machinery used during road rehabilitation. However, noise emission is strongly dependent on the “noise reduction packages” incorporated by the manufacturer of the machinery. With the increasing enforcement of noise control legislation throughout the world, manufacturers have been “encouraged” and are capable of supplying new heavy-duty machinery/vehicles with very low noise emission levels.

The noise emitted by earth moving machinery and heavy duty vehicles can vary considerably during normal operating conditions. The results are rarely repeatable, making it difficult to compare the noise emissions of different vehicles and at different times. For this reason the noise emission is measured under controlled conditions such that the same values are obtained when repeated under the same operating conditions.

The author has measured the noise emission of numerous types of heavy-duty vehicles and of earth moving machinery of different manufacturers under controlled conditions as well as under normal operating conditions. Results obtained under controlled conditions were within 0,5 dB of those provided by the manufacturer, where the information was supplied. However, such results excluded additional sounds as are produced by rocks falling into trucks during loading, squealing of the rubble as it slides out of the truck during dumping, reverse hooter and the effect of the engine operating under differing loads. Sound measurements were therefore also recorded of front end loaders, trucks and bulldozers during normal operating conditions.

Table 7 records the sound power levels, L_W (dB), emitted by typical heavy-duty machinery that might be used during new road construction and the calculated separation distance required for the outdoor $L_{Req,d}$ (dBA), for <u>continuous</u> operation during an 8-hour working day, to decrease to the typical $L_{Req,d}$ for a suburban and a rural residential district of 50 dBA and 45 dBA, respectively. These represent the $L_{Req,d}$ of two of the "noisier" activities recorded, including reverse hooters and noise associated with dumping of rubble, and can thus be considered to be worst-case scenarios. In practice, however, vehicles/machinery on a construction site do not generate noise continuously and simultaneously for extended periods of time.

TABLE 7 L_W emission of heavy-duty machinery and separation distances required for reduction of $L_{Req,d}$ to 50 and 45 dBA, respectively

Machinery & operating conditions	L_W, dB	Distance (m) to reduce to 50 dBA	Distance (m) to reduce to 45 dBA
CAT D11 bulldozer moving earth, reversing and repeating – several cycles	115	448	711
CAT5130B front-end loader loading CAT777D truck after approaching and subsequently leaving loading area – several cycles	112	271	443

This information provides an indication of the range within which continuous road construction noise during normal daytime working hours might be audible but not necessarily intrusive. The significance of any noise impact would depend upon the number and types of machinery/equipment used, distance to noise sensitive receiver locations and the total duration of the construction activities in the vicinity of receiver locations.

The nearest noise sensitive land to the Bantamsklip site is a farm situated more than 2000 m from the R43 and thus the distance to the nearest source of noise during construction of roads on site (See Figure 2). Given the examples in ***Table 8***, no noise impact due to internal road construction is anticipated at Bantamsklip.

For Thyspunt the nearest noise sensitive land to the proposed eastern access road off the R330 would be an informal settlement at Sea Vista, 400 m from the noise source (See Figures 3 and 11). Given the examples in ***Table 7***, no noise impact due to the construction of the eastern access road is anticipated.

The northern route would be more than 1 000 m from farm residences along its route (Refer to Figure 11). No noise impact is anticipated during the construction of this route.

The western route would pass within 230 m of the Umzamowethu township. For continuous operation during 8 hours the $L_{Req,d}$ due to the CAT D11 and the CAT5130B would be 56 dBA and 53 dBA, respectively, at the township boundary. The estimated maximum noise impact on the township for the duration of the construction of the road in the vicinity of the township would be **Medium**. A site visit indicated that Oyster Bay residential suburb would be screened from the western route by sand dunes and therefore no noise impact is anticipated during the construction of the western route at Oyster Bay.

No similar, quantitative record was available of noise emissions during rehabilitation of existing roads. In general, the author has observed that, where rehabilitation occurs while maintaining normal traffic flow over part of a road, there is little increase in total $L_{Req,T}$ due to machinery used for rehabilitation over that due to normal road traffic.

At the Duynefontein site existing and future access roads off the R27 would be more than 1 000 m from the nearest residences in Duynefontein suburb. No noise impact is anticipated during the construction or rehabilitation of this road.

A summary of the impact of road construction noise at the three proposed sites is presented in Table 8.

TABLE 8 Impact of road construction noise

	Duynefontein	Bantamsklip	Thyspunt
Criteria	**Rating**		
Intensity	***Low***	***Low***	***Low***
Extent	***Low***	***Low***	***Low***
Duration	***Low***	***Low***	***Low***
Impact on irreplaceable resources	***Low***	***Low***	***Low***
Probability	***Low***	***Low***	***Medium***
Significance	***Low***	***Low***	***Low***

3.6.2 Site works, construction and demolition of nuclear reactor and infrastructure

Table 9 provides indicative short-term A-weighted sound levels, L_{Aeq}, (dBA), which may be experienced from typical heavy-duty items of equipment at each of the sites. These are based on sound power emission levels contained in British Standard (BS) 5228 – 1 *Noise and vibration control on construction and open sites, Part 1. Code of practice for basic information and procedures for noise and vibration control*. No spectral information is contained in the Standard, thus the distances calculated only took into account spherical spreading of sound and excluded additional attenuation that varies for different frequencies. It is to be noted that these are not long-duration $L_{Req,T}$ values.

TABLE 9 Calculated sound levels (dBA) of construction & demolition equipment at various distances

Equipment	**Distance from equipment**		
	800 m	**1 000 m**	**2 000 m**
Pneumatic concrete breaker	52	50	44
Front end loader/dozer	50	48	42
Excavator	48	46	40
Grader	46	44	38
Tip lorry	47	45	39

Equipment	Distance from equipment		
	800 m	**1 000 m**	**2 000 m**
Concrete mixer	38	36	30
Crane	42	40	34

The L_{Aeq} values in Table 9 indicate that site and construction work would be inaudible beyond the boundary of all the sites and would therefore not result in a noise impact on surrounding land beyond the property boundary.

3.6.3 Blasting

BS 5228 contains no data of airborne noise from blasting. Blasting is controlled by separate legislation. The noise emitted is dependent on initiation of the blast within each blast hole. Initiation of a blast using a detonating fuse on the surface may cause problems associated with air overpressure. This can be significantly reduced by down-the-hole initiation. The author was standing less than 200 m from a quarry wall when "ribbon" blasting of a length of the wall took place. Only because the author happened to look in that direction was he aware that blasting had just taken place. This was followed by a brief and slight pressure on the ears that would otherwise have gone unnoticed.

The anticipated noise impacts during site works are summarized in Table 10.

TABLE 10 Impact of site works, construction and demolition

	Duynefontein	Bantamsklip	Thyspunt
Criteria	**Rating**		
Intensity	***Low***	***Low***	***Low***
Extent	***Low***	***Low***	***Low***
Duration	***Low***	***Low***	***Low***
Impact on irreplaceable resources	***Low***	***Low***	***Low***
Probability	***Low***	***Low***	***Low***
Significance	***Low***	***Low***	***Low***

3.6.4 Transportation of materials & equipment to site

The $L_{Req,d}$ due to noise emanating from existing traffic and that of construction and transportation vehicles to and from each of the sites was estimated using procedures contained in SANS 10210 *Calculating and predicting road traffic noise.* The estimated $L_{Req,d}$ along the respective routes to be used for construction traffic were used to predict the cumulative impact in terms of the typical $L_{Req,d}$ for the land along the routes as well as the relative impact due to construction traffic.

Thyspunt

An estimate of the traffic to the Thyspunt site during a nine year construction period was made available by Eskom in a one page summary entitled *Estimated Eskom and Vendor Staff Traffic Impact*. For each year it included the peak staff traffic per hour and the mean construction traffic per hour of an 8-hour working day. It was construed that this traffic to the Thyspunt site would be via the R330 and the eastern site access. This is illustrated in Figure 11.

The R330 south of Humansdorp passes through mainly undeveloped land, excepting for some residences near the south bank of the Kromme River, of which the nearest is located some 20 m from the R330 and a large informal settlement west of Sea Vista that extends to 10 m from the road edge. Other than a residence at 40 m, all other residences are located 70 m or more from the road edge.

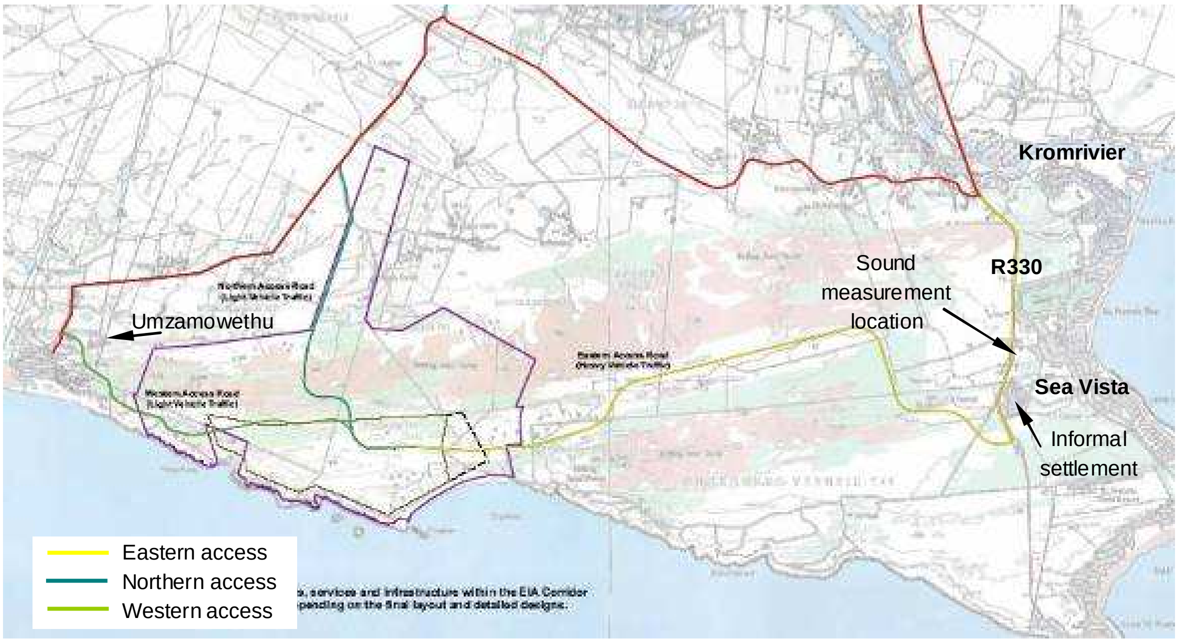

FIGURE 11 Proposed access roads to Thyspunt

The traffic data provided was used to estimate the cumulative impact of the road traffic noise produced by the estimated Eskom and vendor staff traffic plus non-Eskom road traffic for each year during the construction period at two distances from the road edge.

These were:

- ***10 m, being the distance to the nearest dwellings of the informal settlement near Sea Vista;***
- ***70 m, being the distance beyond which most of the residences were located along the R330.***

The existing traffic flow and associated 1-hour $L_{Aeq,T}$ along the R330 were obtained from sound measurements and simultaneous traffic counts recorded on Friday 3 July 2009 on open ground 10 m from the road edge of the R330 in the vicinity of Sea Vista (Refer to Figures 11 ***and 12***). From these measurements the daytime rating level, $L_{Req,d}$, of existing road traffic noise was estimated.

For each year of construction the calculated 16-hour daytime rating level of noise, $L_{Req,d}$, due to non-Eskom traffic was compared to that due to Eskom traffic plus non-Eskom traffic. Due consideration was given to Eskom traffic occurring for 8 hours of the 16-hour daytime period. The difference in rating levels for each year thus represented the estimated increase in $L_{Req,d}$ due to the construction process.

FIGURE 12 Sound measurement location along the R330 near Sea Vista

The results of the calculations and associated relative increase in noise impact at 10 m are recorded in Table 11 (rounded to the nearest decibel). Refer to the impact qualifiers under 1.2.2.

TABLE 11 Existing & predicted future $L_{Req,d}$ at 10 m from the R330 road edge during the construction phase and associated noise impact

Condition	Existing	Year of construction								
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$ Non-Eskom traffic	63	63	63	63	63	63	64	64	64	64
$L_{Req,d}$ Combined		69	71	70	66	67	67	67	66	65
Excess over 55dBA for Urban district	8	14	16	15	11	12	12	12	11	10
Increase due to Eskom traffic		6	8	7	3	4	4	3	2	1
Impact re Urban district, SANS10103	Med	High								
Relative impact due to Eskom traffic		Medium			Low					

The results of the calculations indicated that the existing, non-Eskom traffic causes and will continue to cause a **Medium** noise impact with reference to an "urban district" during the following nine years. However, the existing and future $L_{Req,d}$ would comply with the 65 dBA limit contained in the NCR.

With the addition of Eskom traffic the cumulative noise impact due to the combined traffic would be **High** for the first 8 years of the construction period. The combined road traffic during this period would cause the noise level to exceed the 65 dBA limit contained in the NCR, necessitating noise mitigation procedures to be implemented. However, the situation has arisen due to the uncontrolled use of land typical of informal settlements. It may well be debated whether the onus for compliance with the NCR would rest with Eskom.

The relative impact of noise due to Eskom traffic would be **Medium** during the first three years of construction but would reduce to a **Low** impact during the subsequent years.

Table 12 contains the results of similar calculations for residences located 70 m from the R330.

TABLE 12 Existing & predicted future $L_{Req,d}$ at 70 m from the R330 road edge during the construction phase and associated noise impacts

Condition	Existing	Year of construction								
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$ Non Eskom traffic	54	54	55	55	55	55	55	55	55	56
$L_{Req,d}$ Combined		61	63	62	58	59	59	58	58	57
Excess over 55dBA for Urban district	0	6	8	7	3	4	4	3	3	2
Increase due to Eskom traffic		6	8	7	3	4	4	3	2	1
Impact re Urban district, SANS10103	none	Medium			Low					
Relative impact due to Eskom traffic		Medium			Low					

The non-Eskom traffic would result in an $L_{Req,d}$ within 1 dB of 55 dBA typical for an "urban district", resulting in no impact. With the steady increase in non-Eskom traffic, the $L_{Req,d}$ would be expected to exceed 55 dBA after eight years. The existing and future $L_{Req,d}$ would comply with the 65 dBA limit contained in the NCR.

With the addition of Eskom traffic the cumulative noise impact would be **Medium** during the first three years of the construction period, reducing to **Low** for the remainder of the construction period.

The relative noise impact due to Eskom traffic would be the same. However, the predicted $L_{Req,d}$ during all years of construction would comply with the NCR 65 dBA limit. No noise mitigation would be required in terms of the NCR.

The impact summary in ***Table 13*** records the highest cumulative impact on any residences located 10 m and 70 m from the R330, respectively.

TABLE 13 Impact of transportation noise to Thyspunt at 10 m and 70 m from the R330

Distance of residences from road	10m	70m
Criteria	**Rating**	
Intensity	***Medium***	***Low***
Extent	***Low***	***Low***
Duration	***Low***	***Low***
Impact on irreplaceable resources	***Low***	***Low***
Probability	***Medium***	***Low***
Significance	***Low***	***Low***

Duynefontein

The estimated traffic to the Nuclear-1 site at Thyspunt during a nine year construction period was assumed to apply to all three alternative sites. It was further assumed that most of this traffic to the Duynefontein site would be on the R27 from the south. The nearest noise sensitive land would be the residences of Duynefontein suburb, with the nearest property boundary being 118 m from the nearest road edge of the R27.

Existing hourly traffic flow on the R27 was obtained from Arcus Gibb (Arcus Gibb, 2009). As in the previous section the $L_{Req,d}$ for non-Eskom traffic, with a traffic flow increase of 3% per annum, and for this traffic combined with the Eskom construction traffic was calculated. The $L_{Req,d}$ for the existing and combined traffic was then assessed in terms of the typical outdoor $L_{Req,d}$ of 55 dBA for an "urban district" that is also the maximum recommended level by the WHO. This is followed by the noise impact *of* the combined traffic relative to the non-Eskom traffic. The results are contained in ***Table 14*.**

TABLE 14 Existing & predicted future $L_{Req,d}$ at 118 m from the R27 road edge during the construction phase and associated noise impacts

Condition	Existing	Year of construction								
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$ Non Eskom traffic	**56**	**56**	**57**	**57**	**57**	**57**	**57**	**57**	**57**	**57**
$L_{Req,d}$ Combined		**58**	**59**	**59**	**57**	**58**	**58**	**58**	**58**	**58**
Excess over 55dBA for Urban district	1	3	4	4	2	3	3	3	3	3
Increase due to Eskom traffic		2	3	2	1	1	1	1	1	0
Impact re Urban district, SANS10103	Low									
Relative impact due to Eskom traffic		Low								Negl.

The calculated $L_{Req,d}$ due to existing, non-Eskom traffic is 1dB in excess of 55 dBA and is expected to rise by a further 1 dB over the subsequent 9 years (Refer to row 1 of Table 14). In terms of the typical $L_{Req,d}$ for an "urban district" the noise impact due to non-Eskom traffic would be **Low**.

With the addition of Eskom traffic the noise impact would remain **Low**. Even an increase in $L_{Req,d}$ of 3 dB during the second year of construction would be barely significant. The relative impact due to Eskom construction traffic throughout the first 8 years of the construction period would be **Low**, reducing to **Negligible** thereafter.

The predicted $L_{Req,d}$ during all years of construction would comply with the NCR 65 dBA limit. No noise mitigation would be required in terms of the NCR.

Table 15 contains a summary of the impact of noise due to transportation to the Duynefontein site.

TABLE 15 Iimpact of transportation noise to the Duynefontein site

Criteria	**Rating**
Intensity	***Low***
Extent	***Low***
Duration	***Low***
Impact on irreplaceable resources	***Low***
Probability	***Low***
Significance	***Low***

Bantamsklip

Existing hourly traffic flow on the R43 past Pearly Beach and the Bantamsklip site is low, with an average daytime flow of the order of 23 vehicles per hour. The distance between the R43 and the nearest Pearly Beach residence is more than 1 100 m. The nearest distance to farm residences situated northeast of Pearly Beach is 580 m. In terms of SANS 10103 a "Rural" district would apply to these residences with a typical outdoor $L_{Req,d}$ of 45 dBA.

As in the previous sections the $L_{Req,d}$ for non-Eskom traffic, with a traffic flow increase of 3% per annum, and for this traffic combined with the Eskom construction traffic was calculated. The $L_{Req,d}$ for the existing and combined traffic was then assessed in terms of the typical outdoor $L_{Req,d}$ of 45 dBA for a "rural district". This is followed by the noise impact of the combined traffic relative to the non-Eskom traffic. The results are contained in Table 16.

TABLE 16 Existing & predicted future $L_{Req,d}$ at 580 m from the R43 road edge during the construction phase and associated noise impacts

<table>
<tr><th rowspan="2">Condition</th><th rowspan="2">Existing</th><th colspan="9">Year of construction</th></tr>
<tr><th>1st</th><th>2nd</th><th>3rd</th><th>4th</th><th>5th</th><th>6th</th><th>7th</th><th>8th</th><th>9th</th></tr>
<tr><td>$L_{Req,d}$ Non Eskom traffic</td><td>35</td><td>35</td><td>35</td><td>35</td><td>36</td><td>36</td><td>36</td><td>36</td><td>36</td><td>36</td></tr>
<tr><td>$L_{Req,d}$ Combined</td><td></td><td>52</td><td>54</td><td>53</td><td>47</td><td>49</td><td>49</td><td>48</td><td>47</td><td>44</td></tr>
<tr><td>Excess over 45dBA for Rural district</td><td>0</td><td>7</td><td>9</td><td>8</td><td>2</td><td>4</td><td>4</td><td>3</td><td>2</td><td>0</td></tr>
<tr><td>Increase due to Eskom traffic</td><td></td><td>16</td><td>19</td><td>17</td><td>11</td><td>13</td><td>13</td><td>12</td><td>10</td><td>7</td></tr>
<tr><td>Impact re Rural district, SANS10103</td><td>none</td><td colspan="3">Medium</td><td colspan="5">Low</td><td>Negl</td></tr>
<tr><td>Relative impact due to Eskom traffic</td><td></td><td colspan="7">High</td><td colspan="2">Medium</td></tr>
</table>

The calculated $L_{Req,d}$ due to existing, non-Eskom traffic is well below the typical outdoor $L_{Req,d}$ of 45 dBA for a “rural district” and is expected to remain so over the subsequent 9 years. Refer to row 1 of Table 16. The noise impact due to non-Eskom traffic would remain **Negligible**.

With the addition of Eskom traffic the noise impact would be **Medium** during the first 3 years of construction. It would reduce to **Low** in the 4th through 8th years, where after it would become **Negligible.** Because of the low volume of non-Eskom traffic flow, the relative impact due to Eskom construction traffic throughout the first 7 years of the construction period would be **High** reducing to **Medium** in 8th and 9th year.

It is anticipated that the **High** relative noise impact would elicit a strong response from the farm residents. However, the predicted $L_{Req,d}$ during all years of construction would comply with the NCR 65 dBA limit. ***Therefore noise mitigation would not be a legal requirement (refer to 1.2.5, last paragraph).***

The impact summary in Table 18 records the highest cumulative impact.

TABLE 18 Impact of transportation noise at Bantamsklip

Criteria	**Rating**
Intensity	***Medium***
Extent	***Low***
Duration	***Low***
Impact on irreplaceable resources	***Low***
Probability	***Medium***
Significance	***Medium***

3.6.5 Ultra-Heavy Duty Traffic

Ultra-heavy-duty vehicle(s) transporting turbine, electrical generator and other heavy items to any of the three alternative sites are likely to cause a high noise impact, albeit for short durations. Although no details of the vehicle(s) to be used were available, it is likely to emit high levels of low frequency diesel engine noise that could cause disturbance to residential communities over more than a kilometre from the route. Due to the very low travel speed on the road, prolonged exposure to noise from the vehicle is anticipated as it travels on roads past affected communities, usually during night-time. An associate of JKA, who resided in van Riebeeckstrand, recorded that the residents of Melkbosstrand, van Riebeeeckstrand and Duynefontein experienced sleep disturbance for several hours during the recent night-time delivery of heavy machinery to the Koeberg Nuclear Power Station.

4 MITIGATION MEASURES

The results of the study indicate that there would be no noise impact on land surrounding any of the three sites during construction and operation of Nuclear-1. No noise mitigation procedures would therefore be required.

Where road construction is to take place within approximately 500 m of residences, the intensity of noise impact can be reduced by selecting construction vehicles/machinery with low noise emission levels. The significance of the impact can be reduced by minimising the total construction time.

Little can be done to reduce the levels of noise emitted by ultra-heavy-duty vehicles. The human subjective response to such noise is likely to be minimized by prior knowledge that exposure to such noise will be infrequent, on which day/night it will occur and the duration of the exposure.

5 CONCLUSIONS AND RECOMMENDATIONS

The results of the study indicate that there would be no noise impact on land surrounding any of the three properties during construction and operation of Nuclear-1. No noise mitigation procedures would therefore be required.

It is probable that the OCGT peaking power plant proposed for the Thyspunt site would result in a noise impact on residences situated within 1 000 m of the plant. It is recommended that this be confirmed by a noise prediction study once quantitative noise emission data of the actual plant to be installed is available. Any required noise mitigation procedures would flow from the results of that study.

No noise impact associated with the construction of new roads to the alternative sites is anticipated, excepting the western access road to the Thyspunt site that would pass within 230 m of the Umzamowethu township. In the latter instance the following recommendations are made:

- Construction processes and machinery/vehicles with the lowest noise emission levels available must be utilised.
- A well planned and coordinated “fast track” procedure is implemented to complete the total construction process in the shortest possible time.
- Construction work near residences only takes place during normal daytime working hours.

The impact of noise associated with transportation of materials & equipment to site would have a low impact on the nearest residences located along the R27 leading to the Duynefontein site. The noise impact on the nearest residences along the R43 to the Bantamsklip site would be medium. The noise impact on the nearest informal settlements at Sea Vista along the R330 near St. Francis would be medium. However, in all instances no noise mitigation procedures would be legally required in terms of the NCR.

The transportation of heavy machinery on ultra-heavy-duty vehicles traveling very slowly on roads within 1 000 m of residences is likely to result in a noise impact high significance and medium intensity but of very short duration. It is recommended that prior warning of each ultra-heavy transportation be communicated to residences, hospitals and other noise sensitive areas located within at least 1 000 m from the route to be followed.

A.W.D. Jongens October 2010

6 REFERENCES

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APPENDIX A - Human response to noise and that emitted by machines

A human's subjective response to sound/noise is logarithmically - not linearly - related to the change in sound power (in watts) radiated by a sound source and the subsequent change in sound intensity (in watts/m^2) received by the ear. Humans judge the relative "loudness" of two sounds by the logarithm of the ratio of the two acoustic intensities. The basic unit used in the measurement and assessment of sound is the decibel (dB). Mathematically it is 10 times the logarithm of the ratio of two sound powers radiated by two sound sources or the ratio of two intensities of sound at a receiver/listener location.

If two identical sound sources each radiate the same power, the sound power and intensity level will be 3 dB higher when both sources are radiating sound compared to only one of the sources. A doubling (or halving) of sound power will cause a 3 dB difference in sound power level radiated and sound intensity level at a receiver location. Yet most humans will not perceive any difference in "loudness" for differences in intensity level up to 3 dB. Thus, sound level differences of up to 3 dB are considered insignificant in the assessment of noise and changes in categories of human response to environmental noise are considered in minimum increments of 5 dB. Refer SANS 10103, Tables 2 and 5.

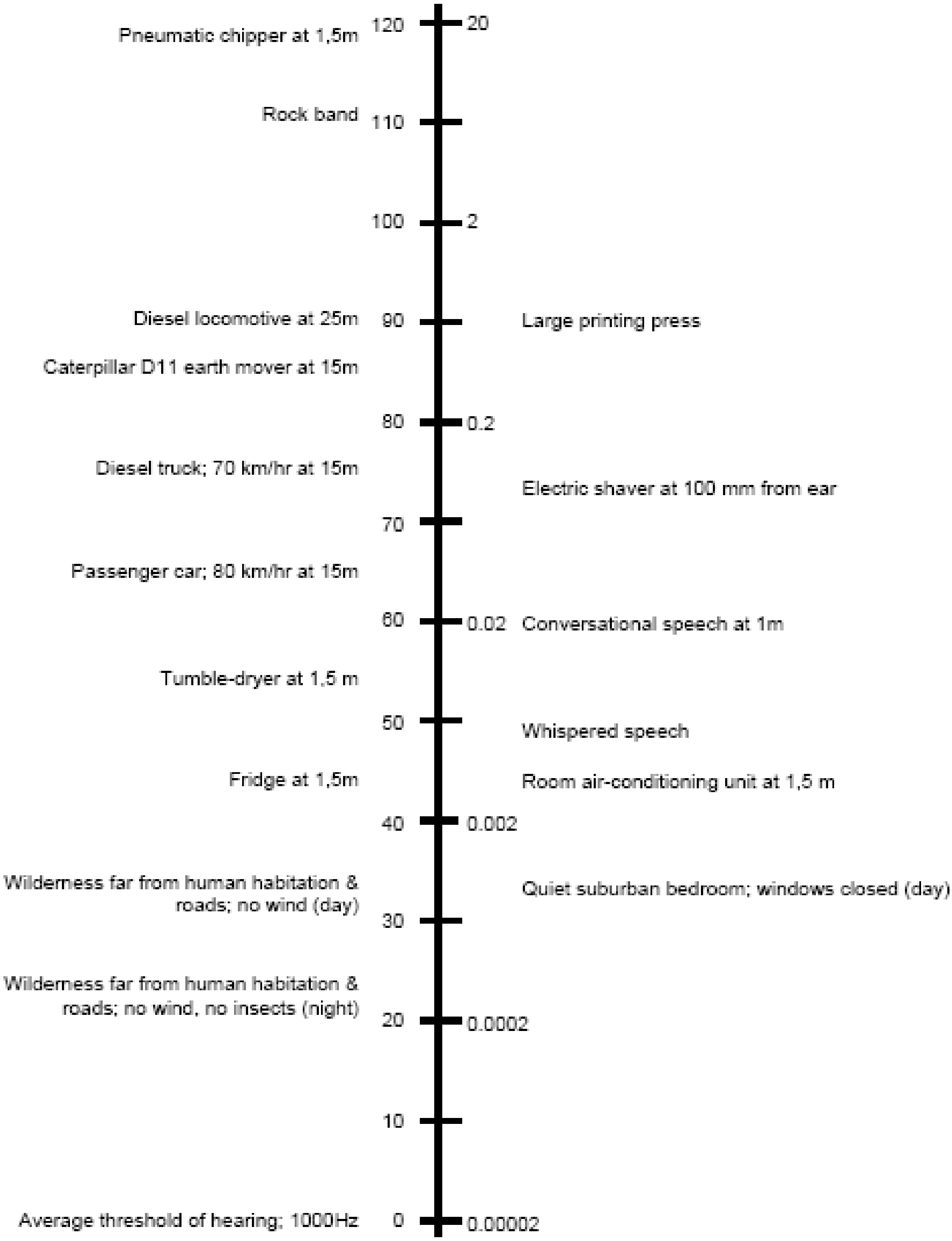
A three-fold change in sound power radiated will result in a sound level difference of just less than 5 dB. Only when the level difference approaches 6 dB (due to a fourfold change in sound power or intensity) will most humans perceive a noticeable change in "loudness". In the assessment of noise a sound/noise level difference of 6 dB or more is considered to be significant. It requires a 10 dB increase in intensity level (due to a tenfold increase in sound power/intensity) for most humans to judge the sound as being "twice as loud".

The above holds provided that the sound sources are identical; for example two or more identical machines operating under identical conditions. However, this relationship does not extend to estimating the difference in noise levels of two seemingly similar machines but with different mechanical and/or electrical output power ratings. Due to numerous factors, including greater efficiency, doubling the "size" of a machine with double the mechanical/electrical power rating will frequently result in less than a doubling of sound power (in watts) emitted. In many instances larger capacity as well as more modern machines emit less noise than smaller and older machines.

Applying the foregoing to the present study, the proposed maximum 4 000 MW combined electrical capacity of Nuclear-1 would be 2,2 times greater than the 1 800 MW of the existing Koeberg Nuclear Power Plant. Even if there were to be a corresponding increase in sound power emitted by the plant, the increase in intensity level of 3,5 dB at a particular distance would be insignificant. Thus, in the absence of quantitative noise emission data of the Nuclear-1 machinery, the noise emission levels of Nuclear-1 could be assumed to be similar to that of the existing Koeberg Nuclear Power Plant and that results of sound measurement of the latter would present the best available data for predicting the potential impact of noise from Nuclear-1.

APPENDIX B - A-weighted sound pressure levels of typical noise sources

A-weighted sound pressure level, dBA Re 0.00002 Pascal | **Sound pressure in Pascal**



APPENDIX C – Results of sound measurements

Results of A-weighted sound spectrum measurements recorded at Koeberg Nuclear Power Station. The $L_{Aeq,T}$ value is recorded in the legend.

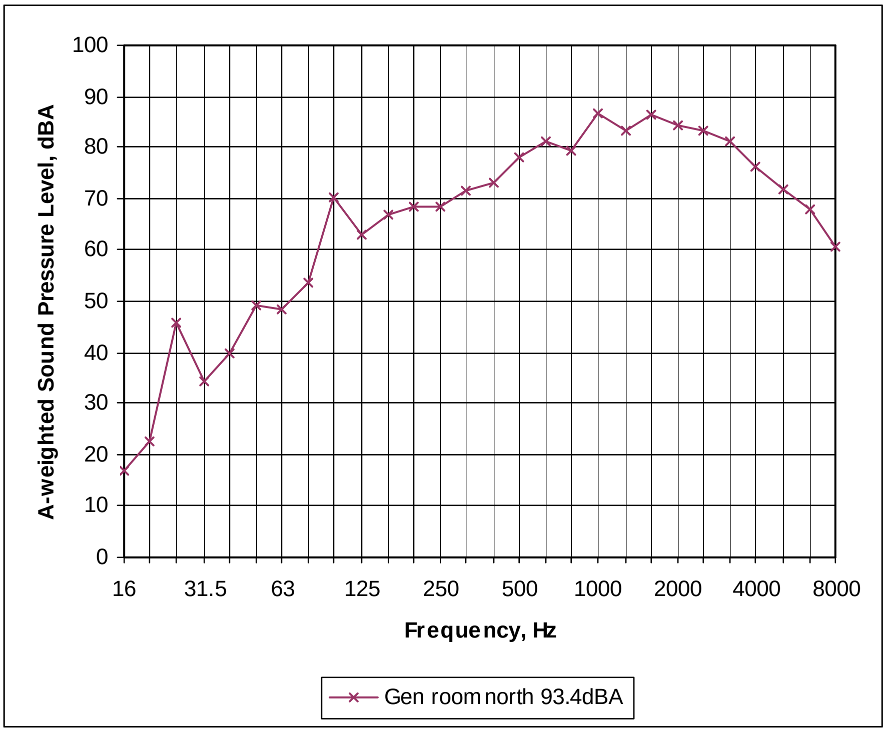


FIGURE C1 **Spatial average A-weighted sound spectrum around northern turbine/generator within generator building**

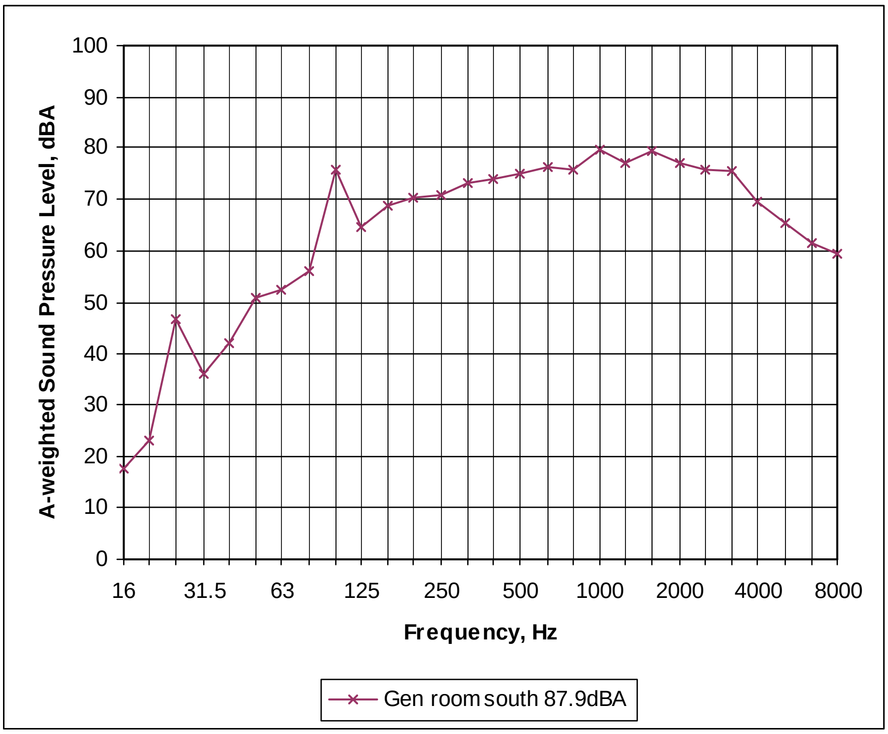


FIGURE C2 **Spatial average A-weighted sound spectrum around southern turbine/generator within generator building**

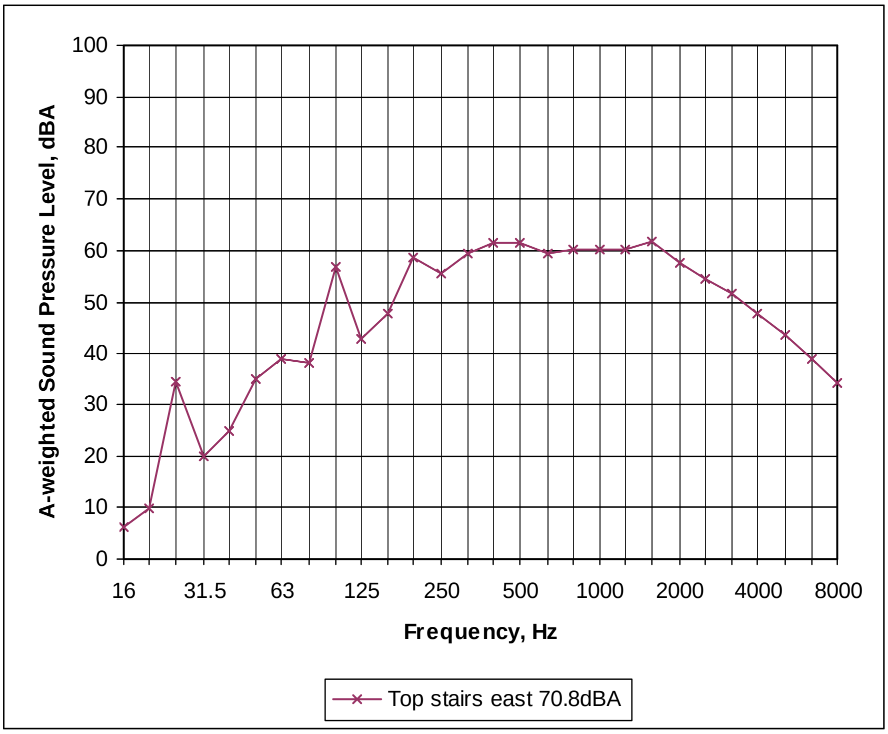


FIGURE C3 A-weighted sound spectrum at top of stairs east of generator building

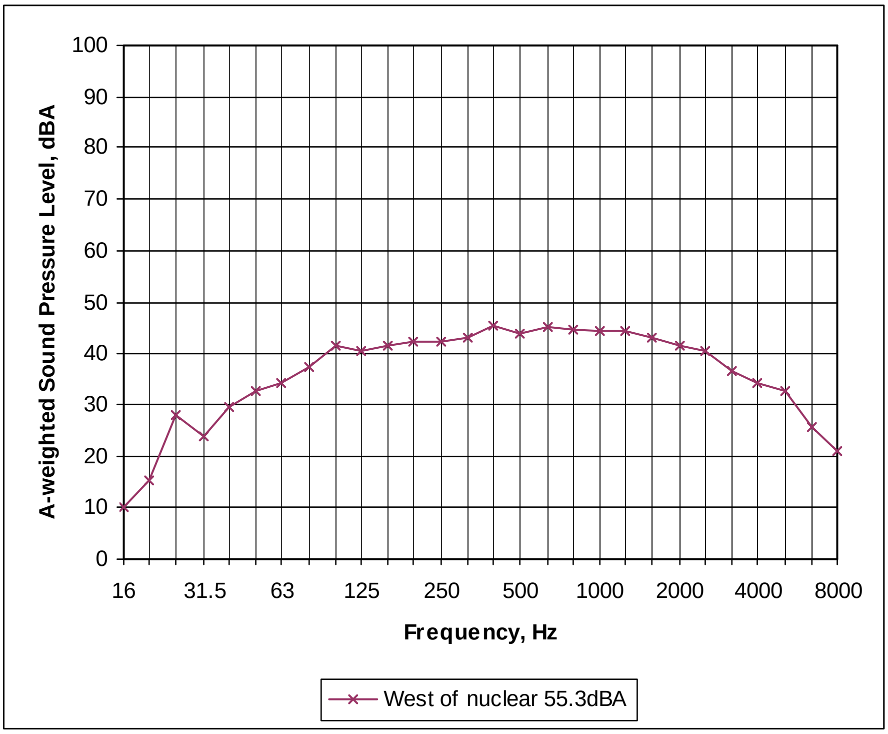


FIGURE C4 A-weighted sound spectrum west of and midway between nuclear reactors

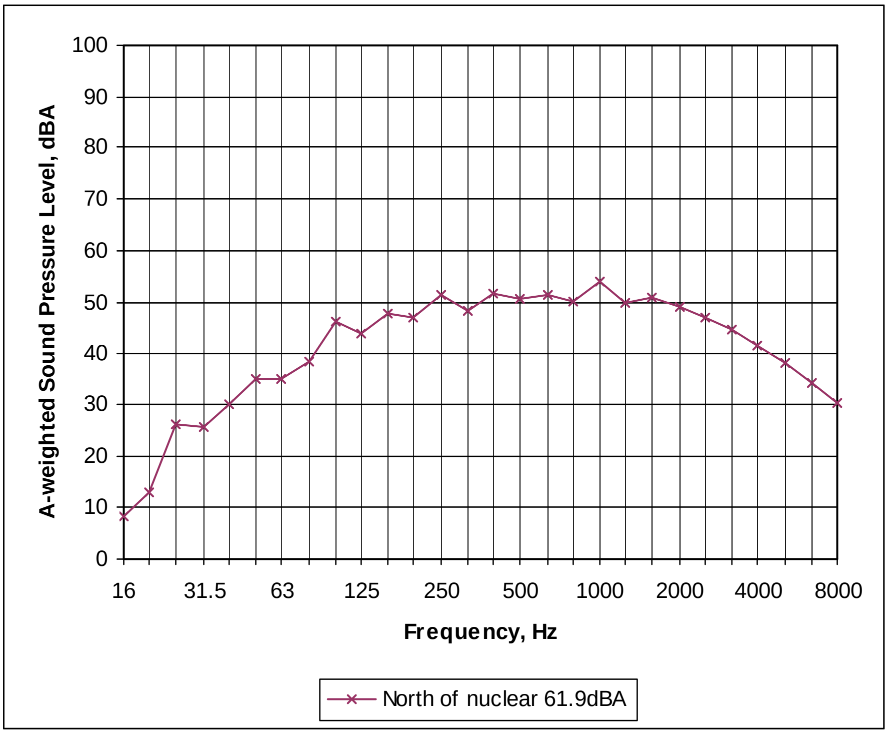


FIGURE C5 A-weighted sound spectrum north of nuclear reactors

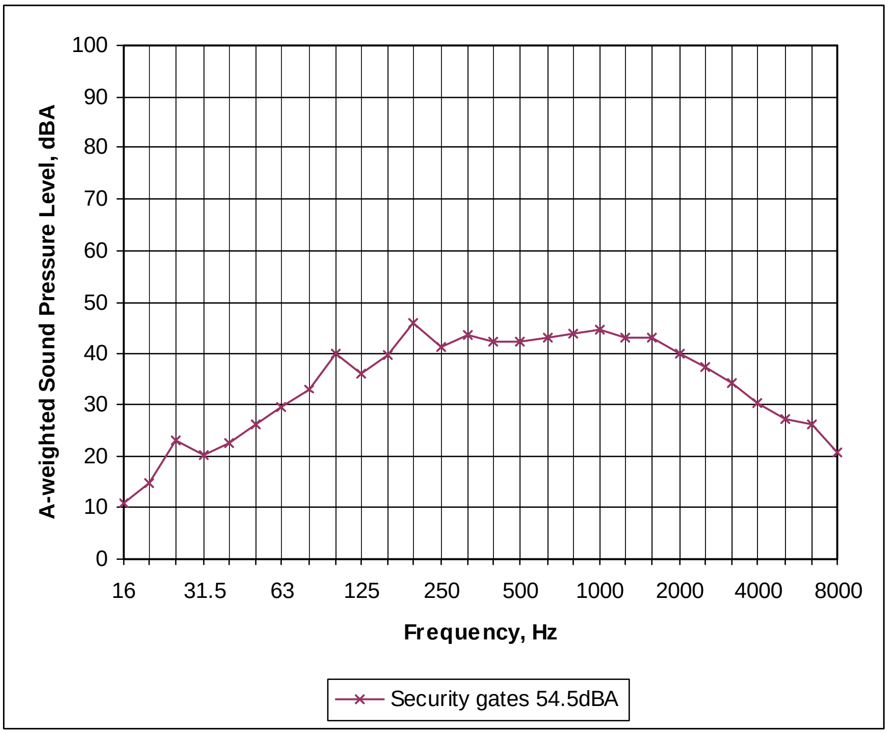


FIGURE C6 A-weighted sound spectrum at gates of Access Control Point 2

APPENDIX D - Response to comment from interested and affected parties

Comment	Response
With regard to sub-sonic vibrations, which terms of reference was I suppose to refer to as no one at the open day event could even answer my question nor had any study been done in this field? I was assured that the technical people would be approached in this regard. I would have expected to find that point if none other to have received some comment instead all my comments are brushed aside with a paragraph "She was requested to review the Draft Terms of Reference to each of the specialist studies that she was concerned about and if she still felt that his concerns would not be addressed that she speak to Ms Ball from Arcus GIBB following the meeting or provide a written response submitted to ACER (Africa)." a fact I am not even aware of.	Considerations of sub-sonic vibration are outside the brief of the noise specialist. This is confirmed by the reviewer of the noise specialist report who states "...it is the opinion of the reviewer the last item under 'Additional tasks' should not form part of the noise study, since the study of subsonic vibrations is a specialist discipline in its own right and requires the input from a specialist in that field. Notwithstanding the above, attention is invited to the sound level spectra contained in Appendix C that included all noise sources measured within the generator room and surrounding areas at Koeberg. The spectra extend to a lower frequency of 16 Hz that is below the lowest audio frequency of 20 Hz and hence can be determined sub-sonic. The measurements did not indicate sub-sonic noise emanating from any of the noise sources.