Kribi Power Project

Stack Height Assessment

November 2009

Prepared for

AES Sonel

Revision Schedule

Kribi Power Project – Stack Height Assessment
November 2009

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1 Introduction

1.1 Background

The Environmental and Social Impact Assessment Report for the Kribi Power Project was produced in October 2006 and approved by the Ministry of Environment and Protection of Nature (MEPN) in April 2007. Since the publication of the ESIA, a number of Addenda have been produced to assess revisions to the plant design:

- The use of reciprocating engines in the place of gas turbines;
- An increase in the size of the plant to 150 MW, then to 216 MW (13 x Wartsila 18V50DF, each of 16.6 MW); and
- The movement of the plant site 200 m to the east of the location assessed within the ESIA.

The 2008 Addendum concluded that, during normal operation on natural gas fuel, the plant would not result in impacts on air quality with the potential to result in exceedance of the World Bank Air Quality Guideline Values. The 2008 Addendum concluded that the WHO guideline for hourly NO_2 would only be achievable at the selected receptors with stack heights in excess of 30 m.

1.2 Scope of Work

This assessment has been produced to provide further information on the air quality impact of the plant with stack heights of 30 m and above, in the context of IFC Environmental, Health and Safety Guidelines for Thermal Power Plants, which have been revised since the issue of the 2008 Addendum.

The assessment has considered stack heights between 30 m and 60 m, in 5 metre increments. Additionally, a stack height of 32 m has also been evaluated.

This assessment specifically focuses on the achievement of the 1 hour WHO Nitrogen Dioxide (NO_2) guideline with the power plant running normally on natural gas fuel.

During times when the plant is running on diesel fuel, emissions will be higher. However, this operation is for very short-term periods up to a maximum of 8 days per year at 30% load. For this reason, the stack height has been evaluated based on the plant running normally on natural gas fuel only.

1.3 Assessment Criteria

Predicted ground-level concentrations are compared with the WHO Air Quality Guidelines set out within the IFC General EHS Guidelines. The WHO guidelines for the pollutants considered within this Assessment are set out in Table 1.

The IFC guidelines also specify that as a general rule, emissions from a single project should not contribute more than 25% of the applicable air quality standards to allow additional future sustainable development within the same airshed.

Table 1 WHO Ambient Air Quality Guidelines

Pollutant	**Averaging Period**	**Guideline Value ($\mu g/m^3$)**
Sulphur Dioxide (SO_2)	24-hour 10-minute	20 (guideline) 500 (guideline)
Nitrogen Dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)
Particulate Matter (PM_{10})	1-year 24-hour	20 (guideline) 50 (guideline)

2 Methodology

2.1 Model Scenarios

This assessment has evaluated the effect of stack height on ground level concentrations of the pollutants emitted at a range of stack heights, between 30 m and 60 m, with the plant running on natural gas fuel. The engine emission data has not been revised since the 2008 Addendum.

The air quality impacts on the surrounding area, as calculated by the dispersion model, are combined with ambient air quality statistics and compared with the assessment criteria to establish the significance of effects.

The methodology and approach to the assessment is consistent with that described within the 2008 Addendum, with the exception of the aspects listed below.

2.1.1 Dispersion Model Selection

The 2008 Addendum used the US EPA preferred model AERMOD. This dispersion modelling exercise was conducted using the advanced dispersion modelling software ADMS 4, produced by CERC. ADMS 4 is a commonly applied regulatory model within the UK, and has been approved by the Environment Agency. ADMS is listed by the US EPA as an alternative model.

The reason for selecting the AMDS model is that there is a high incidence of 'calm' conditions (~50%) within the meteorological data. The latest version of ADMS has proven benefits for modelling meteorological conditions where there is a high incidence of calm conditions, and is now routinely used by Scott Wilson as the model of choice in such situations.

2.1.2 Meteorological Data

The 2008 Addendum used three years (2003 to 2005) of data from Libreville, Gabon which is approximately 230 km to the south of the power plant site. Ideally, hourly sequential meteorological data is used for dispersion modelling purposes. The Libreville data is 3-hourly. Data for Douala, which is closer at around 165 km to the north, was only available in a format suitable for dispersion modelling on a 6-hourly basis at the time the ESIA was published.

A source of hourly sequential meteorological data for Douala has since become available. For this reason, five years of data (2004 to 2008 inclusive) has been used in this study for the reason that it is more representative of local meteorological conditions in the vicinity of the power plant site.

2.1.3 Receptors

This assessment has evaluated impacts at the same ten selected sensitive receptors as the ESIA, within the adjacent village of Mpolongwe to the north and north west of the power plant site. The 2008 Addendum additionally used a site-centred polar grid to predict pollutant concentrations elsewhere within the study area. A polar grid cannot be specified within ADMS, instead a 5 km by 5km wide Cartesian grid, centred on the site was used to evaluate the position and magnitude of maximum predicted ground-level concentrations.

2.1.4 NO_x to NO_2 Conversion

For the reasons given in the 2008 Addendum, NO_x to NO_2 conversion would be ozone limited in close proximity to the power plant site, and photochemistry has been included as a model option in the ADMS study.

3 Dispersion Modelling Results

This results of the stack height analysis is presented in this section. As expected, the model proved to be sensitive to differences in meteorological data and was therefore run with five individual one year datasets (2004 to 2008 inclusive) at each stack height evaluated. The results reported here at each receptor are the maximum concentration obtained from the modelling of five years data. This represents a worst-case approach.

3.1 Nitrogen Dioxide

Maximum predicted 1-hour NO_2 concentrations for a range of stack heights are presented in Table 2.

The greatest impact on maximum 1-hour concentrations would generally occur in close proximity to the power plant site. Throughout the study area, predicted maximum 1 hour NO_2 concentrations would be well within the WHO short-term guideline for all modelled stack heights between 30 m and 60 m. At stack heights of 32 m and above, the maximum process contribution to 1-hour NO_2 concentrations is predicted to be less than 25% of the WHO guideline concentrations throughout the study area.

A progressive improvement is seen in maximum predicted 1-hour ground level concentrations with increasing stack height. This is illustrated in Figure 1. The graph shows that this benefit is more pronounced at stack heights of 40 m or less.

The modelling results predict that the impact of the power plant, with stacks of 30 m or more, would contribute less than 6 $\mu g/m^3$ to ground-level pollutant concentrations within the 5 km by 5 km area covered by the model receptor grid.

A stack height of 32 metres or more is therefore predicted to enable the power plant to satisfy WHO and IFC requirements for impacts on 1 hour concentrations of NO_2.

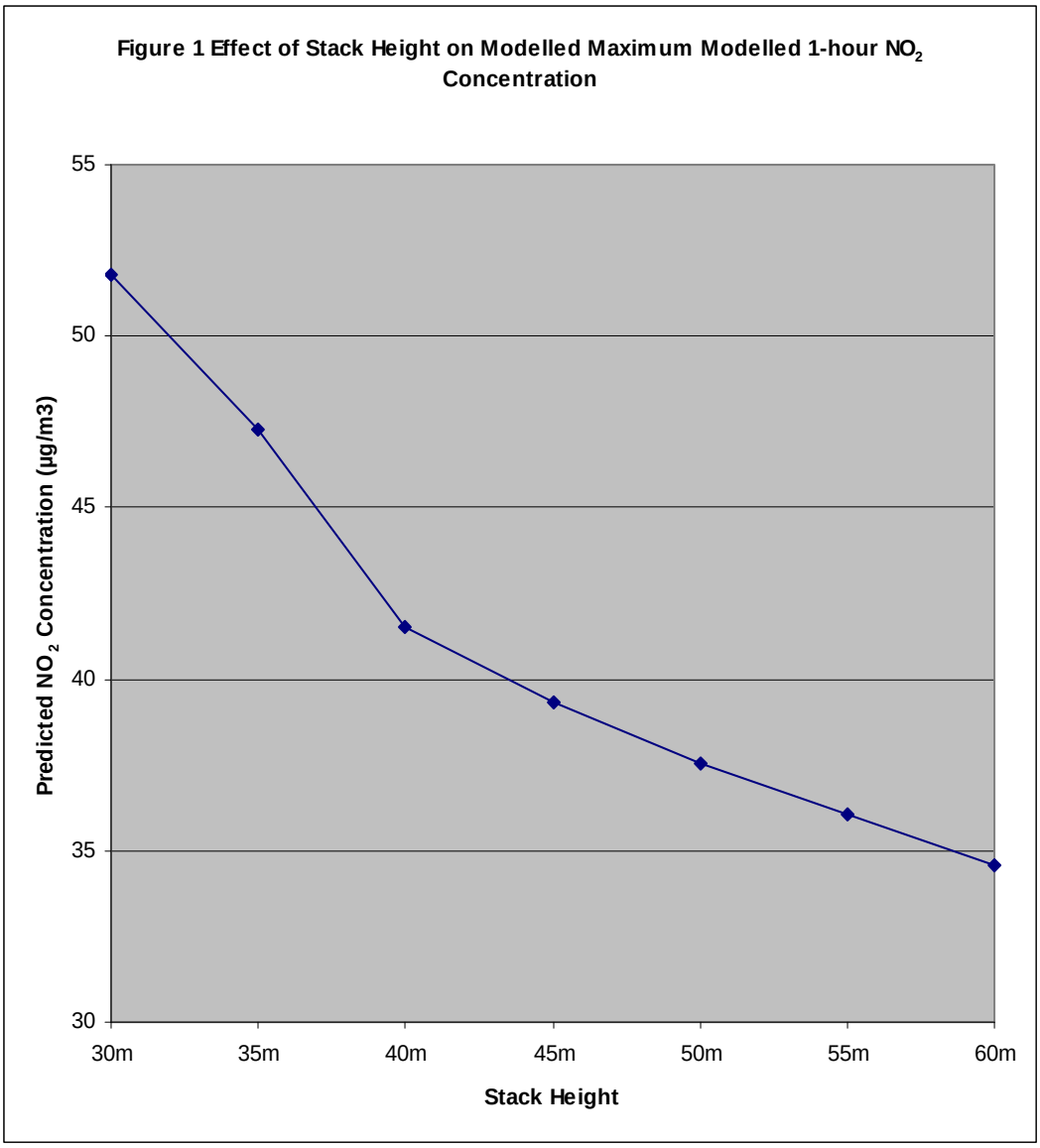
Figure 1 Effect of Stack Height on Modelled Maximum Modelled 1-hour NO2 Concentration
55
50
45
40
35
30
Predicted NO2 Concentration (µg/m3)
30m
35m
40m
45m
50m
55m
60m
Stack Height

Table 2 Predicted Maximum 1-hour NO_2 Concentrations ($\mu g/m^3$), Natural Gas Fuel

Receptor	Stack Height (m)							
	30	**32**	**35**	**40**	**45**	**50**	**55**	**60**
R1	46	45	44	40	37	33	30	26
R2	43	42	41	37	35	32	29	26
R3	44	43	42	39	36	32	30	28
R4	43	43	42	40	38	35	33	30
R5	43	43	42	39	37	35	32	30
R6	41	40	39	34	31	28	26	23
R7	45	44	43	40	38	35	32	29
R8	49	47	45	38	34	31	28	26
R9	45	44	42	39	35	31	28	24
R10	46	45	43	40	37	34	30	27
Maximum in Modelled Domain*	52	49	47	42	39	38	36	35
WHO Guideline	**200**							

*Modelled domain represented by a Cartesian grid of 5km by 5km, centred on the power plant location.

3.2 Particulate Matter (as PM_{10})

The predicted modelled contribution of power plant emissions to ground-level concentrations of particulate matter, with natural gas fuel, was very low. With a 30 m stack, the maximum impact within the modelled domain on annual mean and maximum 24-hour mean PM_{10} concentrations would be 0.4 µg/m^3 and 2.1 µg/m^3 respectively.

This represents a small percentage of WHO guideline values. For this reason, emissions of particulate matter are not considered to be a material consideration in the determination of the height of the power plant stack.

3.3 Sulphur Dioxide (SO_2)

The predicted modelled contribution of power plant emissions to ground-level concentrations of SO_2, with natural gas fuel, are generally low. With a 30 m stack, the maximum impact within the modelled domain on maximum 24-hour mean and maximum 10 minute concentrations would be 4.3 µg/m^3 and 19.3 µg/m^3 respectively.

In the case of 10 minute mean SO_2 impacts, this is a small percentage of the WHO guideline. In respect of the maximum 24 hour mean, the plant is predicted to contribute up to 21% of the WHO guideline value.

For this reason, emissions of sulphur dioxide while the plant is running on natural gas fuel are not considered to be of primary importance in the determination of the height of the power plant stack

4 Conclusions

The 2008 Addendum concluded that, during normal operation on natural gas fuel, the plant would not result in impacts on air quality with the potential to result in exceedance of the World Bank Air Quality Guideline Values. The 2008 Addendum concluded that the WHO guideline for hourly NO_2 would only be achievable at the selected receptors with stack heights in excess of 30 m.

This assessment has specifically focused on the achievement of the 1 hour WHO Nitrogen Dioxide (NO_2) guideline with the power plant running normally on natural gas fuel, at stack heights of 30 m and above.

The greatest impact on maximum 1-hour concentrations would generally occur in close proximity to the power plant site. Throughout the study area, predicted maximum 1 hour NO_2 concentrations would be within the WHO short-term guideline for all modelled stack heights between 30 m and 60 m. At stack heights of 32 m and above, the maximum process contribution to 1-hour NO_2 concentrations is predicted to be less than 25% of the WHO guideline concentrations throughout the study area.

The predicted impacts from a release height of 32 metres or more would satisfy WHO and IFC requirements for 1 hour concentrations of NO_2. The guidelines for annual mean NO_2, SO_2 and PM_{10} would also be met. 32 metres therefore represents the minimum stack height that fully satisfies IFC requirements.